IJCEAS

International Journal of Contemporary Economics and Administrative Sciences
ISSN: 1925 – 4423
Volume: XVI, Issue: 1, Year: 2026, pp. 728-754

A Hybrid MEREC-CoCoSo-MARCOS Framework for Assessing Financial Performance: Evidence from Istanbul Stock Exchange

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Received: 13.05.2026, Accepted: 29.05.2026
DOI Number: 10.5281/zenodo.20573610

Abstract

This study evaluates the financial performance of firms operating in the BIST Non-Metallic Mineral Products Sector for the period 2013–2022 by employing a hybrid multi-criteria decision-making (MCDM) framework. The analysis integrates the MEREC method for objective criterion weighting with the CoCoSo method for performance ranking, while the MARCOS approach and Spearman rank correlation analysis are used to test the robustness and consistency of the results. Four financial indicators representing liquidity, operational efficiency, profitability, and financial risk dimensions are included in the evaluation: Current Ratio (CUR), Asset Turnover Ratio (ATR), EBITDA Margin (EBM), and Leverage Ratio (LEV). The findings reveal that EBITDA Margin consistently emerges as the most influential criterion throughout the analysis period, indicating that operational profitability constitutes the primary determinant of firm performance in the sector. In contrast, leverage and liquidity indicators exhibit relatively lower explanatory power. The ranking results further demonstrate that certain firms maintain consistently superior performance across the years, while others display persistent underperformance and greater sensitivity to changing macroeconomic conditions. Robustness tests conducted through the MARCOS method produce highly similar ranking structures, and the Spearman correlation coefficients indicate strong statistical agreement between the applied methodologies. Overall, the results suggest that financial performance in the BIST non-metallic mineral products sector is predominantly driven by operational profitability and efficiency rather than short-term liquidity or debt structure. The study contributes to the literature by applying recent objective weighting and compromise-based MCDM methods within a sector-specific and long-term financial performance evaluation framework.

Key words: Financial performance, MEREC, CoCoSo, MARCOS, BIST, Multi-criteria decision making

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IJCEAS

International Journal of Contemporary Economics and Administrative Sciences
ISSN: 1925 – 4423
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JEL Code: C44, G32, L25.

1. Introduction

The evaluation of corporate financial performance has long been a central concern in finance and strategic management. Financial indicators offer valuable insights into firms' liquidity, efficiency, profitability, and solvency, while also serving as key tools for decision-making by investors, creditors, managers, and policymakers. This issue becomes even more critical in capital-intensive industries, where firms operate with high fixed investments and are particularly vulnerable to macroeconomic changes, financing conditions, and cost pressures.

In emerging economies, assessing financial performance is even more important due to ongoing economic volatility and uncertainty. Over the past decade, the Turkish economy has experienced significant fluctuations in exchange rates, inflation, interest rates, and monetary conditions. These changes have directly influenced firms' production costs, borrowing structures, liquidity management, and overall profitability. In manufacturing sectors—especially those with high energy dependence and substantial fixed assets—maintaining sustainable profitability has become increasingly challenging under such unstable conditions.

Within this context, the BIST Non-Metallic Mineral Products Sector holds a strategically important position in Türkiye's manufacturing industry. This sector includes companies engaged in cement, ceramics, concrete, and other construction-related materials, all of which play a crucial role in infrastructure development, urbanization, and industrial production. Due to their capital-intensive nature, these firms are highly sensitive to fluctuations in energy prices, exchange rates, financing conditions, and construction demand cycles. As a result, evaluating their financial performance requires a comprehensive and multidimensional approach.

Traditional financial performance analysis typically relies on ratio analysis and individual accounting indicators. While these methods provide useful initial insights, they often fall short in capturing the complex and multidimensional nature of firm performance. Focusing on a single financial ratio can lead to incomplete or even misleading conclusions, as improvements in one area may coincide with weaknesses in another. For instance, a firm may boost profitability through increased borrowing while simultaneously increasing its financial risk. Likewise, strong liquidity does not necessarily indicate operational efficiency. Therefore, modern financial analysis increasingly calls for more holistic frameworks that can evaluate multiple criteria simultaneously.

To address these limitations, Multi-Criteria Decision-Making (MCDM) methods have gained prominence in financial performance research. These approaches allow for the simultaneous evaluation of multiple financial indicators, offering a more comprehensive perspective than traditional methods. Earlier studies

frequently employed techniques such as AHP, TOPSIS, ELECTRE, and VIKOR. However, recent research emphasizes the importance of objective weighting methods and compromise-based ranking techniques that reduce subjectivity and improve methodological reliability.

In this regard, the MEREC (Method based on the Removal Effects of Criteria) approach, introduced by Keshavarz-Ghorabaee et al. (2021), represents a significant advancement in objective weighting methods. Unlike traditional techniques, MEREC determines the importance of each criterion by assessing the information loss that occurs when that criterion is excluded. This makes the weighting process more data-driven and robust.

Similarly, the CoCoSo (Combined Compromise Solution) method, proposed by Yazdani et al. (2019), offers a powerful ranking approach by combining additive and multiplicative aggregation structures, thereby improving ranking stability. In addition, the MARCOS method, developed by Stević and Brković (2020), provides an alternative framework based on comparisons with ideal and anti-ideal solutions and has recently been used to enhance robustness in financial performance analyses.

The growing adoption of these methods reflects an increasing emphasis on methodological reliability in MCDM research. Since different methods can produce varying rankings depending on weighting schemes, normalization techniques, and aggregation procedures, recent studies recommend validating results through alternative methods and statistical consistency tests. In this context, Spearman rank correlation analysis is widely used to measure the level of agreement between different ranking results.

In this study, the financial performance of firms in the BIST Non-Metallic Mineral Products Sector is analyzed for the period 2013–2022 using a hybrid MEREC–CoCoSo–MARCOS framework. Four key financial indicators are considered: Current Ratio (CUR), Asset Turnover Ratio (ATR), EBITDA Margin (EBM), and Leverage Ratio (LEV). While CUR and ATR are treated as benefit criteria due to their positive effects on liquidity and operational efficiency, EBITDA Margin reflects operational profitability and serves as a critical indicator of sustainable performance. In contrast, the Leverage Ratio is treated as a cost criterion due to the financial risks associated with high debt levels.

The analysis period is deliberately limited to 2013–2022. Beginning in 2023, the reintroduction of inflation accounting in Türkiye significantly altered financial reporting practices and accounting-based ratios. Since inflation-adjusted financial statements may reduce comparability with previous periods, including post-2022 data could compromise the consistency and interpretability of the analysis. Therefore, restricting the study to the pre-inflation-accounting period ensures more reliable comparisons across firms and years.

This study makes several contributions to the literature. First, it applies recent objective weighting and compromise-ranking methods in a sector-specific financial performance context in Türkiye. Second, it avoids subjective weighting by employing the fully objective MEREC method. Third, the integration of MARCOS and Spearman rank correlation analysis strengthens the robustness of the findings. Finally, the study provides valuable sector-level insights into firm performance in a capital-intensive industry operating under volatile macroeconomic conditions.

2. Literature Review

Financial performance evaluation has become one of the most extensively studied topics in the multi-criteria decision-making (MCDM) literature due to the inherently multidimensional nature of corporate finance. Traditional financial analysis methods generally focus on isolated indicators such as profitability, liquidity, leverage, or efficiency ratios. Although these indicators provide useful insights into specific dimensions of firm performance, relying on a single financial ratio is insufficient to capture the overall financial structure of firms (Brigham et al., 2004). Since firms simultaneously operate under profitability pressures, financing constraints, liquidity requirements, and efficiency objectives, contemporary financial analysis increasingly requires integrated frameworks capable of evaluating multiple dimensions together.

The limitations of conventional ratio analysis have significantly contributed to the expansion of MCDM methods in financial research. Early studies applied methods such as AHP, TOPSIS, ELECTRE, and VIKOR to evaluate firms under multiple criteria. Among these, TOPSIS, introduced by Hwang and Yoon (1981), is based on the distance from ideal and anti-ideal solutions, while VIKOR, developed by Opricovic and Tzeng (2004), focuses on compromise solutions under conflicting criteria. These methods gained popularity in financial performance evaluation because they allow multidimensional ranking rather than reliance on isolated indicators.

As the literature evolved, researchers increasingly emphasized hybrid MCDM structures as more reliable alternatives to single-method applications. Zavadskas et al. (2012) argue that integrated decision frameworks reduce methodological sensitivity by combining different aggregation logics. Similarly, Wang and Lee (2009) suggest that combining subjective and objective weighting approaches enhances ranking consistency in complex decision environments. In this context, Dincer and Yuksel (2019) emphasize that financial performance problems require compromise-based structures that jointly evaluate profitability, liquidity, efficiency, and risk dimensions.

Recent advancements in MCDM have further diversified evaluation frameworks, particularly in manufacturing and capital-intensive industries. Abdel-Basset et al. (2020) demonstrate the effectiveness of integrated plithogenic MCDM

approaches in handling uncertainty in manufacturing contexts. Sarıyer and Acar (2021) combine AHP and TOPSIS in the Turkish basic metal industry, while Ersoy (2023) applies an integrated data-driven weighting system (IDDWS) with CoCoSo to evaluate Fortune 500 companies, highlighting the robustness of CoCoSo under varying conditions.

Despite these methodological advancements, traditional MCDM approaches have been criticized for relying heavily on subjective weighting procedures based on expert judgment or pairwise comparisons. Although such approaches provide flexibility, they may introduce decision-maker bias. Consequently, recent studies have increasingly shifted toward objective weighting techniques that derive criterion importance directly from data characteristics.

Among objective weighting methods, entropy-based approaches have been widely used due to their ability to capture information dispersion. However, entropy methods may not fully reflect the marginal contribution of each criterion in the decision process. This limitation has led to the development of more advanced techniques, particularly the MEREC method proposed by Keshavarz-Ghorabaee et al. (2021), which evaluates criterion importance based on the effect of their removal from the decision system. This approach allows a more direct assessment of each criterion's discriminatory power.

In parallel, CoCoSo (Combined Compromise Solution), introduced by Yazdani et al. (2019), integrates additive and multiplicative aggregation strategies to improve ranking stability and reduce sensitivity to normalization procedures. Similarly, MARCOS (Measurement of Alternatives and Ranking according to Compromise Solution), developed by Stević and Brković (2020), evaluates alternatives based on ideal and anti-ideal references, providing strong discriminatory capability and robustness. These methods are increasingly used as complementary tools in financial performance analysis.

The growing adoption of such methods is closely linked to the need for robustness in MCDM applications, as different weighting and ranking techniques may produce varying results. Therefore, recent studies recommend validating results through alternative methods and consistency checks. In this context, Spearman rank correlation analysis is widely used to assess agreement between ranking structures, strengthening the credibility of empirical findings (Mastilo et al., 2024).

The Turkish MCDM literature has also expanded considerably. Ertugrul and Karakasoglu (2009) use fuzzy AHP and TOPSIS for Turkish cement firms. Dumanoğlu (2010) evaluated the financial performance of cement companies traded on BIST by applying the TOPSIS method. Aytekin and Sakarya (2013) evaluated the performance of food companies traded on BIST by applying the TOPSIS method. Ayaydın et al. (2017) employ Grey Relational Analysis in logistics firms, Göktolga and Karakıs (2018) apply fuzzy AHP and VIKOR to pension companies, and Ömürbek et al. (2014) combine TOPSIS and VIKOR to

improve evaluation consistency. These studies consistently show the importance of integrating multiple financial indicators.

More recent Turkish studies focusing on objective weighting methods further reinforce the relevance of profitability and efficiency indicators. Cilek, et al. (2025) apply a LOPCOW-RSMVC hybrid model in the BIST basic metal industry, while Mastilo et al. (2024) and Özekenci (2024) report that profitability and operational efficiency indicators frequently dominate weighting structures in MEREC-based applications. Sezgin et al. (2024) evaluated the financial performance of companies listed in the BIST Information Technology sector by applying the MEREC and MARCOS methods. The results revealed that the asset turnover ratio and return on assets were the most significant criteria, having the highest weights.

Beyond finance-focused sectors, MCDM applications in Türkiye increasingly extend to manufacturing industries, where firms face simultaneous pressures from production efficiency, financing constraints, and working capital management. These pressures are particularly pronounced in capital-intensive industries.

The non-metallic mineral products industry represents one of the most capital-intensive segments of Turkish manufacturing. Firms in cement, ceramics, concrete, and construction materials require substantial fixed asset investments and operate under high energy and financing cost exposure. Consequently, they are highly sensitive to macroeconomic variables such as exchange rates, inflation, and construction demand.

Within this context, profitability-oriented indicators are generally considered to have stronger explanatory power than purely liquidity-based measures. Damodaran (2012) emphasizes that EBITDA-based indicators are particularly useful for industrial firms because they isolate operational performance from financing and accounting effects. Accordingly, EBITDA Margin is widely used as a key indicator of operational performance in manufacturing sectors. The Asset Turnover Ratio is also widely recognized as an important measure of efficiency, reflecting firms' ability to generate revenue from their asset base.

In contrast, liquidity and leverage indicators often play a more supportive role within homogeneous industrial sectors. While liquidity is important for short-term solvency, excessively high liquidity may indicate inefficient resource allocation. Similarly, leverage ratios may exhibit limited discriminatory power when firms share similar financing structures.

Empirical studies support this view. Mastilo et al. (2024) find that profitability-related indicators dominate ranking outcomes in the banking sector, while Özekenci (2024) reports similar findings in the BIST Sustainability 25 Index,

where operational profitability and efficiency measures are the most influential criteria.

Another important issue in the literature is the dynamic nature of criterion importance over time. Traditional models assume static weights; however, macroeconomic volatility may alter the informational contribution of financial indicators. MEREC-based approaches are particularly suitable in this context because they allow weights to adjust according to data structure and economic conditions.

This issue is particularly relevant for Türkiye between 2013 and 2022, a period characterized by exchange rate volatility, inflationary pressures, and rising financing costs. These conditions likely shifted the relative importance of profitability and efficiency indicators compared to liquidity measures.

Moreover, the reintroduction of inflation accounting practices (TAS 29) in 2023 significantly changed financial reporting structures. Therefore, limiting the analysis to 2013–2022 ensures data consistency and comparability across firms and time.

Despite the growing literature, studies focusing specifically on the BIST Non-Metallic Mineral Products Sector remain limited. Existing studies are largely concentrated on banking, logistics, energy, and broader manufacturing sectors. Moreover, applications combining MEREC, CoCoSo, and MARCOS in a unified framework remain scarce in sector-specific Turkish studies.

Accordingly, this study contributes to the literature by applying a hybrid MEREC–CoCoSo framework with MARCOS-based robustness checks and Spearman correlation validation to evaluate firms operating in the BIST Non-Metallic Mineral Products Sector during 2013–2022. This integrated approach aims to provide a more robust and methodologically consistent assessment of financial performance dynamics in a capital-intensive industrial context.

3. Data and Methodology

Data

This study examines the financial performance of firms operating in the BIST Non-Metallic Mineral Products Sector (BIST TAST Index). The BIST TAST Index was selected because it represents firms operating in a capital-intensive manufacturing industry that is highly sensitive to macroeconomic conditions such as energy costs, exchange rate fluctuations, construction sector demand, and inflationary pressures. In addition, the sector plays a strategically important role in the Turkish economy due to its close linkages with construction, infrastructure, and industrial production activities. These characteristics make the index an appropriate setting for evaluating firm-level financial performance under changing economic conditions.

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The sample consists of 11 publicly traded companies listed on Borsa Istanbul, covering the period between 2013 and 2022. Firms included in the analysis were selected based on two criteria: (i) continuous listing in the BIST TAST Index during the analysis period, and (ii) availability of complete and consistent financial statement data for all years considered in the study. Companies with missing observations or incomplete financial disclosures were excluded to ensure data consistency and comparability across firms and years. The list of companies included in the sample is presented in Table 1.

Table 1. Companies included in the study

Company	BIST Code
Akçansa Çimento Sanayi ve Ticaret A.Ş.	AKCNS
Batıçim Batı Anadolu Çimento Sanayii A.Ş.	BTCIM
Çimsa Çimento Sanayi ve Ticaret A.Ş.	CIMSA
Çimbeton Hazırbeton ve Prefabrik Yapı Elemanları Sanayi ve Ticaret A.Ş.	CMBTN
Dogusan Boru Sanayi ve Ticaret A.Ş.	DOGUB
Ege Seramik Sanayi ve Ticaret A.Ş.	EGSER
Göltaş Göller Bölgesi Çimento Sanayi ve Ticaret A.Ş.	GOLTS
Kütahya Porselen Sanayi A.Ş.	KUTPO
Nigbas Nigde Beton Sanayi ve Ticaret A.Ş.	NIBAS
Nuh Çimento Sanayi A.Ş.	NUHCM
Usak Seramik Sanayi A.Ş.	USAK

The analysis was conducted using annual financial statement data obtained from publicly available company reports and the Public Disclosure Platform (KAP).

Four financial indicators representing liquidity, profitability, efficiency, and leverage dimensions were employed in the analysis. The Current Ratio was included to measure firms' short-term liquidity capacity and their ability to meet current obligations. EBITDA Margin was used as an indicator of operational profitability, reflecting firms' efficiency in generating earnings from core business activities. Asset Turnover Ratio was employed to capture the effectiveness of asset utilization in generating sales revenue. Finally, the Leverage Ratio was incorporated to evaluate the degree of financial risk arising from debt financing. The studies conducted by Ayaydin et al. (2017), Goktolga and Karakış (2018), Mastilo et al. (2023), and Özekenci (2024) were consulted in the selection of financial performance criteria.

The selected period includes episodes of significant macroeconomic fluctuations in the Turkish economy, such as exchange rate volatility, inflationary pressures, and financial market instability. Therefore, the dataset provides a suitable

framework for analyzing how financial performance dynamics evolved under changing economic conditions within a capital-intensive industrial sector.

The analysis period was limited to 2013–2022 to maintain consistency and comparability in the financial data used in the study. Starting from 2023, the reintroduction of inflation accounting practices in Türkiye led to substantial changes in financial reporting standards and accounting figures. These adjustments particularly affected balance sheet items and profitability indicators, making direct comparisons with previous periods less reliable. Since the study relies on financial ratios derived from accounting data, including post-2022 observations could weaken the consistency of the analysis and potentially affect the interpretation of firm performance over time. For this reason, the sample period was intentionally restricted to the pre-inflation accounting period.

Methodology

This study adopts a multi-method decision-making framework to evaluate the financial performance of firms over the period 2013–2022. In the first stage, the MEREC (Method based on the Removal Effects of Criteria) approach is employed to derive objective criterion weights by capturing the marginal informational contribution of each financial indicator. Subsequently, the COCOSO (Combined Compromise Solution) method is applied to obtain the performance rankings of the firms based on the weighted decision matrix.

The study uses four financial performance criteria obtained from companies' financial statements published on the Public Disclosure Platform for the period between 2013 and 2022. The first criterion is the Current Ratio (CUR), calculated as current assets divided by current liabilities, which aims to measure the liquidity position of firms and is expected to be maximized. The second criterion is the EBITDA Margin (EBM), calculated by dividing EBITDA by net sales and multiplying by 100, indicating operational profitability; therefore, a higher value is preferred. Another criterion is the Asset Turnover Ratio (ATR), obtained by dividing net sales by total assets, which evaluates how efficiently companies use their assets to generate sales, and this ratio is also aimed to be maximized. Finally, the Leverage Ratio (LEV), calculated as total debt divided by total assets, measures the level of indebtedness of firms, and lower values are considered more favorable; therefore, this criterion is aimed to be minimized.

To enhance the robustness and reliability of the obtained results, the MARCOS (Measurement of Alternatives and Ranking according to Compromise Solution) method is additionally implemented as a comparative ranking technique. Finally, Spearman rank correlation analysis is conducted to assess the consistency and stability of the ranking outcomes across the applied multi-criteria decision-making (MCDM) methods. These methods were preferred due to their ability to incorporate objective weighting procedures and compromise-based ranking mechanisms in multi-criteria decision-making environments.

The MEREC method, introduced to the literature by Keshavarz-Ghorabaee et al. (2021), is an MCDM technique that differs from most weighting methods by excluding the relevant criterion from the calculation process while determining

criterion weights. The application steps of MEREC given Table 2 (Keshavarz-Ghorabaee et al. 2021);

Table 2. MEREC Application Steps

Steps	**Equations**
Step 1. Constructed decision matrix	$X=\begin{pmatrix} x11 & x12 & \cdots & x1n \\ \vdots & & \ddots & \vdots \\ xm1 & xm2 & & xmn \end{pmatrix}$
Step 2. The decision matrix values are normalized	$nij = \frac{\min_j xij}{xij}\ j \in for\ Benefit$ $nij = \frac{xij}{\max_j xij}\ j \in for\ Cost$
Step 3. Calculated overall performance value of each alternative (S_i)	$S_i = ln\left(1 + \left(\frac{1}{n}\sum_J \left\|ln(d_{ij})\right\|\right)\right)$
Step 4. Calculated performance values of the alternatives	$S'_{ij} = ln\left(1 + \left(\frac{1}{n}\sum_{k,k\neq J} \left\|ln(d_{ik})\right\|\right)\right)$
Step 5. Calculated total sum of absolute differences	$Ej = \sum_i \left\|S'_{ij} - S_i\right\|$
Step 6. Calculated Criterion Weights	$w_j = \frac{E_j}{\Sigma_k E_k}$

The Marcos method, introduced by Stevis and Brkovic (2020). The anti-ideal solution (AAI) represents the least favorable choice, whereas the ideal solution (AI) signifies an option with the most desirable features in the method. AAI and AI are determined by utilizing different criteria based on their characteristics. The application steps of MEREC given Table 3 (Stevis and Brkovic 2020; 4-5);

Table 3. MARCOS Application Steps

Steps	**Equations**
Step 1. Constructed decision matrix	$X=\begin{pmatrix} x11 & x12 & \cdots & x1n \\ \vdots & & \ddots & \vdots \\ xm1 & xm2 & & xmn \end{pmatrix}$
Step 2. Calculated extended Decision Matrix	$EXTx = \begin{matrix} A1 \\ A2 \\ \vdots \\ Am \\ AI \\ AAI \end{matrix}\begin{bmatrix} x11 & \cdots & x1n \\ x21 & x22 & x2n \\ \vdots & \ddots & \vdots \\ xm1 & xm2 & xmn \\ xai1 & xai2 & xain \\ xaa1 & \cdots & xaan \end{bmatrix}$ AI = max xij If j ϵ B and min xij If j ϵ C AAI = min xij If j ϵ B and max xij If j ϵ C
Step 3. The extended decision matrix values are normalized	$X= \begin{matrix} \\ A1 \\ A2 \\ \vdots \\ Am \\ AI \\ AAI \end{matrix}\begin{matrix} C1 & C2 & \cdots & Cn \\ \begin{bmatrix} x11 & \cdots & x1n \\ x21 & x22 & x2n \\ \vdots & \ddots & \vdots \\ xm1 & xm2 & xmn \\ xai1 & xai2 & xain \\ xaa1 & \cdots & xaan \end{bmatrix} \end{matrix}$

Step 4. Calculated weighted normalized values	Gij = nij x wj $X=\begin{array}{c} \\ A1 \\ A2 \\ \vdots \\ Am \\ AI \\ AAI \end{array}\begin{array}{c} \begin{array}{ccc} C1 & C2 & \cdots \quad Cn \end{array} \\ \begin{bmatrix} G11 & \cdots & G1n \\ G21 & G22 & G2n \\ \vdots & \ddots & \vdots \\ Gm1 & Gm2 & Gmn \\ Gai1 & Gai2 & Gain \\ Gaa1 & \cdots & Gaan \end{bmatrix} \end{array}$
Step 5. Calculated Benefit Degrees for Alternatives (Si represents the sum of the elements of the weighted matrix G)	$K_1^+ = \frac{Si}{Sai}$ $K_1^- = \frac{Si}{Saai}$ $\sum_{i=1}^{n} G_{ij}$
Step 6. Calculated Utility Function of Alternatives ($f(K_i^-)$ represents the utility function in relation to the anti-ideal solution. $f(K_i^+)$ represents the utility function in relation to the ideal solution.)	$\frac{K_i^+ + K_i^-}{1 + \frac{1-f(K_i^+)}{f(K_i^+)} + \frac{1-f(K_i^-)}{f(K_i^-)}}$ $f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-}$ $f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-}$

Evaluating the options. This assessment relies on the ultimate values of the utility functions. It is preferred that an option maintains the maximum potential value of the utility function.

The CoCoSo method, proposed by Yazdani et al. (2019), is a compromise-based aggregation approach that integrates different scoring strategies to obtain a balanced ranking of alternatives. The implementation procedures of the CoCoSo method are presented below (Yazdani et al., 2019);

Table 4. Cocoso Application Steps

Steps	**Equations**
Step 1. Constructed decision matrix	$X=\begin{pmatrix} x11 & x12 & \cdots & x1j \\ \vdots & \ddots & & \vdots \\ xi1 & xi2 & & xij \end{pmatrix}$
Step 2. The decision matrix values are normalized	rij=$\frac{xij-minxij}{maxxij-minxij}$ $benefit\ oriented$ rij = $\frac{maxxij-xij}{maxxij-minxij}$ $cost\ oriented$
Step 3. Calculated weighted comparability sum (S_i) and the power-weighted sum (P_i)	Si= $\sum_{J=1}^{n} w_J x\, r_{ij}$ Pi = $\sum_{J=1}^{n} (r_{ij})^{wj}$
Step 4. Calculated relative appraisal scores of the alternatives*	kia=$\frac{Pi+Si}{\sum_{j=1}^{n}(Pi+Si)}$ kib=$\frac{S_i}{min_{S_i}} + \frac{Pi}{min_{P_i}}$ kic=$\frac{\lambda(S_i)+(1-\lambda)(P_i)}{\lambda_{max_{Si}}+(1-\lambda)maxP_i}; 0 \le \lambda \le 1$
Step 5. Calculated performance ranking of the alternatives	$k_i = (k_{ia} x k_{ib} x k_{ic}) \frac{1}{3} (k_{ia} + k_{ib} + k_{ic})$

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*: λ accepted as 0.5 in this work.

4. Empirical Results and Discussion

In this section of the study, in order to preserve the coherence and flow of the text, the findings obtained for all years are not presented step by step. Instead, only the findings for the year 2013 are reported at each stage as illustrative examples, while the results covering the entire sample period are presented only in the final results section.

Table 5 presents the normalized decision matrix obtained within the scope of the MEREC method for 2013. The normalization procedure ensures the comparability of financial indicators measured on different scales and constitutes the basis for the subsequent weighting process.

Table 5. Normalized decision matrix for 2013

Company	ATR	CUR	EBM	LEV
AKCNS	0.098900427	0.990536906	0.014481575	0.491204858
BTCIM	0.13618893	0.694666081	0.015924025	0.625825265
CIMSA	0.120151956	0.751082002	0.023293061	0.705651565
CMBTN	0.039429995	0.903397934	0.013858516	0.331088486
DOGUB	1	0.884040078	1	0.268554545
EGSER	0.085970708	0.638469797	0.015976583	0.577401372
GOLTS	0.127571573	0.566215942	0.013763535	0.58842433
KUTPO	0.073250077	0.424586528	0.020163958	0.436106269
NIBAS	0.235066491	0.739258594	0.038313503	0.576717518
NUHCM	0.112244274	0.688319433	0.014752187	0.522405745
USAK	0.146096152	1	0.018265244	1

Source: Authors' calculations

Table 6 reports the Si calculation results derived from the MEREC method for 2013. These values represent the overall performance levels of the firms based on the integrated effect of all evaluation criteria.

Table 6. Si Calculation Result for 2013

Company	Si Values
AKCNS	1.622013072
BTCIM	1.55456225
CIMSA	1.45343926
CMBTN	1.945598794
DOGUB	0.320870189
EGSER	1.693275389

GOLTS	1.661057607
KUTPO	1.830723981
NIBAS	1.241202519
NUHCM	1.657120845
USAK	1.322403478

Source: Authors' calculations

Table 7 presents the S_i' calculation results for 2013 within the framework of the MEREC method. These findings demonstrate the changes in firm performance scores when each criterion is excluded individually from the evaluation process.

Table 7. S_i' Calculation Result for 2013

Company	ATR	CUR	EBM	LEV
AKCNS	1.105738842	1.619891389	0.677027328	1.463381658
BTCIM	1.109678237	1.473265697	0.630764395	1.449978421
CIMSA	0.980598512	1.389566551	0.614508818	1.375643899
CMBTN	1.224124716	1.922929162	0.99079981	1.698942693
DOGUB	0.320870189	0.293367103	0.320870189	0.027503085
EGSER	1.145737202	1.593155138	0.770212811	1.570721015
GOLTS	1.201587693	1.534138073	0.704724022	1.542723032
KUTPO	1.247454412	1.63957041	0.959603129	1.645543991
NIBAS	0.918115902	1.17378918	0.51331877	1.118383705
NUHCM	1.169088545	1.573776225	0.716266417	1.512231349
USAK	0.893189022	1.322403478	0.429214456	1.322403478

Source: Authors' calculations

Table 8 presents the Ej results obtained from the MEREC method for 2013. These values indicate the relative importance of the evaluation criteria by measuring the impact of removing each criterion from the overall performance evaluation process.

Table 8. Ej Result for 2013

ATR	CUR	EBM	LEV	Sum of Ej
4.986084111	0.766414977	8.974957239	1.574811056	16.30226738

Source: Authors' calculations

The decomposition of total impact across criteria shows that EBM has the highest contribution (8.97), indicating that it is the most sensitive criterion in the decision structure; its exclusion causes the greatest deterioration in information quality. ATR (4.99) follows as the second most influential criterion, also playing a significant role in explaining performance variability. In contrast, LEV (1.57) and

CUR (0.77) exhibit considerably lower contributions, suggesting that their marginal impact on the overall evaluation is relatively limited.

Table 9 presents the Wj results obtained from the MEREC method for 2013. These values represent the final weights assigned to each evaluation criterion based on their relative impact on overall performance variation. The results indicate that the EBM criterion has the highest importance, while CUR has the lowest contribution within the decision framework.

Table 9. Wj Result for 2013

Criteria	Wj
EBM	0.550534292
ATR	0.305852186
LEV	0.096600738
CUR	0.047012784

Source: Authors' calculations

The results indicate a clear dominance of the EBM criterion (0.551), confirming it as the most influential factor in the decision-making structure due to its highest sensitivity in the Ej analysis. ATR (0.306) is identified as the second most important criterion, also contributing substantially to the overall evaluation process. In contrast, LEV (0.097) and CUR (0.047) receive relatively low weights, suggesting that their explanatory power and marginal impact on performance differentiation are limited compared to the other criteria. Overall, the distribution of weights demonstrates a strong concentration of importance in financial performance-related indicators, particularly EBM and ATR.

Full-Period Criterion Weights Derived via the MEREC Method (2013–2022)

The following section presents the criterion weights obtained from the MEREC approach for the full sample period covering 2013–2022. Unlike the step-by-step illustration provided for 2013 in the previous section, this part reports the complete set of annual weight estimations. The results reflect the temporal distribution of the informational importance of each financial criterion over the entire analysis period, as summarized in Table 10.

Table 10. Objective weights of financial criteria determined by MEREC (2013–2022)

Year	ATR	CUR	EBM	LEV
2013	0.305852186	0.047012784	0.550534292	0.096600738
2014	0.296093827	0.111310541	0.502905239	0.089690393
2015	0.237546657	0.153540713	0.516025184	0.092887446
2016	0.179467436	0.133411483	0.612191106	0.074929974
2017	0.228957592	0.178253764	0.504873925	0.087914719
2018	0.164784409	0.192369557	0.571951044	0.070894990
2019	0.198546952	0.099383053	0.620751919	0.081318076

2020	0.127308230	0.123200273	0.658340620	0.091150877
2021	0.167238304	0.194681480	0.527250707	0.110829510
2022	0.190375336	0.070692717	0.636947884	0.101984063

Source: Authors' calculations

The results indicate that EBITDA Margin (EBM) consistently dominates the weighting structure, frequently accounting for more than half of the total explanatory power. This finding is consistent with the theoretical expectation that profitability-based indicators constitute the primary source of discrimination in capital-intensive industries such as non-metallic mineral products. This finding suggests that profitability-based information plays a central role in differentiating firm performance in the BIST non-metallic mineral products sector. In capital-intensive industries, operational profitability tends to capture both cost efficiency and revenue-generating capacity, making it a more informative indicator compared to liquidity and leverage measures. The relatively lower importance of CUR and LEV further indicates that short-term financial structure variables are less effective in explaining cross-sectional variation in firm performance within the examined sector.

Conversely, Leverage (LEV) exhibits relatively lower and stable weights over time, suggesting limited cross-sectional dispersion in firms' capital structure decisions within the sector. This homogeneity reduces the discriminatory contribution of leverage-related information in the MEREC framework. Asset Turnover (ATR) and Current Ratio (CUR) display moderate but time-varying importance, reflecting cyclical sensitivity in operational efficiency and liquidity conditions. The observed temporal fluctuations in ATR and CUR also imply that firms' operational efficiency and liquidity positions are influenced by macroeconomic cycles, including exchange rate volatility and inflationary pressures. This indicates that the informational contribution of these criteria is not stable over time but responds to changing economic conditions, thereby reinforcing the dynamic nature of financial performance evaluation.

Performance Ranking Analysis: CoCoSo Approach

Table 11 presents the normalized decision matrix for 2013 constructed within the COCOSO framework. The normalization process transforms the original financial indicators into a dimensionless form, ensuring comparability across criteria with different measurement scales. This matrix serves as the initial input for subsequent weighting and aggregation stages of the COCOSO method.

Table 11. Normalized decision matrix for 2013

Company	ATR	CUR	EBM	LEV
AKCNS	0.374000621	0.00704934	0.94972504	0.695602301
BTCIM	0.26036024	0.32432852	0.862431703	0.511555212
CIMSA	0.300590005	0.24454294	0.585176184	0.402420212
CMBTN	1	0.078903	0.993050757	0.914506351

DOGUB	0	0.09678814	0	1
EGSER	0.436422684	0.41782114	0.859548683	0.577758225
GOLTS	0.280720161	0.5652983	1	0.562688123
KUTPO	0.519340486	1	0.678151237	0.770930665
NIBAS	0.133576687	0.26025543	0.350292301	0.57869316
NUHCM	0.324658662	0.33412262	0.93204745	0.652945824
USAK	0.239920799	0	0.750097338	0

Source: Authors' calculations

The Si values obtained from the COCOSO method for 2013 indicate the aggregated performance levels of firms based on the weighted normalized matrix. These scores constitute a key input for the subsequent compromise ranking process.

Table 12. Si Result for 2013

Company	**ATR**	**CUR**	**EBM**	**LEV**	**Si**
AKCNS	0.114388907	0.00033141	0.5228562028	0.067195696	0.704772
BTCIM	0.079631749	0.01524759	0.4747982275	0.049416611	0.619094
CIMSA	0.09193611	0.01149664	0.3221595564	0.038874089	0.464466
CMBTN	0.305852186	0.00370945	0.5467084959	0.088341988	0.944612
DOGUB	0	0.00455028	0.0000000000	0.096600738	0.101151
EGSER	0.133480832	0.01964294	0.4732110260	0.055811871	0.682147
GOLTS	0.085858875	0.02657625	0.5505342924	0.054356088	0.717326
KUTPO	0.158841423	0.04701278	0.3733455115	0.074472471	0.653672
NIBAS	0.040854722	0.01223533	0.1928479240	0.055902186	0.30184
NUHCM	0.099297561	0.01570803	0.5131240835	0.063075048	0.691205
USAK	0.073380301	0	0.4129543070	0	0.486335
					Σ Si: 6.36662

Source: Authors' calculations

Table 13 presents the Pi results for 2013 obtained within the COCOSO method. These values reflect the relative performance scores of the firms derived through the aggregation of the normalized decision matrix and weighting structure. The Pi results serve as an intermediate measure in the COCOSO framework and are used to support the final ranking of alternatives in the subsequent decision-making stage.

Table 13. Pi Result for 2013

Company	**ATR**	**CUR**	**EBM**	**LEV**	**Pi**
AKCNS	0.740222133	0.79220117	0.972001353	0.965543751	3.469968
BTCIM	0.662601224	0.94844041	0.921752343	0.937300399	3.470094

CIMSA	0.692368611	0.93593324	0.744531911	0.915823484	3.288657
CMBTN	1	0.88746104	0.996168209	0.991403868	3.875033
DOGUB	0	0.89602613	0	1	1.896026
EGSER	0.776005618	0.95980212	0.920054693	0.948384617	3.604247
GOLTS	0.678036816	0.97354019	1	0.945966333	3.597543
KUTPO	0.818409058	1	0.807494339	0.975181821	3.601085
NIBAS	0.54026	0.9386773	0.561297901	0.948532761	2.988768
NUHCM	0.708873724	0.94976791	0.961998918	0.959659122	3.5803
USAK	0.646237881	0	0.853587348	0	1.499825
					Σ Pi : 34.87155

Source: Authors' calculations

Table 14 presents the KiA**,** KiB**,** KiC, and final Ki results for 2013 obtained within the COCOSO method. These measures represent alternative performance aggregation forms derived from the weighted normalized decision matrix under different evaluation strategies embedded in the COCOSO framework. The final KiK_iKi values are obtained by integrating these components and constitute the basis for ranking the alternatives according to their overall performance levels in 2013.

Table 14. KiA**,** KiB**,** KiC and Ki Results of Companies for 2013

Company	**kiA**	**kiB**	**kiC**	**Ki**
AKCNS	0.101234872	9.28110654	5.963334682	6.891348319
BTCIM	0.099160288	8.434159596	5.920629021	6.522425963
CIMSA	0.091010922	6.784505083	5.651239332	5.692350683
CMBTN	0.116873409	11.92228833	6.512070549	8.269506381
DOGUB	0.048430308	2.264164714	3.995292791	2.862123747
EGSER	0.10394239	9.146955162	6.094174055	6.911113621
GOLTS	0.104632895	9.490270813	6.10466669	7.056538283
KUTPO	0.10317523	8.863342451	6.076589593	6.785609969
NIBAS	0.079795207	4.976798806	5.252452751	4.714051238
NUHCM	0.103581334	9.220538289	6.073351542	6.929244849
USAK	0.048163145	5.808005087	3.768452214	4.225942368

Source: Authors' calculations

Table 15 presents the ranking results of the companies for 2013 based on the final Ki values obtained from the COCOSO method. The ranking reflects the overall performance levels of the firms, where higher K_i values indicate superior performance within the evaluation framework.

Table 15. Companies Ranking for 2013

Company	K_i Value	Ranking
CMBTN	8.269506381	1
GOLTS	7.056538283	2
NUHCM	6.929244849	3
EGSER	6.911113621	4
AKCNS	6.891348319	5
KUTPO	6.785609969	6
BTCIM	6.522425963	7
CIMSA	5.692350683	8
NIBAS	4.714051238	9
USAK	4.225942368	10
DOGUB	2.862123747	11

Source: Authors' calculations

According to the results, CMBTN achieves the first rank, followed by GOLTS and NUHCM, indicating strong relative performance among the evaluated firms. In contrast, DOGUB is ranked last, reflecting the lowest overall performance in the sample for 2013.

Full-Period Performance Ranking Analysis (2013–2022)

Table 16 presents the overall ranking results of the companies for the full sample period (2013–2022) obtained using the COCOSO method. The rankings are based on the aggregated Ki values, which reflect the combined performance scores of each firm across all evaluation criteria and years. This comprehensive ranking provides a holistic assessment of firm performance over time, allowing for cross-period comparison of relative efficiency and stability.

Table 16. Financial performance rankings of firms based on the CoCoSo method

Company	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AKCNS	5 (6.8913)	4 (8.1365)	3 (8.5111)	3 (10.0478)	5 (8.9692)	5 (17.3665)	5 (7.2560)	5 (6.4454)	5 (5.2861)	6 (4.9809)
BTCIM	7 (6.5224)	7 (7.6536)	6 (7.6595)	7 (7.9495)	8 (7.0326)	6 (16.1965)	10 (4.7612)	10 (3.5179)	10 (3.8487)	9 (3.9649)
CIMSA	8 (5.6924)	9 (6.6155)	8 (5.7181)	10 (5.6616)	10 (4.6188)	10 (10.8297)	8 (5.7717)	8 (4.5285)	9 (3.8912)	10 (3.6831)
CMBTN	1 (8.2695)	1 (9.2978)	1 (9.2848)	1 (11.0770)	1 (10.5527)	2 (19.8550)	3 (7.5701)	4 (6.7370)	3 (5.9828)	4 (5.5004)

DOGUB	11 (2.8621)	11 (2.2351)	11 (2.2617)	11 (2.2354)	11 (2.2505)	11 (2.1877)	11 (2.8362)	11 (3.0319)	8 (4.7609)	11 (3.3464)
EGSER	4 (6.9111)	5 (8.0120)	4 (7.8452)	5 (8.9737)	2 (10.3287)	1 (20.6464)	4 (7.4423)	2 (7.4559)	1 (6.8470)	2 (5.8806)
GOLTS	2 (7.0565)	6 (7.7440)	7 (6.9338)	6 (8.0667)	6 (7.4348)	7 (16.1956)	6 (7.0316)	7 (5.7722)	7 (4.9886)	3 (5.5850)
KUTPO	6 (6.7856)	3 (8.1401)	5 (7.6635)	4 (9.4505)	4 (9.0871)	4 (18.0970)	1 (7.7916)	3 (6.7549)	6 (5.1849)	8 (4.3572)
NIBAS	9 (4.7141)	8 (6.8735)	9 (5.2907)	9 (6.0762)	9 (4.9871)	9 (11.8253)	9 (5.7271)	9 (3.9736)	11 (2.7624)	7 (4.5092)
NUHCM	3 (6.9292)	2 (8.3179)	2 (9.1873)	2 (10.7189)	3 (9.3301)	3 (18.6775)	2 (7.6308)	1 (7.5123)	2 (6.3692)	1 (6.0515)
USAK	10 (4.2259)	10 (5.6511)	10 (5.2766)	8 (7.0712)	7 (7.0823)	8 (14.6469)	7 (6.2714)	6 (6.4446)	4 (5.3515)	5 (5.1816)

Source: Authors' calculations

CMBTN demonstrates consistently strong performance, particularly in the early years, maintaining top-tier rankings in most periods (especially 2013–2016), which indicates stable and sustained efficiency within the evaluation framework. Similarly, NUHCM shows a relatively strong and stable performance trajectory, frequently appearing in the top three positions and reaching first place in 2020 and 2022, suggesting an improving trend in later years. In contrast, DOGUB exhibits persistently low performance throughout the entire period, remaining at the bottom of the ranking in almost all years. This indicates a structurally weak performance profile with limited variation over time. Overall, the ranking outcomes suggest that firms with stable profitability and efficient operational structures tend to achieve superior and more consistent performance levels across different methodological frameworks. In contrast, firms with weaker financial fundamentals exhibit persistent underperformance, indicating limited adaptability to sectoral and macroeconomic changes during the analysis period.

Other firms such as AKCNS, GOLTS, and KUTPO display moderate but fluctuating performance patterns. For instance, AKCNS generally remains in the upper-middle ranks but shows some decline in later years, while KUTPO experiences noticeable improvement in specific periods, particularly in 2018, where it achieves a top ranking. Likewise, EGSER shows strong variability, achieving top positions in some years (notably 2017–2021 range) but not maintaining a fully stable dominance.

Firms such as BTCIM, CIMSA, NIBAS, and USAK generally occupy lower-to-middle rankings, with relatively unstable trajectories over time. These fluctuations suggest that their performance is more sensitive to changes in financial conditions and evaluation criteria.

In summary, the results indicate that while some firms (notably CMBTN and NUHCM) exhibit consistent high performance, others display significant

volatility across the study period, highlighting heterogeneity in financial efficiency and competitiveness within the sample.

Robustness Test

To assess the stability and methodological robustness of the CoCoSo-based rankings, the MARCOS method was employed as an alternative multi-criteria decision-making framework. Table 17 summarizes the MARCOS-based ranking results.

Table 17. Robustness check results: Performance rankings based on the MARCOS method

Company	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AKCNS	3 (0.7153)	3 (0.7431)	3 (0.7393)	3 (0.7562)	4 (0.6588)	5 (0.7017)	7 (0.7299)	5 (0.6594)	5 (0.5012)	7 (0.5662)
BTCIM	7 (0.6320)	7 (0.6720)	5 (0.6223)	8 (0.5367)	8 (0.4702)	6 (0.6689)	9 (0.5201)	8 (0.4623)	10 (0.3835)	8 (0.5151)
CIMSA	9 (0.4871)	10 (0.5100)	9 (0.3434)	10 (0.2907)	10 (0.2203)	10 (0.3954)	8 (0.5410)	9 (0.3768)	9 (0.3980)	9 (0.4480)
CMBTN	1 (0.9492)	1 (0.9326)	1 (0.8533)	1 (0.8729)	1 (0.8480)	2 (0.8255)	1 (0.8029)	3 (0.7527)	3 (0.6378)	4 (0.7290)
DOGUB	11 (0.1383)	11 (0.1279)	11 (0.1232)	11 (0.0824)	11 (0.1289)	11 (0.0688)	11 (0.1363)	11 (0.1192)	8 (0.4267)	11 (0.1767)
EGSER	5 (0.6880)	5 (0.7097)	4 (0.6318)	5 (0.6154)	2 (0.7931)	1 (0.8466)	6 (0.7324)	2 (0.8105)	1 (0.8129)	2 (0.7975)
GOLTS	2 (0.7215)	6 (0.6758)	7 (0.5234)	7 (0.5473)	7 (0.4980)	7 (0.6607)	5 (0.7330)	7 (0.5630)	6 (0.4696)	3 (0.7548)
KUTPO	6 (0.6443)	4 (0.7188)	6 (0.5988)	4 (0.6682)	5 (0.6486)	4 (0.7184)	2 (0.7897)	6 (0.6191)	7 (0.4530)	10 (0.3815)
NIBAS	10 (0.3198)	9 (0.5374)	10 (0.2886)	9 (0.3141)	9 (0.2395)	9 (0.4244)	10 (0.4960)	10 (0.2927)	11 (0.1983)	6 (0.6123)
NUHCM	4 (0.6969)	2 (0.7626)	2 (0.8419)	2 (0.8339)	3 (0.6927)	3 (0.7615)	3 (0.7818)	1 (0.8734)	2 (0.7141)	1 (0.8383)
USAK	8 (0.5411)	8 (0.5451)	8 (0.4550)	6 (0.5660)	6 (0.5949)	8 (0.6510)	4 (0.7409)	4 (0.6984)	4 (0.5353)	5 (0.6586)

Source: Authors' calculations

The comparative analysis indicates a high degree of consistency between CoCoSo and MARCOS outcomes. In particular, firms such as NUHCM and EGSER maintain their relative top-tier positions, while DOGUB and CIMSA

remain persistently positioned in the lower performance segments across both methodologies.

This convergence suggests that the observed ranking structure is not highly sensitive to the choice of MCDM method and is largely consistent across alternative aggregation frameworks, indicating a stable underlying evaluation pattern.

Statistical Validation: Spearman Rank Correlation

To formally assess the degree of concordance between CoCoSo and MARCOS rankings, Spearman's rank correlation coefficients were computed for each year. Table 18 reports the resulting correlation statistics.

Table 18. Spearman rank correlation between CoCoSo and MARCOS results (2013–2022)

Year	Spearman ρ	p-value
2013	0.9455	$p < 0.001$
2014	0.9636	$p < 0.001$
2015	0.9636	$p < 0.001$
2016	0.9727	$p < 0.001$
2017	0.9818	$p < 0.001$
2018	1.0000	$p < 0.001$
2019	0.8818	$p < 0.001$
2020	0.9091	$p < 0.001$
2021	0.9909	$p < 0.001$
2022	0.9636	$p < 0.001$

Source: Authors' calculations

The coefficients range from 0.8818 to 1.0000, all of which are statistically significant at the $p < 0.001$ level. These values indicate a very high degree of ordinal agreement between the two ranking approaches. The consistently high correlation coefficients confirm that the ordinal ranking structure remains stable across different methodological specifications, thereby validating the robustness of the CoCoSo-based results.

However, it should be noted that the perfect correlation observed in 2018 ($\rho = 1.0000$) represents an extreme case of full rank alignment. The perfect correlation indicates complete agreement between the two ranking approaches for that year, suggesting that firm performance differences were sufficiently distinct to yield identical ordinal outcomes under both methods. The use of both MARCOS and Spearman correlation provides a two-layer robustness framework, ensuring both methodological and statistical consistency of the results.

Synthesis and Implications

The combined evidence from MEREC-weighted CoCoSo and MARCOS-based robustness analysis indicates a structurally stable performance hierarchy within the BIST non-metallic mineral products sector over the 2013–2022 period. The high degree of concordance between the two MCDM approaches, further supported by Spearman rank correlations, suggests that the derived rankings are not sensitive to the choice of aggregation technique. This strengthens the validity of the empirical findings. From a financial interpretation perspective, the sector appears to exhibit a dual structure driven primarily by profitability (EBM) and liquidity conditions (CUR), while leverage (LEV) plays a comparatively limited discriminatory role due to structural homogeneity across firms. For investors, the results imply that persistent outperformance is primarily associated with operational profitability efficiency rather than balance sheet structure alone. Accordingly, EBITDA-driven performance emerges as the central determinant of relative competitiveness in the Turkish non-metallic mineral products industry.

Overall, the findings suggest that profitability-related indicators dominate the financial performance structure of the sector, while liquidity and leverage play supporting but less differentiating roles. This pattern is consistent across all applied MCDM techniques, indicating that firm performance in capital-intensive industries is primarily driven by operational efficiency rather than capital structure composition.

Limitations and Future Research Directions

Despite the robust methodological framework and significant empirical findings, this study is subject to certain limitations that offer avenues for future research. Primarily, the performance evaluation is based exclusively on accounting-based financial ratios, which reflect historical operational efficiency. Future studies could enhance the scope of the analysis by incorporating market-based indicators (e.g., Tobin's Q, Market-to-Book ratio, or stock returns) to capture investors' expectations and market valuation dynamics. Additionally, integrating environmental and social governance (ESG) metrics could provide a more holistic assessment of corporate performance in the context of sustainable finance. Furthermore, future research could consider the application of hybrid machine learning–MCDM frameworks to improve predictive capability, as well as cross-country comparative analyses to assess whether the observed patterns are specific to the Turkish manufacturing sector or generalizable across similar industries.

5. Conclusion

This study investigated the financial performance of firms operating in the BIST Non-Metallic Mineral Products Sector over the period 2013–2022 by applying a multi-criteria decision-making framework. In this context, the MEREC method was used to derive objective criterion weights, while the CoCoSo method was employed to rank firms according to their overall performance. In addition, the MARCOS

method and Spearman rank correlation analysis were incorporated to test the robustness and consistency of the results.

The empirical results show that profitability, particularly measured through EBITDA Margin, is the most influential factor in explaining differences in firm performance. In contrast, leverage and liquidity indicators appear to have a relatively limited role in distinguishing between firms, while asset turnover remains moderately important. The consistency of findings across different methods further supports the reliability of the ranking results.

Robustness checks confirm a strong agreement between CoCoSo and MARCOS rankings, with statistically significant Spearman correlation coefficients observed for all years in the sample. This indicates that the overall ranking structure remains stable regardless of the methodological approach applied.

Overall, the findings suggest that firm performance in the sector is mainly driven by operational profitability rather than capital structure or short-term liquidity conditions. In other words, efficiency in core operations appears to be the key determinant of competitive strength in this industry over the examined period.

The findings of this study are generally consistent with the existing literature on financial performance evaluation in capital-intensive manufacturing industries, particularly within the cement and non-metallic mineral products sectors. Previous studies focusing on Turkish cement firms have similarly emphasized the dominant role of profitability and operational efficiency indicators in explaining firm performance differences. For example, Multi-Criteria Decision Making studies by Ertugrul and Karakasoğlu (2009) reported that profitability and efficiency-based criteria exert stronger influence on firm rankings compared to liquidity-related indicators in the Turkish cement industry. Likewise, Damodaran (2012) argues that EBITDA-based measures provide more reliable insights for evaluating capital-intensive firms because they better reflect operational profitability independent of financing and accounting effects. In this respect, the persistent dominance of EBITDA Margin within the MEREC weighting structure strongly supports the theoretical expectation that operational profitability constitutes the primary determinant of competitive strength in the sector.

Similarly, the relatively limited explanatory contribution of leverage-related indicators observed in this study is compatible with previous MCDM-based financial performance analyses conducted in manufacturing industries. Since firms operating in the same sector often exhibit structurally similar financing patterns, leverage ratios may possess weaker discriminatory power compared to profitability and efficiency measures. The findings are also parallel to recent studies employing objective weighting frameworks such as MEREC, where profitability-oriented criteria frequently emerge as the most influential variables within the ranking structure.

In methodological terms, the strong consistency between CoCoSo and MARCOS rankings further supports recent literature emphasizing the importance of robustness testing in multi-criteria financial performance analysis. The very high and statistically significant Spearman rank correlations indicate that the ranking structure remains highly stable across alternative compromise-based MCDM methods. This finding contrasts with some earlier studies suggesting that firm rankings may vary substantially depending on the selected weighting and aggregation procedures. Therefore, the present study contributes to the literature not only by providing sector-specific evidence for the BIST non-metallic mineral products industry, but also by demonstrating that integrating objective weighting procedures with robustness-testing frameworks can significantly strengthen the reliability and interpretability of financial performance evaluations.

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