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Financial Performance in the Post-Pandemic Normalization Process: An Entropy-MOORA Hybrid MCDM Model on BIST Transportation and Storage Companies

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ABSTRACT

Purpose: In the transportation and storage sector, which constitutes the backbone of global supply chains, the intense competition and high capital requirements experienced in recent years have made the effective management of financial resources and the multidimensional measurement of performance critical. This study aims to evaluate the financial performance of 13 transportation and storage companies listed on Borsa Istanbul (BIST) for the 2022-2024 period by using an integrated Multi-Criteria Decision-Making (MCDM) framework.

Methodology**:** In the analysis, 13 financial ratios were weighted using the objective Entropy method, and company rankings were derived via the MOORA approach. The robustness of the model was systematically validated in two stages through scenario-based analyses and comparisons with the ARAS, TOPSIS, COPRAS, and VIKOR methods.

Findings: The findings indicate that operational efficiency (specifically receivables and inventory turnover) and liquidity quality were the primary determinants of performance, while the relative importance of profitability indicators increased towards 2024. The ranking results identify GRSEL and TLMAN as consistently top-performing firms, whereas TAVHL and RYSAS exhibited weaker performance.

Originality: Consequently, this study contributes a current and evidence-based perspective to the literature by demonstrating with methodological robustness that sustainable competitiveness is achieved through efficiency and debt optimization rather than profitability.

Keywords*:* Financial Performance, Transport and Storage Companies, MCDM, Entropy, MOORA.
JEL Codes: C61, D81, L25, R40.

Pandemi Sonrası Normalleşme Sürecinde Finansal Performans: BIST Ulaştırma ve Depolama Şirketleri Üzerine Entropi-MOORA Hibrit ÇKKV Modeli

ÖZET

Amaç: Küresel tedarik zincirlerinin belkemiği olan ulaştırma ve depolama sektöründe son yıllarda yaşanan yoğun rekabet ve yüksek sermaye gereksinimi, finansal kaynakların etkin yönetimini ve performansın çok boyutlu ölçümünü kritik bir hale getirmiştir. Bu çalışma, Borsa İstanbul'da (BIST) işlem gören 13 ulaştırma ve depolama şirketinin 2022-2024 dönemi finansal performansını, bütünleşmiş Çok Kriterli Karar Verme (ÇKKV) çerçevesi kullanarak değerlendirmeyi amaçlamaktadır.

Yöntem**:** Analizde, 13 finansal oran objektif Entropi yöntemi kullanılarak ağırlıklandırılmış ve MOORA yaklaşımı ile şirket sıralamaları elde edilmiştir. Modelin tutarlılığı, senaryo bazlı analizler ve ARAS, TOPSIS, COPRAS, VIKOR yöntemleriyle yapılan karşılaştırmalarla iki aşamalı sistematik olarak doğrulanmıştır.

Bulgular: Bulgular, operasyonel verimlilik (özellikle alacaklar ve stok devir hızı) ve likidite kalitesinin performansın temel belirleyicileri olduğunu, kârlılık göstergelerinin göreceli öneminin ise 2024'e doğru arttığını göstermektedir. Sıralama sonuçları GRSEL ve TLMAN'ı sürekli olarak en iyi performans gösteren şirketler olarak belirlerken, TAVHL ve RYSAS daha zayıf performans göstermiştir.

Özgünlük: Sonuç olarak, sürdürülebilir rekabetin kârlılıktan ziyade verimlilik ve borç optimizasyonuyla sağlandığını metodolojik sağlamlıkla ortaya koyan bu çalışma, literatüre güncel ve kanıta dayalı bir perspektif kazandırmaktadır.

Anahtar Kelimeler*:* Finansal Performans, Ulaştırma ve Depolama Şirketleri, ÇKKV, Entropi, MOORA.
JEL Kodları: C61, D81, L25, R40.

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1. INTRODUCTION

In recent decades, the globalisation of financial markets, intensified competition and rapid macroeconomic shifts have heightened uncertainty and volatility within corporate decision-making environments. Under these conditions, traditional single-indicator evaluations, such as profit-only comparisons, often fail to capture the multi-dimensional nature of firm performance; consequently, the integration of financial theory with quantitative modelling has become increasingly salient (Zopounidis and Doumpos, 2002). In the contemporary competitive landscape, an accurate and comparable assessment of financial performance is critical not only for managers but also for investors and creditors, as it facilitates efficient resource allocation, risk management and resilience against future shocks (Yabuuchi, 2013; Inani and Gupta, 2017; Dong et al., 2018).

Financial performance is a multidimensional concept encompassing diverse elements such as profitability, productivity, firm-level growth and value creation; it is widely regarded as a fundamental indicator of managerial effectiveness (Cheng et al., 2012; Abdel-Basset et al., 2020). For company managers, creditors and investors, a reliable and accurate assessment of corporate financial performance is of strategic importance (Farrokh et al., 2016; Tsolas, 2020). Financial outcomes reflect the measurable achievement of organisational objectives; accordingly, management teams can formulate prudent budgets, whilst investors can shape their investment decisions based on risk-return analyses (Lam et al., 2021). However, evaluating the success of modern and complex organisations presents a significant challenge. Profit generation alone, often presented as a single performance criterion, is insufficient. Managers require multiple criteria that extend beyond earnings per share to capture the key determinants of organisational success (Chan and Lynn, 1991). Within this evaluation process, financial ratios constitute some of the most widely used and appropriate metrics, as they effectively reflect the financial condition of firms alongside their strengths and weaknesses (Dong et al., 2018; Lam et al., 2021). Accounting scholars suggest that these ratios should be grouped into specific clusters to avoid repetitive assessments based on similar indicators (Rezaie et al., 2014). Consequently, ranking firms based on financial ratios to determine competitive positions and formulate appropriate strategies constitutes a cornerstone of rational decision-making processes in the business environment (Abdel-Basset et al., 2020; Lam et al., 2021).

Given that it involves multiple evaluation criteria, financial performance measurement is inherently categorised as a MCDM problem (Yalçın and Ünlü, 2018; Dong et al., 2018). MCDM methods are widely utilised techniques amongst academics and investors, as they provide decision support by integrating the assessment of alternatives under potentially conflicting qualitative and quantitative criteria (Türegün, 2022; Baydaş and Pamučar, 2022). These methods facilitate simplicity and practicality in performance assessment by transforming complex, multi-criteria data into a single composite score; thereby, they enable meaningful comparability amongst competing firms even in highly complex decision-making scenarios (Danesh et al., 2017).

The primary objective of MCDM is not to prescribe a single 'correct' decision; rather, it aims to support decision-makers in selecting the most appropriate alternative that best satisfies their evaluation criteria (Chan et al., 2014; Vatankhah et al., 2019). In this process, the determination of criterion weights directly influences the outcomes. Alongside subjective weights based on expert judgement, the utilisation of objective weights derived from the characteristics of the dataset is of paramount importance for generating data-driven, less subjective and more reproducible rankings (Kaya et al., 2024). Since the 1960s, numerous MCDM methods have been developed to offer distinctive advantages for decision-making under uncertainty, and these methods have produced successful results across a wide range of industrial sectors (Pineda et al., 2018; Türegün, 2022). In response to globalisation, transportation and storage companies have assumed increasingly comprehensive and strategic roles, evolving into more sophisticated structures to meet the growing demands of global supply chains. Although these firms are often preferred for their levels of specialisation and technological capabilities, achieving a competitive advantage in the sector fundamentally depends on operational and financial performance. Strong financial performance, reflected in profitability, efficiency, liquidity strength and financial resilience, is vital for maintaining long-term competitiveness in this sector. Effective financial management extends beyond short-term cost minimisation to encompass efficient resource allocation and the strategic management of risks. Consequently, sustaining sound financial performance is a primary priority for the transportation and storage sector, as it is for all industries (Oztemiz et al., 2025). In this context, this research evaluates the financial standing of transportation and storage firms traded on BIST over the 2022-2024 timeframe, utilizing a hybrid MCDM model that integrates Entropy and MOORA (Multi-Objective Optimisation on the Basis of Ratio Analysis) techniques. Specifically, the Entropy approach was applied to determine the objective weights of the performance criteria, while the final ranking of the companies was derived using the MOORA method. Furthermore, a two-level sensitivity analysis was conducted to test the robustness and stability of the proposed Entropy-MOORA hybrid MCDM model. The sample consists of 13 companies, including 12 transportation and storage firms listed on BIST and TAVHL (TAV Airports Holding Inc.), which operates in airport operations and related aviation services. The companies included in the study were selected from various sub-segments that reflect the multidimensional structure of the Turkish transportation and storage industry. These internationally active firms operate in areas such as logistics-related services, ground handling services, port operations, fleet leasing, and air, land and maritime transportation; they represent leading players within the sector. With these characteristics, the selected companies are intended to reflect the dynamism and strategic importance of Türkiye’s transportation and storage sector (Oztemiz et al., 2025). The selection criteria required that the companies had been actively traded on the stock exchange during the 2022-2024 period and that complete data were available for all financial ratios used in the analysis. Within the scope of the study, 13 financial ratios were employed as evaluation criteria and grouped under four main categories: liquidity, financial structure, profitability and operational efficiency. The choice of financial indicators was grounded in a broad analysis of the relevant academic literature.

The COVID-19 pandemic, which rapidly intensified its global impact from 2020 onwards, caused unprecedented disruptions in global supply chains and placed the transportation and storage sector at the very epicentre of the crisis. As the acute phase of the pandemic was largely left behind and the normalisation process commenced, fluctuating freight rates, shifting consumer habits, and supply chain restructurings emerged as new financial challenges for companies. Consequently, the multidimensional measurement of transportation companies' capacity to adapt to this post-pandemic new normal, alongside their operational resilience, is of paramount importance. Whilst existing studies in the literature generally focus on the pre-pandemic context or the acute crisis phase of the pandemic, this research provides an up-to-date perspective to the literature by elucidating the distinct financial dynamics of the 2022 to 2024 post-pandemic normalisation period. Ultimately, the primary rationale for selecting the 2022 to 2024 timeframe for analysis is the necessity to observe the actual financial responses exhibited by firms during the reopening, rebalancing, and normalisation phases of economies and supply chains following the acute shocks induced by the global pandemic. From a methodological standpoint, this research goes beyond merely presenting a performance ranking; it establishes a highly robust and evidence-based decision support framework for both investors and managers by testing the validity of the proposed Entropy-MOORA hybrid model in two stages, utilising weight scenarios and four alternative MCDM methods (ARAS, TOPSIS, COPRAS, and VIKOR).

This study aims to identify critical financial ratios that directly influence financial performance, thereby providing actionable implications for enhancing firm value within the transportation and storage sector. Furthermore, it seeks to offer strategic recommendations to strengthen the competitive positions of these companies. Whilst emphasising the significance of financial performance for managers, investors and industry stakeholders, the study provides a roadmap for the more effective implementation of financial management practices to support sustainable growth. Moreover, the proposed model serves as a reference tool for investors by facilitating the identification of top-performing companies and supporting the formulation of optimal portfolio decisions. Within this framework, the study is organized as follows: Section 2 presents the literature review. Section 3 outlines the research gap, demonstrating the specific void in the literature that this study addresses. Section 4 describes the methodology, encompassing the Entropy weighting approach, the MOORA ranking procedure, the dataset, and the application process; it also details the two-level sensitivity and robustness analysis. Section 5 reports the empirical results, including criterion weights, firm rankings, and robustness findings. Section 6 discusses these findings in relation to the sector context and prior evidence. Finally, Section 7 concludes the study by summarizing the main implications, offering recommendations, and outlining limitations alongside directions for future research.

2. LITERATURE REVIEW

In the initial section of this literature review, Türkiye-focused studies evaluating financial performance within the BIST transportation and storage ecosystem using MCDM methods are reviewed and summarised in a tabular format. Subsequently, selected studies from the international literature addressing the financial performance of transportation and storage companies are briefly examined. Thereafter, representative studies employing the Entropy and MOORA methods in financial performance analysis are presented to illustrate the methodological foundation of the proposed approach. Finally, a comprehensive evaluation of the existing literature is provided; the position of the present study within this context is clarified, and the academic gap that this research aims to address is explicitly identified.

Table 1. Literature on BIST transportation and storage firms

Study	*Number of Firms / Period*	*Method(s)*	*Main Findings*
Kendirli and Kaya (2016)	7/2010-2013	Equal Weights, TOPSIS	DOCO ranked among the top two firms in all years, while CLEBI ranked within the top four.
Tufan and Kılıç (2019)	6/2014-2018	TOPSIS, VIKOR	The lowest-performing firms were RYSAS and GSDDE; the highest-performing were TLMAN, CLEBI, and PGSUS.
Oral and Kıpkıp (2019)	8/2014-2018	Equal Weights, TOPSIS, PROMETHEE	TLMAN, BEYAZ, CLEBI, and DOCO showed the best performance, whereas THYAO, RYSAS, and GSDDE exhibited weak performance.
Gümüş and Çıbık (2019)	8/2016-2017	AHP, MOORA, VIKOR	TLMAN was identified as the best-performing company.
Ersoy (2020)	8/2016-2018	Equal Weights, GRA	BEYAZ and CLEBI demonstrated the strongest financial performance.
Sakarya and Aksu (2020)	5/2013-2017	Entropy, TOPSIS	The best-performing firms by year were RYSAS, CLEBI, CLEBI, BEYAZ, and CLEBI, whereas the worst-performing firms by year were THYAO, BEYAZ, RYSAS, PGSUS, and THYAO.
Pala (2021)	7/2019-2020	Entropy, CILOS, IDOCRIW, MARCOS	Debt ratio, asset turnover, and return on equity were key criteria; TLMAN and BEYAZ performed well.
Elmas and Özkan (2021)	8/2015-2019	SWARA, OCRA	The study identified asset turnover, return on assets, and the quick ratio as the primary determinants, with DOCO and BEYAZ emerging as the top performers.
Alnıpak and Kale (2021)	10/2008-2020	OCRA	The sector experienced severe pandemic effects and its weakest financial performance during this period.
Sakarya and Saçkes (2022)	8/2018-2020	AHP, GRA	TLMAN showed the best performance, while THYAO had the weakest performance.
Kınalı (2022)	6/2016-2020	Entropy, TOPSIS	CLEBI and RYSAS emerged as the top performers, whereas BEYAZ and GSDDE demonstrated the weakest results.
Kefe (2023)	11/2020-2022	DuPont Analysis	TLMAN exhibited the highest overall performance.
Ayaz and Ömürbek (2023)	6/2019-2020	CRITIC, PROMETHEE	TLMAN, RYSAS, and THYAO showed strong performance; PGSUS, CLEBI, and GSDDE performed poorly.
İyigün (2024)	9/2022	Entropy, OCRA	The most important criteria were debt-to-equity and return on assets; GSDDE, TLMAN, and PGSUS ranked highest.
Özarı (2024)	10/2017-2021	Entropy, EDAS, COPRAS	Firms produced divergent results in terms of bankruptcy risk and financial performance; strong positive Spearman correlations were found except for 2017.
Durmuş (2025)	12/2023	Entropy, WASPAS	Return on equity was the most important criterion; PGSUS showed the best performance.
Kahramani-Koç and Öztürk (2025)	7/2013-2022	Entropy, MAIRCA, MABAC	CLEBI (4 times), GSDDE (3 times), and PGSUS/BEYAZ/RYSAS (once each) ranked highest; GSDDE and PGSUS/BEYAZ frequently ranked lowest.
Oztemiz et al. (2025)	9/2022-2024	SIWEC, MEREC, LODECI, CoCoSo	Top three firms were TLMAN-GSDDE-CLEBI (2022), TLMAN-RYSAS-GRSEL (2023), and RYSAS-CLEBI-TLMAN (2024); BEYAZ showed the weakest performance.

Note: AHP denotes the Analytic Hierarchy Process, whereas GRA stands for Grey Relational Analysis

Within the international literature regarding the transportation and storage sector employing MCDM methods, Feng and Wang (2000) examined five airline companies within a model developed to measure financial performance. In the initial stage of their study, 22 financial ratios covering liquidity, asset efficiency, fleet structure, labour and flight equipment were identified; financial performance was subsequently assessed using GRA and TOPSIS methods. Focusing on the competitiveness and financial performance of airline companies in the East Asian region, Chang et al. (2003) analysed ten firms. In their integrated framework, Fuzzy AHP was employed to determine the relative importance of evaluation criteria, whilst TOPSIS was utilised to obtain the final financial performance rankings. Lee et al. (2012) concentrated on the maritime transportation sector by comparing the financial conditions of companies based in Taiwan and South Korea. The analysis utilised 21 financial indicators, including profitability, cash flow, leverage, liquidity, return on investment and operational ratios. Whilst the Entropy method (an objective weighting approach) was applied to determine criterion weights, company performance rankings were derived using Grey Relational Analysis. In the field of container transportation, Wang (2014) analysed the financial performance of three major companies in Taiwan. In this study, 21 financial ratios grouped under solvency, financial structure, profitability and operational efficiency were initially clustered using GRA; subsequently, 15 representative ratios with high explanatory power were included in the final analysis. Following a weighting process supported by expert judgement and fuzzy logic, company rankings were obtained using the Fuzzy TOPSIS method. Addressing the Indonesian transportation sector, Rosini and Gunawan (2018) analysed the financial performance of 20 companies using data from 2015. In their study, equity and total assets were selected as input variables, whilst net profit and revenue were treated as output variables; the analysis employed Data Envelopment Analysis (DEA) and TOPSIS methods. A more recent study by Ceyhan and Karapolat (2025) investigated the financial impact of the COVID-19 pandemic on the global aviation sector. The authors compared pre-pandemic (2015-2019) and pandemic-period (2020–2021) data for 20 internationally operating airline companies. In the study, 15 financial ratios grouped under liquidity, profitability, financial structure and operational efficiency were weighted using the Entropy method, whilst TOPSIS and PROMETHEE were applied for performance ranking. To test differences between the two periods, Spearman rank correlation analysis was conducted, confirming that the applied methods produced broadly comparable results across periods. Although the findings indicate that the pandemic generally had a negative impact on financial performance, some carriers (such as Emirates and Delta Airlines) were reported to show relatively better performance during the pandemic period, which the authors associate with firm-specific financial policies and operational adaptability.

The accurate and objective measurement of financial performance constitutes the foundation of strategic decision-making for investors, corporate managers and stakeholders. In this context, MCDM techniques, which allow multiple financial ratios to be evaluated simultaneously, occupy a significant position within the literature. Within the methodological framework of this study, the Entropy method is distinguished as an effective tool for determining criterion weights based on objective, data-driven information; conversely, the MOORA Ratio method is prominent for ranking alternatives according to their performance under these weights. In recent years, the integrated use of these two methods in the financial analysis of companies listed on BIST has been successfully adapted across various sectors and indices. A review of the literature indicates that Entropy and MOORA Ratio have been widely applied in a broad range of contexts, spanning from banking to technology and from manufacturing to services. Within the banking and finance sector (one of the fundamental pillars of the financial system), Çilek and Karavardar (2021), Ünvan and Ergenç (2022), Erben Yavuz et al. (2023), Vatansever and Öztemiz (2025), Karadağ Ak et al. (2025) focused on banks; Bektaş (2023) examined financial leasing and factoring companies; Şeyranlıoğlu and Kara (2024) analysed brokerage firms; and Kartal and Özdil (2024) evaluated insurance companies using these methods. Applications within the manufacturing and energy sectors are equally diverse. Turunç and Ersoy (2023) investigated the basic metal industry and Topal (2024) examined the stone and earth-based industries. Furthermore, Kavas et al. (2023) focused on the electricity, gas and steam sector, whilst Çanakçıoğlu and Özarı (2025) analysed the performance of energy companies more broadly. Collectively, these studies suggest that the approach can yield stable and interpretable results when analysing financial data in capital-intensive industries. Recent studies have also addressed service, trade and technology-oriented sectors. For instance, Coşkun and Çetiner (2022) evaluated tourism firms; Çilek and Şeyranlıoğlu (2024) examined retail trade companies; Akın and Aktan (2024) focused on health sector firms; and Satır (2024) analysed information technology companies. Beyond sectoral classifications, researchers have also explored thematic indices; for example, Kara and Şeyranlıoğlu (2023) examined firms included in the sustainability index using these methods. Overall, this literature review covering the last five years indicates that Entropy and MOORA have become widely utilised analytical tools for measuring financial performance within the BIST context, although results may still be sensitive to the choice of criteria, weighting strategy and ranking technique.

3. RESEARCH GAP and CONTRIBUTION

The transportation and storage sector constitutes a strategic pillar of Türkiye's economy due to the country's unique position as a global logistics bridge. In the volatile post-pandemic environment of 2022 to 2024, accurately assessing the financial resilience of these capital-intensive firms is essential for sustainable growth. A review of the existing literature indicates that while BIST transportation firms have been evaluated using various MCDM techniques, evidence remains limited regarding the specific financial dynamics of the normalization period. Furthermore, prior studies frequently omit rigorous robustness checks or report them only in a limited capacity. This study bridges these gaps by establishing an up-to-date and data-driven assessment framework. It integrates the Entropy method for objective weighting with the MOORA approach for ranking to analyse the specific conditions of the post-pandemic phase. Distinct from previous research, this study systematically validates its rankings through a two-level sensitivity analysis that includes scenario-based weight changes and cross-method comparisons with ARAS, TOPSIS, COPRAS, and VIKOR. The primary rationale for selecting these methods is that each employ distinct mathematical algorithms within the decision-making process. Whilst TOPSIS (Hwang et. al, 1993; Lai et. al, 1994) and VIKOR (Opricovic and Tzeng, 2004) utilise the principle of distance to the ideal solution, ARAS (Zavadskas and Turskis, 2010) is predicated on the proportional superiority of alternatives relative to one another (the utility function); COPRAS (Zavadskas et. al., 1994), conversely, operates directly to maximise or minimise the importance weights of the criteria. This algorithmic diversity provides a robust and objective validation instrument to demonstrate the degree to which the derived MOORA ranking is resilient against differing mathematical approaches (Brauers and Zavadskas, 2006). This comprehensive validation design strengthens the credibility of the proposed model for both managerial and investment-oriented decision contexts.

4. METHODOLOGY

4.1. Entropy Method

Rooted in information theory, the Entropy method is a frequently employed technique for establishing objective criterion weights in multi-criteria decision-making contexts (Shannon, 1948; Hwang and Yoon, 1981: 52; Zeleny, 1982: 190). This method aims to assign higher weights to criteria carrying greater information content; specifically, it favours criteria with higher discriminating power amongst alternatives by measuring the degree of regularity or uncertainty in the distribution of observations within each criterion column. Conversely, criteria exhibiting more homogeneous distributions are assigned lower weights (Wang and Lee, 2009; Mukhametzyanov, 2021). Fundamentally, Entropy-based weighting relies upon the internal variation structure of the data rather than the subjective judgements of the researcher, thereby strengthening the objectivity of the MCDM process (Bakır and Atalık, 2018). The Entropy method consists of the following steps (Ecer, 2020: 54-55):

Step 1. Construction of the decision matrix: The decision matrix of an MCDM problem can be represented, as shown in Equation 1, by m alternatives and n decision criteria.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \qquad (1)$$

Step 2. Construction of the normalized (standardized) decision matrix: In order to allow criteria measured on different scales to be evaluated simultaneously, the initial decision matrix must be normalized. The normalization procedures for benefit (maximum) and cost (minimum) criteria are presented in Equations 2 and 3, respectively.

$$r_{ij} = \frac{x_{ij}}{\max_j x_{ij}}, \text{ (i = 1,2, …, m; j = 1,2,…,n)} \qquad (2)$$

$$r_{ij} = \frac{\min_j x_{ij}}{x_{ij}}, \ \min_j x_{ij} \neq 0, \text{ (i = 1,2, …, m; j = 1,2,…,n)} \qquad (3)$$

Step 3. Calculation of entropy values for the criteria: The normalized values used to compute the entropy measures are obtained using Equation 4.

$$f_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} \qquad (4)$$

Using the normalized values obtained in Equation 4, the entropy values of all criteria are calculated by applying Equation 5.

$$e_j = -\frac{\sum_{i=1}^{m} f_{ij} \ln f_{ij}}{\ln m} \qquad (5)$$

Step 4. Calculation of Entropy weights: The Entropy weights of all criteria are determined using Equation 6.

$$w_j = \frac{1 - e_j}{n - \sum_{j=1}^{n} e_j}, \qquad (6)$$

4.2. MOORA Method

Decision-making requires measurable criteria to compare options and identify the best solution. Therefore, MCDM approaches are widely utilized for ranking or selecting alternatives within contexts involving a multitude of conflicting objectives (Ecer, 2020: 232). The MOORA method constitutes one such approach. Introduced by Brauers and Zavadskas in 2006, MOORA possesses distinct advantages over other MCDM techniques (Yıldırım and Önder, 2018; Arslankaya and Göraltay, 2019). These benefits include computational efficiency, mathematical simplicity, ease of implementation and the capability to yield stable results. Furthermore, the method facilitates the simultaneous consideration of all objectives and provides a holistic treatment of the interactions between alternatives and criteria (Ceyhan and Demirci, 2017). The procedural steps of the MOORA method are outlined below (Brauers and Zavadskas, 2006):

Step 1. Construction of the decision matrix: Equation 7 defines the structure of the decision matrix, which consists of m alternatives evaluated against n distinct criteria.

$$X = [x_{ij}]mxn \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \tag{7}$$

Step 2. Normalization of the decision matrix: The MOORA approach standardizes the decision matrix by converting it into a dimensionless state. This is optimally accomplished through vector normalization, where the denominator is calculated as the square root of the sum of squares for each criterion (Equation 8).

$$x_{ij}^* = \frac{xij}{\sqrt[2]{\sum_{j=1}^{m} x_{ij}^2}} \ , \ i = \overline{(1,n)} \ ; \ j = \overline{(1,m)} \ ; \ x_{ij}^* \in [0,1] \tag{8}$$

Step 3. Calculation of the weighted normalized matrix: The weighted normalized matrix is obtained by multiplying the values of the normalized decision matrix by the corresponding criterion weights. This procedure is expressed in Equation 9.

$$\tilde{x} = [\tilde{x}_{ij}]mxn \ = \begin{bmatrix} \tilde{x}_{11} & \cdots & \tilde{x}_{1n} \\ \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \cdots & \tilde{x}_{mn} \end{bmatrix} \tag{9}$$

Step 4. Derivation of the ranking: Using Equation 10, the net performance value is established by calculating the difference between the aggregate of weighted maximization attributes and the aggregate of weighted minimization attributes.

$$\tilde{y}_j^* = \sum_{i=1}^{g} w_j \ \tilde{x}_{ij} \quad - \quad \sum_{i=g+1}^{n} w_j \ \tilde{x}_{ij} \tag{10}$$

The alternatives are ranked in descending order based on their calculated performance scores; the alternative with the highest score is regarded as the best choice.

4.3. Data Set

This quantitative research evaluates the financial performance of 13 companies in the BIST transportation and storage sector utilizing MCDM techniques. The study sample encompasses 12 transportation and storage firms listed on BIST for the 2022-2024 period, along with TAV Airports Holding Inc., which specializes in airport operations. The initial phase of the analysis focused on defining the decision parameters and alternatives. Accordingly, the assessment employed liquidity, financial structure, profitability, and operational efficiency ratios calculated from the companies' public financial reports. These criteria were selected based on a review of relevant literature and are detailed in Table 2.

Table 2. Financial indicators utilized for corporate performance evaluation

Financial Ratio Group	*Symbol*	*Subcategory*	*Ratio Calculation*	*Objective*
Liquidity Ratios	R1	Current Ratio	Current Assets / Short-Term Liabilities	Max
	R2	Quick Ratio	(Current Assets − Inventories) / Short-Term Liabilities	Max
	R3	Cash Ratio	(Cash and Cash Equivalents + Marketable Securities) / Short-Term Liabilities	Max
Financial Structure Ratios	R4	Debt-to-Total Capital Ratio	Total Liabilities / Total Capital	Min
	R5	Short-Term Debt to Assets Ratio	Total Short-Term Liabilities / Total Assets	Min
	R6	Equity-to-Assets Ratio	Equity / Total Assets	Max
	R7	Debt-to-Equity Ratio	Total Liabilities / Equity	Min
Profitability Ratios	R8	ROA	Net Income / Total Assets	Max
	R9	ROE	Net Income / Equity	Max
	R10	Net Profit Margin	Net Income / Net Sales	Max
Operational Efficiency Ratios	R11	Asset Turnover Ratio	Net Sales / Total Assets	Max
	R12	Receivables Turnover Ratio	Net Sales / Short-Term Trade Receivables	Max
	R13	Inventory Turnover Ratio	Cost of Goods Sold / Inventories	Max

Source: Bolak (1998); Akdoğan and Tenker (2001); Akgüç (2010); Elmas and Ardıç (2018)
Note: Short-Term Liabilities (STL), Return on Assets (ROA), Return on Equity (ROE).

The study's alternatives consist of 13 firms whose data was accessible for the 2022-2024 duration. The specific publicly listed companies selected for analysis are detailed in Table 3.

Table 3. Companies in the BIST Transportation Sector

No.	*Code*	*Company Name*
1	BEYAZ	Beyaz Fleet Vehicle Leasing Inc.
2	CLEBI	Çelebi Air Services Inc. / Ground Handling
3	GRSEL	Gür-Sel Tourism Transportation and Shuttle Services Inc.
4	GSDDE	GSD Maritime, Real Estate and Construction Industry and Trade Inc.
5	HOROZ	Horoz Logistics Cargo Services and Trade Inc.
6	HRKET	Hareket Project Transportation and Heavy Lift Engineering Inc.
7	PASEU	Pacific Eurasia Logistics Foreign Trade Inc.
8	PGSUS	Pegasus Air Transportation Inc.
9	RYSAS	Reysaş Transportation and Logistics Trade Inc.
10	TAVHL	TAV Airports Holding Inc.
11	THYAO	Turkish Airlines Inc.
12	TLMAN	Trabzon Port Operations Inc.
13	TUREX	Tureks Tourism Transportation Inc.

Upon examination of the data for 2023 and 2024, it was observed that certain profitability ratios exhibited negative values (refer to Appendix 1 and Appendix 2). Transformation approaches applicable to decision matrices containing negative values were comprehensively discussed by Ersoy (2021). Within the context of the PIV method, Ersoy (2021) empirically demonstrated that matrix elements should be mapped to the 0 to 1 interval; furthermore, min-max normalisation was identified as the most suitable technique for handling negative values for this purpose. Within the scope of this research, the Entropy method was applied on an annual basis to objectively determine the discriminating power of the criteria and to compute criterion importance weights. For ratios containing negative values, the min-max normalisation recommended in the literature was employed to transform all observations into the 0 to 1 range. The resulting Entropy weights were subsequently incorporated into the MOORA procedure by constructing the weighted normalised decision matrix, and annual composite performance scores were calculated for each company. Accordingly, companies were ranked in descending order for the years 2022, 2023 and 2024. The findings are presented in tables and figures to demonstrate both annual changes in criterion importance and the variation in the relative financial performance of transportation companies. All computations were performed using Microsoft Excel 365; subsequently, calculations were cross-checked through manual verification to ensure accuracy.

4.4. Application Process

4.4.1. Entropy Method Application Steps

The analytical procedure was demonstrated using data from 2022. Detailed tables covering the remaining years are included in the Appendix.

Step 1. Formation of the initial decision matrix: Using the data for 2022, the initial decision matrix was constructed based on liquidity, financial structure, profitability, and operational efficiency ratios, as presented in Table 4.

Table 4. 2022 Initial decision matrix

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	1.210	0.790	20.140	74.560	73.510	25.440	293.140	1.590	0.400	5.590	3.940	15.150	14.980
CLEBI	1.490	1.440	95.670	59.610	26.580	34.690	171.850	15.980	17.790	52.090	0.900	10.740	80.190
GRSEL	1.470	1.450	47.970	46.780	22.630	52.290	89.450	11.980	9.360	23.460	1.280	8.560	578.950
GSDDE	5.390	5.340	530.640	25.540	8.420	74.460	34.300	3.900	12.140	5.330	0.320	176.760	84.110
HOROZ	0.630	0.600	2.730	76.960	57.750	22.180	347.050	11.500	7.460	60.040	1.540	5.690	105.000
HRKET	0.820	0.690	16.280	48.580	16.360	49.750	97.650	3.500	11.440	7.590	0.310	4.160	20.370
PASEU	1.030	0.850	3.280	79.600	55.450	20.400	390.160	23.760	10.250	115.020	2.320	4.240	106.000
PGSUS	1.000	0.970	61.750	81.160	21.670	18.840	430.920	9.550	16.620	57.000	0.570	35.040	77.770
RYSAS	0.970	0.930	50.680	82.950	34.530	17.750	467.320	4.900	7.980	23.310	0.610	10.820	70.440
TAVHL	1.030	0.900	55.950	72.060	17.280	27.470	262.320	2.790	10.370	9.950	0.270	7.850	15.620
THYAO	0.880	0.830	57.060	68.640	26.620	31.360	218.910	10.170	15.240	34.870	0.670	16.900	44.900
TLMAN	3.420	3.280	239.740	21.790	12.740	78.210	27.860	41.630	51.480	53.740	0.810	30.460	110.400
TUREX	1.070	0.980	17.210	36.000	24.060	63.970	56.270	1.600	0.940	2.480	1.700	10.630	68.520
MAX	5.390	5.340	530.640	82.950	73.510	78.210	467.320	41.630	51.480	115.020	3.940	176.760	578.950
MIN	0.630	0.600	2.730	21.790	8.420	17.750	27.860	1.590	0.400	2.480	0.270	4.160	14.980

Step 2. Formation of the normalized decision matrix: Normalization was executed via Equation 2 for maximization (benefit) criteria and Equation 3 for minimization (cost) criteria. In this process, benefit indicators in Table 4 were standardized by dividing each entry by the column's maximum, while cost indicators were derived by dividing the column's minimum by the specific entry. Consequently, the entire 2022 dataset was normalized.

Table 5. Normalized Values for the Year 2022

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.224	0.148	0.038	0.292	0.115	0.325	0.095	0.038	0.008	0.049	1.000	0.086	0.026
CLEBI	0.276	0.270	0.180	0.366	0.317	0.444	0.162	0.384	0.346	0.453	0.228	0.061	0.139
GRSEL	0.273	0.272	0.090	0.466	0.372	0.669	0.311	0.288	0.182	0.204	0.325	0.048	1.000
GSDDE	1.000	1.000	1.000	0.853	1.000	0.952	0.812	0.094	0.236	0.046	0.081	1.000	0.145
HOROZ	0.117	0.112	0.005	0.283	0.146	0.284	0.080	0.276	0.145	0.522	0.391	0.032	0.181
HRKET	0.152	0.129	0.031	0.449	0.515	0.636	0.285	0.084	0.222	0.066	0.079	0.024	0.035
PASEU	0.191	0.159	0.006	0.274	0.152	0.261	0.071	0.571	0.199	1.000	0.589	0.024	0.183
PGSUS	0.186	0.182	0.116	0.268	0.389	0.241	0.065	0.229	0.323	0.496	0.145	0.198	0.134
RYSAS	0.180	0.174	0.096	0.263	0.244	0.227	0.060	0.118	0.155	0.203	0.155	0.061	0.122
TAVHL	0.191	0.169	0.105	0.302	0.487	0.351	0.106	0.067	0.201	0.087	0.069	0.044	0.027
THYAO	0.163	0.155	0.108	0.317	0.316	0.401	0.127	0.244	0.296	0.303	0.170	0.096	0.078
TLMAN	0.635	0.614	0.452	1.000	0.661	1.000	1.000	1.000	1.000	0.467	0.206	0.172	0.191
TUREX	0.199	0.184	0.032	0.605	0.350	0.818	0.495	0.038	0.018	0.022	0.431	0.060	0.118
Σ	3.787	3.567	2.260	5.738	5.063	6.608	3.671	3.431	3.331	3.916	3.868	1.907	2.379

Note: Σ denotes the column-wise sum of normalized values

Step 3. Calculation of entropy values for the criteria: In this step, the f_{ij} values were first calculated using Equation 4. Accordingly, the values in Table 5 were divided by the sum of their respective columns, and the resulting f_{ij} values for the 2022 data are presented in Table 6.

Table 6. f_{ij} values for the year 2022

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
BEYAZ	0.059	0.041	0.017	0.051	0.023	0.049	0.026	0.011	0.002	0.012	0.259	0.045	0.011
CLEBI	0.073	0.076	0.080	0.064	0.063	0.067	0.044	0.112	0.104	0.116	0.059	0.032	0.058
GRSEL	0.072	0.076	0.040	0.081	0.073	0.101	0.085	0.084	0.055	0.052	0.084	0.025	0.420
GSDDE	0.264	0.280	0.443	0.149	0.198	0.144	0.221	0.027	0.071	0.012	0.021	0.525	0.061
HOROZ	0.031	0.031	0.002	0.049	0.029	0.043	0.022	0.081	0.044	0.133	0.101	0.017	0.076
HRKET	0.040	0.036	0.014	0.078	0.102	0.096	0.078	0.025	0.067	0.017	0.020	0.012	0.015
PASEU	0.050	0.045	0.003	0.048	0.030	0.039	0.019	0.166	0.060	0.255	0.152	0.013	0.077
PGSUS	0.049	0.051	0.051	0.047	0.077	0.036	0.018	0.067	0.097	0.127	0.037	0.104	0.056
RYSAS	0.048	0.049	0.042	0.046	0.048	0.034	0.016	0.034	0.047	0.052	0.040	0.032	0.051
TAVHL	0.050	0.047	0.047	0.053	0.096	0.053	0.029	0.020	0.060	0.022	0.018	0.023	0.011
THYAO	0.043	0.044	0.048	0.055	0.062	0.061	0.035	0.071	0.089	0.077	0.044	0.050	0.033
TLMAN	0.168	0.172	0.200	0.174	0.131	0.151	0.272	0.291	0.300	0.119	0.053	0.090	0.080
TUREX	0.052	0.051	0.014	0.105	0.069	0.124	0.135	0.011	0.005	0.006	0.112	0.032	0.050

For the operations shown in Equation 5, the values of $\ln f_{ij}$ and $f_{ij}\ln\ f_{ij}$ were calculated. The $\ln f_{ij}$ values were obtained by taking the natural logarithm of each f_{ij} value in Table 6, and the resulting values for the 2022 data are presented in Table 7.

Table 7. $\ln f_{ij}$ values for the year 2022

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
BEYAZ	-2.825	-3.183	-4.087	-2.977	-3.789	-3.011	-3.654	-4.498	-6.061	-4.389	-1.353	-3.102	-4.521
CLEBI	-2.617	-2.582	-2.528	-2.754	-2.771	-2.701	-3.120	-2.190	-2.266	-2.157	-2.829	-3.446	-2.843
GRSEL	-2.631	-2.576	-3.219	-2.511	-2.611	-2.291	-2.467	-2.479	-2.908	-2.955	-2.477	-3.673	-0.867
GSDDE	-1.331	-1.272	-0.815	-1.906	-1.622	-1.937	-1.508	-3.601	-2.648	-4.437	-3.863	-0.645	-2.796
HOROZ	-3.478	-3.458	-6.085	-3.009	-3.547	-3.148	-3.823	-2.519	-3.135	-2.015	-2.292	-4.081	-2.574
HRKET	-3.214	-3.318	-4.299	-2.549	-2.286	-2.341	-2.555	-3.709	-2.707	-4.083	-3.895	-4.395	-4.214
PASEU	-2.986	-3.110	-5.901	-3.043	-3.507	-3.232	-3.940	-1.794	-2.817	-1.365	-1.882	-4.376	-2.564
PGSUS	-3.016	-2.978	-2.966	-3.062	-2.567	-3.312	-4.039	-2.705	-2.334	-2.067	-3.286	-2.264	-2.874
RYSAS	-3.046	-3.020	-3.164	-3.084	-3.033	-3.371	-4.120	-3.373	-3.067	-2.961	-3.218	-3.439	-2.973
TAVHL	-2.986	-3.052	-3.065	-2.943	-2.341	-2.935	-3.543	-3.936	-2.805	-3.813	-4.033	-3.760	-4.479
THYAO	-3.144	-3.133	-3.045	-2.895	-2.773	-2.802	-3.362	-2.642	-2.420	-2.559	-3.124	-2.993	-3.423
TLMAN	-1.786	-1.759	-1.610	-1.747	-2.036	-1.888	-1.300	-1.233	-1.203	-2.126	-2.935	-2.404	-2.524
TUREX	-2.948	-2.967	-4.244	-2.249	-2.672	-2.089	-2.003	-4.492	-5.206	-5.202	-2.193	-3.456	-3.001

The f_{ij} values in Table 6 were multiplied by the corresponding $\ln f_{ij}$ values in Table 7, and the resulting $f_{ij}\ln\ f_{ij}$ values for the 2022 data are presented in Table 8.

Table 8. $f_{ij}.\ln f_{ij}$ values for the year 2022

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
BEYAZ	-0.168	-0.132	-0.069	-0.152	-0.086	-0.148	-0.095	-0.050	-0.014	-0.054	-0.350	-0.139	-0.049
CLEBI	-0.191	-0.195	-0.202	-0.175	-0.173	-0.181	-0.138	-0.245	-0.235	-0.249	-0.167	-0.110	-0.166
GRSEL	-0.189	-0.196	-0.129	-0.204	-0.192	-0.232	-0.209	-0.208	-0.159	-0.154	-0.208	-0.093	-0.364
GSDDE	-0.352	-0.357	-0.361	-0.283	-0.320	-0.279	-0.334	-0.098	-0.187	-0.052	-0.081	-0.338	-0.171
HOROZ	-0.107	-0.109	-0.014	-0.148	-0.102	-0.135	-0.084	-0.203	-0.136	-0.269	-0.232	-0.069	-0.196
HRKET	-0.129	-0.120	-0.058	-0.199	-0.232	-0.225	-0.199	-0.091	-0.181	-0.069	-0.079	-0.054	-0.062
PASEU	-0.151	-0.139	-0.016	-0.145	-0.105	-0.128	-0.077	-0.298	-0.168	-0.349	-0.287	-0.055	-0.197
PGSUS	-0.148	-0.152	-0.153	-0.143	-0.197	-0.121	-0.071	-0.181	-0.226	-0.262	-0.123	-0.235	-0.162
RYSAS	-0.145	-0.147	-0.134	-0.141	-0.146	-0.116	-0.067	-0.116	-0.143	-0.153	-0.129	-0.110	-0.152
TAVHL	-0.151	-0.144	-0.143	-0.155	-0.225	-0.156	-0.103	-0.077	-0.170	-0.084	-0.071	-0.088	-0.051
THYAO	-0.136	-0.137	-0.145	-0.160	-0.173	-0.170	-0.117	-0.188	-0.215	-0.198	-0.137	-0.150	-0.112
TLMAN	-0.299	-0.303	-0.322	-0.304	-0.266	-0.286	-0.354	-0.359	-0.361	-0.254	-0.156	-0.217	-0.202
TUREX	-0.155	-0.153	-0.061	-0.237	-0.185	-0.259	-0.270	-0.050	-0.029	-0.029	-0.245	-0.109	-0.149
Σ	-2.320	-2.283	-1.805	-2.448	-2.403	-2.435	-2.116	-2.164	-2.224	-2.176	-2.265	-1.769	-2.034

Note: Σ denotes the column-wise sum of normalized values

In this study, given that m = 13, the value of $ln(13)$ = 2.5649 was utilised. By applying the formula presented in Equation 5 (specifically, by multiplying the negative inverse of this constant by the sum of each criterion column in Table 8), the entropy values for the 2022 data were derived; these results are subsequently presented in Table 9.

Table 9. eij values for the year 2022

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
ej	0.904	0.890	0.704	0.955	0.937	0.949	0.825	0.844	0.867	0.848	0.883	0.690	0.793
Σej							11.089						

Step 4. Calculation of Entropy weights: Since 13 criteria were used in the application, n = 13 was set in Equation 6. Using Equation 6, the criterion importance weights were computed by dividing the complement of each entropy value $(1-e_j)$by the sum of complements across all criteria $\sum_{j=1}^{n}(1-e_j)$. The resulting criterion importance weights for 2022 are reported in

Table 10. Criterion importance weights for the year 2022

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
w_j	0.050	0.058	0.155	0.024	0.033	0.026	0.092	0.082	0.069	0.079	0.061	0.162	0.108

An examination of Table 10 shows that, in 2022**,** the criteria that most strongly discriminated the financial performance of transportation companies were the receivables turnover ratio ($w = 0.162$), the cash ratio ($w = 0.155$), and the inventory turnover ratio ($w = 0.108$). These were followed by the debt-to-equity ratio ($w = 0.092$), return on assets (ROA) ($w = 0.082$), and the net profit margin ($w = 0.079$). In contrast, leverage-related indicators such as the debt ratio ($w = 0.024$), equity to total assets ratio ($w = 0.026$), and short-term debt to total assets ratio ($w = 0.033$)were assigned relatively lower weights. From the perspective of the Entropy method, this finding indicates that inter-firm differentiation in the transportation sector is driven primarily by operational efficiency associated with trade receivables and inventory management, as well as by cash management**,** rather than by capital structure indicators. In other words, while firms exhibit relatively homogeneous capital structure ratios, greater variability in liquidity quality and working capital turnover rates plays a more decisive role in explaining relative financial performance. Accordingly, for decision-makers, improving receivables and inventory turnover ratios together with strengthening the cash ratio emerges as a critical area for enhancing financial performance in transportation companies.

The criterion importance weights for 2023 and 2024 were calculated using the same methodology (see Appendix 1 and Appendix 2) and are presented together with the 2022 results in Figure 1.

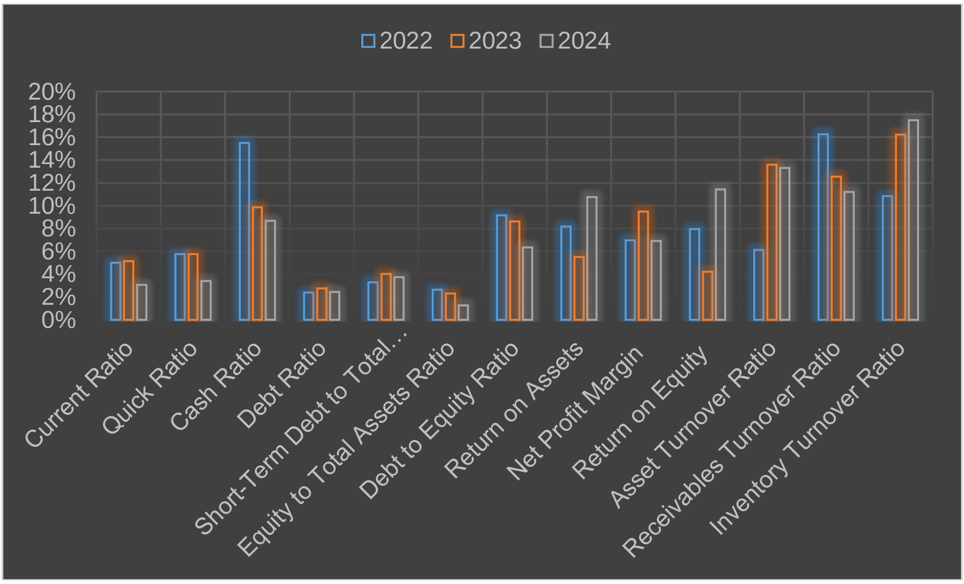

Figure 1. Criterion importance weights by year

An examination of Figure 1 reveals that, throughout the 2022–2024 period, Entropy-based criterion weights are predominantly concentrated on operational efficiency and liquidity-related ratios. During this timeframe, the most significant importance weights are attributed to activity ratios, specifically inventory turnover, receivables turnover and asset turnover; this indicates that operational efficiency indicators possess greater discriminative power in differentiating the relative performance of transportation companies when compared to liquidity and capital structure ratios. From a year-on-year perspective, receivables turnover and the cash ratio are prominent in 2022; however, in 2023 and particularly in 2024, the importance weights of inventory turnover and asset turnover become more pronounced. Furthermore, it is noteworthy that the importance levels of profitability indicators, specifically return on equity (ROE) and return on assets (ROA), exhibit an upward trend over time. In contrast, liquidity and financial structure measures, such as the current ratio, quick ratio and equity-to-assets ratio, maintain relatively low weights throughout the period. This suggests a more homogeneous distribution of these ratios across firms and a limited contribution to discrimination within the decision-making process.

4.4.2. Application Steps of the MOORA Method

Step 1. Construction of the decision matrix: For the year 2022, the decision matrix was constructed in the same manner as in the Entropy method, with criteria represented in columns and alternatives in rows (see Table 4).

Step 2. Standardization of the decision matrix: In this step, the denominator specified in Equation 8 is first calculated, followed by the standardization procedure. Table 11 presents the calculated denominator values obtained from the computations, which were derived by taking the square root of the sum of squares of each criterion column in Table 4.

Table 11. Square root of the sum of squares values for the year 2022

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	1.46	0.62	405.6	5559.1	5403.7	647.2	85931	2.5	0.16	31.2	15.5	229.5	224.4
CLEBI	2.22	2.07	9152.7	3553.3	706.4	1203.4	29532.4	255.3	316.4	2713.3	0.8	115.3	6430.4
GRSEL	2.16	2.10	2301.1	2188.3	512.1	2734.2	8001.3	143.5	87.6	550.3	1.6	73.2	335183
GSDDE	29.0	28.51	281578.8	652.2	70.8	5544.3	1176.4	15.2	147.3	28.4	0.1	31244	7074.4
HOROZ	0.39	0.36	7.4	5922.8	3335	491.9	120443.	132.2	55.6	3604.8	2.3	32.3	11025
HRKET	0.67	0.47	265.0	2360	267.6	2475	9535.52	12.2	130.8	57.6	0.1	17.3	414.9
PASEU	1.06	0.72	10.7	6336.1	3074.7	416.1	152224	564.5	105	13229.6	5.3	17.9	11236
PGSUS	1.00	0.94	3813	6586.9	469.5	354.9	185692	91.2	276.2	3249.0	0.3	1227	6048.1
RYSAS	0.94	0.86	2568.4	6880.7	1192.3	315	218387	24	63.6	543.3	0.3	117.0	4961.8
TAVHL	1.06	0.81	3130.4	5192.6	298.5	754.6	68811.7	7.7	107.5	99.0	0.07	61.6	243.9
THYAO	0.77	0.68	3255.8	4711.4	708.6	983.4	47921.5	103.4	232.2	1215.9	0.4	285.6	2016
TLMAN	11.6	10.75	57475.2	474.8	162.3	6116.8	776.1	1733	2650.1	2887.9	0.6	927.8	12188.1
TUREX	1.14	0.96	296.1	1296.0	578.8	4092.1	3166.3	2.5	0.8	6.15	2.9	112.9	4694.9
Σ	53.6	49.8	364260.7	51714.7	16780.9	26129.3	931601	3087.7	4173.9	28216.8	30.6	34462	401741
$\sqrt{(\Sigma x^2)}$	7.32	7.06	603.5	227.4	129.5	161.6	965.1	55.5	64.6	167.9	5.5	185.6	633.8

Note: Σ denotes the column-wise sum of squared values, and $\sqrt{\Sigma x^2}$represents the MOORA normalization denominator for each criterion.

After completing the calculations reported in Table 11, the standardized decision matrix was obtained by applying Equation 8. Accordingly, each value in Table 4 was divided by the corresponding square root value reported in Table 11, resulting in the standardized decision matrix presented in Table 12.

Table 12. Standardized decision matrix for the year 2022

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.165	0.112	0.033	0.328	0.567	0.157	0.304	0.029	0.006	0.033	0.711	0.082	0.024
CLEBI	0.203	0.204	0.159	0.262	0.205	0.215	0.178	0.288	0.275	0.310	0.162	0.058	0.127
GRSEL	0.201	0.205	0.079	0.206	0.175	0.323	0.093	0.216	0.145	0.140	0.231	0.046	0.913
GSDDE	0.736	0.756	0.879	0.112	0.065	0.461	0.036	0.070	0.188	0.032	0.058	0.952	0.133
HOROZ	0.086	0.085	0.005	0.338	0.446	0.137	0.360	0.207	0.115	0.357	0.278	0.031	0.166
HRKET	0.112	0.098	0.027	0.214	0.126	0.308	0.101	0.063	0.177	0.045	0.056	0.022	0.032
PASEU	0.141	0.120	0.005	0.350	0.428	0.126	0.404	0.428	0.159	0.685	0.419	0.023	0.167
PGSUS	0.137	0.137	0.102	0.357	0.167	0.117	0.446	0.172	0.257	0.339	0.103	0.189	0.123
RYSAS	0.132	0.132	0.084	0.365	0.267	0.110	0.484	0.088	0.124	0.139	0.110	0.058	0.111
TAVHL	0.141	0.127	0.093	0.317	0.133	0.170	0.272	0.050	0.161	0.059	0.049	0.042	0.025
THYAO	0.120	0.117	0.095	0.302	0.205	0.194	0.227	0.183	0.236	0.208	0.121	0.091	0.071
TLMAN	0.467	0.464	0.397	0.096	0.098	0.484	0.029	0.749	0.797	0.320	0.146	0.164	0.174
TUREX	0.146	0.139	0.029	0.158	0.186	0.396	0.058	0.029	0.015	0.015	0.307	0.057	0.108

Step 3. Construction of the weighted normalized matrix: The weighted normalized matrix was obtained by multiplying each column of the standardized decision matrix in Table 12 by the corresponding criterion importance weight for the year 2022. The resulting weighted normalized matrix is presented in Table 13.

Table 13. Weighted normalized matrix for the year 2022

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.008	0.006	0.005	0.008	0.019	0.004	0.028	0.002	0.000	0.003	0.044	0.013	0.003
CLEBI	0.010	0.012	0.025	0.006	0.007	0.006	0.016	0.023	0.019	0.025	0.010	0.009	0.014
GRSEL	0.010	0.012	0.012	0.005	0.006	0.009	0.008	0.018	0.010	0.011	0.014	0.007	0.099
GSDDE	0.037	0.044	0.136	0.003	0.002	0.012	0.003	0.006	0.013	0.003	0.004	0.155	0.014
HOROZ	0.004	0.005	0.001	0.008	0.015	0.004	0.033	0.017	0.008	0.028	0.017	0.005	0.018
HRKET	0.006	0.006	0.004	0.005	0.004	0.008	0.009	0.005	0.012	0.004	0.003	0.004	0.003
PASEU	0.007	0.007	0.001	0.008	0.014	0.003	0.037	0.035	0.011	0.054	0.026	0.004	0.018
PGSUS	0.007	0.008	0.016	0.008	0.006	0.003	0.041	0.014	0.018	0.027	0.006	0.031	0.013
RYSAS	0.007	0.008	0.013	0.009	0.009	0.003	0.044	0.007	0.009	0.011	0.007	0.009	0.012
TAVHL	0.007	0.007	0.014	0.008	0.004	0.004	0.025	0.004	0.011	0.005	0.003	0.007	0.003
THYAO	0.006	0.007	0.015	0.007	0.007	0.005	0.021	0.015	0.016	0.016	0.007	0.015	0.008
TLMAN	0.023	0.027	0.062	0.002	0.003	0.013	0.003	0.061	0.055	0.025	0.009	0.027	0.019
TUREX	0.007	0.008	0.004	0.004	0.006	0.010	0.005	0.002	0.001	0.001	0.019	0.009	0.012

Step 4. Derivation of company rankings: Using Equation 10, the overall performance score for each alternative was calculated. In this process, the sum of the weighted normalized values of the minimum criteria was subtracted from the sum of the weighted normalized values of the maximum criteria. The resulting performance scores were then ranked in descending order. The alternative with the highest score was considered the best-performing company. Table 14 presents the ranking of transportation companies based on their financial performance for the year 2022.

Table 14. Ranking of transportation companies based on financial performance for the year 2022

Company	*Overall Performance Score*	*Rank*
BEYAZ	0.035	11
CLEBI	0.123	4
GRSEL	0.183	3
GSDDE	0.415	1
HOROZ	0.051	9
HRKET	0.037	10
PASEU	0.107	5
PGSUS	0.088	6
RYSAS	0.023	13
TAVHL	0.029	12
THYAO	0.076	7
TLMAN	0.313	2
TUREX	0.059	8

According to Table 14, the financial performance scores for 2022 calculated using the MOORA method indicate that GSDDE secures the first position, followed by TLMAN in second place and GRSEL in third. Conversely, the placement of RYSAS, TAVHL and BEYAZ at the bottom of the rankings suggests that these companies exhibit relatively weaker financial performance within the sample.

The rankings for 2023 and 2024 were calculated using the same methodology (see Appendix 3 and Appendix 4) and are presented together with the 2022 results in Figure 2.

An examination of Figure 2 shows that, in 2023, GRSEL, TLMAN, and BEYAZ emerged as the companies with notably strong performance, whereas HOROZ, TAVHL, and RYSAS exhibited relatively weak performance. In 2024, GRSEL, CLEBI, and TLMAN ranked among the top-performing firms, while HRKET, TAVHL, TUREX, and PASEU were positioned at the lower end of the ranking, indicating weaker financial performance.

Considering the overall 2022-2024 period, GRSEL and TLMAN consistently demonstrated strong financial performance, whereas TAVHL and RYSAS persistently recorded weak performance across the three years.

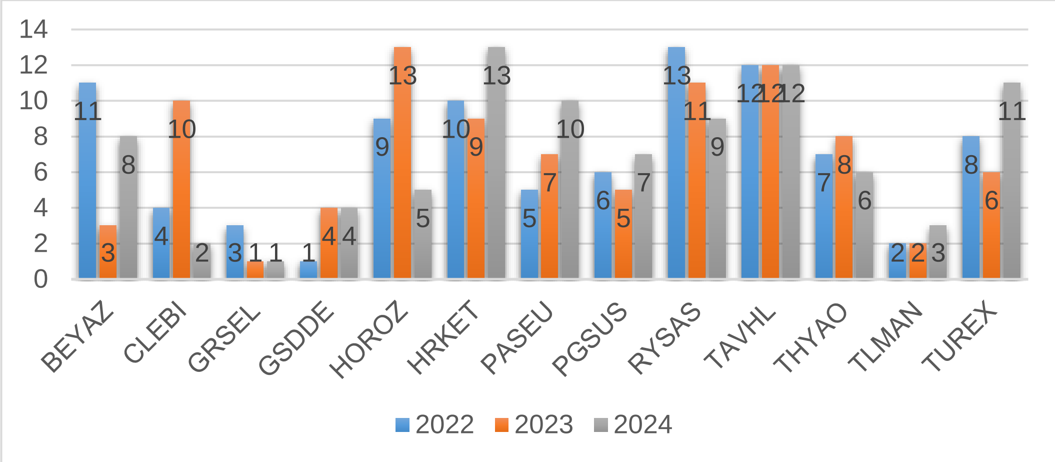

Figure 2. Financial performance of transportation companies by year

When evaluated in conjunction with the criterion weights derived from the Entropy method, this pattern confirms that relative performance differentiation within the transportation sector is primarily driven by operational efficiency and cash management. Companies exhibiting strong performance in highly weighted indicators (specifically inventory turnover, receivables turnover, asset turnover and the cash ratio) tend to occupy the upper segment of the rankings throughout the three-year period. Conversely, firms possessing similar leverage and liquidity structures yet displaying weaker operational efficiency remain in lower positions. This finding suggests that, even during the post-COVID-19 normalisation period, clusters of firms with robust versus fragile financial structures persist within the sector. This indicates that recovery has not been uniformly reflected across all companies; consequently, operational efficiency remains a key determinant of sustainable financial performance.

4.5. Sensitivity Analysis

In studies applying MCDM methods, the literature frequently reports the use of various sensitivity analyses to assess the reliability of both the importance weights assigned to criteria and the rankings obtained amongst alternatives. Sensitivity analysis allows for the construction of different scenarios under changing conditions and enables the comparison of results derived from these scenarios (Goodridge, 2016). Through this approach, the effects of variations in model inputs on MCDM outcomes can be examined; consequently, the robustness of the model can be evaluated (Karande et al., 2016). Moreover, sensitivity analysis contributes to testing the stability of results produced by decision models, identifying uncertain input parameters that lead to substantial changes in outputs and determining the parameter ranges within which the model yields consistent outcomes (Butler et al., 1997). In this study, a two-stage sensitivity analysis was conducted to evaluate the reliability of the criterion weights calculated using the Entropy method and the alternative performance rankings obtained through the MOORA method. In the first stage, a first-level sensitivity analysis was performed to examine the robustness of the weights determined by the Entropy method. In the second stage, a second-level sensitivity analysis was carried out to assess the stability of the alternative rankings by comparing the MOORA results with those obtained using other widely applied ranking methods found in the literature.

4.5.1. First-Level Sensitivity Analysis

A first-level sensitivity analysis was conducted to evaluate the reliability and robustness of the calculated criterion weights. Within this framework, 20 alternative weight sets (Set1-Set20) were generated using Equation (11) to investigate the effect of changes in criterion weights on the final rankings (Bakır et al., 2021; Torkayesh et al., 2021; Bakır and İnce, 2024).

$$w_{n\beta} = (1 - w_{n\alpha})\frac{w_\beta}{1-w_n} \qquad (11)$$

In this study, $w_{n\beta}$ represents the new scenario-based criterion weights, while $w_{n\alpha}$denotes the reduced weight coefficient of the most important criterion in the decision problem (Accounts Receivable Turnover for 2022; Inventory Turnover for 2023 and 2024). Accordingly, the weight reduction rate for $w_{n\alpha}$was set at 15%, and in each successive scenario, the weight of the most important criterion was reduced by 15%, reaching zero in Set20.

Here, $w_\beta$refers to the initial (original) weight of the relevant criterion, and $w_n$denotes the initial weight of the most important criterion. By applying Equation 11 to the criterion with the highest entropy weight, 20 different weighting scenarios were generated. The resulting scenario-based criterion weights are visually presented in Figures 3, 4, and 5**.**

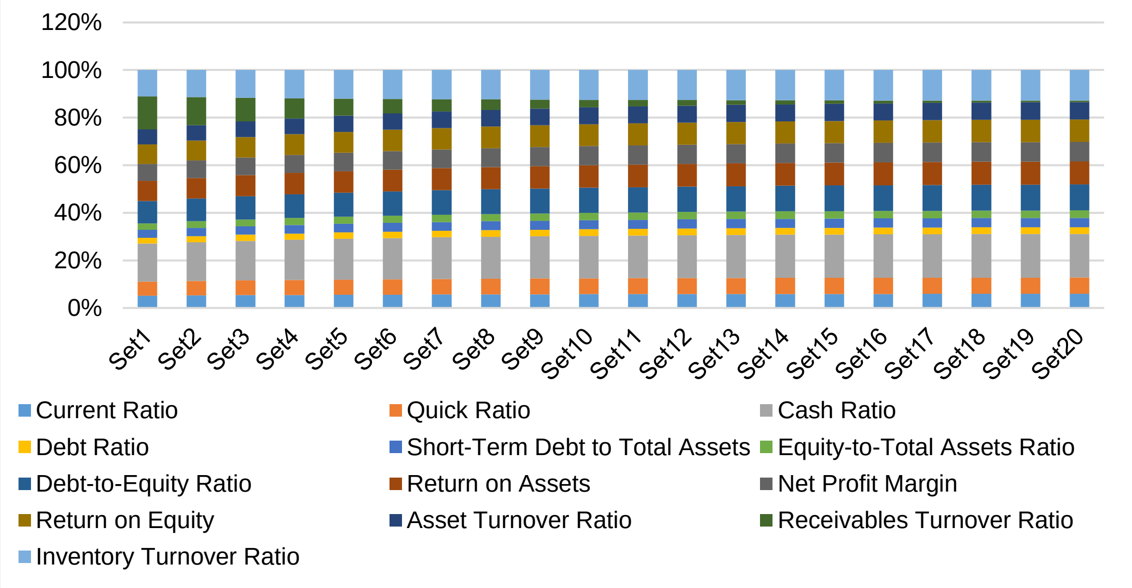

Figure 3. Scenario-based criterion weights (2022)

Figure 3 presents the scenario-based criterion weights for 2022 (Set1-Set20) generated by progressively reducing the weight of the most important criterion by 15% in each scenario. As the dominant criterion's weight decreases across sets, the remaining criteria are proportionally re-scaled, allowing an examination of how sensitive the subsequent MOORA rankings are to systematic shifts in the weight structure.

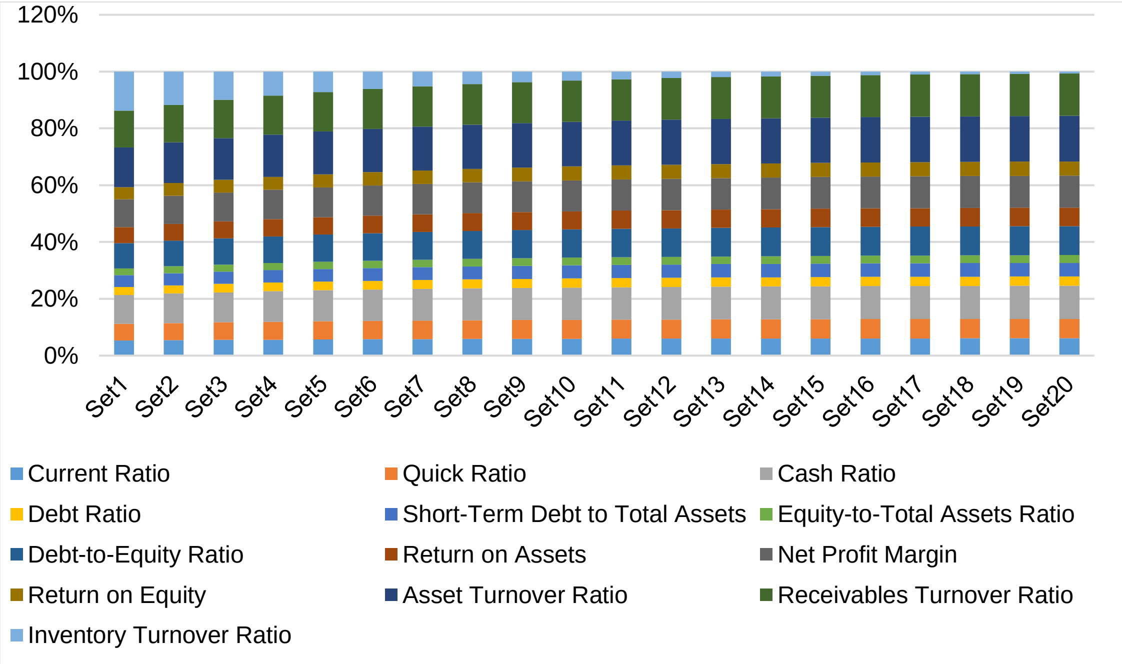

Figure 4. Scenario-based criterion weights (2023)

Figure 4 illustrates the scenario-based criterion weights for 2023 (Set1-Set20), generated by gradually reducing the weight of the most influential criterion (Inventory Turnover) by 15% in each scenario. As the dominant criterion's weight declines across scenarios, the remaining criteria are proportionally redistributed, while the overall weight structure remains stable. This pattern indicates that the relative importance of criteria in 2023 is not excessively sensitive to systematic weight perturbations, supporting the robustness of the entropy-based weighting scheme.

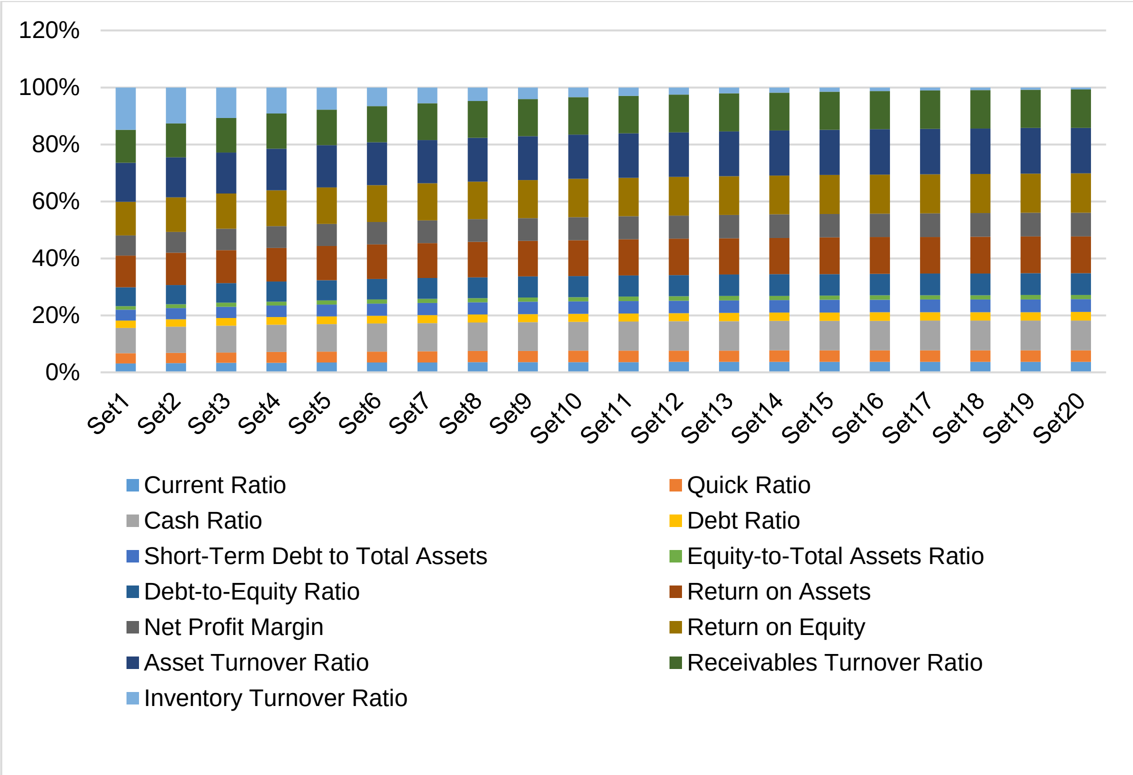

Figure 5. Scenario-based criterion weights (2024)

Compared to previous years, the 2024 scenario structure highlights a more pronounced role of operational efficiency and profitability indicators, while liquidity and capital structure ratios remain relatively stable across scenarios. This pattern further supports the robustness of the entropy-based weighting scheme in the post-normalization period.

Using these 20 alternative weight sets (scenarios), the performance rankings of the alternatives (transportation companies) were recalculated (Bakır and İnce, 2024). Figures 6–8 report the resulting MOORA based rankings across the scenarios.

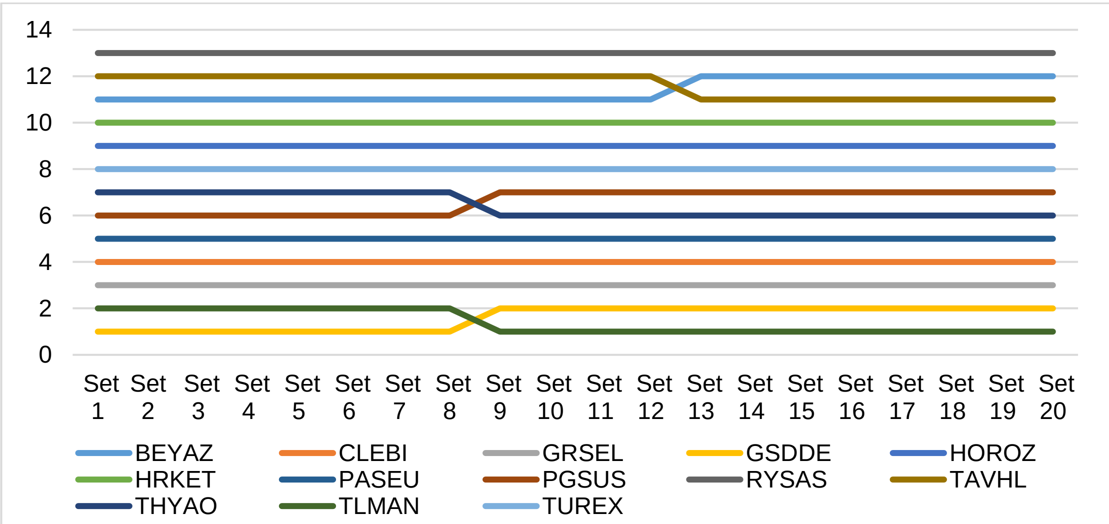

Figure 6. Alternative rankings under 20 scenarios (2022)

Figure 6 illustrates the alternative rankings obtained under 20 scenario-based weight sets for the year 2022. The results indicate that the relative positions of the transportation companies remain largely stable across scenarios, with only minor rank reversals observed in a limited number of cases. In particular, the top- and bottom-ranked firms preserve their relative positions throughout the scenarios, providing strong evidence of the robustness of the MOORA based rankings against changes in criterion weights.

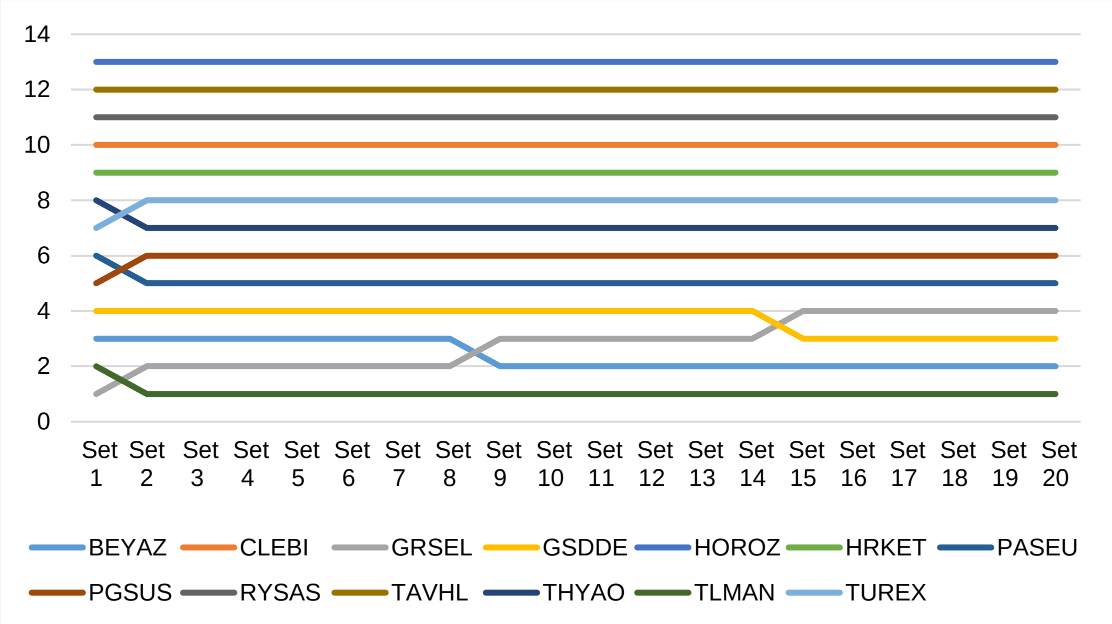

Figure 7. Alternative rankings under 20 scenarios (2023)

Figure 7 presents the alternative performance rankings obtained under 20 scenario-based weight sets for the year 2023. The results reveal a high degree of ranking stability across scenarios, with the relative positions of most companies remaining unchanged. Only limited and short-range rank shifts are observed for a small number of firms in the middle of the ranking, while the top- and bottom-performing companies preserve their positions throughout all scenarios. These findings indicate that the MOORA based rankings for 2023 are robust to systematic variations in criterion weights.

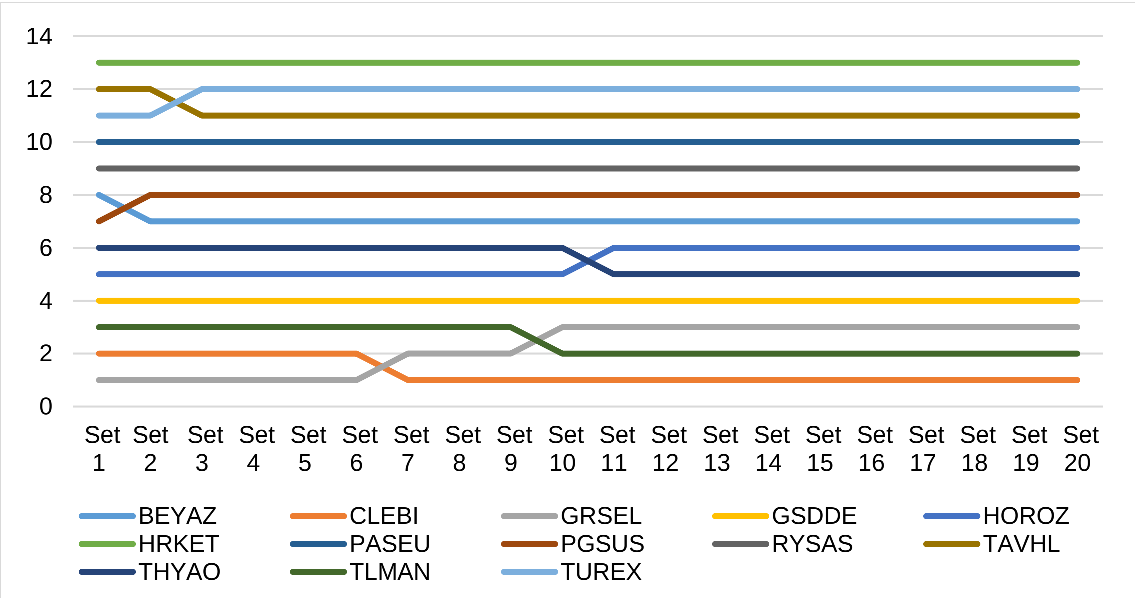

Figure 8. Alternative rankings under 20 scenarios (2024)

Figure 8 illustrates the alternative performance rankings obtained under 20 scenario-based weight sets for the year 2024. The results demonstrate a high level of robustness in the MOORA rankings, as the relative positions of most companies remain stable across all scenarios. Minor rank changes are observed only among a limited number of mid-ranked firms, while the top- and bottom-performing companies preserve their positions throughout the full range of weight variations. This stability confirms that the financial performance rankings for 2024 are not sensitive to systematic reductions in the weight of the most influential criterion.

Correlation coefficients were calculated between the baseline ranking obtained using the original criterion weights and the ranking produced under Scenario 20, where the weight of the most influential criterion was reduced to zero. The association between the two ranking sequences is remarkably strong (2022: ρ = 0.9835; 2023: ρ = 0.9396; 2024: ρ = 0.9670), indicating that the MOORA rankings are highly robust to systematic perturbations in the dominant criterion weight. Overall, these results support the stability and consistency of the Entropy-based weighting structure and the resulting performance rankings.

4.5.2. Second-Level Sensitivity Analysis

The performance rankings obtained using the MOORA method were evaluated through comparison with alternative performance ranking techniques. For this purpose, performance rankings were recalculated using four widely applied methods in the literature: ARAS, COPRAS, TOPSIS and VIKOR (Bakır and İnce, 2024; Yılmaz and Civelek, 2025). The findings of the second-level sensitivity analysis are presented in Tables 15-17.

Table 15. Performance Rankings Obtained Using Different Methods (2022)

Company	*MOORA*	*ARAS*	*COPRAS*	*TOPSIS*	*VIKOR*
BEYAZ	11	10	10	8	9
CLEBI	4	4	4	5	5
GRSEL	3	3	3	3	4
GSDDE	1	1	1	1	1
HOROZ	9	9	8	10	11
HRKET	10	12	12	11	10
PASEU	5	5	5	4	8
PGSUS	6	6	6	6	3
RYSAS	13	11	11	13	13
TAVHL	12	13	13	12	12
THYAO	7	7	7	9	6
TLMAN	2	2	2	2	2
TUREX	8	8	9	7	7
Correlation Coefficient	1	0.973	0.967	0.951	0.918

When Table 15 is examined, it is observed that the performance ranking obtained using the MOORA method for the year 2022 largely coincides with the rankings derived from the ARAS, COPRAS, TOPSIS, and VIKOR methods, with similarity levels exceeding 91%. This high degree of agreement indicates a strong consistency among the applied multi-criteria decision-making techniques. The correlation coefficients further confirm that the MOORA-based ranking exhibits a very high level of concordance with alternative methods, particularly ARAS (0.973) and COPRAS (0.967). These findings clearly demonstrate that the proposed approach produces reliable, robust, and stable results, thereby validating the methodological soundness of the MOORA method within the context of the study.

Table 16. Performance Rankings Obtained Using Different Methods (2023)

Company	*MOORA*	*ARAS*	*COPRAS*	*TOPSIS*	*VIKOR*
BEYAZ	3	3	3	2	9
CLEBI	10	9	9	10	8
GRSEL	1	1	1	1	1
GSDDE	4	12	11	4	3
HOROZ	13	13	13	13	13
HRKET	9	5	6	6	10
PASEU	7	7	8	9	11
PGSUS	5	4	4	5	5
RYSAS	11	10	10	11	6
TAVHL	12	11	12	12	12
THYAO	8	8	7	7	7
TLMAN	2	2	2	3	2
TUREX	6	6	5	8	4
Correlation Coefficient	1	0.769	0.824	0.945	0.758

An examination of Table 16 indicates that, for the year 2023, the performance ranking obtained using the MOORA method exhibits a very high level of agreement with the TOPSIS method (94.5%). Furthermore, a strong similarity is observed with the COPRAS method (82.4%), whilst the level of consistency with the ARAS (76.9%) and VIKOR (75.8%) methods remains at a moderate-to-high level. These findings suggest that the applied methods generally display similar ranking patterns; nevertheless, certain methods (particularly VIKOR and ARAS) appear to be more sensitive to variations in criterion weighting schemes.

Table 17. Performance Rankings Obtained Using Different Methods (2024)

Company	*MOORA*	*ARAS*	*COPRAS*	*TOPSIS*	*VIKOR*
BEYAZ	8	5	6	3	11
CLEBI	2	3	3	2	3
GRSEL	1	1	1	1	1
GSDDE	4	4	4	4	4
HOROZ	5	6	5	6	5
HRKET	13	13	13	13	13
PASEU	10	10	10	10	8
PGSUS	7	7	7	7	6
RYSAS	9	9	9	9	9
TAVHL	12	12	12	11	12
THYAO	6	8	8	8	7
TLMAN	3	2	2	5	2
TUREX	11	11	11	12	10
Correlation Coefficient	1	0.956	0.973	0.901	0.951

An examination of Table 17 shows that, for the year 2024, the performance ranking obtained using the MOORA method exhibits a similarity exceeding 90% with the ARAS, COPRAS, TOPSIS, and VIKOR methods. This finding clearly demonstrates that the method employed in the study produces reliable, robust, and consistent results.

5. RESULTS

The Entropy-based weighting results show that, across the 2022-2024 period, criterion importance is primarily concentrated on operational efficiency and liquidity quality indicators (Figure 1). In 2022, the most discriminating criteria are receivables turnover (w = 0.162), cash ratio (w = 0.155), and inventory turnover (w = 0.108), followed by debt-to-equity (w = 0.092), ROA (w = 0.082), and net profit margin (w = 0.079) (Table 10). By contrast, several capital-structure indicators—such as debt-to-total capital (w = 0.024) and equity-to-assets (w = 0.026)—receive relatively lower weights, indicating that cross-firm differentiation in 2022 is driven more by working-capital turnover and cash quality than by leverage structure (Table 10). Over time, Figure 1 further indicates that efficiency measures (especially inventory turnover and asset turnover) remain prominent, while the relative importance of profitability indicators (ROA/ROE) increases toward 2024.

Firm-level performance rankings obtained via the MOORA method are presented for 2022 in Table 14 and for 2022–2024 comparatively in Figure 2. For 2022, the ranking places GSDDE first, TLMAN second, and GRSEL third, whereas RYSAS, TAVHL, and BEYAZ appear at the bottom of the distribution (Table 14). In 2023, the best-performing firms are GRSEL, TLMAN, and BEYAZ, while HOROZ, TAVHL, and RYSAS show weak performance (Figure 2). In 2024, GRSEL, CLEBI, and TLMAN rank among the top performers, whereas HRKET, TAVHL, and TUREX are positioned at the lower end of the ranking (Figure 2). When evaluated jointly for 2022-2024, GRSEL and TLMAN exhibit consistently strong performance, while TAVHL and RYSAS display persistently weak performance across the three-year window (Figure 2).

Robustness was examined through a two-level sensitivity analysis. In the first level, 20 scenario-based weight sets were generated by progressively reducing the weight of the most influential criterion, with scenario weights illustrated for 2022-2024 in Figures 3-5. Under these alternative weight sets, the resulting MOORA rankings remain largely stable for each year, with only minor rank shifts observed for a limited number of mid-ranked firms (Figures 6-8). In addition, the correlation between the baseline ranking and Scenario 20 (where the dominant criterion weight is reduced to zero) is very strong for all years (2022: ρ = 0.9835; 2023: ρ = 0.9396; 2024: ρ = 0.9670), further supporting ranking stability. In the second level, MOORA rankings were compared with ARAS, COPRAS, TOPSIS, and VIKOR, showing high concordance, particularly in 2022 and 2024 (Tables 15-17).

6. DISCUSSION

According to the Entropy-based findings, the primary factors explaining cross-firm performance gaps in the BIST transportation ecosystem after the pandemic are operational efficiency and liquidity management, particularly regarding working capital turnover. This trend reflects the industry's response to fluctuating demand and costs, where timely receivables collection and inventory control are critical. Although liquidity and efficiency indicators remain the dominant discriminators, there is a noticeable shift toward 2024; as the sector stabilizes, the relative importance of profitability measures has risen, suggesting a return to value-driven differentiation.

The observed ranking profile also suggests that firms combining profitability with efficient asset utilization tend to remain in the upper segment of the distribution, whereas firms that are persistently weak may be constrained by less favourable efficiency and liquidity-quality profiles. In particular, the fact that leverage-related measures receive relatively lower Entropy weights implies that capital-structure ratios may be more homogeneous across firms, while efficiency and cash-related indicators provide greater discriminatory power. Accordingly, performance gaps appear to reflect differences in operational execution and working-capital effectiveness during the normalization phase rather than purely balance-sheet leverage differences.

The two-level sensitivity analysis strengthens the credibility of these interpretations. The first-level scenario tests indicate that rankings are not materially driven by a single dominant criterion, as the overall ordering remains largely stable even under systematic weight perturbations (Figures 6-8). The second-level method comparisons (Tables 15-17) show substantial agreement between MOORA and alternative MCDM methods, indicating that the main performance signal is robust to methodological choice. Overall, the pattern that TLMAN and GRSEL exhibit relatively strong performance while TAVHL and RYSAS exhibit weak performance is broadly aligned with several Türkiye-focused studies cited in the literature (e.g., Tufan and Kılıç, 2019; Oral and Kıpkıp, 2019; Pala, 2021; Sakarya and Saçkes, 2022; Kefe, 2023; Ayaz and Ömürbek, 2023; İyigün, 2024; Oztemiz et al., 2025), while the minor differences in mid-ranking positions across studies remain plausible given variations in criteria sets, weighting strategies, periods, and ranking algorithms.

The dramatic fluctuations observed in company rankings across the years (for instance, the HOROZ logistics company ranking last in 2023 and leaping to fifth place in 2024) may be directly related to the high uncertainty and shifting cost structures inherent in the post-pandemic normalisation period. The positioning of GSDDE in first place in 2022 can be explained by the temporary abundance of liquidity created by the persistently high freight rates in maritime transport at the end of the pandemic. However, the consistent success of GRSEL and TLMAN in 2023 and 2024, alongside GRSEL taking the lead, suggests that as supply chains stabilise, sustainable competitiveness stems not from temporary profitability shocks, but rather from their maximisation of operational efficiency by optimising receivables and inventory turnover rates instead of holding idle cash.

7. CONCLUSIONS and POLICY IMPLICATIONS

This study evaluated the post-COVID-19 financial performance of Borsa Istanbul transportation and storage firms, including TAVHL, for the 2022-2024 period using an Entropy-MOORA hybrid framework supported by sensitivity analysis. The results indicate that sectoral performance is primarily driven by operational efficiency and liquidity quality. These factors highlight the critical role of cost discipline, asset utilization, and working capital effectiveness. Furthermore, profitability indicators such as ROA and ROE gained greater relative importance toward 2024. Ultimately, the findings suggest that sustained competitiveness in the post-pandemic era relies on transforming operational capability and cash resilience into value-generating performance as the market stabilizes.

From a managerial perspective, the results suggest that companies should direct capital toward initiatives that bolster operational efficiency. In this context, to enhance their financial performance, the managers of companies that ranked lower during the analysed years (for example, HOROZ in 2023 and HRKET in 2024) must urgently focus on aggressive receivables management policies to shorten collection periods, alongside operational improvements to accelerate logistics and inventory processes, rather than holding idle cash or increasing borrowing. Specifically, allocating resources to fleet modernization, digital transformation, route planning, advanced warehouse operations, and supply chain integration is essential for enhancing corporate performance. In parallel, the results highlight that the debt maturity structure constitutes a key financial vulnerability channel: the comparatively weaker performance of firms with higher short-term debt-to-assets ratios points to the risks of maturity mismatch under volatile financing conditions. Accordingly, financial managers should adopt policies that support medium- to long-term debt planning, while actively mitigating interest-rate and exchange-rate exposures to preserve financial flexibility, particularly during shock-like periods characterized by heightened uncertainty. Additionally, while maintaining liquidity buffers remains essential as a safeguard, the evidence suggests that excessive idle liquidity may reduce performance efficiency; therefore, cash and cash equivalents should be kept at levels sufficient to meet short-term obligations, whereas surpluses may be allocated to liquid, return-generating instruments aligned with each firm's risk profile. Finally, the study's multi-criteria structure also implies that internal performance monitoring should move beyond a narrow ratio set and be updated toward structured multi-criteria assessment systems, which may enable more reliable tracking of performance dynamics over time.

For investors and regulatory authorities, the integrated performance scores derived from the MCDM approach offer a practical decision-support tool. When evaluated from the perspective of investors, priority in stock selection should be given to companies demonstrating a robust operational cash cycle, as observed in the cases of GRSEL and TLMAN, rather than relying solely upon profitability ratios. Furthermore, the annual macro-level fluctuations evident in corporate performance (as illustrated by the HOROZ example) make it imperative for investors to establish a balanced equity portfolio comprising transportation firms that operate across diverse sub-segments, such as aviation, maritime, and road logistics, rather than committing their capital to a single entity, thereby safeguarding themselves against sectoral shocks. Rather than relying on single indicators (e.g., profit or revenue), investors may improve the robustness of firm evaluations by incorporating composite performance scores and rankings that jointly reflect liquidity, leverage, profitability, and operational efficiency. In a similar vein, public institutions and regulators may consider developing sector-specific early warning systems based on the ratio framework employed in this study, allowing financially vulnerable firms to be detected earlier during disruption periods and enabling timely macroprudential and supervisory interventions.

Despite its contributions, this study is subject to several limitations and provides avenues for future research. First, the analysis period is restricted to 2022-2024; extending the window to include both pre- and post-pandemic years may facilitate deeper comparisons across different macro-financial regimes. Second, the assessment relies solely on financial ratios; future studies may broaden the criterion set by incorporating operational indicators (e.g., passenger/cargo volume, capacity utilization, delivery times), environmental performance metrics, and corporate governance variables to produce a more comprehensive evaluation of firm performance. Third, although the Entropy-MOORA hybrid model and sensitivity analyses strengthen internal consistency, alternative MCDM techniques may generate different rankings under the same dataset; thus, applying multiple methods may support methodological triangulation and enrich the literature. Finally, because the study focuses on the transportation and storage sector, extending similar approaches to other sectors may enable cross-sector comparisons and contribute to a better understanding of post-COVID-19 recovery and vulnerability patterns.

Author Contributions

Onur Şeyranlıoğlu: Literature Review, Conceptualization, Methodology, Data Curation, Writing-original draft *Aykan Coşkun*: Modelling, Methodology, Data Curation, Analysis, Writing-review and editing *Arif Çilek*: Modelling, Methodology, Data Curation, Analysis, Writing-review and editing

Conflict of Interest

No potential conflict of interest was declared by the author(s).

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Compliance with Ethical Standards

It was declared by the authors that the tools and methods used in the study do not require the permission of the Ethics Committee.

Ethical Statement

It was declared by the authors that scientific and ethical principles have been followed in this study and all the sources used have been properly cited.

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APPENDIX

Appendix 1. Calculation of Criteria Importance Weights for 2023

Table A1. Initial decision matrix for 2023

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	1.370	0.860	39.390	66.050	63.250	33.950	194.590	5.460	0.970	18.180	5.640	38.770	21.020
CLEBI	1.260	1.210	77.500	65.820	31.800	30.380	216.660	14.310	15.350	44.900	0.930	10.070	59.940
GRSEL	1.540	1.530	57.200	38.350	23.420	60.390	63.500	27.530	24.070	47.780	1.140	7.380	708.810
GSDDE	2.730	2.690	263.760	22.890	8.660	77.110	29.690	-16.060	-117.570	-21.140	0.140	93.150	95.350
HOROZ	0.800	0.740	3.320	76.410	48.090	23.590	323.850	4.700	2.500	20.410	1.880	5.180	107.000
HRKET	0.850	0.750	3.790	41.100	13.880	59.560	69.010	19.400	65.090	34.690	0.300	2.900	26.280
PASEU	2.140	2.000	44.870	29.900	22.320	70.100	42.660	22.250	33.200	38.910	0.670	3.290	108.000
PGSUS	1.290	1.260	93.090	72.930	18.410	27.070	269.410	14.040	29.640	57.510	0.470	39.500	65.170
RYSAS	0.990	0.920	52.920	56.260	31.890	33.760	166.640	10.160	11.060	35.510	0.920	17.980	75.040
TAVHL	1.160	1.060	81.010	69.990	18.690	29.690	235.730	6.300	21.870	21.780	0.290	8.440	18.810
THYAO	0.940	0.890	66.500	56.420	25.440	43.590	129.430	20.030	32.320	51.040	0.620	22.530	40.640
TLMAN	5.260	5.100	134.530	21.880	9.580	78.120	28.010	19.790	36.070	25.320	0.550	28.210	151.320
TUREX	1.200	1.140	23.790	29.680	11.770	70.300	42.210	13.730	14.100	19.950	0.970	10.880	137.200
MAX	5.260	5.100	263.760	76.410	63.250	78.120	323.850	27.530	65.090	57.510	5.640	93.150	708.810
MIN	0.800	0.740	3.320	21.880	8.660	23.590	28.010	-16.060	-117.570	-21.140	0.140	2.900	18.810

Table A2. Standardized values for 2023

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.260	0.169	0.149	0.331	0.137	0.435	0.144	0.198	0.015	0.316	1.000	0.416	0.030
CLEBI	0.240	0.237	0.294	0.332	0.272	0.389	0.129	0.520	0.236	0.781	0.165	0.108	0.085
GRSEL	0.293	0.300	0.217	0.571	0.370	0.773	0.441	1.000	0.370	0.831	0.202	0.079	1.000
GSDDE	0.519	0.527	1.000	0.956	1.000	0.987	0.943	0.000	0.000	0.000	0.025	1.000	0.135
HOROZ	0.152	0.145	0.013	0.286	0.180	0.302	0.086	0.171	0.038	0.355	0.333	0.056	0.151
HRKET	0.162	0.147	0.014	0.532	0.624	0.762	0.406	0.705	1.000	0.603	0.053	0.031	0.037
PASEU	0.407	0.392	0.170	0.732	0.388	0.897	0.657	0.808	0.510	0.677	0.119	0.035	0.152
PGSUS	0.245	0.247	0.353	0.300	0.470	0.347	0.104	0.510	0.455	1.000	0.083	0.424	0.092
RYSAS	0.188	0.180	0.201	0.389	0.272	0.432	0.168	0.369	0.170	0.617	0.163	0.193	0.106
TAVHL	0.221	0.208	0.307	0.313	0.463	0.380	0.119	0.229	0.336	0.379	0.051	0.091	0.027
THYAO	0.179	0.175	0.252	0.388	0.340	0.558	0.216	0.728	0.497	0.887	0.110	0.242	0.057
TLMAN	1.000	1.000	0.510	1.000	0.904	1.000	1.000	0.719	0.554	0.440	0.098	0.303	0.213
TUREX	0.228	0.224	0.090	0.737	0.736	0.900	0.664	0.499	0.217	0.347	0.172	0.117	0.194
Σ	4.093	3.951	3.570	6.867	6.156	8.162	5.078	6.455	4.398	7.233	2.574	3.095	2.278

Table A3. fij values for 2023

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.064	0.043	0.042	0.048	0.022	0.053	0.028	0.031	0.003	0.044	0.388	0.134	0.013
CLEBI	0.059	0.060	0.082	0.048	0.044	0.048	0.025	0.081	0.054	0.108	0.064	0.035	0.037
GRSEL	0.072	0.076	0.061	0.083	0.060	0.095	0.087	0.155	0.084	0.115	0.079	0.026	0.439
GSDDE	0.127	0.133	0.280	0.139	0.162	0.121	0.186	0.000	0.000	0.000	0.010	0.323	0.059
HOROZ	0.037	0.037	0.004	0.042	0.029	0.037	0.017	0.026	0.009	0.049	0.129	0.018	0.066
HRKET	0.039	0.037	0.004	0.078	0.101	0.093	0.080	0.109	0.227	0.083	0.021	0.010	0.016
PASEU	0.099	0.099	0.048	0.107	0.063	0.110	0.129	0.125	0.116	0.094	0.046	0.011	0.067
PGSUS	0.060	0.063	0.099	0.044	0.076	0.042	0.020	0.079	0.104	0.138	0.032	0.137	0.040
RYSAS	0.046	0.046	0.056	0.057	0.044	0.053	0.033	0.057	0.039	0.085	0.063	0.062	0.046
TAVHL	0.054	0.053	0.086	0.046	0.075	0.047	0.023	0.035	0.076	0.052	0.020	0.029	0.012
THYAO	0.044	0.044	0.071	0.056	0.055	0.068	0.043	0.113	0.113	0.123	0.043	0.078	0.025
TLMAN	0.244	0.253	0.143	0.146	0.147	0.123	0.197	0.111	0.126	0.061	0.038	0.098	0.094
TUREX	0.056	0.057	0.025	0.107	0.120	0.110	0.131	0.077	0.049	0.048	0.067	0.038	0.085

Table A4. Infij values for 2023

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	-2.755	-3.154	-3.174	-3.032	-3.806	-2.933	-3.563	-3.483	-5.687	-3.130	-0.946	-2.006	-4.341
CLEBI	-2.838	-2.813	-2.497	-3.028	-3.118	-3.044	-3.671	-2.519	-2.926	-2.226	-2.748	-3.354	-3.293
GRSEL	-2.638	-2.578	-2.801	-2.488	-2.812	-2.357	-2.443	-1.865	-2.476	-2.164	-2.544	-3.665	-0.823
GSDDE	-2.065	-2.014	-1.273	-1.972	-1.818	-2.112	-1.683	0.000	0.000	0.000	-4.642	-1.130	-2.829
HOROZ	-3.293	-3.304	-5.648	-3.177	-3.532	-3.297	-4.073	-3.633	-4.741	-3.015	-2.044	-4.019	-2.714
HRKET	-3.232	-3.291	-5.515	-2.557	-2.289	-2.371	-2.527	-2.215	-1.481	-2.484	-3.879	-4.599	-4.118
PASEU	-2.309	-2.310	-3.044	-2.239	-2.764	-2.208	-2.046	-2.078	-2.154	-2.369	-3.076	-4.473	-2.705
PGSUS	-2.815	-2.772	-2.314	-3.131	-2.572	-3.159	-3.889	-2.538	-2.268	-1.979	-3.431	-1.988	-3.210
RYSAS	-3.079	-3.087	-2.879	-2.871	-3.121	-2.938	-3.408	-2.862	-3.253	-2.461	-2.759	-2.775	-3.069
TAVHL	-2.921	-2.945	-2.453	-3.090	-2.587	-3.067	-3.755	-3.340	-2.572	-2.950	-3.913	-3.531	-4.452
THYAO	-3.131	-3.120	-2.650	-2.874	-2.895	-2.683	-3.155	-2.183	-2.181	-2.098	-3.154	-2.549	-3.682
TLMAN	-1.409	-1.374	-1.946	-1.927	-1.918	-2.099	-1.625	-2.195	-2.071	-2.799	-3.273	-2.324	-2.367
TUREX	-2.887	-2.872	-3.678	-2.232	-2.124	-2.205	-2.035	-2.561	-3.011	-3.037	-2.706	-3.277	-2.465

Table A5. fij.Infij values for 2023

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	-0.175	-0.135	-0.133	-0.146	-0.085	-0.156	-0.101	-0.107	-0.019	-0.137	-0.367	-0.270	-0.057
CLEBI	-0.166	-0.169	-0.206	-0.147	-0.138	-0.145	-0.093	-0.203	-0.157	-0.240	-0.176	-0.117	-0.122
GRSEL	-0.189	-0.196	-0.170	-0.207	-0.169	-0.223	-0.212	-0.289	-0.208	-0.249	-0.200	-0.094	-0.361
GSDDE	-0.262	-0.269	-0.356	-0.274	-0.295	-0.255	-0.313	0.000	0.000	0.000	-0.045	-0.365	-0.167
HOROZ	-0.122	-0.121	-0.020	-0.132	-0.103	-0.122	-0.069	-0.096	-0.041	-0.148	-0.265	-0.072	-0.180
HRKET	-0.128	-0.122	-0.022	-0.198	-0.232	-0.221	-0.202	-0.242	-0.337	-0.207	-0.080	-0.046	-0.067
PASEU	-0.229	-0.229	-0.145	-0.239	-0.174	-0.243	-0.265	-0.260	-0.250	-0.222	-0.142	-0.051	-0.181
PGSUS	-0.169	-0.173	-0.229	-0.137	-0.196	-0.134	-0.080	-0.201	-0.235	-0.274	-0.111	-0.272	-0.130
RYSAS	-0.142	-0.141	-0.162	-0.163	-0.138	-0.156	-0.113	-0.164	-0.126	-0.210	-0.175	-0.173	-0.143
TAVHL	-0.157	-0.155	-0.211	-0.141	-0.195	-0.143	-0.088	-0.118	-0.196	-0.154	-0.078	-0.103	-0.052
THYAO	-0.137	-0.138	-0.187	-0.162	-0.160	-0.183	-0.134	-0.246	-0.246	-0.257	-0.135	-0.199	-0.093
TLMAN	-0.344	-0.348	-0.278	-0.281	-0.282	-0.257	-0.320	-0.244	-0.261	-0.170	-0.124	-0.227	-0.222
TUREX	-0.161	-0.162	-0.093	-0.240	-0.254	-0.243	-0.266	-0.198	-0.148	-0.146	-0.181	-0.124	-0.209
Σ	-2.381	-2.358	-2.212	-2.466	-2.421	-2.482	-2.256	-2.368	-2.225	-2.414	-2.078	-2.115	-1.983

Table A6. eij values for 2023

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
e_j	0.928	0.919	0.862	0.961	0.944	0.968	0.880	0.923	0.867	0.941	0.810	0.824	0.773
$\Sigma\ e_j$	11.602												

Table A7. Criteria importance weights for 2023

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
w_j	0.051	0.058	0.098	0.028	0.040	0.023	0.086	0.055	0.095	0.042	0.136	0.126	0.162

Appendix 2. Calculation of Criteria Importance Weights for 2024

Table A8. Initial Decision Matrix for 2024

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	1.230	0.860	47.250	63.620	61.610	36.380	174.900	-1.240	-0.250	-3.530	4.980	26.880	15.910
CLEBI	1.310	1.260	76.960	60.820	32.420	36.470	166.740	20.470	18.600	60.550	1.100	9.860	83.110
GRSEL	1.690	1.680	63.930	34.060	25.210	64.880	52.500	17.170	19.810	27.200	0.870	4.350	738.050
GSDDE	3.110	3.070	303.060	27.570	8.860	72.430	38.060	-0.990	-6.280	-1.330	0.160	70.470	70.540
HOROZ	1.330	1.280	53.170	56.350	28.720	43.330	130.030	10.190	8.130	28.330	1.250	6.290	116.000
HRKET	1.570	1.490	68.810	45.940	13.700	53.990	85.080	-1.090	-3.820	-1.940	0.290	3.720	45.800
PASEU	1.650	1.560	14.530	38.800	34.040	60.900	63.710	6.890	13.840	10.700	0.500	1.610	63.310
PGSUS	1.280	1.250	105.310	73.560	19.220	26.440	278.170	5.480	11.880	20.500	0.460	38.490	64.510
RYSAS	1.030	1.010	67.210	25.560	15.170	53.890	47.430	5.590	12.500	11.610	0.450	10.490	39.030
TAVHL	1.050	0.920	62.640	66.630	16.630	33.060	201.550	3.930	11.080	12.490	0.360	10.910	23.500
THYAO	1.010	0.910	63.030	51.410	24.260	48.580	105.840	9.260	15.210	19.940	0.610	21.040	34.280
TLMAN	4.230	4.000	285.710	17.720	7.460	82.280	21.540	6.820	19.820	8.480	0.340	18.050	153.520
TUREX	1.170	1.100	22.550	33.590	17.320	66.440	50.560	2.540	4.080	3.730	0.620	6.060	69.500
MAX	4.230	4.000	303.060	73.560	61.610	82.280	278.170	20.470	19.820	60.550	4.980	70.470	738.050
MIN	1.010	0.860	14.530	17.720	7.460	26.440	21.540	-1.240	-6.280	-3.530	0.160	1.610	15.910

Table A9. Standardized values for 2024

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.291	0.215	0.156	0.279	0.121	0.442	0.123	0.000	0.046	0.000	1.000	0.381	0.022
CLEBI	0.310	0.315	0.254	0.291	0.230	0.443	0.129	1.000	0.938	1.000	0.221	0.140	0.113
GRSEL	0.400	0.420	0.211	0.520	0.296	0.789	0.410	0.839	0.999	0.449	0.175	0.062	1.000
GSDDE	0.735	0.768	1.000	0.643	0.842	0.880	0.566	0.012	0.000	0.034	0.032	1.000	0.096
HOROZ	0.314	0.320	0.175	0.314	0.260	0.527	0.166	0.498	0.410	0.468	0.251	0.089	0.157
HRKET	0.371	0.373	0.227	0.386	0.545	0.656	0.253	0.007	0.094	0.025	0.058	0.053	0.062
PASEU	0.390	0.390	0.048	0.457	0.219	0.740	0.338	0.337	0.698	0.177	0.100	0.023	0.086
PGSUS	0.303	0.313	0.347	0.241	0.388	0.321	0.077	0.268	0.599	0.339	0.092	0.546	0.087
RYSAS	0.243	0.253	0.222	0.693	0.492	0.655	0.454	0.273	0.631	0.192	0.090	0.149	0.053
TAVHL	0.248	0.230	0.207	0.266	0.449	0.402	0.107	0.192	0.559	0.206	0.072	0.155	0.032
THYAO	0.239	0.228	0.208	0.345	0.308	0.590	0.204	0.452	0.767	0.329	0.122	0.299	0.046
TLMAN	1.000	1.000	0.943	1.000	1.000	1.000	1.000	0.333	1.000	0.140	0.068	0.256	0.208
TUREX	0.277	0.275	0.074	0.528	0.431	0.807	0.426	0.124	0.206	0.062	0.124	0.086	0.094
Σ	5.121	5.098	4.072	5.962	5.579	8.253	4.253	4.334	6.949	3.420	2.408	3.239	2.055

Table A10. fij values for 2024

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.057	0.042	0.038	0.047	0.022	0.054	0.029	0.000	0.007	0.000	0.415	0.118	0.010
CLEBI	0.060	0.062	0.062	0.049	0.041	0.054	0.030	0.231	0.135	0.292	0.092	0.043	0.055
GRSEL	0.078	0.082	0.052	0.087	0.053	0.096	0.096	0.194	0.144	0.131	0.073	0.019	0.487
GSDDE	0.144	0.151	0.246	0.108	0.151	0.107	0.133	0.003	0.000	0.010	0.013	0.309	0.046
HOROZ	0.061	0.063	0.043	0.053	0.047	0.064	0.039	0.115	0.059	0.137	0.104	0.028	0.076
HRKET	0.072	0.073	0.056	0.065	0.098	0.080	0.060	0.002	0.014	0.007	0.024	0.016	0.030
PASEU	0.076	0.077	0.012	0.077	0.039	0.090	0.079	0.078	0.100	0.052	0.042	0.007	0.042
PGSUS	0.059	0.061	0.085	0.040	0.070	0.039	0.018	0.062	0.086	0.099	0.038	0.169	0.043
RYSAS	0.048	0.050	0.054	0.116	0.088	0.079	0.107	0.063	0.091	0.056	0.038	0.046	0.026
TAVHL	0.048	0.045	0.051	0.045	0.080	0.049	0.025	0.044	0.080	0.060	0.030	0.048	0.015
THYAO	0.047	0.045	0.051	0.058	0.055	0.072	0.048	0.104	0.110	0.096	0.051	0.092	0.023
TLMAN	0.195	0.196	0.232	0.168	0.179	0.121	0.235	0.077	0.144	0.041	0.028	0.079	0.101
TUREX	0.054	0.054	0.018	0.088	0.077	0.098	0.100	0.029	0.030	0.018	0.052	0.027	0.046

Table A11. lnfij values for 2024

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	-2.868	-3.166	-3.263	-3.064	-3.830	-2.927	-3.542	0.000	-5.026	0.000	-0.879	-2.139	-4.558
CLEBI	-2.805	-2.784	-2.775	-3.019	-3.188	-2.924	-3.494	-1.466	-2.002	-1.230	-2.389	-3.142	-2.904
GRSEL	-2.551	-2.496	-2.960	-2.439	-2.937	-2.348	-2.339	-1.642	-1.939	-2.030	-2.623	-3.960	-0.721
GSDDE	-1.941	-1.893	-1.404	-2.227	-1.891	-2.238	-2.017	-5.931	0.000	-4.601	-4.317	-1.175	-3.068
HOROZ	-2.790	-2.768	-3.145	-2.942	-3.067	-2.752	-3.246	-2.164	-2.830	-1.989	-2.261	-3.591	-2.571
HRKET	-2.624	-2.616	-2.887	-2.738	-2.327	-2.532	-2.821	-6.441	-4.300	-4.926	-3.722	-4.117	-3.500
PASEU	-2.575	-2.570	-4.442	-2.569	-3.237	-2.411	-2.532	-2.555	-2.298	-2.963	-3.177	-4.954	-3.176
PGSUS	-2.829	-2.792	-2.461	-3.209	-2.665	-3.246	-4.006	-2.784	-2.450	-2.313	-3.261	-1.780	-3.158
RYSAS	-3.046	-3.005	-2.910	-2.152	-2.429	-2.534	-2.237	-2.764	-2.400	-2.881	-3.283	-3.080	-3.660
TAVHL	-3.027	-3.098	-2.981	-3.110	-2.521	-3.022	-3.684	-3.117	-2.520	-2.808	-3.506	-3.041	-4.168
THYAO	-3.066	-3.109	-2.975	-2.851	-2.898	-2.638	-3.040	-2.260	-2.203	-2.341	-2.978	-2.384	-3.790
TLMAN	-1.633	-1.629	-1.463	-1.785	-1.719	-2.111	-1.448	-2.566	-1.939	-3.196	-3.563	-2.537	-2.291
TUREX	-2.918	-2.920	-4.002	-2.425	-2.561	-2.324	-2.301	-3.553	-3.519	-4.017	-2.962	-3.629	-3.083

Table A12. fij.lnfij values for 2024

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	-0.163	-0.134	-0.125	-0.143	-0.083	-0.157	-0.103	0.000	-0.033	0.000	-0.365	-0.252	-0.048
CLEBI	-0.170	-0.172	-0.173	-0.148	-0.131	-0.157	-0.106	-0.338	-0.270	-0.360	-0.219	-0.136	-0.159
GRSEL	-0.199	-0.206	-0.153	-0.213	-0.156	-0.224	-0.226	-0.318	-0.279	-0.267	-0.190	-0.075	-0.351
GSDDE	-0.279	-0.285	-0.345	-0.240	-0.285	-0.239	-0.268	-0.016	0.000	-0.046	-0.058	-0.363	-0.143
HOROZ	-0.171	-0.174	-0.135	-0.155	-0.143	-0.176	-0.126	-0.249	-0.167	-0.272	-0.236	-0.099	-0.197
HRKET	-0.190	-0.191	-0.161	-0.177	-0.227	-0.201	-0.168	-0.010	-0.058	-0.036	-0.090	-0.067	-0.106
PASEU	-0.196	-0.197	-0.052	-0.197	-0.127	-0.216	-0.201	-0.198	-0.231	-0.153	-0.132	-0.035	-0.133
PGSUS	-0.167	-0.171	-0.210	-0.130	-0.185	-0.126	-0.073	-0.172	-0.211	-0.229	-0.125	-0.300	-0.134
RYSAS	-0.145	-0.149	-0.158	-0.250	-0.214	-0.201	-0.239	-0.174	-0.218	-0.162	-0.123	-0.142	-0.094
TAVHL	-0.147	-0.140	-0.151	-0.139	-0.203	-0.147	-0.093	-0.138	-0.203	-0.169	-0.105	-0.145	-0.065
THYAO	-0.143	-0.139	-0.152	-0.165	-0.160	-0.189	-0.145	-0.236	-0.243	-0.225	-0.152	-0.220	-0.086
TLMAN	-0.319	-0.320	-0.339	-0.299	-0.308	-0.256	-0.340	-0.197	-0.279	-0.131	-0.101	-0.201	-0.232
TUREX	-0.158	-0.158	-0.073	-0.215	-0.198	-0.227	-0.230	-0.102	-0.104	-0.072	-0.153	-0.096	-0.141
Σ	-2.446	-2.434	-2.228	-2.470	-2.421	-2.517	-2.319	-2.148	-2.297	-2.122	-2.050	-2.131	-1.887

Table A13. eij values for 2024

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
e_j	0.954	0.949	0.869	0.963	0.944	0.981	0.904	0.838	0.896	0.827	0.799	0.831	0.736
Σ e_j	11.489												

Table A14. Criteria importance weights for 2024

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
w_j	0.031	0.034	0.087	0.024	0.037	0.012	0.063	0.107	0.069	0.114	0.133	0.112	0.175

Appendix 3. MOORA Ratio Method Calculations for 2023

Table A15. Square root values of the sum of squares for 2023

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	1.87	0.74	1551.5	4362.60	4000.5	1152.6	37865.2	29.8	0.94	330.5	31.8	1503.1	441.8
CLEBI	1.58	1.46	6006.2	4332.27	1011.2	922.9	46941.5	204.7	235.6	2016	0.8	101.4	3592.8
GRSEL	2.37	2.34	3271.8	1470.72	548.49	3646.9	4032.2	757.9	579.3	2282.9	1.3	54.4	502411.6
GSDDE	7.45	7.23	69569.3	523.95	74.9	5945.9	881.5	257.9	13822.7	446.9	0.02	8676.9	9091.6
HOROZ	0.64	0.54	11.0	5838.48	2312.6	556.4	104878	22.1	6.2	416.5	3.53	26.8	0.00
HRKET	0.72	0.56	14.3	1689.21	192.6	3547.3	4762.3	376.3	4236.7	1203.3	0.09	8.41	690.6
PASEU	4.58	4.00	2013.3	894.01	498.2	4914.0	1819.8	495	1102.2	1513.9	0.45	10.82	0.00
PGSUS	1.66	1.58	8665.7	5318.78	338.9	732.7	72581.7	197.1	878.5	3307.4	0.22	1560.2	4247.13
RYSAS	0.98	0.84	2800.5	3165.18	1016.9	1139.7	27768.8	103.2	122.3	1260.9	0.84	323.2	5631
TAVHL	1.34	1.12	6562.6	4898.60	349.3	881.4	55568.6	39.7	478.3	474.3	0.08	71.2	353.8
THYAO	0.88	0.79	4422.2	3183.21	647.2	1900.08	16752.1	401.2	1044.5	2605.1	0.38	507.6	1651.6
TLMAN	27.6	26.01	18098.3	478.73	91.7	6102.7	784.5	391.6	1301	641.1	0.30	795.8	22897.7
TUREX	1.44	1.3	565.9	880.9	138.5	4942.1	1781.6	188.5	198.8	398	0.94	118.3	18823.8
Σ	53.2	48.5	123553	37036	11221	36385	376419.2	3465	24007.4	16897	40.8	13758	569833.6
$\sqrt{(\Sigma x^2)}$	7.29	6.96	351.50	192.44	105.93	190.74	613.53	58.86	154.94	129.98	6.39	117.29	754.87

Table A16. Standardized decision matrix for 2023

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.188	0.123	0.112	0.343	0.597	0.178	0.317	0.093	0.006	0.140	0.882	0.331	0.028
CLEBI	0.173	0.174	0.220	0.342	0.300	0.159	0.353	0.243	0.099	0.345	0.146	0.086	0.079
GRSEL	0.211	0.220	0.163	0.199	0.221	0.317	0.103	0.468	0.155	0.368	0.178	0.063	0.939
GSDDE	0.374	0.386	0.750	0.119	0.082	0.404	0.048	-0.273	-0.759	-0.163	0.022	0.794	0.126
HOROZ	0.110	0.106	0.009	0.397	0.454	0.124	0.528	0.080	0.016	0.157	0.294	0.044	0.000
HRKET	0.117	0.108	0.011	0.214	0.131	0.312	0.112	0.330	0.420	0.267	0.047	0.025	0.035
PASEU	0.293	0.287	0.128	0.155	0.211	0.367	0.070	0.378	0.214	0.299	0.105	0.028	0.000
PGSUS	0.177	0.181	0.265	0.379	0.174	0.142	0.439	0.239	0.191	0.442	0.074	0.337	0.086
RYSAS	0.136	0.132	0.151	0.292	0.301	0.177	0.272	0.173	0.071	0.273	0.144	0.153	0.099
TAVHL	0.159	0.152	0.230	0.364	0.176	0.156	0.384	0.107	0.141	0.168	0.045	0.072	0.025
THYAO	0.129	0.128	0.189	0.293	0.240	0.229	0.211	0.340	0.209	0.393	0.097	0.192	0.054
TLMAN	0.721	0.732	0.383	0.114	0.090	0.410	0.046	0.336	0.233	0.195	0.086	0.241	0.200
TUREX	0.165	0.164	0.068	0.154	0.111	0.369	0.069	0.233	0.091	0.153	0.152	0.093	0.182

Table A17. Weighted standardized matrix for 2023

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.010	0.007	0.011	0.009	0.024	0.004	0.027	0.005	0.001	0.006	0.120	0.042	0.005
CLEBI	0.009	0.010	0.022	0.009	0.012	0.004	0.030	0.013	0.009	0.015	0.020	0.011	0.013
GRSEL	0.011	0.013	0.016	0.006	0.009	0.007	0.009	0.026	0.015	0.015	0.024	0.008	0.152
GSDDE	0.019	0.022	0.074	0.003	0.003	0.009	0.004	-0.015	-0.072	-0.007	0.003	0.100	0.020
HOROZ	0.006	0.006	0.001	0.011	0.018	0.003	0.045	0.004	0.002	0.007	0.040	0.006	0.000
HRKET	0.006	0.006	0.001	0.006	0.005	0.007	0.010	0.018	0.040	0.011	0.006	0.003	0.006
PASEU	0.015	0.017	0.013	0.004	0.008	0.008	0.006	0.021	0.020	0.013	0.014	0.004	0.000
PGSUS	0.009	0.010	0.026	0.010	0.007	0.003	0.038	0.013	0.018	0.019	0.010	0.042	0.014
RYSAS	0.007	0.008	0.015	0.008	0.012	0.004	0.023	0.009	0.007	0.012	0.020	0.019	0.016
TAVHL	0.008	0.009	0.023	0.010	0.007	0.004	0.033	0.006	0.013	0.007	0.006	0.009	0.004
THYAO	0.007	0.007	0.019	0.008	0.010	0.005	0.018	0.019	0.020	0.017	0.013	0.024	0.009
TLMAN	0.037	0.042	0.038	0.003	0.004	0.009	0.004	0.018	0.022	0.008	0.012	0.030	0.033
TUREX	0.008	0.009	0.007	0.004	0.004	0.008	0.006	0.013	0.009	0.006	0.021	0.012	0.029

Table A18. Derivation of company rankings for 2023

Company	*Total Score*	*Rank*
BEYAZ	0.149	3
CLEBI	0.073	10
GRSEL	0.264	1
GSDDE	0.143	4
HOROZ	-0.001	13
HRKET	0.084	9
PASEU	0.105	7
PGSUS	0.110	5
RYSAS	0.073	11
TAVHL	0.039	12
THYAO	0.103	8
TLMAN	0.239	2
TUREX	0.108	6

Appendix 4. MOORA Ratio Method Calculations for 2024

Table A19. Square Root Values of the Sum of Squares for 2024

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	1.5	0.7	2232.5	4047.5	3795.7	1323.5	30590.0	1.52	0.06	12.46	24.8	722.5	253.1
CLEBI	1.7	1.5	5922.8	3699.0	1051.0	1330.0	27802.2	419.0	345.96	3666.3	1.21	97.22	6907.2
GRSEL	2.8	2.8	4087.04	1160.0	635.5	4209.4	2756.2	294.8	392.43	739.8	0.75	18.92	544717.8
GSDDE	9.6	9.4	91845.3	760.1	78.5	5246.1	1448.5	0.98	39.43	1.76	0.02	4966	4975.8
HOROZ	1.7	1.6	2827.05	3175.3	824.8	1877.4	16907.8	103.8	66.09	802.5	1.56	39.5	13456.0
HRKET	2.4	2.2	4734.8	2110.4	187.6	2914.9	7238.6	1.1	14.59	3.76	0.08	13.8	2097.6
PASEU	2.7	2.4	211.1	1505.4	1158.7	3708.8	4058.9	47.4	191.54	114.5	0.25	2.5	4008.1
PGSUS	1.6	1.5	11090.2	5411.0	369.4	699.0	77378.5	30.03	141.13	420.2	0.21	1481.4	4161.5
RYSAS	1.0	1.0	4517.1	653.3	230.1	2904.1	2249.6	31.24	156.25	134.8	0.20	110	1523.3
TAVHL	1.1	0.84	3923.7	4439.5	276.5	1092.9	40622.4	15.44	122.76	156	0.13	119.02	552.2
THYAO	1.0	0.82	3972.7	2642.9	588.5	2360.0	11202.1	85.74	231.34	397.6	0.37	442.6	1175.1
TLMAN	17.8	16.0	81630.2	313.9	55.6	6769.9	463.9	46.51	392.83	71.9	0.11	325.8	23568.3
TUREX	1.3	1.21	508.5	1128.2	299.9	4414.2	2556.3	6.45	16.64	13.9	0.38	36.7	4830.2
Σ	46.7	42.3	217503	31047	9552.4	38850.7	225275	1084.2	2111.1	6535.6	30.1	8376.4	612226.7
$\sqrt{(\Sigma x^2)}$	6.8	6.5	466.3	176.2	97.7	197.1	474.6	32.9	45.9	80.8	5.4	91.5	782.5

Table A20. Normalized decision matrix for 2024

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.180	0.132	0.101	0.361	0.630	0.185	0.368	-0.038	-0.005	-0.044	0.908	0.294	0.020
CLEBI	0.191	0.194	0.165	0.345	0.332	0.185	0.351	0.622	0.405	0.749	0.200	0.108	0.106
GRSEL	0.247	0.258	0.137	0.193	0.258	0.329	0.111	0.521	0.431	0.336	0.159	0.048	0.943
GSDDE	0.455	0.472	0.650	0.156	0.091	0.367	0.080	-0.030	-0.137	-0.016	0.029	0.770	0.090
HOROZ	0.194	0.197	0.114	0.320	0.294	0.220	0.274	0.309	0.177	0.350	0.228	0.069	0.148
HRKET	0.230	0.229	0.148	0.261	0.140	0.274	0.179	-0.033	-0.083	-0.024	0.053	0.041	0.059
PASEU	0.241	0.240	0.031	0.220	0.348	0.309	0.134	0.209	0.301	0.132	0.091	0.018	0.081
PGSUS	0.187	0.192	0.226	0.417	0.197	0.134	0.586	0.166	0.259	0.254	0.084	0.421	0.082
RYSAS	0.151	0.155	0.144	0.145	0.155	0.273	0.100	0.170	0.272	0.144	0.082	0.115	0.050
TAVHL	0.153	0.141	0.134	0.378	0.170	0.168	0.425	0.119	0.241	0.154	0.066	0.119	0.030
THYAO	0.148	0.140	0.135	0.292	0.248	0.246	0.223	0.281	0.331	0.247	0.111	0.230	0.044
TLMAN	0.618	0.615	0.613	0.101	0.076	0.417	0.045	0.207	0.431	0.105	0.062	0.197	0.196
TUREX	0.171	0.169	0.048	0.191	0.177	0.337	0.107	0.077	0.089	0.046	0.113	0.066	0.089

Table A21. Weighted normalized decision matrix for 2024

	R1	*R2*	*R3*	*R4*	*R5*	*R6*	*R7*	*R8*	*R9*	*R10*	*R11*	*R12*	*R13*
BEYAZ	0.006	0.004	0.009	0.009	0.023	0.002	0.023	-0.004	0.000	-0.005	0.121	0.033	0.004
CLEBI	0.006	0.007	0.014	0.008	0.012	0.002	0.022	0.067	0.028	0.086	0.027	0.012	0.019
GRSEL	0.008	0.009	0.012	0.005	0.010	0.004	0.007	0.056	0.030	0.038	0.021	0.005	0.165
GSDDE	0.014	0.016	0.056	0.004	0.003	0.005	0.005	-0.003	-0.009	-0.002	0.004	0.086	0.016
HOROZ	0.006	0.007	0.010	0.008	0.011	0.003	0.017	0.033	0.012	0.040	0.030	0.008	0.026
HRKET	0.007	0.008	0.013	0.006	0.005	0.003	0.011	-0.004	-0.006	-0.003	0.007	0.005	0.010
PASEU	0.007	0.008	0.003	0.005	0.013	0.004	0.009	0.022	0.021	0.015	0.012	0.002	0.014
PGSUS	0.006	0.007	0.020	0.010	0.007	0.002	0.037	0.018	0.018	0.029	0.011	0.047	0.014
RYSAS	0.005	0.005	0.013	0.004	0.006	0.003	0.006	0.018	0.019	0.016	0.011	0.013	0.009
TAVHL	0.005	0.005	0.012	0.009	0.006	0.002	0.027	0.013	0.017	0.018	0.009	0.013	0.005
THYAO	0.005	0.005	0.012	0.007	0.009	0.003	0.014	0.030	0.023	0.028	0.015	0.026	0.008
TLMAN	0.019	0.021	0.053	0.002	0.003	0.005	0.003	0.022	0.030	0.012	0.008	0.022	0.034
TUREX	0.005	0.006	0.004	0.005	0.007	0.004	0.007	0.008	0.006	0.005	0.015	0.007	0.016

Table A22. Derivation of company rankings for 2024

Company	*Total Score*	*Rank*
BEYAZ	0.113	8
CLEBI	0.224	2
GRSEL	0.327	1
GSDDE	0.170	4
HOROZ	0.139	5
HRKET	0.018	13
PASEU	0.082	10
PGSUS	0.116	7
RYSAS	0.096	9
TAVHL	0.055	12
THYAO	0.123	6
TLMAN	0.219	3
TUREX	0.059	11