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FINANCIAL PERFORMANCE MEASUREMENT IN BUSINESSES USING MCDM TECHNIQUES: AN APPLICATION ON BIST XKURY BUSINESSES (2015-2019)¹

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Abstract: *The aim of this study is to analyse the financial ratios of 25 companies listed on the BIST XKURY index by constructing a model using Multi-Criteria Decision-Making techniques (TOPSIS, ELECTRE, GRA, VIKOR, PROMETHEE II, MOORA) and the CRITIC weighting method, which are commonly used in decision-making problems. Within this scope, the 15 financial ratios of the 25 companies listed on the BIST XKURY index between 2015 and 2019 were subjected to analysis. In addition to the rankings obtained with MCDM, the scores used to generate these rankings were also used in the study. The calculated MCDM results were compared with corporate governance rating scores and stock returns from two perspectives: based on rankings and based on scores, and a very low-grade relationship was found between them. Additionally, the MCDM scores and rankings for the years 2014-2018 were compared with those for 2019, and it was observed that MCDM results could be used to predict future years. The main findings indicate that MCDM methods are significantly more reliable for predicting financial performance trends than for correlating with market returns or governance ratings.*

Keywords: *Performance Evaluation, MCDM, Financial Performance Measurement, CRITIC, Optimal Direction of MCDM Criteria*

JEL Classification: *M41, C38, L25*

¹ This study is derived from the doctoral dissertation titled "Measurement of Financial Performance of BIST Corporate Governance Index Enterprises with Multi-Criteria Decision Making Techniques".

INTRODUCTION

In today's competitive environment, it is crucial for businesses to measure and evaluate their performance realistically in order to achieve their growth and sustainability goals. This process is essential for successful management performance, as it enables businesses to compare their planned targets with their actual performance in terms of managerial control (Abdel-Maksoud et al., 2005; Laitinen, 2002). Periodic performance measurements contribute to management's ability to correct negative deviations and take corrective measures. Additionally, accurately and regularly evaluating performance is important not only for the organisation itself (managers and shareholders) but also for external stakeholders such as lenders, suppliers, and customers.

The interest in performance evaluation, which began with productivity measurement at the beginning of the 20th century, has been growing rapidly every day (Amaratunga et al., 2000). Performance measurement and evaluation, which express the level of achievement of objectives and the benefits obtained, include many qualitative and quantitative indicators (criteria). These indicators are an important factor for business stakeholders, especially investors, in selecting businesses, while also influencing investors' decisions regarding which businesses to choose. Financial performance indicators are at the forefront of these criteria (performance indicators) (Voulgaris et al., 2000).

In today's increasingly competitive business environment, it has become essential for businesses to compare their financial performance with that of their competitors in order to survive and succeed. Managers must accurately measure and evaluate their financial performance, identify areas that pose or may pose problems in achieving their goals, determine the causes of these problems, and develop realistic plans for the future (Ayan, 2016). This enables businesses to identify their position relative to other companies in the sector and develop effective strategies to improve that position. Although there are many criteria that can be used to measure financial performance, there is no clear consensus on how to measure financial performance in a definitive manner. In contrast, basic financial performance measures that define commercial and economic activities from various perspectives and can be obtained from companies' financial statements can be listed under four main headings as follows (Fatihudin et al., 2018; Ginevičius & Podvezko, 2008; Sayılğan, 2017); 1. Liquidity ratios, 2. Activity ratios (Efficiency ratios), 3. Profitability ratios and 4. Financial ratios (Leverage ratios). The first group measures short-term debt payment capacity, the second shows current capital usage, the third defines profitability, and the last reveals the resource structure, i.e., the types of resources used to finance the company's assets and the proportions of these resources.

Although there are many financial performance measures under these headings, it will not be sufficient to utilise only the experience and expertise of decision makers in the evaluation of these measures. This is because many conflicting performance measures emerge from time to time. The existence and complexity of different financial performance measures may cause difficulties in the measurement and evaluation of financial performance. Therefore, there is a need for modelling to select the most appropriate criteria (Bülbül & Köse, 2011).

Individuals and organisations are faced with complex situations such as choosing among many conflicting alternatives or abandoning their decisions in line with

financial performance criteria and various other criteria. Such problems can be solved by Multi-Criteria Decision Making (MCDM) techniques, which have been used in decision-making processes for more than 50 years (Perez, 1995). These techniques offer a systematic approach to selecting the best possible alternative and using it in decision-making processes by ranking or grouping multiple alternatives in line with various criteria. There are many developed MCDM techniques, and due to the different mathematical operations used in the techniques, the ranking of alternatives may differ depending on the methods adopted (Chakraborty et al., 2015). It is also possible to develop different modelling based on these methods. In the literature, it is seen that many business performance measurements and evaluations, especially the financial performance of companies, have been made by using the aforementioned MCDM techniques or modelling.

Regardless of which technique is preferred or which MCDM models are created, determining the relative importance (weights) of the criteria is a critical factor due to the existence of multiple criteria. Many objective and subjective methods have been developed to determine these weights. While there are assumptions that criteria have equal weights in decision-making problems, there is a tendency to establish criteria with different weights. Subjective weight determination methods provide flexibility specific to each decision-making process from the perspective of decision-makers in decision-making processes that are different from one another. However, difficulties such as decision-makers' reluctance to determine weights or their inability to make a clear assessment may arise (Lahdelma & Salminen, 2001; Ponhan & Sureeyatanapas, 2022). Furthermore, different individuals approaching the same decision-making process from different perspectives based on their characteristics can make it difficult to establish a common weighting and render comparisons meaningless. For these reasons, objective weighting methods or hybrid methods combining objective and subjective approaches are often preferred in MCDM methods.

It is believed that investment decisions made by companies with corporate governance practices, which are a prominent concept today alongside financial performance, will be more accurate. Successful companies should operate in line with high performance goals that encompass both financial and corporate governance. Although there are numerous studies examining the relationship between corporate governance and financial performance, studies analysing this relationship using multi-criteria decision-making techniques are quite limited.

In this study, the literature on the use of multi-criteria decision-making techniques in financial performance measurement was first reviewed. Subsequently, the financial performance of companies included in the Borsa Istanbul (BIST) Corporate Governance Index (CGI), were obtained using six different multi-criteria decision-making techniques (TOPSIS, GRA, ELECTRE, VIKOR, MOORA Reference-point, and PROMOTHEE II techniques). The relationships between the MCDM results and the CGI and market returns were examined. Studies were conducted on the use of the same MCDM scores and rankings in the subsequent years' rankings of the companies, and the findings were evaluated.

LITERATURE REVIEW

Literature Review on Financial Performance and MCDM Relationship Studies

A literature review on financial performance measurement with MCDM techniques was conducted, and a summary of the reviewed studies is presented in Table 1 below.

Table 1: Summary of Literature Studies on Financial Performance Measurement with MDMC

Studies Analysed	N	Summary of Studies
Baležentis et al. (2012)	1	Rankings and evaluations were made by considering alternative sectors.
Ege and Yaman (2018)	1	MCDM rankings were compared with pay-off rankings, and it was stated that the TOPSIS method had a significant effect while the MOORA method had no significant effect.
Ayan (2016)	1	Effective and ineffective businesses were identified using MCDM techniques, and recommendations were made.
Temizel and Bayçelebi (2016)	1	Rankings were made using the TOPSIS method, and it was stated that there was no correlation between the annual average return.
Demirbaş (2019)	1	It has been stated that MCDM techniques can be applied in predicting financial failure. Additionally, a study on scale transformation for certain financial indicators has been conducted.
Hajihassani (2015); Hsu et al. (2015)	2	It has been stated that the companies ranked at the top of the rankings can be selected as investment targets.
Güler (2019)	1	It has been stated that businesses can achieve better performance in rankings by focusing on criteria with high weighting.
Bülbül and Köse (2011); Mıhçı (2014) Ertikin (2019); İç et al. (2015); Karaoğlu (2016)	5	Different MCDM methods were compared by ranking them, and evaluations were made.
Ege et al. (2013); Esendemirli and Erdener Acar (2016); Sakarya and Aksu (2016); Yıldırım et al. (2018)	4	Rankings were compared with "Corporate Governance Rating Rankings," and it was stated that the Corporate Governance Rating (CGR) rankings do not reflect the MCDM rankings and that there is no significant relationship between them.
(Çonkar et al., 2011; Gemicı, 2017)	2	Evaluations were made by comparing CGR score rankings using the TOPSIS method.
(Ünlü et al., 2017)	1	The study indicated that there was no difference in financial performance and shareholder value creation between BIST 30 companies included in the corporate governance index and those not included.

Source: Authors' literature review

In addition to the studies listed above, there are 32 more studies in the literature that have only presented ranking results (e.g., "1st Company A, 2nd Company B...") without providing additional analysis beyond ranking. Due to page limitations, these studies are not individually listed here. However, the MCDM techniques, weighting methods, and criteria used in these studies have been taken into account in this study. The full list of these studies is available from the authors upon request

The MCDM techniques used in the literature and their respective frequencies are presented as follows: TOPSIS (39), VIKOR (13), MOORA (5), PROMETHEE (5), GRA (7), ELECTRE (6), and others (11: COPRAS, FUZZY ARAS, FLOWSORT, MAIRCA, MAUT, DEA, Compromise Programming). Some studies utilized more than one MCDM technique in combination.

The weights and their usage frequencies in literature studies, which have an important place in MCDM techniques for financial performance measurement, are presented in Table 2.

Table 2: Weight Techniques Used in Literature Review Studies

Weight Methods Used	Number of Uses	Weight Methods Used	Number of Uses
Equal Weight	20	AHP	8
ENTROPY	8	Criterion totals, ratioed to criterion totals	2
CRITIC	2	Normalised values divided by the criterion total	2
DEMATEL	1	Expert or Faculty Member Opinion	8
Weight information not specified / not available		4	

Source: Authors' literature review

When examining the weights and usage counts employed in the MCDM techniques in the study, it was observed that the equal weight method was used 20 times, the Entropy method 8 times, and the CRITIC method 2 times among objective methods. In some of the studied works, multiple weighting methods were used.

In the literature, the frequency of use of financial ratio groups is as follows: Activity Rates (119 times), Profitability Ratios (154 times), Leverage Ratios (96 times), Liquidity Ratios (89 times), Market Rates (28 times), Growth Rates (15 times), Absolute Figures (9 times), and Other Indicators (28 times). The most frequently used individual financial ratios are the current ratio (43 times), total debt ratio (41 times), return on equity (41 times), quick ratio (31 times), and asset turnover ratio (30 times). Based on this literature review, 15 financial ratios were determined as criteria for the MCDM model developed in this study. These criteria are presented in Table 4, along with their abbreviations and calculation methods.

Literature Review of Studies on the Relationship Between Corporate Governance and Financial Performance

MCDM-based studies on the relationship between financial performance and corporate governance report that CGR rankings do not reflect MCDM rankings (Ege et al., 2013; Esendemirli & Erdener Acar, 2016; Sakarya & Aksu, 2016; Yıldırım et al., 2018), while others only ranked CGR scores using TOPSIS without financial analysis (Çonkar et al., 2011; Gemici, 2017). Non-MCDM studies present mixed findings: some report a positive relationship between governance and firm performance (Cengiz & Karabayır, 2022; Fernando et al., 2017; Garzón Castrillón, 2021; Zelenyuk & Zheka, 2006), while others find no significant relationship (Farooq et al., 2022; Soylu & Ayanoğlu, 2022).

Studies on the Relationship Between Financial Performance and Market Performance literature review

Studies on the relationship between financial performance and market performance report mixed findings. Ege and Yaman (2018) compared MCDM rankings with pay-off rankings and found that the TOPSIS method had a significant effect, whereas the MOORA method had no significant effect. In contrast, Temizel and Bayçelebi (2016) found no correlation between financial performance rankings and annual stock returns using the TOPSIS method. Other non-MCDM studies also present conflicting results; Büyüksalvarcı (2010) found mostly non-linear relationships between financial indicators and stock returns, and Ünal and Yüksel (2017) reported no statistically significant relationship between financial performance and stock returns using the PROMETHEE technique.

MEASURING FINANCIAL PERFORMANCE WITH MCDM TECHNIQUES Purpose and Importance of the Research

The purpose of this study is to measure and evaluate the financial performance of the companies by comparing the Corporate Governance Index (CGI) ratings, market returns and financial performances for the coming years through the models to be created with the help of financial performance indicators and Multi-Criteria Decision Making (MCDM) techniques.

In the study, 6 different MCDM methods were used and these are TOPSIS, GRA, ELECTRE Net Incompatibility ranking, VIKOR, MOORA Reference Approach and PROMETHEE II techniques.

In the literature, it has been observed that, in general, by using the rankings obtained with the MCDM, the companies are compared and evaluated by years or with the companies included in the study. In these rankings obtained by MCDM, the ratios between the alternative rankings contain very sharp values (such as a ratio of 100 per cent between the 1st rank and the 2nd rank). On the other hand, it is possible to reveal the relative superiority between two alternatives / data more clearly (an alternative with a CGI score of 91.25 and an alternative with a CGI score of 90.18, etc.) in the scoring that constitutes the MCDM rankings or in the data such as CGI score and return on equity used in the studies. In this respect, unlike the literature, in addition to the rankings, the study also tried to make financial performance measurements by using the ratings, CGI ratings and market return ratios, which constitute the MCDM rankings, in addition to the rankings. In order to avoid a subjective evaluation for the determination of criteria weights in the use of CRITIC techniques, CRITIC weighting method was used to determine objective criteria weights.

Based on the view that analyzing five years of historical financial statements is sufficient to identify trends within a company, this study was designed to cover the period from 2014 to 2019 (Hitchner, 2003). The companies included in the study are the companies that are independently audited and continuously traded in the BIST Corporate Governance Index (XKURY) between 2015-2019.

Research Questions

The research questions related to the three main relationship dimensions and sub-headings formed in line with the research objectives are listed below:

1)Analysing the relationship between MCDM techniques and corporate governance ratings

a. What is the relationship between the 5-year MCDM scores and the 5-year CGI scores

b. What is the relationship between the 5-year MCDM rankings and the 5-year CGI score rankings

2) Analysing the relationship between stock return and MCDM techniques

a. What is the relationship between the 5-year MCDM scores and the 5-year stock return rates.

b. What is the relationship between the 5-year CGI rankings and the 5-year stock return rankings.

3) Analysing the relationship between the 2015-2018 MCDM data and the 2019 MCDM data

a. What is the level of the relationship between the 2015-2018 MCDM scores and the 2019 MCDM scores

b. What is the level of the relationship between the Combined Single MCDM rankings of 2015-2018 and the MCDM rankings of 2019

Research Data

a. Determination of Alternatives and Criteria

- *Identification of alternatives:* The 25 BIST (XKURY) index companies, which were taken as alternatives in the application, are given in Table 3 for the years 2015-2019 and BIST stock names (abbreviations) were used in the application.

Table 3: Enterprises and Abbreviations Used in the Application

Companies	Abbr	Companies	Abbr
Anadolu Efes Biracılık ve Malt Sanayii A.Ş.	Aefes	Otokar Otomotiv ve Savunma Sanayi A.Ş.	Otkar
Aksa Akrilik Kimya Sanayii A.Ş.	Aksa	Pinar Entegre Et ve Un Sanayii A.Ş.	Petun
Arçelik A.Ş.	Arclk	Pegasus Hava Taşımacılığı A.Ş.	Pgsus
Aselsan Elektronik Sanayi ve Ticaret A.Ş.	Asels	Pinar Su ve İçecek Sanayi ve Ticaret A.Ş.	Pinsu
Aygaz A.Ş.	Aygaz	Pinar Süt Mamulleri Sanayii A.Ş.	Pnsut
Coca-Cola İçecek A.Ş.	Ccola	Türk Prysmian Kablo ve Sistemleri A.Ş.	Prkab
Doğuş Otomotiv Servis ve Ticaret A.Ş.	Doas	Park Elektrik Üretim Madencilik San.ve Tic. A.Ş.	Prkme
Enka İnşaat ve Sanayi A.Ş.	Enkai	Tofaş Türk Otomobil Fabrikası A.Ş.	Toaso
Ereğli Demir ve Çelik Fabrikaları T.A.Ş.	Eregl	Türk Telekomünikasyon A.Ş.	Ttkom
Hürriyet Gazetecilik ve Matbaacılık A.Ş.	Hurgz	Türk Traktör ve Ziraat Makineleri A.Ş.	Ttrak
İhlas Ev Aletleri İmalat Sanayi ve Tic. A.Ş.	Iheva	Tüpraş-Türkiye Petrol Rafinerileri A.Ş.	Tuprs
Logo Yazılım Sanayi ve Ticaret A.Ş.	Logo	Vestel Elektronik Sanayi ve Ticaret A.Ş.	Vestl
Migros Ticaret A.Ş.	Mgros		

Source: Prepared by the authors

- *Determination of Performance Indicators (criteria)*: The criteria to be used in the MCDM model developed for financial performance measurement were determined based on a literature review and are presented in Table 4, which includes 15 criteria.

Table 4: Performance Indicators (Criteria)

Abbreviation	Criteria	Calculation
CR	Current Ratio	Current Assets / Current Liabilities
LR	Liquidity Ratio	(Current Assets - Inventory) / Current Liabilities
QR	Quick Ratio	Cash and Cash Equivalents / Current Liabilities
DR	Debt Ratio	(Current Liabilities + Long-Term Liabilities) / Total Assets
CA/TA	Current Assets to Total Assets	Current Assets / Total Assets
FA/PC	Fixed Assets Permanent Capital Ratio	Fixed Assets / (Equity + Long-Term Liabilities)
CL/LTL	Current Liabilities to Long-Term Liabilities	Current Liabilities / Long-Term Liabilities
RTR	Receivable Turnover Rate	Net Sales / Trade Receivables
ETR	Equity Turnover Rate	Net Sales / Equity
ATR	Asset Turnover Rate	Net Sales / Total Assets
ITR	Inventory Turnover Rate	Cost of Sales / Inventories
OPM	Operating Profit Margin	Operating Profit / Net Sales
ROA	Return on Assets	Net Income / Total Assets
ROE	Return on Equity	Net Income / Shareholders' Equity
NPM	Net Profit Margin	Net Income / Net Sales

Source: Prepared by the authors based on the literature

b. Obtaining Data

- *Obtaining financial statement information and creating financial performance indicators (criteria)*: The financial statement data used in the application was obtained by transferring the individual share names of the companies subject to the application from the financial statements section of the(<https://isyatirim.com.tr>) website to Excel, and accuracy checks were performed by conducting sample comparisons via the Public Disclosure Platform. The financial statement items and amounts of the financial statements of the relevant companies were programmed in Excel, and the financial indicators (criteria) were calculated separately for the years 2015-2019 to form the initial matrix (decision matrix) for the CRITIC weight determination method and the MCDM technique, thereby creating data sets.
- *Obtaining Corporate Governance Rating Scores*: Data related to corporate governance rating scores were obtained from the relevant sections of the Turkey Corporate Governance Association (TKYD) website(<https://www.tkyd.org.tr>, 2022) . For companies with multiple rating scores in the same year, the most recent rating score was considered. Due to the different dates of the ratings, the calendar year in which the rating score was obtained was

accepted as the year of the rating score. For companies with more than one same rating, the same rankings were given and the next rankings continued from where they left off.

- *Obtaining the market return data and constructing the return percentages:* The information required to calculate annual returns for businesses includes the year-end closing prices of shares and the amounts of dividends distributed. The aforementioned amounts were obtained from the “Historical Price Information” section of “İş Yatırım Menkul Değerler A.Ş.”’s website: (<https://isyatirim.com.tr>, 2022) . The data obtained were calculated using the *following* formula (Hanifah & Khafid, 2016; Huda et al., 2015; Okka, 2015; Sakarya et al., 2018; Sayilgan, 2017).

$$\text{Rate of return per share} = \frac{(P_t - P_{t-1}) + D_t}{P_{t-1}}$$

Here, P_t = current period stock price, P_{t-1} = previous period stock price, D_t = dividend amount paid in the current period.

Restrictions

The limitations related to the application are listed below.

- The years 2020 and 2021 were excluded from the study due to the pandemic period, during which some sectors were highly active while others came to a standstill.
- During the application period (2015-2019), there were 48 companies listed in the BIST Corporate Governance Index. However, 21 financial institutions in the index and 2 companies that were not included in the Corporate Governance Index throughout the entire 5-year period were excluded from the study.
- In the literature review, it was observed that the indicators “ratio of debt to total assets” and “ratio of equity to total assets” were used intensively as criteria. Since the ratio of equity to total assets = (1-debt) ratio of total assets, only one of these two criteria (ratio of debt to total assets) was included in the study.
- While the ENTROPI method was the most commonly used weighting determination method in literature reviews, methods that perform logarithmic calculations do not work with negative-valued criteria (such as profit/loss that can be negative). Therefore, the CRITIC method, which finds application in objectively determining weights, was used in this study.

Application of the Study

Determining Criteria Weights (CRITIC Method)

To objectively determine the criterion weights to be used in multi-criteria decision-making techniques, the CRITIC technique was applied using Excel to calculate separate weights for each year 2015–2019 (Ayçin, 2019) . The average of the 5-year weights prepared has been used as the weight in all applications in the study and is presented in the following Table 5.

Table 5: Criteria Weights Determined Using CRITIC Method (%)

	CRITERIA														
	CR	LR	QR	DR	CA/TA	FA/PC	CL/LTL	RTR	ETR	ATR	ITR	OPM	ROA	ROE	NPM
5-Year Avg. Weights (Total 100)	6,85	6,40	8,66	10,87	8,54	6,95	8,04	4,94	6,25	7,65	5,82	4,80	5,22	4,03	5,00

Source: Authors' calculations using CRITIC method in Excel

Determination of Criteria Directions (Maximum - Minimum)

The criteria used in the study and their aspects (benefit or cost) are given in Table 6. For criteria that cannot be expressed as maximum or minimum, the ideal dimensions are also indicated in the table.

Table 6: Criteria and Aspects Used in the Study

CRITERIA	DIRECTIONS
CR	Current Ratio
LR	Liquidity Ratio
QR	Quick Ratio
DR	Debt Ratio
CA/TA	Current Assets to Total Assets
FA/PC	Fixed Assets Permanent Capital Ratio
CL/LTL	Current Liabilities to Long-Term Liabilities
RTR	Receivable Turnover Rate
ETR	Equity Turnover Rate
ATR	Asset Turnover Rate
ITR	Inventory Turnover Rate
OPM	Operating Profit Margin
ROA	Return on Assets
ROE	Return on Equity
NPM	Net Profit Margin

Source: Authors' own work based on the literature review

Multi-criteria decision-making techniques are used by considering the benefit or cost (max-min) aspects of the criteria. As seen in the literature review, almost all studies have applied all criteria (financial indicators) with their benefit or cost aspects. A contrary situation was observed in a single application by (Demirbaş) in 2019, where scale transformations were performed for some criteria (criterion functions were created). In this study, an application similar to that of (Demirbaş, 2019) was also performed. Transformation functions were created for the first four criteria in Table 6, where the benefit or cost direction could not be clearly specified. For the first three criteria (CR, LR and QR), functions were created in such a way that the values 4 times the optimum value and above are taken equal to 0, and for the fourth criterion (leverage ratio with a value between 0 and 1), functions were created in such a way that those above the opti-

num value (0.50) are (1-DR). The criterion direction conversion table, which displays the graphs related to the created functions and criteria, is provided in Table 7.

Table 7: Criteria Directions Conversion Table

Criteria	Most Suitable Values	Function	Graphic
CR	2,00	$P(X) = \begin{cases} X & X \leq 2 \\ (8-X)/3 & 2 < X < 8 \\ 0 & X \geq 8 \end{cases}$	
LR	1,00	$P(X) = \begin{cases} X & X \leq 1 \\ (4-X)/3 & 1 < X < 4 \\ 0 & X \geq 4 \end{cases}$	
QR	0,35	$P(X) = \begin{cases} X & X \leq 0,35 \\ (1,40-X)/3 & 0,35 < X < 1,40 \\ 0 & X \geq 1,40 \end{cases}$	
DR	0,50	$P(X) = \begin{cases} X & X \leq 0,50 \\ (1-X) & 0,50 < X < 1,00 \\ 0 & X \geq 1,00 \end{cases}$	
Other Criteria	Max-Min	$P(X) = \begin{cases} X & -\infty \leq X \leq \infty \end{cases}$	

Source: Authors' own work, inspired by Demirbaş (2019)

Application of Multi-Criteria Decision Making Methods

The data sets created for each year using the transformation functions for the criteria directions specified in Table 7 have been converted into the initial matrices (decision matrices) required for all MCDM techniques in the study.

For the application of MCDM methods, Excel programs were prepared for each technique by utilizing the applications in the studies of (Özbek, 2019), (Çakın, 2019), (Ayçin, 2019) and (Dağ & Yıldırım, 2018) MCDM technique rankings were created for the years 2015-2019.

Conversion of Scores and Rankings Obtained by Different MCDM Methods into Single Scores and Single Rankings

The 5-year MCDM scores and rankings obtained by all MCDM applications (6 methods) were prepared separately, a single common ranking for each year is provided in the following two items;

• **Conversion of Multiple MCDM Technique Scores into a Single Score:**

MCDM techniques create scores/grades for alternatives based on criteria in order to obtain rankings. Since each MCDM technique has different scoring techniques

from the others, a normalisation process was performed in the study to convert these different scores into a single score. In the normalisation process, the formulas of the GRA technique, which assign values between 0 and 1, were used. The combination of different MCDM technique ratings to be used in the study, has been prepared based on the cost/benefit studies of the MCDM techniques.

- **Conversion of Multiple MCDM Technique Rankings into a Single Ranking (COPELAND Technique):**

COPELAND technique is utilised in order to combine different rankings into a single ranking in cases where there are more than one MCDM techniques. With the COPELAND technique, the ranking value of each alternative is compared with the ranking value of other alternatives to determine whether it is superior or not, and COPELAND scores are obtained by determining the total gain and loss scores. By ranking these scores, a new single ranking is obtained (Eş, 2013; Zavadskas et al., 2017). In the application of the technique, an Excel programme was prepared using the studies of Özdağoğlu et al. (2021), and the results of the six different MCDM techniques used in the study were converted into single rankings for each year separately.

Conversion of Scores and Rankings Obtained by MCDM Methods for Multiple Years into Single Scores and Rankings

In the study, in order to compare the 2015-2018 years (four years of data) with the 2019 data, the scoring and ranking of the MCDM techniques were combined into a single data in the form of two items.

- **Conversion of Multiple Year Rankings into Single Rankings (COPELAND Technique):**

The 2015-2018 (four-year) rankings of the studies, which were converted into a single ranking for each year by COPELAND method with 6 different MCDM techniques, were converted into a single ranking by using the same method (COPELAND method). For those with the same score, the same ranking number is given, and the next same scores are given the next ranking number and added as an addition to the last column.

- **Conversion of multiple years' MCDM scores into a single score:**

In the study, it was aimed to compare the 2015-2018 MCDM scores with the 2019 MCDM scores. For this purpose, the 2015-2018 (four-year) scores of the MCDM techniques used in the study were combined into a single score. The combined MCDM scores for the years 2015-2018 were created by normalizing and averaging the scores of the different MCDM methods annually. Subsequently, the four-year average of these combined annual scores was calculated.

Research Findings

The scores and rankings obtained using the MCDM techniques, CGR scores and rankings, and stock return rates and rankings were subjected to a correlation analysis prepared in Excel to answer the three main research questions of the study. The correlation coefficient expresses the linear relationship between two variables, ranging from -1 to +1. Values close to +1 indicate a strong positive relationship, values close to -1 indicate a strong negative relationship, and values close to 0 indicate no linear relationship (Sönmez, 2012).

The correlation values obtained for the research questions are given in Table 8, Table 9, and Table 10 and were evaluated according to the direction and degree of the correlation coefficient.

Table 8: Examination of the relationship between MCDM techniques and Corporate Governance Ratings

RESEARCH QUESTIONS	Correlation Value
a. What is the relationship between 5 years MCDM scores and 5-year CGR scores?	
- What is the level of the relationship between the Unified Single MCDM scores and the CGR scores?	0,17
- What is the level of the relationship between MCDM-TOPSIS scores and CGR scores?	0,16
- What is the level of the relationship between MCDM -GRA scores and CGR scores?	0,06
- What is the level of the relationship between MCDM-ELECTRE Net Incompatibility scores and CGR scores?	-0,04
- What is the level of the relationship between MCDM -VIKOR scores and the CGR scores?	-0,18
- What is the level of the relationship between MCDM -MOORA Reference Approach scores and CGR scores?	-0,07
- What is the level of the relationship between MCDM -PROMETHEE scores and CGR scores?	0,11
b. What is the relationship between the 5-year MCDM Rankings and the 5-year CGR score Rankings?	
- What is the level of the relationship between the Unified Single MCDM rankings and the CGR score rankings?	-0,02
- What is the level of the relationship between MCDM -TOPSIS rankings and CGR score rankings?	0,04
- What is the level of the relationship between MCDM -GRA rankings and CGR score rankings?	-0,05
- What is the level of the relationship between MCDM -VIKOR rankings and CGR score rankings?	0,11
- What is the level of the relationship between MCDM-ELECTRE Net Incompatibility rankings and CGR score rankings?	-0,06
- What is the level of the relationship between MCDM -MOORA Reference Approach rankings and the CGR score rankings?	0,17
- What is the level of the relationship between MCDM -PROMETHEE rankings and CGR score rankings?	-0,05

Source: Authors' calculations based on the study results

Table 8 shows the research questions and the correlation values of the binary relationships and it is seen that the relationship between the Corporate Governance Rating Scores (CGRS) and the MCDM ratings is at a very low level.

The Unified Single MCDM scoring and the CGRS have a correlation value of (0.17). Among the six different MCDM techniques, the relationship between the MCDM-ELECTRE Net Incompatibility scoring and the CGRS is the lowest, with a correlation of (-0.04), while the relationship with the MCDM-VIKOR scoring has the largest but inverse correlation, with a value of (-0.18). The ELECTRE Net Incompatibility, VIKOR, and MOORA Reference Approach scoring methods work in a mini-

imum directional (where lower values appear at the top ranks), and therefore, the scoring correlations for these methods have occurred in a negative direction.

It has been observed that there is almost no relationship between the MCDM rankings and the Corporate Governance Rating Rankings (CGRR). The relationship between the unified single MCDM rankings and CGRR has a correlation value of (-0.02) , and among the six different MCDM techniques used with CGRR, the MCDM-TOPSIS rankings have the lowest correlation (0.04), while the MCDM-MOORA Reference Approach rankings have the highest correlation (0.17). All rankings in the study are minimum directional. Both the MCDM rankings and CGRR work in the same direction (in the minimum direction), meaning lower values are considered better (for example, the 1st rank is better than the 2nd).

Table 9: Examining of the relationship between MCDM techniques and stock returns

RESEARCH QUESTIONS		Correlation Value
a. What is the relationship between 5-year MCDM scores and 5-year stock return rates?		
-	What is the level of the relationship between the Unified Single MCDM scores and stock return rates?	-0,01
-	What is the level of the relationship between MCDM-TOPSIS scores and stock return rates?	0,18
-	What is the level of the relationship between MCDM-GRA scores and stock return rates?	0,04
-	What is the level of the relationship between MCDM-ELECTRE Net Incompatibility scores and stock return rates?	-0,04
-	What is the level of the relationship between MCDM-VIKOR scores and stock return rates?	-0,05
-	What is the level of the relationship between MCDM-MOORA Reference Approach scores and stock return rates?	0,31
-	What is the level of the relationship between MCDM-PROMETHEE scores and stock return rates?	0,01
b. What is the relationship between 5-year MCDM rankings and 5-year stock return rankings?		
-	What is the level of the relationship between the Unified Single MCDM rankings and stock return rankings?	0,20
-	What is the level of the relationship between MCDM-TOPSIS rankings and stock return rankings?	0,18
-	What is the level of the relationship between MCDM-GRA rankings and stock return rankings?	0,14
-	What is the level of the relationship between MCDM-VIKOR rankings and stock return rankings?	0,16
-	What is the level of the relationship between the MCDM-ELECTRE Net Incompatibility rankings and stock return rankings?	0,19
-	What is the level of the relationship between MCDM-MOORA Reference Approach rankings and stock return rankings?	0,14
-	What is the level of the relationship between CRM-PROMETHEE rankings and stock return rankings?	0,23

Source: Authors' calculations based on the study results

When Table-9 analyses the relationship between the stock return ratios and the MCDM scores, it is seen that there is no relationship between the combined single MCDM scoring and the stock return rates with a correlation value of -0.01. Among the 6 different MCDM techniques used with stock return ratios, MCDM-PROMETHEE II ratings have the lowest correlation with 0.01, and MCDM-MOORA Reference Approach ratings and stock return ratios have the highest correlation with 0.31.

When the relationship between the stock return rankings and the MCDM rankings is analysed, it is seen that the relationship between the combined single MCDM ranking and the stock return rankings is low with a correlation value of 0.20. Among the 6 different MCDM techniques used with the stock return rankings, it is seen that MCDM-GRA and MCDM-MOORA Reference Approach ratings have the lowest correlation degree with 0.14, while MCDM-PROMETHEE II rankings and stock return ratios have the highest correlation degree with 0.23.

Table 10: Examining the relationship between the 2015-2018 MCDM data and the 2019 MCDM data

RESEARCH QUESTIONS	Correlation Value
3. Analysing the relationship between 2015-2018 MCDM data and 2019 MCDM data	
a. <i>What is the level of relationship between the 2015-18 MCDM <u>scores</u> and the 2019 MCDM <u>scores</u>?</i>	
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM scores and the fifth year (2019) the Unified Single MCDM scores?	0,87
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM-TOPSIS scores and the fifth year (2019) MCDM-TOPSIS scores?	0,85
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM-GRA scores and the fifth year (2019) MCDM-GRA scores?	0,86
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM- ELECTRE Net Incompatibility scores and the fifth year (2019) MCDM- ELECTRE Net Incompatibility scores?	0,82
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM- VIKOR scores and the fifth year (2019) MCDM- VIKOR scores?	0,80
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM- MOORA Reference Approach scores and the fifth year (2019) MCDM- MOORA Reference Approach scores?	0,44
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM- PROMETHEE scores and the fifth year (2019) MCDM- PROMETHEE scores?	0,87
b. <i>What is the level of relationship between the 2015-18 MCDM <u>rankings</u> and the 2019 MCDM <u>rankings</u>?</i>	
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM rankings and the fifth year (2019) the Unified Single MCDM rankings?	0,76
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM-TOPSIS rankings and the fifth year (2019) MCDM-TOPSIS rankings?	0,68
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM-GRA rankings and the fifth year (2019) MCDM-GRA rankings?	0,81
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM- ELECTRE Net Incompatibility rankings and the fifth year (2019) MCDM- ELECTRE Net Incompatibility rankings?	0,70

- What is the relationship between the four-year (2015-2018) the Unified Single MCDM- VIKOR rankings and the fifth year (2019) MCDM- VIKOR rankings?	0,75
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM- MOORA Reference Approach rankings and the fifth year (2019) MCDM- MOORA Reference Approach rankings?	0,67
- What is the relationship between the four-year (2015-2018) the Unified Single MCDM- PROMETHEE rankings and the fifth year (2019) MCDM- PROMETHEE rankings?	0,80

Source: Authors' calculations based on the study results

Table 10, which examines the relationship between the 4-year (2015-2018) MCDM scores and rankings and the scores and rankings of the following year (2019), shows a high level of correlation in terms of both scoring and ranking. The comparison of the combined MCDM scores from the four-year period with the MCDM rankings from the fifth year showed a correlation coefficient of 0.76, while the comparison of the MCDM scores alone yielded a higher correlation coefficient of 0.87, indicating that these methods can be used to predict future years. When examined separately by technique, PROMETHEE Scoring showed the same level of correlation with the combined MCDM scores in terms of ranking, while GRA ranking had a correlation value of 0.81 and PROMETHEE ranking had a correlation value of 0.80, indicating a high level of relationship in terms of rankings. In terms of ranking and scoring values for the years 2015-2018, the MOORA Reference Approach method was found to have a moderate relationship with the following year (2019) with a correlation value of 0.44 in terms of scoring and 0.67 in terms of ranking, and a lower relationship compared to other methods in the study.

CONCLUSION AND RECOMMENDATIONS

There are many performance indicators that are realised and quantified for internal and external purposes. These performance indicators are primarily classified according to whether they are financial or not, and financial performance indicators are used in many studies due to the reliability and accessibility of financial information of companies listed on the stock exchange. While each of these indicators has different meanings for the company, evaluating only a single indicator or comparing it with other companies does not provide a healthy evaluation or comparison. In order to make healthy evaluations, the number of performance indicators must be increased, which brings with it difficulties in valuation, observation, and calculation. The large number of companies compared can also create a matrix structure that makes these evaluations more difficult and complex. In this study, a model was established using Multi-Criteria Decision Making techniques to measure financial performance from the perspective of multiple companies using these complex performance indicators.

The study utilized 25 BIST Corporate Governance Index companies and 15 financial performance indicators (criteria) for the years 2015-2019. Among the numerous evolving MCDM techniques, the most widely used ones in the literature—TOPSIS, GRA, ELECTRE Incompatibility, VIKOR, MOORA Reference Approach, and PROMOTHEE II—were selected for this study.

In the study, a financial performance measurement model was developed by combining the CRITIC objective weight determination method, six different MCDM

techniques, and COPELAND ranking methods to obtain rankings for the years 2015-2019 based on the aforementioned criteria. These rankings do not indicate how well a company performs compared to others, but rather its position in the ranking. With the data obtained, company managements can evaluate financial performance rankings of the included companies to support decision-making regarding current or potential investors, as well as develop strategies to maintain a high ranking or avoid dropping to lower positions.

Since the MCDM rankings do not show the relative advantages of businesses, the MCDM scores or ratings obtained in the creation of these rankings were included in the study, as they may show the relative advantages of businesses. In addition, the study examined the criteria (financial indicators) used in the application of MCDM techniques and developed functions for financial indicators that do not have a benefit or cost dimension but have an ideal value.

The study found that there is only a minimal level of correlation between the comparison of financial performance measurements using CGR and MCDM methods (in terms of separate rankings and scores), and that this is consistent with the results obtained in the literature. This result may be attributed to the fact that all the companies included in the study possess the minimum corporate governance rating scores required to be listed on the BIST Corporate Governance Index (XKURY). It has been observed that the general belief that corporate governance positively contributes to financial performance does not hold true for companies listed on the BIST CGI index.

In the comparison of Equity Returns and MCDM methods in terms of Financial Performance measurements, it was observed that MOORA Reference Approach and TOPSIS methods had a low level of positive correlation in terms of MCDM scores, while there was no correlation in terms of other methods and combined MCDM scores. On the other hand, in the analysis made in terms of MCDM rankings and Stock Return rankings, it was observed that there was a positive and low level of correlation (between 0.14 and 0.20 correlation values) in the individual and combined rankings of all criteria.

The study found that there is a strong relationship between MCDM techniques and the rankings and scores of subsequent years, both in terms of combined rankings and combined scores, and that this relationship is much stronger in terms of MCDM scores. It was also observed that the model can be used to predict the financial performance of companies in future years. In terms of methodology, PROMETHEE II and GRA methods showed a high level of relationship with subsequent years in terms of scoring and ranking, while the MOORA Reference Approach method showed a moderate level of relationship.

Even if there were a high correlation between MCDM and stock returns, it would have been possible to make predictions for achieving high stock returns using MCDM techniques in future years. However, based on the application data and model in the study, the very low correlation between MCDM rankings and scores and stock returns, coupled with the high correlation between MCDM rankings and scores across subsequent years, indicates that MCDM techniques cannot be used to predict stock returns in future periods.

While attempting to answer the research questions, it is considered that the use of MCDM scores, which allow for a clearer assessment of the relative superiority

among alternatives, alongside MCDM rankings, as well as the conversion of different MCDM scores into a single score using normalisation methods, could contribute to the literature. Moreover, consolidating MCDM scores from multiple years into a single score, and demonstrating that both the scores and rankings can be used to predict MCDM scores and rankings in subsequent years, is also among the contributions this study could make to the literature.

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