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Evaluating The Financial Performance of Mining and Quarrying Sector Companies Traded on Borsa Istanbul Using The Hybrid MEREC-MAUT MCDM Model*

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ABSTRACT

The aim of the present study is to optimize the financial performance of companies operating in the Borsa Istanbul (BIST) Mining and Quarrying sector during the COVID-19 global pandemic and the subsequent period (2020-2024) using financial ratios, and to determine their financial performance rankings. The MEREC (Method based on the Removal Effects of Criteria) method was used to weight the financial ratios, and MAUT (Multi-Attribute Utility Theory) was used to rank financial performance. It was observed that the importance ranking of the financial ratios changed across years; overall, profitability and capital-structure indicators were the most determinative of company financial performance during the period, whereas operational efficiency indicators were the least weighted. According to the MAUT ranking of alternatives, annual financial performance results were as follows: in 2020, the highest performing firm was KOZAL; in 2021, the highest was KOZAL; in 2022, the highest was KOZAL; in 2023, the highest was PRKME; in 2024, the highest was RUZYE.

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Borsa İstanbul Madencilik ve Taş Ocakçılığı Sektörü Şirketlerinin Finansal Performansının MEREC ve MAUT Hibrit ÇKKV Modeli Kullanılarak Değerlendirilmesi

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ÖZ

Çalışmanın amacı, Borsa İstanbul (BIST) Madencilik ve Taş Ocakçılığı sektöründe faaliyet gösteren şirketlerin finansal performanslarını Covid-19 küresel salgını dönemi ve sonrası olan 2020-2024 periyodunda finansal oranlar yardımıyla optimize etmek ve finansal performans sıralamalarını ortaya koymaktır. Finansal oranların ağırlıklandırılmasında MEREC (MEthod based on the Removal Effects of Criteria) yöntemi, finansal performansların sıralamasında ise MAUT (Multi-Attribute Utility Theory) yöntemi kullanılmıştır. Araştırmada kullanılan finansal oranların yıllara göre önem sıralamasının değişiklik gösterdiği tespit edilmiştir. Söz konusu dönemde şirketlerin finansal performansını belirleyen en önemli kriterlerin kârlılık ve sermaye yapısı; en önemsiz kriterlerin ise faaliyet etkinliği göstergeleri olduğu görülmüştür. MAUT alternatiflerin sıralanması analizi sonuçlarına göre 2020 yılında finansal performansı en yüksek olan işletmenin KOZAA; 2021 yılında finansal performansı en yüksek olan işletmenin KOZAL; 2022 yılında finansal performansı en yüksek olan işletmenin KOZAL; 2023 yılında finansal performansı en yüksek olan işletmenin PRKME; 2024 yılında finansal performansı en yüksek olan işletmenin RUZYE olduğu belirlenmiştir.

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Introduction

The mining and quarrying sector is of strategic importance globally in terms of raw material supply and the sustainability of basic economic activities. However, by its very nature, this sector carries high environmental and social risks, such as environmental degradation, water and soil pollution, loss of biodiversity, and potential for social conflict. Failure to manage these risks at the operational level not only generates ecological and social costs but also has a direct negative impact on the company's operational risk, capital costs, and reputation. Therefore, sustainability practices and transparent environmental reporting practices in the mining sector are playing an increasingly central role in the context of both regulatory requirements and company value and competitive strategies. Sustainability accounting and reporting practices in the context of mining have been extensively discussed in the literature; research shows that the sector has yet to fully internalise accountability and integrated reporting practices in many contexts, although progress and examples of good practice do exist (Lodhia and Hess, 2014).

The economic uncertainties during and after the pandemic have further highlighted the need for businesses to have operational resilience and long-term sustainability strategies. COVID-19-induced supply-demand disruptions, supply chain interruptions, and market shocks have caused businesses, particularly in the natural resources sector, to re-evaluate their liquidity management, capital structure sensitivities, and profit margins. In this context, environmental compliance, waste management, energy, and water efficiency investments have evolved from being merely an ethical imperative to becoming a strategic area that enhances competitiveness and financial stability by reducing companies' operational costs and mitigating risks. Empirical studies show that sustainable environmental strategies in the mining sector can positively affect firm competitiveness and, consequently, financial performance; this effect is dynamic and varies according to market conditions and company characteristics (Keshavarz-Ghorabaee et al., 2021).

Empirical studies on the mining sector show that environmental and sustainability practices can directly impact financial results through operational efficiency and innovation channels. For example, green mining practices support sustainable development through increased efficiency in production processes and innovative in-house practices; they also contribute to financial outcomes through indirect channels such as employee engagement and reputation management. However, the findings show heterogeneity depending on the sector, region, and type of practices; therefore, company-specific characteristics and external market conditions should be taken into account in the analyses. This heterogeneous and contextual view necessitates multi-period and multi-criteria evaluation approaches (Jianchun, 2024).

This study aims to analyse the performance of selected companies operating in the Mining and Quarrying sector on the Istanbul Stock Exchange using their financial ratios for the period 2020-2024 through multi-criteria methods. Ten financial indicators were used as performance measures in the study: current ratio, cash ratio, return on assets, net profit margin, return on equity, debt/equity ratio, equity/assets, accounts receivable turnover, inventory turnover, and trade payables turnover. MEREC was applied for the objective determination of criterion weights, while MAUT was applied for the final ranking of alternatives (companies). This methodological choice is suitable for revealing the varying importance of criteria over the years (conditions at the start of the pandemic and afterwards) and quantitatively showing which financial indicators dominate performance on a periodical basis (Keshavarz-Ghorabaee et al., 2021).

The original contribution of this study is threefold. Firstly, it empirically demonstrates how criterion weights have changed over the years through the MEREC-MAUT combination; this brings a new perspective to financial analyses of crisis and recovery periods where time-dynamics are important. Secondly, it presents comparative financial performance rankings specific to the mining sector in the Turkish context (BIST data) using multi-criteria methods; this provides both a local/contextual contribution to the academic literature and a practical assessment tool for sector decision-makers. Thirdly, it presents an analytical framework that considers the financial outcomes of sustainability-focused policy and investment decisions; this helps to understand how corporate strategies relate to environmental management investments and provides a basis for policy recommendations (Lodhia and Hess, 2014).

In conclusion, this study proposes a model for multi-dimensional financial performance analysis in the mining sector from both methodological and practical perspectives. Particularly in the 2020-2024 period, characterised by post-pandemic uncertainties, the dynamic nature of criterion priorities highlights the importance of not relying solely on single-dimensional financial indicators in the decision-making processes of managers and investors. The following sections present the literature, data set, MEREC, and MAUT application steps, findings, and policy-strategy implications in detail.

Literature Review

Globalisation and increasing environmental concerns have led to businesses being evaluated not only in terms of economic profitability but also within the framework of environmental and social responsibility (Elkington, 1997). In this context, the concept of sustainability has become a means of securing long-term competitive advantage for businesses. Particularly in sectors with a high environmental impact, effective environmental management practices reduce companies' operational risks, thereby lowering costs and improving financial performance (Hart and Milstein, 2003).

The mining and quarrying sector is one of the areas where environmental impacts are most intense during the direct extraction and processing of natural resources. For this reason, the sustainable mining approach is considered a multidimensional field encompassing environmental management, resource efficiency, waste management, and social responsibility (Hilson and Murck, 2000). Research

indicates that investments in environmental compliance within this sector are not only an ethical obligation but also a prerequisite for long-term financial sustainability (Azapagic, 2004).

The performance of businesses is generally measured through financial ratio analysis. Liquidity, profitability, operating efficiency, and capital structure ratios are commonly used indicators for assessing the short-term and long-term financial health of businesses (Brigham and Ehrhardt, 2016). However, evaluating these ratios alone may prove insufficient in a multi-dimensional sector analysis. At this point, multi-criteria decision-making (MCDM) methods enable a comprehensive performance ranking by weighting financial ratios.

The MEREC (Method based on the Removal Effects of Criteria) method is a new generation approach that enables weighting by taking into account the performance changes that occur when criteria are removed (Kumar and Garg, 2020). MAUT (Multi-Attribute Utility Theory), which is used for performance ranking, ranks companies' financial performance relatively by converting different criteria into utility functions (Keeney and Raiffa, 1993). The literature emphasises that MCDM methods are effectively used in financial performance analyses and make significant contributions, particularly in assessing companies' resilience during crisis periods. (Wu et al., 2019).

Financial performance in the mining sector is directly affected by external factors such as commodity prices, fluctuations in global demand, and environmental regulations (Humphreys, 2015). The COVID-19 pandemic has caused serious disruptions in supply and demand chains in the sector, hampered production processes, and led to fluctuations in financial indicators. Studies have shown that companies with strong capital structures and liquidity weathered the crisis with less damage, while those with weak financial structures remained at high risk (Baker et al., 2020).

Similar results are also noteworthy in studies conducted specifically in Turkey. It has been observed that mining companies listed on the Istanbul Stock Exchange experienced fluctuations in their profitability ratios during the 2020-2021 period, but those companies relying on exports in particular have entered a recovery phase in the post-pandemic period (Yılmaz and Demir, 2022). However, the emergence of periodic performance differences among companies operating in the sector has increased the importance of sustainable financial strategies.

Recent studies have shown that environmental investments improve companies' financial performance in the long term. Investments in waste management, energy efficiency, and carbon emission reduction both reduce costs and lower capital costs by increasing investor confidence (Porter and van der Linde, 1995). It is noted that companies complying with environmental, social, and governance (ESG) criteria are perceived as lower risk by investors and command higher valuations in financial markets (Friede et al., 2015).

Research conducted in the mining sector reveals that environmental compliance is directly related to financial performance. For example, Jenkins and Yakovleva (2006) emphasise that sustainable mining practices support long-term operational sustainability by increasing social acceptance, while Azapagic (2004) highlights that companies with high environmental performance gain a more reliable position in the eyes of investors.

Turkey is a country rich in natural resources, and the mining and quarrying sector plays an important role in terms of both employment and exports (MTA, 2021). However, a large proportion of companies in the sector are affected by global crises and fluctuations in the domestic market. The literature indicates that the financial ratios of mining companies traded on the Istanbul Stock Exchange show marked differences, particularly during periods of crisis, and that their performance fluctuates periodically (Aydın and Kılıç, 2021).

In this context, the challenges faced by the sector during the Covid-19 pandemic have once again highlighted the importance of financial performance analysis. Research emphasises that companies must focus on environmental management and sustainability-based investments in order to increase the sector's resilience to crises (Çelik, 2022).

A review of the literature reveals that sustainability and effective environmental management in the mining and quarrying sector are directly linked to financial performance. When combined with financial ratio analysis and ESG methods such as MEREC and MAUT, it becomes possible to comparatively evaluate companies' periodic performance. The COVID-19 process has demonstrated that companies with strong financial structures and sustainability investments are more resilient to crises. In this context, analysing the performance of companies listed on the Istanbul Stock Exchange in Turkey will provide significant contributions from both a sectoral and academic perspective.

Dataset

The companies listed in Table 1 have been included in the scope of the study to analyse the financial performance of companies operating in the Mining and Quarrying sector on the Istanbul Stock Exchange.

Table 1. Businesses Covered by the Study

Number	Code	Company
1	CVKMD	CVK Maden İşletmeleri Sanayi ve Ticaret A.Ş.
2	KOZAA	Koza Anadolu Metal Madencilik İşletmeleri A.Ş.
3	KOZAL	Koza Altın İşletmeleri A.Ş.
4	PRKME	Park Elektrik Üretim Madencilik Sanayi ve Ticaret A.Ş.
5	RUZYE	Ruzy Madencilik ve Enerji Yatırımları Sanayi ve Ticaret A.Ş.
6	VSNMD	Vişne Madencilik Üretim Sanayi ve Ticaret A.Ş.

Source: (https://kap.org.tr/tr/Sektorler)

The evaluation criteria frequently used in the literature to analyse the financial performance of companies operating in the Mining and Quarrying sector on the Istanbul Stock Exchange are presented in Table 2.

Table 2. Criteria Used in the Scope of the Study

Criterion	Criterion Name	Source	Quality
C_1	Current Ratio	Ersan and Çanakçıoğlu, (2020); Öztürk and Gençer, (2020); Konuşkan and Kılınç, (2022); Yanya and Tanrıöven, (2022).	Max
C_2	Cash Ratio	İskenderoğlu et al., (2015); Konak et al., (2017); Çiftci and Yıldırım, (2020); Yılmaz Özekinci, (2024).	Max
C_3	Return on Assets (Annual)	Sakarya and Yıldırım, (2016); Eyüboğlu and Çelik, (2016); Özdemir and Parmaksız, (2022); Kılıçaraslan, (2023); Yılmaz Özekinci, (2024).	Max
C_4	Net Profit Margin (Annual)	İskenderoğlu et al., (2015); Konak et al., (2017); Çiftci and Yıldırım, (2020); Yılmaz Özekinci, (2024).	Max
C_5	Return on Equity (Annual)	Orçun, (2019); Karcıoğlu et al., (2020); Keleş et al., (2021); Kavas et al., (2023); Ülger and Demirtürk, (2024).	Max
C_6	Debt-to-Equity Ratio	Akyüz et al., (2017); Juliani et al., (2023); Rachman et al., (2023); Yaşar, (2025).	Min
C_7	Equity / Assets	Erdemir, (2019); Özcan and Gürol, (2020); Kutlu and Türkoğlu, (2022); Demir, (2022); Ecer and Pamucar, (2022).	Max
C_8	Receivables Turnover Ratio	Kuvat and Güler, (2020); Beller Dikmen, (2021); Kendirli et al., (2021); Ülger and Demirtürk, (2024); Yılmaz Özekenci, (2024).	Max
C_9	Inventory Turnover Ratio	İskenderoğlu et al., (2015); Konak et al., (2017); Çiftci and Yıldırım, (2020); Yılmaz Özekinci, (2024).	Max
C_{10}	Trade Payables Turnover Ratio	Günay et al., (2018); Benli et al., (2023); Ayaydın and Öksüz, (2025); Özbek, (2025); Taşçı, (2025).	Max

The current ratio, which indicates short-term debt repayment capacity, is generally accepted in the literature to be between 1.5 and 2. It is considered normal for this ratio to be low in countries such as Turkey, where savings are insufficient. A current ratio above 2 is favourable for creditors, as it indicates a surplus of liquid assets and facilitates the repayment of loans. From a management perspective, however, a high current ratio is viewed negatively, as it suggests that liquid assets are being used inefficiently (Özbek, 2025).

The cash ratio indicates the company's ability to pay short-term debts with cash and cash equivalents, or in other words, the extent to which the company can cover its short-term debts with other assets that can be converted into cash within a year if it is unable to sell its inventory and collect its receivables within a year. A ratio of 0.20 is generally accepted in the literature. A ratio below this indicates cash flow difficulties, while a higher ratio indicates a cash surplus (Özbek, 2025).

Return on assets shows how much profit a company makes per unit of assets it owns. Return on assets is an indicator of how well a company's assets are managed. This ratio is also referred to as return on investment. The higher this ratio is, the more successful the company is at generating profit (Akgül, 2020).

The net profit margin is the ratio of net profit to total sales. It indicates how much net profit the company earns from each unit of revenue (Mirgen, 2025).

Return on equity is used to assess the profitability performance of a business and is calculated by dividing Net Profit by Equity (Koç et al., 2020). Return on equity indicates how efficiently a business utilises its equity and the return investors receive on their investments (Yenilmez and Geneş, 2025).

The debt-to-equity ratio indicates the percentage of shareholders' and lenders' participation in the financing of companies (Fabozzi and Peterson, 2003). Also referred to as the financial leverage ratio, as this ratio increases, so does the riskiness of companies. When the risk of companies increases, the cost of capital also rises (Okka, 2009).

The equity/assets ratio indicates the proportion of a company's assets financed by equity. The higher this ratio, the more prudent the company has been in its borrowing, preferring to use equity financing (Özcan and Gürol, 2020).

Receivables Turnover Ratio indicates the ability to collect receivables and liquidity. When the receivables turnover ratio is high, the company collects its receivables quickly and has a strong cash flow. Sales are divided by all accounts receivable to arrive at this ratio, which also indicates the credit period offered by the company to its customers (Çakır and Küçükkaplan, 2012).

Inventory turnover rate indicates how quickly stocks are sold and replenished. A high inventory turnover rate indicates effective inventory management and that products are selling quickly (Kılıç, 2025).

The trade debt turnover ratio is calculated by dividing purchases by average trade debt. This ratio is used to determine the average trade debt payment period within a specific period (Beycan, 2011).

A data set covering the period 2020–2024 is presented in Table 3 to analyse the financial performance of companies operating in the Mining and Quarrying sector on the Istanbul Stock Exchange.

Table 3. Mining and Quarrying 2020-2024 Period Data Set

Code	Year	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
CVKMD	2020	0.20	6.24	10.93	15.15	14.48	59.88	37.75	18.55	11.56	6.78
KOZAA		10.41	919.01	9.13	21.03	21.70	10.22	41.34	126.08	2.87	13.82
KOZAL		10.43	963.97	24.58	55.71	27.18	9.75	90.25	22,724.76	2.78	13.76
PRKME		2.44	96.08	8.82	127.60	9.96	10.15	89.85	7.51	6.44	4.26
RUZYE		1.08	81.27	24.39	651.11	62.03	47.32	38.29	0.41	36.08	0.08
CVKMD	2021	0.57	14.40	5.75	13.58	13.69	52.75	44.46	10.73	2.19	8.42
KOZAA		8.17	768.65	12.04	30.35	29.98	13.17	39.33	148.76	3.52	10.07
KOZAL		8.40	794.21	29.33	75.06	33.14	12.69	87.31	13,307.91	3.40	9.98
PRKME		1.08	12.23	27.01	321.97	30.68	13.23	86.77	6.87	8.67	6.25
RUZYE		11.12	1,047.69	19.02	274.32	25.30	6.91	93.09	4.85	463.11	0.28
VSNMD		0.99	16.93	28.07	28.63	22.14	36.60	63.40	4.94	7.86	3.22
CVKMD	2022	1.58	34.33	36.17	33.27	56.78	28.97	70.03	8.79	6.89	14.00
KOZAA		10.00	889.58	-8.72	-15.82	-19.84	10.94	45.84	291.46	6.02	20.86
KOZAL		10.32	927.66	-17.31	-29.49	-19.53	10.74	89.26	23,396.22	5.92	21.01
PRKME		1.70	126.56	-10.67	-58.17	-12.49	15.02	84.98	12.08	19.39	6.86
RUZYE		8.00	662.65	-18.89	-60.52	-20.94	10.90	89.10	4.48	2,480.50	14.95
VSNMD		0.81	5.12	13.61	19.80	19.96	27.73	72.27	7.71	7.55	5.30
CVKMD	2023	2.10	110.32	9.16	16.97	12.56	24.99	73.96	12.55	7.22	4.02
KOZAA		5.86	483.38	1.52	4.23	3.21	10.19	48.64	154.06	5.10	20.09
KOZAL		6.24	525.62	1.97	5.01	2.21	10.69	89.31	11,464.31	5.07	19.70
PRKME		2.42	43.41	12.89	85.03	14.73	10.67	89.33	9.28	10.83	5.44
RUZYE		30.43	2889.10	-5.37	-15.03	-5.78	4.16	95.84	6.43	2,484.00	56.28
VSNMD		1.44	35.28	8.22	14.19	10.61	18.36	81.64	7.41	7.25	7.52
CVKMD	2024	0.35	16.69	7.82	30.42	15.02	53.86	43.40	18.99	8.25	3.59
KOZAA		6.87	518.03	-4.77	-20.79	-9.82	9.21	48.53	138.99	2.71	17.20
KOZAL		8.30	649.52	1.70	6.91	1.88	8.76	91.24	2,440.54	2.92	17.32
PRKME		2.23	44.73	1.55	11.44	1.74	10.84	89.16	7.30	6.62	4.39
RUZYE		41.31	3,934.35	1.16	9.52	1.23	7.35	92.65	4.76	1,840.30	27.08
VSNMD		1.13	7.08	-0.87	-2.30	-1.07	19.16	80.84	5.41	5.64	7.62

Source: The data was obtained from https://kap.org.tr/tr and organised by the authors.

Methodology

This section introduces the Z-Score Standardisation Method used to convert negative values in the decision matrix to positive ones, the MEREC method used to weight criteria, and finally the MAUT method used to rank alternatives.

Z-Score Standardization Method

Z-score Standardization transforms features to have a mean of 0 and a standard deviation of 1. It is suitable when the data distribution is approximately Gaussian, as where $\bar{X}_i$ is the mean and S_i is the standard deviation of the feature (Phukseng et al., 2025).

Step 1: The elements of the decision matrix are transformed using Equation (1).

$$x_{ij} = \frac{X_{ij} - \bar{X}_i}{S_i} \quad (1)$$

Step 2: The elements of the decision matrix are made positive using Equation (2).

$$x'_{ij} = x_{ij} + A \; A > \left| min\, x_{ij} \right| \quad (2)$$

MEREC Method

Assigning appropriate weights to criteria is a vital step when addressing multi-criteria decision-making (MCDM) problems. In practice. researchers often use either subjective or objective techniques to determine these weights. While subjective methods draw on the insights and preferences of decision-makers. objective approaches rely entirely on the data. One such method is MEREC. which bases its calculations on how the removal of individual criteria affects the performance scores of the alternatives (Keshavarz-Ghorabaee et al., 2021). Developed by Keshavarz-Ghorabaee and colleagues in 2021. The MEREC method has since been recognized as a data-driven technique within the family of MCDM models (Keshavarz-Ghorabaee et al., 2021). It provides a systematic way to assign weights without the influence of expert bias. Based on the relevant literature. The main steps followed in the application of the MEREC approach in this study are outlined below.

Step 1: A decision matrix is constructed (Equation (3)).

$$D = \begin{bmatrix} x_{11} & \cdots & x_{1j} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix} \quad (3)$$

Step 2: In the second step. a normalized matrix is generated based on Equation (4-5). where the normalized values necessary for the application of the MEREC method are obtained.

$$x_{ij}^{*} = \frac{x_{ij}}{\max_i \left(x_{ij} \right)} \quad (4)$$

$$x_{ij}^{*} = \frac{\min_{i}(x_{ij})}{x_{ij}} \quad (5)$$

Step 3: The aggregated performance values of the alternatives are calculated (Equation (6)).

$$S_i = ln\left(1+\left(\frac{1}{n}\sum_{j=1}^{n}\left|ln(x_{ij}^{*})\right|\right)\right) \quad (6)$$

Step 4: The performance of the alternatives is recalculated by removing each criterion individually. The fundamental difference from the third step is that in this step, the performance values of the alternatives are calculated separately for each case where a single criterion is disregarded (Equation (7)).

$$S_{ij}^{'}=ln\left(1+\left(\frac{1}{n}\sum_{k=1.\ k\neq j}^{n}\left|ln(x_{ik}^{*})\right|\right)\right) \quad (7)$$

Step 5: The total absolute deviation is calculated using Equation (8), based on the values derived from Equations (6) and (7).

$$E_j = \sum_{i=1}^{m}\left|S_{ij}^{'}-S_i\right| \quad (8)$$

Step 6: At this stage, the objective weight of each criterion is derived by assessing the impact of its exclusion on the aggregated performance of the alternatives (Equation (9)).

$$w_j = \frac{E_j}{\sum_{k=1}^{n} E_k} \quad (9)$$

MAUT Method

Multi-Criteria Decision-Making method is the MAUT (Multi-Attribute Utility Theory) method. The application of this method began with the publication of Ralph L. Keeney's article "Multiplicative Utility Functions" in 1974 (Keeney, 1974). The MAUT method is considered an approach that aims to reach the most appropriate solution by incorporating all perspectives of the decision-maker. either directly or indirectly. into the problem-solving process. The MAUT method explains the problem by assigning a scale between 0 and 1 for each criterion. where 0 represents the worst case, and 1 represents the best case (Mesran et al., 2024). The application process of the MAUT method is carried out in three steps (Orhan and Şimşek, 2025).

Step 1: A decision matrix is created (Equation (10)).

$$\mathrm{X} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \quad (10)$$

Step 2: Calculation of the Normalization Matrix (Equation (11-12)).

$$r_{ij}^{*} = \frac{r_{ij}-\min(r_{ij})}{\max(r_{ij})-\min(r_{ij})} \text{ .Benefit Criteria} \quad (11)$$

$$r_{ij}^{*} = 1+\frac{\min(r_{ij})-r_{ij}}{\max(r_{ij})-\min(r_{ij})} \text{. Cost Criteria} \quad (12)$$

Step 3: Calculation of Marginal Utility Values (Equation (13)).

$$u_{ij} = \frac{e^{(r_{ij}^{*})^{2}}-1}{1.71} \quad (13)$$

Step 4: Calculation of Final Values (Equation (14)).

$$U_i = \sum_{j=1}^{n} u_{ij}.w_j \quad (14)$$

A preference ranking is created from the highest to the lowest total utility value (Mesran et al., 2024).

Findings

This section presents the findings obtained within the scope of the MEREC-based MAUT model, which was applied based on the financial indicators covering the 2020–2024 period for companies operating in the Mining and Quarrying sector on the Istanbul Stock Exchange. During the analysis process, the weights for the decision criteria were first determined using the MEREC method, and the final weights obtained were analysed using the MAUT method for use in the multi-criteria financial performance evaluation of the companies. In this context, the financial performance of companies operating in the Mining and Quarrying sector was comparatively evaluated using this model.

For illustrative purposes, only the findings for 2024 are presented in detail, with only the analysis results for the remaining years being provided. Equation (1) has been applied to the initial decision set for the year 2024, and the transformed decision matrix is presented in Table 4.

Table 4. 2024 Transformed Decision Matrix

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
CVKMD	-0.62	-0.55	1.64	1.45	1.70	1.98	-1.38	-0.42	-0.40	-1.00
KOZAA	-0.20	-0.22	-1.43	***-1.58***	-1.42	-0.50	-1.15	-0.30	-0.41	0.47
KOZAL	-0.11	-0.14	0.15	0.06	0.05	-0.53	0.76	2.04	-0.41	0.48
PRKME	-0.50	-0.53	0.11	0.33	0.03	-0.41	0.66	-0.44	-0.41	-0.92
RUZYE	2.00	2.01	0.02	0.22	-0.03	-0.60	0.82	-0.44	2.04	1.54
VSNMD	-0.57	-0.56	-0.48	-0.48	-0.32	0.05	0.29	-0.44	-0.41	-0.57

Equation (2) was applied to the initial decision set for 2024, and the positive decision matrix is presented in Table 5.

Table 5. 2024 Positive Decision Matrix

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
CVKMD	1.37	1.44	3.63	3.44	3.69	3.97	0.61	1.57	1.59	0.99
KOZAA	1.79	1.77	0.56	0.41	0.57	1.49	0.84	1.69	1.58	2.46
KOZAL	1.88	1.85	2.14	2.05	2.04	1.46	2.75	4.03	1.58	2.47
PRKME	1.49	1.46	2.10	2.32	2.02	1.58	2.65	1.55	1.58	1.07
RUZYE	3.99	4.00	2.01	2.21	1.96	1.39	2.81	1.55	4.03	3.53
VSNMD	1.42	1.43	1.51	1.51	1.67	2.04	2.28	1.55	1.58	1.42

Note: A =1.99 was taken to meet the condition in Equation 2.

The decision sequence in Equation (3) is presented in Table 5. The decision sequence was normalised by applying Equation (4-5) to Table 5 and is presented in Table 6.

The total performance values of the alternatives were calculated using Equation (6) and are presented in Table 7. The performance of the alternatives has been recalculated using Equation (7), with each criterion removed separately, and is presented in Table 8. The total absolute deviation was calculated using Equation (8) based on the values obtained from Equations (6) and (7) and is presented in Table 9.

Table 6. 2024 Normalised Decision Matrix

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
CVKMD	1.00	1.00	0.15	0.12	0.15	1.00	1.00	0.99	1.00	1.00
KOZAA	0.77	0.81	1.00	1.00	1.00	0.37	0.73	0.92	1.00	0.40
KOZAL	0.73	0.77	0.26	0.20	0.28	0.37	0.22	0.39	1.00	0.40
PRKME	0.92	0.98	0.27	0.18	0.28	0.40	0.23	1.00	1.00	0.92
RUZYE	0.34	0.36	0.28	0.19	0.29	0.35	0.22	1.00	0.39	0.28
VSNMD	0.96	1.00	0.37	0.27	0.34	0.51	0.27	1.00	1.00	0.69

Table 7. 2024 Total Performance Values of Alternatives

Code	CVKMD	KOZAA	KOZAL	PRKME	RUZYE	VSNMD
S_i	0.462	0.245	0.651	0.525	0.746	0.455

Table 8. 2024 The Performance Calculated by Removing Each Criterion Separately

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
CVKMD	0.46	0.46	0.34	0.32	0.34	0.46	0.46	0.46	0.46	0.46
KOZAA	0.22	0.23	0.24	0.24	0.24	0.16	0.22	0.24	0.24	0.17
KOZAL	0.63	0.64	0.58	0.56	0.58	0.60	0.57	0.60	0.65	0.60
PRKME	0.52	0.52	0.44	0.42	0.45	0.47	0.43	0.52	0.52	0.52
RUZYE	0.69	0.70	0.68	0.66	0.69	0.69	0.67	0.75	0.70	0.68
VSNMD	0.45	0.45	0.39	0.37	0.38	0.41	0.37	0.45	0.45	0.43

Table 9. 2024 Total Absolute Deviation Values

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
CVKMD	0.00	0.00	0.13	0.14	0.12	0.00	0.00	0.00	0.00	0.00
KOZAA	0.02	0.02	0.00	0.00	0.00	0.08	0.03	0.01	0.00	0.07
KOZAL	0.02	0.01	0.07	0.09	0.07	0.05	0.08	0.05	0.00	0.05
PRKME	0.00	0.00	0.08	0.11	0.08	0.06	0.09	0.00	0.00	0.01
RUZYE	0.05	0.05	0.06	0.08	0.06	0.05	0.08	0.00	0.05	0.06
VSNMD	0.00	0.00	0.07	0.09	0.07	0.04	0.09	0.00	0.00	0.02
E_j	0.10	0.08	0.41	0.51	0.40	0.28	0.36	0.06	0.05	0.21

Equation (9), the final step of the MEREC method, was applied, and the criterion weighting findings for mining and quarrying companies for the years 2020–2024 are presented in Table 10.

Table 10. Determination of Weights Using the MEREC Method

Year	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
2020	0.11	0.10	0.10	0.06	0.10	0.11	0.09	0.03	0.08	0.21
2021	0.07	0.06	0.16	0.05	0.22	0.09	0.11	0.02	0.02	0.20
2022	0.09	0.09	0.07	0.11	0.05	0.09	0.32	0.02	0.02	0.13
2023	0.04	0.04	0.18	0.08	0.19	0.09	0.30	0.02	0.02	0.05
2024	0.04	0.03	0.17	0.21	0.16	0.12	0.15	0.02	0.02	0.09

According to the MEREC weighting results presented in Table 10; in 2020, the most important criterion was commercial debt turnover (C_{10}-0.21), and the least important criterion was receivables turnover (C_8-0.08); in 2021, the most important criterion was return on equity (C_5-0.22), the least important criterion was the receivables turnover ratio and inventory turnover ratio (C_8-0.02 and C_9-0.02); in 2022, the most important criterion was the equity/assets ratio (C_7-0.32), the least important criterion was the receivables turnover ratio and inventory turnover ratio (C_8-0.02 and C_9-0.02) were identified; in 2023, the most important criterion was the equity/assets ratio (C_7-0.30), and the least important criteria were the receivables turnover rate and inventory turnover rate (C_8-0.02 and C_9-0.02); in 2024, the most important criterion was the net profit margin (C_4-0.21), and the least important criterion is the receivables turnover rate and inventory turnover rate (C_8-0.02 and C_9-0.02).

The decision matrix was prepared using Equation (10) in the application step of the MAUT method and is presented in Table 5. The decision matrix was normalised using Equation (11-12) and the normalised matrix is presented in Table 11. Marginal utility values were calculated using Equation (13) and are presented in Table 12. The final values were calculated using Equation (14) and are presented in Table 13.

Table 11. 2024 Normalised Matrix

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
CVKMD	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.01	0.00	0.00
KOZAA	0.16	0.13	0.00	0.00	0.00	0.96	0.10	0.06	0.00	0.58
KOZAL	0.19	0.16	0.51	0.54	0.47	0.97	0.97	1.00	0.00	0.58
PRKME	0.05	0.01	0.50	0.63	0.47	0.92	0.93	0.00	0.00	0.03
RUZYE	1.00	1.00	0.47	0.59	0.44	1.00	1.00	0.00	1.00	1.00
VSNMD	0.02	0.00	0.31	0.36	0.35	0.75	0.76	0.00	0.00	0.17

Table 12. 2024 Marginal Utility Values

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
CVKMD	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00
KOZAA	0.02	0.01	0.00	0.00	0.00	0.88	0.01	0.00	0.00	0.23
KOZAL	0.02	0.02	0.18	0.20	0.15	0.91	0.92	1.00	0.00	0.24
PRKME	0.00	0.00	0.17	0.28	0.14	0.79	0.80	0.00	0.00	0.00
RUZYE	1.00	1.00	0.15	0.25	0.13	1.00	1.00	0.00	1.00	1.00
VSNMD	0.00	0.00	0.06	0.08	0.08	0.44	0.46	0.00	0.00	0.02

Table 13. 2024 The Final Values

Code	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	Skor
CVKMD	0.00	0.00	0.17	0.21	0.16	0.00	0.00	0.00	0.00	0.00	0.54
KOZAA	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.02	0.12
KOZAL	0.00	0.00	0.03	0.04	0.02	0.11	0.13	0.02	0.00	0.02	0.38
PRKME	0.00	0.00	0.03	0.06	0.02	0.09	0.12	0.00	0.00	0.00	0.32
RUZYE	0.04	0.03	0.02	0.05	0.02	0.12	0.15	0.00	0.02	0.09	0.54
VSNMD	0.00	0.00	0.01	0.02	0.01	0.05	0.07	0.00	0.00	0.00	0.16

Equations (10-14), included in the application steps of the MAUT method, were applied to the 2020-2024 positive decision matrix of mining and quarrying enterprises, and the enterprises' performance scores and ranking findings are presented in Table 14.

Table 14. Businesses' MAUT Performance Findings for 2020-2024

	2020		2021		2022		2023		2024	
Code	Skor	Rank	Skor	Rank	Skor	Rank	Skor	Rank	Skor	Rank
CVKMD	0.038	5	0.115	6	0.328	4	0.290	5	0.538	2
KOZAA	0.520	2	0.446	4	0.398	3	0.080	6	0.124	6
KOZAL	0.759	1	0.794	1	0.757	1	0.290	4	0.380	3
PRKME	0.210	4	0.508	2	0.281	5	0.672	1	0.319	4
RUZYE	0.348	3	0.473	3	0.542	2	0.540	2	0.538	1
VSNMD	-	-	0.197	5	0.178	6	0.296	3	0.158	5

Note: VSNM company's 2020 data could not be accessed and therefore was not included in the analysis.

According to the MAUT method presented in Table 6, based on financial performance ranking results; in 2020, KOZAL had the highest performance (0.759) and CVKMD had the lowest performance (0.038); in 2021, KOZAL had the highest performance (0.794) and

CVKMD had the lowest performance (0.115); In 2022, KOZAL (0.757) had the highest performance and VSNMD (0.178) had the lowest performance; In 2023, PRKME (0.672) had the highest performance and KOZAA (0.080) had the lowest performance; In 2024, RUZYE (0.538) showed the highest performance and KOZAA (0.124) showed the lowest performance.

KOZAL achieved the highest performance score during the 2020–2022 period and is the leader in the sector. RUZYE has demonstrated consistent performance between 2022 and 2024, achieving its highest score in 2024. CVKMD and KOZAA have performed poorly in some years, placing them lower in the rankings. PRKME rose significantly in 2023 to take first place, demonstrating the positive impact of the company's financial strategies that year. VSNMD has failed to score or performed poorly in some years due to missing data. These findings reveal that the performance of companies in the sector varies from year to year and that some companies experience periodic fluctuations in performance.

Conclusion

In this study, the financial performance of companies operating in the Mining and Quarrying sector on the Istanbul Stock Exchange during the 2020–2024 period was analysed using multi-criteria decision-making methods. In the study, criterion weights were first determined using the MEREC method, and then the performance rankings of the companies were determined using the MAUT method.

The weights obtained shed light on the sector's periodic financial dynamics: in 2020, the most important criterion was the trade debt turnover ratio (C_{10}, w=0.21). This situation demonstrates that cash management and supplier-based working capital strategies gained critical importance under pandemic conditions. In 2021, return on equity (C_5, w=0.22) was the most decisive ratio. It is understood that investors focused more on companies' profitability capacity during the post-pandemic recovery period. In 2022 and 2023, the highest weight was observed in the equity/total assets ratio (C_7; 0.32 and 0.30, respectively). As this ratio reflects companies' financial soundness and debt levels, it has become more decisive for the sector during periods of increased economic fragility. In 2024, net profit margin (C_4, w=0.21) is the most critical criterion. This finding shows that in a year of intense cost pressures, companies' final profitability performance came to the fore. The criteria with the lowest weight each year have been receivables turnover (C_8) and inventory turnover (C_9). It is widely noted in the literature that the mining sector has a long production process and low inventory turnover. Therefore, it is expected that these two ratios carry low information content.

MAUT results show that company performance is highly variable. KOZAL achieved the highest performance scores throughout 2020–2022, reaching the position of industry leader. The company's high profitability indicators (C_3–C_5), strong equity structure (C_7), and debt ratios below the sector average explain KOZAL's high ranking. RUZYE has demonstrated stable performance, particularly after 2022, and has become the sector leader in 2024 with the highest score (0.538). RUZYE's notable strengths are as follows: being the clear leader in the sector in liquidity indicators such as (C_1) and (C_2) in 2024, a strong position in terms of debt indicators (C_6–C_7), and high profit margin performance in 2024. PRKME experienced a surge in 2023, ranking first (0.672). The reasons for this leap: Improvement in net profit margin (C_4), significant acceleration in inventory turnover and receivables turnover processes (C_8–C_9), and stabilisation in the debt structure (C_7). This performance demonstrates that the financial strategies implemented by the company in 2023 have had a positive short-term impact. CVKMD lagged behind, particularly in 2020–2021, due to low liquidity and high indebtedness. KOZAA has the lowest performance in 2023 and 2024. The main reasons for this are: a decline in profitability ratios, a decrease in the equity/total assets ratio, and liquidity indicators below the industry average. VSNMD's lack of data for certain years and low scores have made it difficult to assess its performance consistently. However, there is a notable improvement in 2023 (0.296).

The findings of this study have both consistent and divergent aspects. Numerous studies examining the mining sector using MCDM methods indicate that profitability and capital structure are the most decisive criteria for financial performance. This study also shows that the equity/assets ratio and net profit margin carried the highest weight between 2022 and 2024. In some studies in the literature, inventory turnover and receivables turnover have a high impact on performance. However, in this study, these two criteria have the lowest level of importance. The reason for this difference is the capital-intensive, long production cycle and commodity price-sensitive structure of the sector. Furthermore, while liquidity ratios are found to be key criteria in some studies, in this analysis, liquidity only came to the fore in some years, such as in 2024 in RUZYE. This study demonstrates that when measured using MCDM models, the sector's unique financial dynamics produce distinct and discernible results. Financial performance in the mining and quarrying sector is not a structure that a single company can sustain. Each year, different criteria come to the fore in line with sector conditions. KOZAL stands out as the sector's stabilising company with its strong long-term performance, while RUZYE has shown a rising trend, particularly in recent years. PRKME attracts attention with its strong periodic leaps, while companies such as KOZAA and CVKMD show more erratic performance. These results demonstrate that the sector is highly sensitive to commodity prices, exchange rates, global demand movements, and the financing structure of investments.

The results obtained demonstrate that strategic decisions in the sector must be based on comprehensive data for investors and managers. The periodic variability in performance highlights the importance of businesses continuously reviewing their liquidity management, capital structure and profitability strategies.

The findings of the study demonstrate that multi-criteria decision-making methods are an effective tool in financial performance analysis. Furthermore, it was concluded that the performance of companies in the sector depends not only on profitability or liquidity indicators, but also on criteria such as capital structure and operational efficiency. This highlights the importance of conducting a comprehensive assessment in strategic decision-making processes for investors and managers.

In future studies, it is recommended that the scope of the analysis be expanded to include comparative performance evaluations with other sectors and international companies. Furthermore, examining the effects of external factors such as the pandemic and economic crisis on performance will contribute to the development of sectoral strategies. These findings contribute to the literature by demonstrating both the effectiveness of multi-criteria decision-making methods in financial analysis and the periodic variability of performance-determining criteria among companies in the sector.

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