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# Financial Performance of BIST Sustainability Index Enterprises: Unearthing the Most Optimum MCDA Methods for Decision-Makers

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***ABSTRACT***

***Purpose*:** The aim of this study is to examine the financial performance of companies traded in BIST Sustainability index using 7 MCDA applications. Although there have been previous studies on aforementioned index, this study will be the first comparative and most comprehensive study conducted across 7 methods.

***Methodology*:** Analyzes were performed using VIKOR, FUCA, MOORA, GRA, COPRAS, SAW and CODAS methods and the CRITIC technique for the financial performance of 34 companies that achieved to remain in the relevant index continuously for 11 periods, within the timeframe spanning from Q1 2019 to Q3 2021.

***Findings*:** According to the comparative MCDA analysis, the highest capacity was found in the VIKOR method with 65.8% ($p<0.01$). The FUCA method followed the relevant method with 61.14% ($p<0.01$) and the MOORA method with 55.08% ($p<0.02$) capacities. COPRAS, SAW and CODAS were established as the methods with the lowest capacity.

***Originality*:** This study is the first sustainability index study that measures the MCDA applications capacity with regard to association between the outputs they produce for corporations and the stock returns of the relevant firms and conclusively makes a comparison among analyzed methods. In this sense, it makes significant contributions to the literature.

***Keywords*:** Capital Markets, Share Return, Sustainability, MCDA.
***JEL Codes*:** D53, D81, G11, G23.

## BIST Sürdürülebilirlik Endeksi İşletmelerinin Finansal Performansı: Karar Vericiler için en Optimum ÇKKA Yöntemlerinin Ortaya Çıkarılması

***ÖZET***

***Amaç*:** Bu çalışmanın amacı, BIST Sürdürülebilirlik endeksinde işlem gören şirketlerin finansal performansını ÇKKA uygulamaları ile incelemektir. Daha önce bu endeksle ilgili çalışmalar olmakla birlikte, bu çalışma 7 metot üzerinden gerçekleştirilen ilk karşılaştırmalı ve en kapsamlı çalışma olacaktır.

***Yöntem*:** Ç1 2019 ile Ç3 2021 arasındaki 11 dönem boyunca sürekli ilgili endekste kalmayı başarabilmiş 34 şirketin finansal performansı için VIKOR, FUCA, MOORA, GRA, COPRAS, SAW ve CODAS yöntemleri ile CRITIC tekniği kullanılarak analizler gerçekleştirilmiştir.

***Bulgular*:** Yapılan karşılaştırmalı ÇKKA analizine göre en yüksek kapasite %65.80 ile VIKOR yönteminde bulunmuştur ($p$<0,01). FUCA yöntemi %61,14 ($p$<0,01) ve MOORA yöntemi ise %55,08 ($p$<0,02) kapasiteleri ile ilgili yöntemi takip etmişlerdir. COPRAS, SAW ve CODAS ise en düşük kapasiteye sahip metotlar olarak tespit edilmişlerdir.

***Özgünlük*:** Bu çalışma, ÇKKA yöntemlerinin kapasitesini, şirketler için ürettikleri skorlar ile ilgili şirketlerin hisse getirileri arasındaki ilişkiye göre ölçen ve bu şekilde yöntemler arası karşılaştırma yapan ilk sürdürülebilirlik endeksi çalışmasıdır. Bu anlamda literatüre önemli katkılar sağlamaktadır.

***Anahtar Kelimeler*:** Sermaye Piyasaları, Hisse Getirisi, Sürdürülebilirlik, ÇKKA.
***JEL Kodları*:** D53, D81, G11, G23.

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## 1. INTRODUCTION

Sustainability is one of the most important parameters for businesses in the current technological age. The concept aims to meet the needs of future generations without negatively affecting their peace and prosperity, while also meeting the needs of the present generation (United Nations, 1987: 16). To this end, sustainability reports, which include non-financial information about companies, are presented to the public in a way that covers environmental, social, and governance factors, as well as related plans and statistics, with attention to the long-term financial performance planned to be achieved.

Sustainability indices have taken their place in the capital markets at the beginning of the new millennium, as countries have increasingly focused on environmentally oriented policies and changes in consumer behavior. In this sense, the Domini 400 Social Index (DSI) is seen as the precursor of sustainability indices and became operational on May 1, 1990 (Paul and Lydenberg, 1996). On the other hand, the Dow Jones Sustainability Indices (DJSI) began operations in 1999. As of November 4, 2014, the Sustainability Index started trading on the Borsa Istanbul (BIST). Indices in this class make decisions about whether a company is included in the index based on different methodologies, focusing on a company's environmental, social, and governance policies. Within the scope of environmental policies, companies' sensitivity to issues such as biological diversity, air and water pollution, and climate change is investigated. To that end, statistics related to energy consumption, greenhouse gas emissions, and waste management methods of companies are examined (Manrique and Martí-Ballester, 2017). Within social policies, data regarding the equal rights, privileges, and working standards provided by companies to their employees are scrutinized (Phan et al., 2020). From a managerial policy perspective, the company's score is determined in relation to factors such as the protection of shareholder rights and compliance with laws and regulations (Khatib and Nour, 2021).

Financial performance demonstrates the efficiency and productivity of companies, assisting financial stakeholders in their decision-making. Additionally, financial performance has a vital impact on determining investment routes (Maqbool and Zamir, 2021). Multi-criteria decision analysis (MCDA) applications are utilized to assist decision-makers in solving complex problems with multiple criteria. Due to the numerous sub-parameters that can demonstrate financial performance, the topic has become an agenda in MCDA applications. In this sense, there are many studies in the literature. Indeed, MCDA studies in the finance field mainly focus on portfolio selection and financial performance (Zopounidis and Doumpos, 2013).

Since October 1, 2021, the methodology of the BIST Sustainability Index (XUSRD) has been updated and Refinitiv has been utilized in this context. Therefore, there has been a significant change in the companies included in this index as of the fourth quarter of 2021. In order to observe the pre-pandemic and post-pandemic periods comparatively, this study will examine 11 periods between Q1 2019 and Q3 2021. As known, according to the old methodology of XUSRD, the companies in this index were updated every year, and there were companies that were later included in the index as well as companies that were removed. A comprehensive and comparative MCDA study investigating the most optimum method has not been conducted before in the BIST Sustainability Index. The framework of this research was created to fill this critical research gap. To that end, performance of 34 companies that have consistently remained in this index throughout the mentioned 11 periods will be analyzed in this study. Analyses will be conducted using VIKOR, FUCA, MOORA, GRA, COPRAS, SAW, and CODAS methods. 6 criteria were used for the relevant calculations, and the CRITIC method, which is included in the objective techniques category, was preferred for the criteria weight calculations.

In the second section of the research, financial performance studies conducted with MCDA applications will be examined. In the third section, the methodology and theoretical background of the research will be presented, while the weighting technique, MCDA methods and criteria employed in the analyses will be explained with an extensive coverage. In the fourth section, financial performance analyses will be performed using 7 methods. In the fifth section, insights emerging from the findings will be detailed. In the sixth and final section, the results of the study and the potential future research directions will be uncovered.

## 2. LITERATURE REVIEW

When the studies conducted on financial performance with MCDA applications are examined, it is noted that the body of literature revolves around just one or two methods. In this sense, some financial performance studies conducted with MCDA methods in the literature are given in Table 1. In this study, analyses will be exercised with 7 different methods, and then these methods will be compared according to their capacities to assist decision-makers more clearly and efficiently.

**Table 1. Some financial performance studies executed with MCDA methods**

| *Author(s)* | *Findings* | *Method* | *Period* | *Sector* |
|---|---|---|---|---|
| Kalogeras et al. (2013) | ROA has emerged as one of the most important criteria | PROMETHEE II | 1999-2010 | Agricultural Cooperatives |
| Hsu (2014) | Analyzes were performed by dividing companies into different risk groups and the most successful companies were identified. | VIKOR and GRA | 2010 | Optronics Enterprises |
| Özdağoğlu et al. (2017) | Cement companies have been found to have higher performance | GRA | 2015 | BIST Manufacturing Index |
| Sarraf and Nejad (2020) | Findings demonstrated that GRA method produced more accurate results than DEA. | GRA and DEA | 2017 | Water and Waste Water Companies |
| Batrancea et al. (2022) | The rankings produced by VIKOR and the rankings of companies included in the Fortune list were found to be similar. | VIKOR | 2012-2021 | Airline Companies |
| Arsu and Arsu (2023) | ROE has been found to be one of the most critical criteria. | MEREC and CoCoSo | 2020 | Manufacturing firms in BIST Sustainability Index |
| Kumar and Sharma (2023) | ROE was found to be the most important criterion in the analyzed process. | FAHP and TOPSIS | 2016-2021 | Commercial Banks |
| Akdemir and Şimşek (2023) | DE was calculated as the most important criterion while ROE was found to be the least important criterion. | COPRAS, ARAS, SAW | 2005-2019 | Amazon Co. |

The financial performance of 14 agricultural cooperatives operating in the Netherlands has been the subject of another study (Kalogeras et al., 2013). 11 periods were analyzed over 15 financial ratios using the PROMETHEE II method. Return on assets (ROA) was identified as the second most important criterion. Companies were ranked based on the scores generated by the selected method for the period analyzed.

The financial performance of 8 cement companies operating in Iran and listed on the Tehran Stock Exchange has been examined in a study (Moghimi and Anvari, 2014). In the analyses based on FAHP and TOPSIS methods, 16 financial ratios were used. As a consequence of the relevant work, cement companies were ranked in accordance with the performance scores produced by the TOPSIS method.

Financial performance of 62 optoelectronics companies traded on the Taiwan Stock Exchange have been subject to evaluation via integrating VIKOR-E and GRA methods in a publication (Hsu, 2014). Companies were divided into 3 different risk groups, and their performances were determined according to the group they were in. Results expressed that investment can be made for 5 companies, while investment for 3 companies is not advisable.

GRA method was exercised in a study on revealing the financial performance of 98 companies traded on the BIST Manufacturing Index (Özdağoğlu et al., 2017). Research was conducted by determining 11 criteria from the 2015 financial statements. Findings signalized that cement companies performed well compared to other sectors.

The financial performance of 35 water and wastewater companies operating in Iran was examined using DEA and GRA methods (Sarraf and Nejad, 2020). For the study conducted based on 2017 data, 14 financial and non-financial criteria were determined. According to the findings of the study, GRA produced more successful and robust results compared to DEA.

AHP and DoE models were used in a study analyzing the financial performance of 18 commercial banks operating in Türkiye (Iç et al., 2022). The research, which investigated 15 periods with 12 criteria, determined performance rankings for the relevant banks. In addition, the capital adequacy ratio emerged as the most important criterion.

Financial performance of airline companies was investigated in a study which exercised VIKOR method (Batrancea et al., 2022). Among the 10 criteria integrated into the analysis, EPS, ROA, and DE are included. Findings signified that, the companies in the VIKOR rankings were similar to the companies on the Fortune list.

Sustainability performance of 14 production enterprises traded on BIST Sustainability Index examined in a study, while adopting MEREC weighting technique and CoCoSo method (Arsu and Arsu, 2023).

Sustainability performance rankings were made for the investigated companies, as a result of the analyses conducted based on 11 criteria.

HFTOPSIS method was preferred in a financial performance study of 4 energy companies traded on the BIST Sustainability Index (Dağıstanlı, 2023). According to the findings of the study exercised on 5 criteria, differences were observed between the results of trend analysis and HFTOPSIS. Rankings were made based on the performance scores obtained for the relevant companies.

The financial performance of 4 automotive companies traded on the BIST Sustainability Index was examined over 6 periods based on 10 criteria in another study (Ceyhan and Kara, 2023). Following the use of the GRA method, rankings were made based on the performance scores generated according to the aforementioned method for the relevant automotive companies.

TOPSIS method is implemented in a scholarly publication to evaluate the financial performance of 10 commercial banks operating in India (Kumar and Sharma, 2023). The finding of the study, which determined criteria weights by integrating Fuzzy AHP, indicates that return on equity (ROE) is the most important criterion. Additionally, the performance rankings of the relevant banks were established according to the methodology used in the analyses.

The financial performance of 5 energy companies operating in Saudi Arabia was investigated using the TOPSIS method with 11 criteria (Makki and Alqahtani, 2023). In the study where the criteria weights were assigned with AHP, efficiency and profitability were determined as the most important criteria. Conclusively, the 3-year performance rankings of the analyzed energy companies were revealed.

When the above-mentioned studies in the literature are scrutinized, it is seen that the researches are generally executed with one or two methods. However, in order to define a decision support system for making complex financial decisions, comparative studies involving more methods are needed. To that end, in this study, 11 periods covering before and after the pandemic will be analyzed comparatively and in great-depth through 7 methods.

## 3. METHODOLOGY

In this research, financial performance of 34 firms traded on XUSRD before and after pandemic was examined using 6 criteria, 7 methods, and CRITIC objective weighting technique. In the following subheadings, weighting technique, criteria, and methods integrated will be detailed.

### 3.1. Performance Metrics

Financial ratios are indicators containing important clues about the positions of companies within the sectors in which they operate. Thus, companies' underperforming activities and prominent investments compared to their competitors can be more easily identified. However, there are many ratios that managers, investors, and creditors can benefit from. In this sense, financial performance analysis emerges as an MCDA problem.

In order to conduct the MCDA study, criteria need to be determined first regarding the complex problem to be solved. In the studies conducted so far, different numbers of ratios have been used for financial performance analysis. Unfortunately, there is not a single ratio that provides all the details about the company (Venanzi, 2010). In this respect, the literature related to financial performance research was examined, and in this study, return on assets (ROA), return on equity (ROE), earnings per share (EPS), market to book (MB), debt to equity (DE), and market value added (MVA) were integrated into the analyses.

COPRAS, ARAS, and SAW methods were practiced in a study delved into discovering the financial performance of Amazon corporation (Akdemir and Şimşek, 2023). DE has been found to be the most significant, while ROA has been found to be the least, among the criteria integrated. The findings demonstrated that 2005 was the most, while 2014 was the least successful financial year for Amazon.

Financial performance of 3 airlines operating in China was examined in another study, while integrating ROA and ROE into the analyses (Dong et al., 2018). In the relevant study, it is expressed that there are many financial ratios, but in order to measure financial performance more accurately, the most relevant and important ratios should be preferred.

Data envelopment analysis was adopted in a study investigating the financial performance of 72 companies traded on the Tehran Stock Exchange (Karimi and Barati, 2018). ROA, ROE, DE, and EPS are included among the 19 criteria used. Findings revealed that the cement sector has the highest financial performance in the Tehran Stock Exchange, while the petrochemical sector has the lowest.

Financial performance of 5 petrochemical companies traded on the Malaysia Stock Exchange was examined via NDAHP method (Tey et al, 2019). DE, ROA, and ROE are included among the 15 criteria

used in the study based on 2017 financial data. The ranking results found in the relevant research were compared with the results of 5 other methods.

Financial performance of 4 sports clubs operating in Türkiye was examined in a study, which implemented Entropy weighting technique and COPRAS method into the analysis (Erdoğan et al., 2020). DE, ROA, and ROE are included among the 17 criteria chosen for the study examining the data between 2014 and 2017.

The performance of 10 tourism companies operating in Türkiye and traded on the BIST was identified in a study using VIKOR and TOPSIS (Türegün, 2022). The research conducted based on data between 2018 and 2020 includes MB among the 20 criteria used, and the relevant ratio has entered the top 6 performance metrics in order of significance.

Financial performance of 18 companies operating in Japan was examined in a study, while integrating 21 criteria into the analysis using FAHP and TOPSIS (Aduba, 2022). Among the criteria classified into profitability and value-focused categories in the relevant study, EPS and MVA are included in the value-focused segment.

### 3.2. Grey Relational Analysis (GRA)

GRA is a method used to solve problems involving complex interrelated variables. (Deng, 1989). This method is integrated in studies, such as the evaluation of financial performance (Wang, 2008) and efficient management of clean and accessible energy in sustainability (Ocon et al., 2018).

Initially, the evaluation matrix is created. After that, normalization is exercised for the values containing alternative information by using Equations 1 and 2. $F_j^+$ reference values are determined using Equation 3.

$$F_{ij} = \frac{f_{ij} - min_{i\in m} f_{ij}}{max_{i\in m} f_{ij} - min_{i\in m} f_{ij}} \quad (1)$$

$$F_{ij} = \frac{max_{i\in m} f_{ij} - f_{ij}}{max_{i\in m} f_{ij} - min_{i\in m} f_{ij}} \quad (2)$$

$$F_j^+ = max_{i\in m} F_{ij} \quad (3)$$

The difference between reference and comparability indices is calculated using Equation 4.

$$\Delta I_{ij} = |F_j^+ - F_{ij}| \quad (4)$$

Consequently, gray relational coefficients to be used in performance rankings are determined via Equation 5.

$$GRC_i = \frac{1}{m} \sum_{j=1}^{n} \frac{\Delta min + \Delta max}{\Delta I_{ij} + \Delta max} \quad (5)$$

By ranking the gray relational coefficients from largest to smallest, performance rankings related to this method are determined.

### 3.3. Combinative Distance-Based Assessment (CODAS)

CODAS is a method in which outputs are produced based on the negative ideal solution (Keshavarz et al., 2016). Euclidean and Taxicab distances are used to make relative evaluations. This method is exercised in applications, such as determining the optimal location for renewable energy production (Karaşan et al., 2019) and transportation services valuation (Pérez-Dominguez et al., 2021).

After the evaluation matrix is created for the complex problem to be solved, max normalization is applied to the values containing information about the alternatives. Equation 6 is used for benefit-based criteria and Equation 7 is used for cost-based criteria.

$$F_{ij} = \frac{f_{ij}}{max_{i\in m} f_{ij}} \quad i \in \{1,2,\dots,m\};\ j \in \{1,2,\dots,n\} \quad for\ benefit \quad (6)$$

$$F_{ij} = \frac{min_{i\in m} f_{ij}}{f_{ij}} \quad i \in \{1,2,\dots,m\};\ j \in \{1,2,\dots,n\} \quad for\ cost \quad (7)$$

Criterion weights calculated by the weighting technique is exercised as shown in Equation 8, in order to obtain the weighted and normalized evaluation matrix.

$$v_{ij} = F_{ij} \times w_j \quad i \in \{1,2,\dots,m\};\ j \in \{1,2,\dots,n\} \quad (8)$$

Equation 9 is used to determine the negative ideal solution.

$$A^- = \{(Min_i(v_{ij}) | i \in 1,2,\dots,m\} = \{v_1^-, v_2^-, v_3^-, \dots, v_j^-, \dots, v_n^-\} \quad (9)$$

Euclidean and Taxicab distances are calculated through Equations 10 and 11.

$$E_i = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^-\right)^2} \quad i = 1,2,3,\dots,m \tag{10}$$

$$T_i = \sum_{j=1}^{n} |v_{ij} - v_j^-| \quad i = 1,2,3,\dots,m \tag{11}$$

Penultimately, through the Equation 12, relative assessment matrix is established.

$$h_{ik} = (E_i - E_k) + \psi(E_i - E_k) \times (T_i - T_k) \quad i,k \in \{1,2,\dots,m\} \tag{12}$$

$H_i$ values, which indicate the outputs of the method, are calculated using Equation 13.

$$H_i = \sum_{k=1}^{m} h_{ik} \quad i = 1,2,3,\dots,m \tag{13}$$

The results of this method are sorted in a descending order for each period, creating performance rankings that decision makers can use as a reference.

### 3.4. Viekriterijumsko Kompromisno Rangiranje (VIKOR)

VIKOR excels in analyzing conflicting criteria and determining the compromise solution (Opricovic and Tzeng, 2004). The solution closest to the ideal solution is called the compromise solution. VIKOR has been utilized in various studies such as activity efficiency and effectiveness measurement (Hsieh et al., 2010) and climate change adaptation (Kim and Chung, 2015).

First, an evaluation matrix is created for the decision problem to be analyzed, and then the largest criterion values for benefit-based types and the smallest values for cost-based types are determined (Equation 14 and 15).

$$F_j^+ = Max_{i\in m} f_{ij} \text{ and } F_j^- = Min_{i\in m} f_{ij}\ , for\ the\ objectives\ to\ be\ maximized \tag{14}$$

$$F_j^+ = Min_{i\in m} f_{ij} \text{ and } F_j^- = Max_{i\in m} f_{ij}, for\ the\ objectives\ to\ be\ minimized \tag{15}$$

Afterwards, $S_i$ and $R_i$ values are determined by applying Equations 16 and 17.

$$S_i = \sum_{j=1}^{n} w_j \left(\frac{F_j^+ - f_{ij}}{F_j^+ - F_j^-}\right) \tag{16}$$

$$R_i = Max_{j\in n}\left[w_j \left(\frac{F_j^+ - f_{ij}}{F_j^+ - F_j^-}\right)\right] \tag{17}$$

Finally, $Q_i$ values are calculated using Equation 18 and 19.

$$Q_i = \gamma\left(\frac{S_i - S^+}{S^- - S^+}\right) + (1-\gamma)\left(\frac{R_i - R^+}{R^- - R^+}\right) \tag{18}$$

$$\text{where } S^+ = Min_{i\in m} S_i,\ S^- = Max_{i\in m} S_i,\ R^+ = Min_{i\in m} R_i, R^- = Max_{i\in m} R_i \tag{19}$$

The outputs obtained for this method are sorted from smallest to largest to obtain performance lists that decision makers can use as a reference.

### 3.5. Complex Proportional Assessment (COPRAS)

The COPRAS method can provide a compromise solution by determining the ratio of the ideal solution and the ratio of the non-ideal solution to the problem to be decided (Zavadskas et al., 1994). This method is used in studies concerning such as, financial performance analysis (Ghadikolaei et al., 2014) and accessible and clean energy management (Büyüközkan. et al., 2018).

An evaluation matrix is created regarding the decision problem to be solved. Normalization is applied to the values in this matrix, which contains the information about the alternatives regarding the criteria, through Equation 20.

$$F_{ij} = \frac{f_{ij}}{\sum_{k=1}^{m} f_{kj}} \quad i \in \{1,2,\dots,m\};\ j \in \{1,2,\dots,n\} \tag{20}$$

The criterion weights previously calculated through the selected weighting technique are applied as in Equation 21 to obtain the weighted and normalized evaluation matrix.

$$v_{ij} = F_{ij} \times w_j \quad i \in \{1,2,\dots,m\};\ j \in \{1,2,\dots,n\} \tag{21}$$

For benefit and cost-based criteria, the sums of the weighted and normalized values in the above steps are calculated by applying Equation 22 and 23.

$$S_{i+} = \sum_{j=1}^{g} v_{ij} \quad i \in \{1,2,\dots,m\} \tag{22}$$

$$S_{i-} = \sum_{j=g+1}^{n} v_{ij} \quad i \in \{1,2,\dots,m\} \tag{23}$$

The relative priority of each option is calculated by applying Equations 24-26 below, depending on whether the criteria are benefit or cost based.

$$Q_i = S_{i+} + \frac{\sum_{i=1}^{m} S_{i-}}{S_{i-} \sum_{i=1}^{m} \frac{1}{S_{i-}}} \qquad for\ both\ benefit\ and\ cost \tag{24}$$

$$Q_i = S_{i+} \qquad for\ only\ benefit \tag{25}$$

$$Q_i = \frac{\sum_{i=1}^{m} S_{i-}}{S_{i-} \sum_{i=1}^{m} \frac{1}{S_{i-}}} \qquad for\ only\ cost \tag{26}$$

The $Q_i$ values, which are the performance outputs produced by the COPRAS method, are sorted in a descending order to obtain performance rankings to be used in the decision-making phase.

### 3.6. Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA)

The MOORA method is a technique that produces ranking results by taking into account both benefit- and cost-based criteria within the proportions (Brauers et al., 2010). It has been used to solve various problems such as, determination of bank performances (Ozcalici and Bumin, 2020) and portfolio selection (Khan et al., 2021).

An evaluation matrix is established to be used in solving the complex problem to be decided. Afterwards, vector normalization is applied to the values containing alternative information with Equation 27.

$$F_{ij} = \frac{f_{ij}}{\sqrt{\sum_{k=1}^{m} {f_{kj}}^2}} \tag{27}$$

The $v_{ij}$ values are revealed by using the criterion weights calculated via the weighting technique integrated in the research, as shown in Equation 28.

$$v_{ij} = F_{ij} \times w_j \tag{28}$$

By subtracting the cost-based $v_{ij}$ values from the benefit-based $v_{ij}$ values, $P_i$ values representing the performance outputs for this method are established (Equation 29).

$$P_i = \sum_{j=1}^{g} v_{ij} - \sum_{j=g+1}^{n} v_{ij} \qquad i \in \{1,2,\dots,m\} \tag{29}$$

The calculated $P_i$ values are sorted from largest to smallest to obtain performance rankings for the relevant method.

### 3.7. Simple Additive Weighting (SAW)

SAW method is one of the simple and straightforward techniques used in MCDA applications. It is used in cases where there are conflicting criteria (Zionts and Wallenius, 1983). It has been used in studies such as sustainable supplier selection (Stević et al., 2019) and determination of company performance with big data analysis (Yasmin et al., 2020).

An evaluation matrix should initially be created regarding the problem to be solved. This matrix should contain the criterion values of all alternatives regarding the period under consideration. In this evaluation matrix, the normalization process is applied by exercising Equation 30 to the benefit-based criteria and Equation 31 to the cost-based criteria.

$$F_{ij} = \frac{f_{ij}}{f_j^+}\ for\ a\ maximization, where\ f_j^+ = Max_{i \in m} f_{ij} \tag{30}$$

$$F_{ij} = \frac{f_j^-}{f_{ij}}\ for\ a\ minimization, where\ f_j^- = Min_{i \in m} f_{ij} \tag{31}$$

The criterion weights determined by the selected weighting technique for the complex problem to be solved are used as in Equation 32.

$$v_{ij} = F_{ij} \times w_j \tag{32}$$

The mathematical avenues, as shown in Equation 33, are exercised to make the sum of the $v_{ij}$ values calculated in the previous step equal to 1.

$$A_i = \sum_{j=1}^{n} v_{ij} \tag{33}$$

As a result, $A_i$ values representing the method outputs are obtained. The method results are sorted from largest to smallest, and ranking lists are created to represent a reference in the solution process.

### 3.8. Faire Un Choix Adéquat (FUCA)

In this method, which has a simple mathematical methodology, the alternatives are first ranked according to their values regarding the decision problem to be solved (Fernando et al., 2011). Cost-based criteria get their ranking values before calculation via ranking alternative values from smallest to largest, while benefit-based criteria get their ranking values via ranking alternative values from largest to smallest. It is one of the rare methods where the normalization process is not applied.

Afterwards, method outputs are obtained by using the weights previously calculated for the criteria. For this, Equation 34 is used.

$$v_i = \sum_{j=1}^{n}(r_{ij} \times w_j) \quad (34)$$

After these simple and short mathematical operations, the relevant method outputs calculated are sorted from smallest to largest, and the final ranking list to be used in the decision-making process regarding the examined period is revealed.

### 3.9. Criteria Importance Through Intercriteria Correlation (CRITIC)

The CRITIC technique assigns the weights of the criteria by processing all the data in the decision matrix, based only on mathematical calculations (Diakoulaki et al., 1995). Correlation and standard deviation are used for these weight computations. The values of the decision matrix are transformed according to the concept of the ideal point in this popular objective weighting technique.

Identical as in method calculations, an evaluation matrix must first be created in order to make a weighting calculation. This matrix, which contains alternative values according to the criteria regarding the problem to be solved, is normalized using Equation 35.

$$r_{ij} = \frac{x_{ij} - x_j min}{x_j max - x_j min} \quad (35)$$

After the normalization process is completed, the correlation densities of each criterion related to the research to be performed are calculated. For this, Spearman's correlation coefficient is used. Afterwards, the standard deviations of the criterion values in the normalized evaluation matrix are determined. Correlation density calculations are performed using Equation 36.

$$C_j = \sigma_j \sum_{i=1}^{m}(1 - r_{ij}) \quad (36)$$

In the last step of calculating the objective weights, the correlation densities are normalized using Equation 37 given below. The weight of each criterion for the relevant period is hereby determined.

$$w_j = \frac{C_j}{\sum_{i=1}^{m} C_i} \quad (37)$$

If calculations are to be made for other periods, separate evaluation matrices should be created with new data values of alternatives.

## 4. APPLICATION

### 4.1. Findings and Results

In this study, a financial performance analysis of 34 companies traded on XUSRD between Q1 2019 and Q3 2021 was conducted. To that end, calculations and comparisons were made using 7 different methods, unlike previous literature. In the study where the objective weighting technique CRITIC was preferred, 6 criteria were integrated. Additionally, this study is the most comprehensive financial performance study conducted on XUSRD to date. In order to make calculations with MCDA methods, evaluation matrices containing relevant criterion values for alternatives must first be created. Since there are 11 periods in the study, decision matrices containing separate values for each period were created. The decision matrix showing the values related to the first period of this study, the Q1 2019 period, is given in Table 2 below.

**Table 2. Decision matrix for the first period of the analysis (Q1 2019)**

| | *ROA* | *EPS* | *MB* | *DE* | *ROE* | *MVA* |
|---|---|---|---|---|---|---|
| AKSA | -0.71105 | -0.71357 | 0.180674 | -0.07473 | -0.72518 | -3.81462 |
| AEFES | -1.9644 | -2.06752 | -0.2024 | 0.100686 | -2.00172 | -2.79802 |
| ANELE | -0.83449 | -0.82258 | -0.06558 | 0.036307 | -0.83108 | 0.091223 |
| ARCLK | -0.76364 | -0.73582 | -2.6E-05 | 0.062358 | -0.75318 | 0.070206 |
| ASELS | -0.73852 | -0.72856 | -0.16807 | -0.04766 | -0.74447 | -0.22074 |
| AYGAZ | -0.95612 | -0.9559 | 0.004123 | 0.374083 | -0.9479 | -0.1403 |
| BRISA | -1.02352 | -1.02771 | 0.038369 | 0.089383 | -1.02519 | 0.180647 |
| CIMSA | -0.92869 | -0.9249 | -0.12783 | 0.076906 | -0.92564 | 0.439938 |
| CCOLA | -1.1088 | -1.12007 | -0.06482 | 0.097221 | -1.11428 | -0.18869 |
| DOHOL | -0.94483 | -0.93978 | 0.116289 | 0.212702 | -0.93986 | -0.07663 |
| DOAS | -1.52865 | -1.50596 | 0.08809 | 0.014709 | -1.53452 | -0.28302 |
| FROTO | -0.74965 | -0.71604 | 0.087937 | 0.37586 | -0.68334 | -0.00191 |
| GLYHO | 0.67664 | 0.887007 | 0.1023 | 0.226321 | 0.955769 | 4.23897 |
| KORDS | -0.70674 | -0.67285 | 0.001681 | 0.087068 | -0.69213 | 0.112904 |
| LOGO | -0.78954 | -0.78138 | 0.389228 | 0.000859 | -0.78973 | 0.754169 |
| MGROS | -0.77884 | -0.72372 | 0.406063 | 0.987731 | -0.57314 | -0.00937 |
| NETAS | 0.053552 | 0.282587 | 0.203359 | 0.283826 | 0.221868 | -0.17696 |
| OTKAR | -1.05734 | -1.06664 | 0.553202 | 0.62438 | -1.08708 | 0.284096 |
| PETKM | -0.83375 | -0.82802 | -0.13143 | -0.00243 | -0.83417 | -0.23115 |
| POLHO | -1.64324 | -1.30716 | 0.060273 | -0.01534 | -1.64009 | 0.145366 |
| SAHOL | -0.75587 | -0.7338 | 0.039097 | 0.095524 | -0.73468 | -0.03983 |
| SISE | -0.84329 | -0.81451 | -0.00416 | 0.382352 | -0.82035 | -2.67392 |
| TATGD | -0.65072 | -0.64456 | 0.093112 | -0.02259 | -0.65403 | 2.692923 |
| TAVHL | -0.90995 | -0.90823 | 0.028822 | 0.109329 | -0.90324 | 0.046037 |
| TKFEN | -0.50087 | -0.44282 | -0.01343 | 0.020111 | -0.49469 | 0.068233 |
| TOASO | -0.75088 | -0.75591 | 0.199786 | 0.225401 | -0.71074 | 0.144161 |
| TUPRS | -1.07194 | -1.09632 | -0.1011 | 0.167431 | -1.08096 | 0.008492 |
| THYAO | -1.26181 | -1.30977 | -0.24305 | 0.162433 | -1.29214 | 0.693476 |
| TTKOM | -1.19877 | -1.22279 | 0.053347 | 0.073692 | -1.2104 | 0.183335 |
| TTRAK | -0.97069 | -0.96842 | -0.12678 | 0.088016 | -0.96865 | -0.18911 |
| TCELL | -0.46963 | -0.42854 | -0.06692 | 0.018887 | -0.46325 | -0.1111 |
| ULKER | -0.53523 | -0.49284 | 0.03734 | -0.03954 | -0.54708 | 0.24164 |
| VESBE | -0.87007 | -0.86604 | 0.342873 | -0.02484 | -0.87205 | 1.783161 |
| ZOREN | 5.253302 | 5.189033 | 0.164548 | 0.167577 | 6.149299 | -160.069 |

Before performing the calculations related to the methods to be applied, it is necessary to determine the criteria weights. For this purpose, the CRITIC objective weighting technique is preferred in the analysis of this study. The criterion weights calculated for each period with this technique, in which all weights are assigned based solely on mathematical calculations, are given in Table 3 below. When all periods are scrutinized, CRITIC established DE as the most vital criterion. Especially in the sensitive capital markets environment caused by the pandemic, this ratio had the most impact on financial performance for the XUSRD companies examined. In addition, MB and MVA have emerged as the ratios that have the most effect on financial performance, especially before the pandemic.

**Table 3. Criteria weights computed via CRITIC for each period of the analysis**

| *CRITIC* | *2019-I* | *2019-II* | *2019-III* | *2019-IV* | *2020-I* | *2020-II* | *2020-III* | *2020-IV* | *2021-I* | *2021-II* | *2021-III* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ROA | 0.112 | 0.1026 | 0.1015 | 0.1104 | 0.105 | 0.1272 | 0.1178 | 0.0977 | 0.092 | 0.1037 | 0.1220 |
| EPS | 0.111 | 0.1028 | 0.1012 | 0.1101 | 0.106 | 0.1262 | 0.1213 | 0.0996 | 0.093 | 0.1046 | 0.1223 |
| MB | 0.209 | 0.2247 | *0.2864* | *0.2548* | 0.210 | 0.1920 | 0.2281 | 0.2204 | 0.271 | 0.2350 | 0.1757 |
| DE | 0.210 | *0.2515* | 0.2370 | 0.2452 | *0.269* | 0.2318 | *0.2538* | *0.2512* | *0.312* | *0.2544* | *0.2361* |
| ROE | 0.113 | 0.1140 | 0.1064 | 0.1082 | 0.109 | 0.1300 | 0.1196 | 0.1149 | 0.095 | 0.1049 | 0.1217 |
| MVA | *0.245* | 0.2044 | 0.1674 | 0.1713 | 0.201 | 0.1927 | 0.1594 | 0.2162 | 0.138 | 0.1975 | 0.2221 |

After determining the criterion weights for each period, the next application step is the method calculations. To that end, the performance outputs of the 7 methods analyzed in this study for each period were calculated by applying the equations given above between (1) and (34). The method outputs related to the first quarter examined in this study are shown in Table 4 below. When the relevant outputs are examined, it is determined that VIKOR, MOORA, and COPRAS methods assigned the highest performance for Logo Software (LOGO). On the other hand, Zorlu Energy (ZOREN) for the GRA, Tat Food (TATGD) for the

FUCA, and Petkim Petrochemicals (PETKM) for SAW and CODAS became the top performer enterprises for the aforementioned methods, in the first period of the analysis.

**Table 4. MCDA scores generated with each analyzed method for the first period**

| | *VIKOR* | *MOORA* | *GRA* | *FUCA* | *COPRAS* | *SAW* | *CODAS* |
|---|---|---|---|---|---|---|---|
| AKSA | 0.111848 | 0.009275 | 0.712668 | 13.12072 | 0.033839 | 0.014293 | 37.13624 |
| AEFES | 0.847408 | -0.14466 | 0.638387 | 30.5675 | 0.014757 | -0.51702 | 8.993752 |
| ANELE | 0.505304 | -0.05351 | 0.678588 | 17.42975 | 0.011613 | -0.5029 | 3.452356 |
| ARCLK | 0.416159 | -0.04105 | 0.681394 | 15.81958 | 0.015074 | -0.29376 | 15.78766 |
| ASELS | 0.607146 | -0.05814 | 0.685407 | 17.99954 | -0.01202 | 0.208461 | 50.47881 |
| AYGAZ | 0.561491 | -0.09351 | 0.647084 | 24.42587 | 0.015838 | -0.10676 | 28.8005 |
| BRISA | 0.398962 | -0.04902 | 0.675789 | 18.51689 | 0.022244 | -0.21345 | 20.95697 |
| CIMSA | 0.618577 | -0.07508 | 0.668036 | 18.27909 | 0.002234 | -0.28371 | 18.27343 |
| CCOLA | 0.557856 | -0.0747 | 0.665447 | 25.53673 | 0.012461 | -0.26503 | 19.62475 |
| DOHOL | 0.333518 | -0.04807 | 0.670357 | 20.46066 | 0.028532 | -0.09185 | 28.08053 |
| DOAS | 0.345885 | -0.05081 | 0.679546 | 22.60561 | 0.049311 | -1.14432 | -37.8049 |
| FROTO | 0.420821 | -0.067 | 0.65825 | 17.24628 | 0.021335 | -0.05252 | 30.54149 |
| GLYHO | 0.176542 | 0.030375 | 0.711375 | 8.893457 | -0.00698 | 0.265165 | 44.30498 |
| KORDS | 0.418291 | -0.04156 | 0.679781 | 13.85013 | 0.013219 | -0.21545 | 20.69729 |
| LOGO | *0.01524* | *0.04328* | 0.729187 | 8.661271 | *0.32515* | -18.1508 | -964.392 |
| MGROS | 0.786593 | -0.09068 | 0.660435 | 16.15514 | 0.056008 | 0.094345 | 36.3705 |
| NETAS | 0.133681 | 0.007172 | 0.695515 | 14.27559 | 0.020888 | 0.022466 | 31.89588 |
| OTKAR | 0.351339 | -0.02605 | 0.696652 | 18.04191 | 0.077917 | 0.134915 | 37.673 |
| PETKM | 0.58342 | -0.06149 | 0.679207 | 21.21067 | -0.09742 | *6.35601* | *451.302* |
| POLHO | 0.371675 | -0.05154 | 0.681793 | 17.741 | 0.014678 | 0.962501 | 97.67053 |
| SAHOL | 0.374264 | -0.03788 | 0.680431 | 16.84869 | 0.018161 | -0.19731 | 21.64125 |
| SISE | 0.572647 | -0.0947 | 0.645914 | 25.0618 | 0.016867 | -0.24766 | 21.54224 |
| TATGD | 0.230687 | -0.00242 | 0.704526 | *6.30336* | 0.005833 | 0.846751 | 85.88243 |
| TAVHL | 0.410066 | -0.04884 | 0.674888 | 19.81226 | 0.019106 | -0.18556 | 22.94665 |
| TKFEN | 0.391516 | -0.02599 | 0.691318 | 12.92678 | 0.017286 | -0.81169 | -17.5635 |
| TOASO | 0.209506 | -0.02453 | 0.681097 | 14.11891 | 0.03434 | -0.03112 | 30.26373 |
| TUPRS | 0.635151 | -0.09011 | 0.656158 | 24.59528 | 0.006633 | -0.19765 | 24.08263 |
| THYAO | 0.851109 | -0.12491 | 0.645378 | 23.68441 | -0.00707 | -0.22704 | 24.138 |
| TTKOM | 0.388742 | -0.05183 | 0.675349 | 18.35595 | 0.02729 | -0.25637 | 18.53111 |
| TTRAK | 0.627847 | -0.07926 | 0.665345 | 24.64366 | 0.003592 | -0.2965 | 18.21068 |
| TCELL | 0.46481 | -0.03545 | 0.688154 | 14.72279 | 0.011959 | -0.89132 | -21.9592 |
| ULKER | 0.298331 | -0.00929 | 0.702636 | 8.366503 | 0.005917 | 0.393508 | 59.24678 |
| VESBE | 0.038604 | 0.035885 | 0.725806 | 9.127143 | 0.039351 | 0.812157 | 82.02154 |
| ZOREN | 0.607858 | 0.000944 | *0.83105* | 15.5951 | 0.18206 | -8.94865 | -348.828 |

Performance rankings related to methods are made after the calculation of method outputs. In VIKOR and FUCA, rankings based on method outputs are listed in an ascending order, while in remaining 5 methods they are listed in a descending order. According to the performance outputs given for the first period above, performance rankings for the 7 methods of the examined companies are given in Table 5 below. The enterprises showing the least performance for the methods examined in the relevant period are Turkish Airlines (THYAO) for the VIKOR method, Anadolu Efes (AEFES) for MOORA, GRA, and FUCA methods, Petkim Petrochemicals (PETKM) for the COPRAS method, and Logo Software (LOGO) for the SAW and CODAS methods.

The outputs of each method for each period were obtained by taking into account the calculation steps of all methods and the calculated criterion weights for the relevant period. The association between method outputs and stock returns for each period is shown in Table 6 below.

In this study, unlike previous XUSRD studies, the capacities of the methods were calculated using the stock returns of the relevant companies as an anchor. Spearman's correlation coefficient is used in order to establish this relationship. The main motivation of this study is to establish the most suitable methods for financial decision-makers. VIKOR method has provided the highest relationship in 5 periods, while FUCA method in 5 periods, and MOORA method in 1 period.

When all periods are examined, the average association level provided by the methods is shown in Table 7 below. In line with the above results, VIKOR method has provided the highest relationship level at 65.80%, with statistically significant results ($p<0.01$). Then, FUCA method established a statistically significant association with stock returns at the level of 61.14% ($p<0.01$). Subsequently, MOORA method has achieved

a statistically significant relationship at the level of 55.08% (p<0.02). The relationship levels of COPRAS, SAW, and CODAS methods are lower and also statistically insignificant.

**Table 5. Ranking results of the analyzed methods for the first period**

| | *VIKOR* | *MOORA* | *GRA* | *FUCA* | *COPRAS* | *SAW* | *CODAS* |
|---|---|---|---|---|---|---|---|
| AKSA | 3 | 4 | 4 | 7 | 8 | 11 | 9 |
| AEFES | 33 | 34 | 34 | 34 | 20 | 29 | 28 |
| ANELE | 22 | 22 | 20 | 17 | 25 | 28 | 29 |
| ARCLK | 18 | 14 | 14 | 13 | 19 | 26 | 27 |
| ASELS | 27 | 23 | 12 | 19 | 33 | 7 | 6 |
| AYGAZ | 24 | 31 | 31 | 29 | 18 | 15 | 14 |
| BRISA | 16 | 18 | 21 | 23 | 11 | 19 | 21 |
| CIMSA | 29 | 27 | 25 | 21 | 30 | 25 | 25 |
| CCOLA | 23 | 26 | 26 | 33 | 23 | 24 | 23 |
| DOHOL | 9 | 16 | 24 | 25 | 9 | 14 | 15 |
| DOAS | 10 | 19 | 18 | 27 | 5 | 32 | 32 |
| FROTO | 20 | 25 | 29 | 16 | 12 | 13 | 12 |
| GLYHO | 5 | 3 | 5 | 4 | 31 | 6 | 7 |
| KORDS | 19 | 15 | 17 | 8 | 22 | 20 | 22 |
| LOGO | 1 | 1 | 2 | 3 | 1 | 34 | 34 |
| MGROS | 32 | 30 | 28 | 14 | 4 | 9 | 10 |
| NETAS | 4 | 5 | 9 | 10 | 13 | 10 | 11 |
| OTKAR | 11 | 11 | 8 | 20 | 3 | 8 | 8 |
| PETKM | 26 | 24 | 19 | 26 | 34 | 1 | 1 |
| POLHO | 12 | 20 | 13 | 18 | 21 | 2 | 2 |
| SAHOL | 13 | 13 | 16 | 15 | 15 | 17 | 19 |
| SISE | 25 | 32 | 32 | 32 | 17 | 22 | 20 |
| TATGD | 7 | 7 | 6 | 1 | 28 | 3 | 3 |
| TAVHL | 17 | 17 | 23 | 24 | 14 | 16 | 18 |
| TKFEN | 15 | 10 | 10 | 6 | 16 | 30 | 30 |
| TOASO | 6 | 9 | 15 | 9 | 7 | 12 | 13 |
| TUPRS | 31 | 29 | 30 | 30 | 26 | 18 | 17 |
| THYAO | 34 | 33 | 33 | 28 | 32 | 21 | 16 |
| TTKOM | 14 | 21 | 22 | 22 | 10 | 23 | 24 |
| TTRAK | 30 | 28 | 27 | 31 | 29 | 27 | 26 |
| TCELL | 21 | 12 | 11 | 11 | 24 | 31 | 31 |
| ULKER | 8 | 8 | 7 | 2 | 27 | 5 | 5 |
| VESBE | 2 | 2 | 3 | 5 | 6 | 4 | 4 |
| ZOREN | 28 | 6 | 1 | 12 | 2 | 33 | 33 |

**Table 6. The magnitude of the association between MCDA scores and share returns**

| | *19-I* | *19-II* | *19-III* | *19-IV* | *20-I* | *20-II* | *20-III* | *20-IV* | *21-I* | *21-II* | *21-III* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VIKOR | *80.60%* | 49.60% | *71.60%* | *66.60%* | 75.10% | 34.70% | 65.10% | 72.50% | 74.90% | *72.90%* | *60.20%* |
| | *0.00* | 0.00 | *0.00* | *0.00* | 0.00 | 0.04 | 0.00 | 0.00 | 0.00 | *0.00* | *0.00* |
| MOORA | 74.30% | 47.50% | 59.20% | 42.90% | 70.60% | 23.40% | 56.90% | *76.10%* | 62.80% | 43.30% | 48.90% |
| | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 0.18 | 0.00 | *0.00* | 0.00 | 0.01 | 0.00 |
| GRA | 60.40% | 37% | 53.60% | 37.80% | 53.60% | 22% | 57.10% | 66.50% | 69.90% | 22.80% | 44% |
| | 0.00 | 0.03 | 0.00 | 0.03 | 0.00 | 0.21 | 0.00 | 0.00 | 0.00 | 0.19 | 0.01 |
| FUCA | 55.10% | *57.60%* | 38.90% | 59.10% | *79.20%* | *40.10%* | *74%* | 73.80% | *75.90%* | 59.60% | 59.20% |
| | 0.00 | *0.00* | 0.02 | 0.00 | *0.00* | *0.02* | *0.00* | 0.00 | *0.00* | 0.00 | 0.00 |
| COPRAS | 47.90% | 12.30% | 47% | 3.80% | 57.80% | 8.70% | 53.30% | 49.90% | 5.50% | 64.20% | 16% |
| | 0.00 | 0.49 | 0.01 | 0.83 | 0.00 | 0.63 | 0.00 | 0.00 | 0.76 | 0.00 | 0.37 |
| SAW | 23.10% | 11.20% | 2.50% | 11% | 26.60% | 29.30% | 26.50% | 4.70% | 39.60% | 3.90% | 33.30% |
| | 0.19 | 0.53 | 0.89 | 0.53 | 0.13 | 0.09 | 0.13 | 0.79 | 0.02 | 0.83 | 0.06 |
| CODAS | 18% | 10.80% | 7.70% | 11.90% | 24% | 34.90% | 26.60% | 2.40% | 34.60% | 2.80% | 33% |
| | 0.31 | 0.54 | 0.66 | 0.50 | 0.17 | 0.04 | 0.13 | 0.89 | 0.05 | 0.88 | 0.06 |

**Table 7. The overall capacity of the methods considering the whole period**

| *Method* | *Ranking* | *Capacity* | *p-value* |
|---|---|---|---|
| VIKOR | 1 | 65.80% | 0.00 |
| FUCA | 2 | 61.14% | 0.00 |
| MOORA | 3 | 55.08% | 0.02 |
| GRA | 4 | 47.70% | 0.04 |
| COPRAS | 5 | 33.31% | 0.28 |
| SAW | 6 | 19.25% | 0.38 |
| CODAS | 7 | 18.79% | 0.38 |

The association level between the financial performance outputs generated by the examined methods and stock returns for all analyzed periods is provided in Figure 1 below. The success of VIKOR, FUCA, and MOORA methods in terms of capacity can be clearly observed in this graph. SAW and CODAS methods are the lowest performing methods in 7 periods, while COPRAS method is the lowest in 4 periods. The GRA method has not achieved the highest or lowest relationship level in any period.

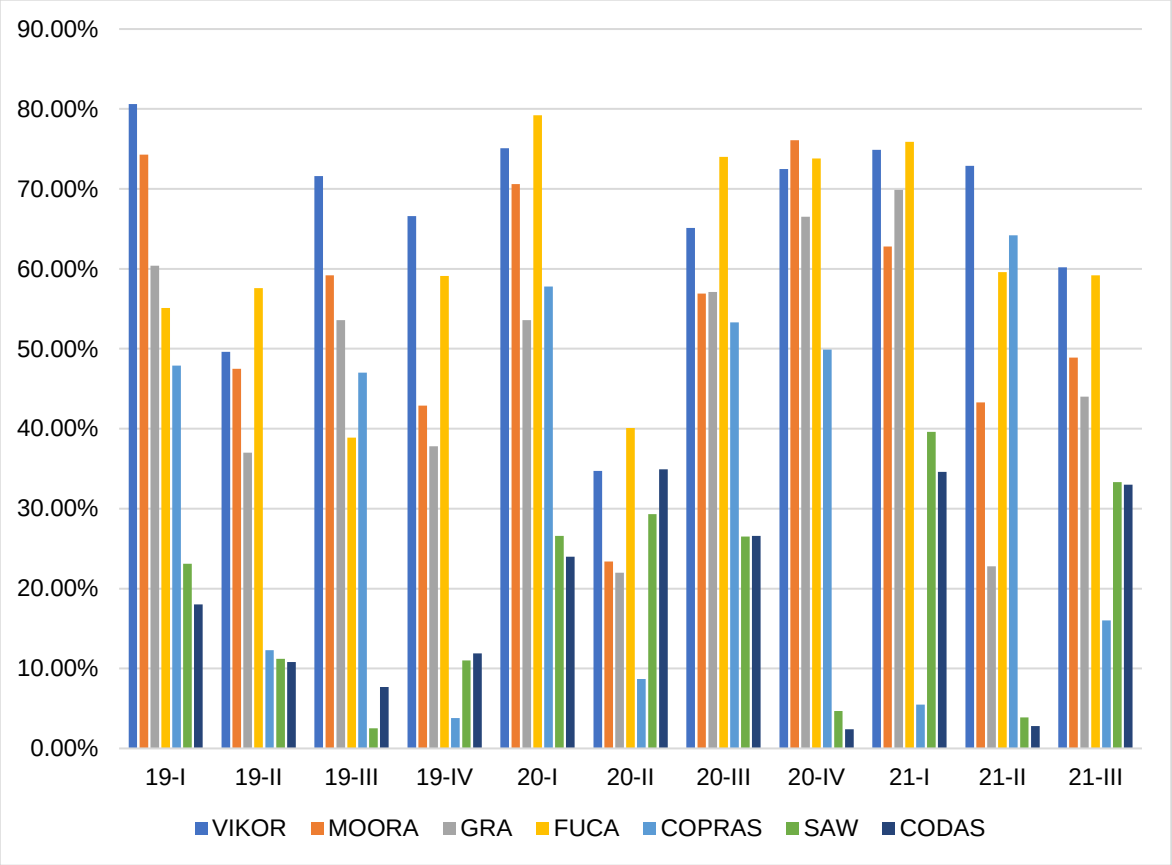


**Figure 1. Capacity of all analyzed methods in terms of share return through the 11 periods**

Performance rankings based on the outputs of the methods have been determined for the 11 periods analyzed. Accordingly, the companies showing the highest and lowest financial performance for each method in the examined periods are shown in Table 8 below. Although the rankings vary for all methods, the same companies have shown the highest and lowest performance for all periods in SAW and CODAS methods. As a result of this study on XUSRD, VIKOR is recommended to decision-makers as it stands out as the method with the highest capacity. In addition, FUCA and MOORA have been identified as alternative methods that financial stakeholders can use in the decision-making process due to their high association with share returns. The results of this study are consistent with previous MCDA studies on capital markets (Baydaş et al., 2022; Elma, 2023a, Elma, 2023b).

Although aforementioned methods stand out in the analysis of financial data, it must be noted that these methods should not be used in solving all problems in various scientific fields, as parameters such as marginal values and unit differences may make other methods more optimal.

**Table 8. Top and bottom performers of each method for every quarter analyzed**

| Period | *Ranking* | *VIKOR* | *MOORA* | *GRA* | *FUCA* | *COPRAS* | *SAW* | *CODAS* |
|---|---|---|---|---|---|---|---|---|
| 2019-I | Best Perf. | LOGO | LOGO | ZOREN | TATGD | LOGO | PETKM | PETKM |
| | Worst Perf. | THYAO | AEFES | AEFES | AEFES | PETKM | LOGO | LOGO |
| 2019-II | Best Perf. | SISE | SISE | AYGAZ | TTKOM | AYGAZ | TAVHL | TAVHL |
| | Worst Perf. | OTKAR | OTKAR | OTKAR | POLHO | OTKAR | ARCLK | ARCLK |
| 2019-III | Best Perf. | TTRAK | POLHO | POLHO | TTRAK | DOAS | ULKER | ULKER |
| | Worst Perf. | TKFEN | THYAO | THYAO | TKFEN | THYAO | DOAS | DOAS |
| 2019-IV | Best Perf. | BRISA | AKSA | AKSA | TTRAK | THYAO | THYAO | THYAO |
| | Worst Perf. | NETAS | DOAS | DOAS | TKFEN | CIMSA | CIMSA | CIMSA |
| 2020-I | Best Perf. | ASELS | ASELS | DOAS | ANELE | KORDS | KORDS | KORDS |
| | Worst Perf. | OTKAR | TUPRS | TUPRS | TAVHL | TTKOM | TTKOM | TTKOM |
| 2020-II | Best Perf. | DOAS | POLHO | OTKAR | POLHO | PETKM | SAHOL | SAHOL |
| | Worst Perf. | MGROS | PETKM | PETKM | ULKER | OTKAR | TOASO | TOASO |
| 2020-III | Best Perf. | ASELS | ASELS | ANELE | CIMSA | KORDS | LOGO | LOGO |
| | Worst Perf. | ZOREN | KORDS | KORDS | TKFEN | ASELS | CIMSA | CIMSA |
| 2020-IV | Best Perf. | NETAS | NETAS | NETAS | AKSA | NETAS | GLYHO | GLYHO |
| | Worst Perf. | MGROS | TKFEN | TKFEN | TKFEN | TKFEN | TKFEN | TKFEN |
| 2021-I | Best Perf. | ANELE | ANELE | KORDS | KORDS | SISE | CIMSA | CIMSA |
| | Worst Perf. | TKFEN | TKFEN | TKFEN | ZOREN | TAVHL | TKFEN | TKFEN |
| 2021-II | Best Perf. | TCELL | NETAS | NETAS | CIMSA | POLHO | POLHO | POLHO |
| | Worst Perf. | GLYHO | AYGAZ | AYGAZ | ANELE | AYGAZ | ULKER | ULKER |
| 2021-III | Best Perf. | AEFES | AEFES | ULKER | AEFES | DOHOL | POLHO | POLHO |
| | Worst Perf. | THYAO | THYAO | THYAO | ANELE | POLHO | DOHOL | DOHOL |

## 5. DISCUSSION

MCDA methods help decision-makers solve complex problems and can propose different solutions based on their mathematical infrastructure. They transform the problem that decision-makers want to analyze into a structural and controllable format and produce outputs related to the problem based on predetermined criteria. Thus, decision-makers can make more informed choices about the relevant problem.

The increase in greenhouse gas emissions, the climate change felt worldwide, and the catastrophic damage caused to nature by mass production processes have brought the concept of sustainability to the agenda of societies. The environmental, social, and governance decisions made by companies in a responsible manner towards nature and future generations are followed not only by governments but also by investors. To that end, sustainability indices attract the attention of many stakeholders.

In this study, the financial performance of 34 companies traded consistently in XUSRD's pre-Refinitiv process has been analyzed. This study encompasses the most comprehensive and first comparative MCDA analysis conducted on companies traded on XUSRD. To that end, analyses were conducted based on data from 11 quarterly periods covering the pre-pandemic and post-pandemic periods.

While previous research mainly focused on performance studies on a single method, this study performed analyses using 7 different MCDA applications. In addition, the stock returns of the relevant companies were used as a benchmark for the comparability of the methods, and the most suitable methods were investigated. Research findings indicate that VIKOR has the highest capacity as a method, followed by FUCA and MOORA.

The CRITIC technique has been integrated into the analyses for determining the criteria weights. Before the pandemic, MVA and MB emerged as the most important criteria, while with the onset of the pandemic, the impact of DE ratio in the uncertain environment has remained the most vital criterion throughout remaining quarters. In this sense, the influence of COVID-19 on XUSRD corporations is revealed.

## 6. CONCLUSION

Just as real-life problems are complex and multidimensional, many parameters need to be reviewed and taken into account in transactions within financial markets. Several methods to be implemented for this purpose could be able to produce suitable solutions as regards to the priorities of financial stakeholders. In addition, versatility of MCDA applications has also led to their utilization in many scientific fields.

Financial performance is revealed by taking into account the numerous data of companies and signalizes the efficiency of a company by simplifying the identification of its position, advantages, and disadvantages in the sector it operates in. In this sense, there are many parameters that need to be examined, including competitors. The increasing importance of sustainability every day has led to the need for sustainability indices in financial markets due to the growing sensitivity of investors and consumers on this issue.

Financial performance of 34 XUSRD enterprises has been examined comparatively with 7 methods in this pioneering study. During the analysis of the 11-quarter period, a high and statistically significant relationship was found between the outputs of VIKOR method and stock returns. Similarly, FUCA and MOORA methods have emerged as other prospering methods according to the study results. In this sense, these three methods are recommended to financial stakeholders involved in decision-making, regarding stocks traded in the capital markets.

Methods applied to address complex issues generally can produce different outputs and rankings. This diversity stems from the fact that applied methods are designed to respond to different needs, with varying normalization and mathematical infrastructures. Thus, it can be inferred that there is no single optimal method that can solve complex problems in all scientific fields. However, it is advantageous to search for the most optimal method related to a field of science by taking into account the related data. In this sense, this study makes significant contributions to the literature for stakeholders and researchers in the decision-making stage in financial markets.

### 6.1. Limitations of the Study

In this study, the financial performance analysis of 34 companies that traded consistently in XUSRD during the 11 periods, immediately before Borsa Istanbul's transition to the Refinitiv methodology, has been exercised. To that end, the examined period is a limitation of this study. Furthermore, the use of 7 MCDA methods in this study is another limitation. Additionally, the fact that this study only analyzes XUSRD companies is another limitation.

### 6.2. Potential Future Research

In future research, the analysis of companies trading in XUSRD after Refinitiv methodology is employed will be important for comparability. Also, addition of other methods will expedite the determination of the most optimal method for financial stakeholders for further research. In addition, in the future, analyzing companies trading in sustainability indices of developed and developing country markets will expand the outputs and scope of this study.

**Conflict of Interest**
No potential conflict of interest was declared by the authors.

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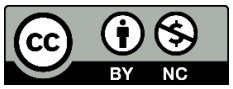
**Compliance with Ethical Standards**
It was declared by the authors that the tools and methods used in the study do not require the permission of the Ethics Committee.

**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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