İKTİSADİ İDARİ VE SİYASAL ARAŞTIRMALAR DERGİSİ
JOURNAL OF ECONOMICS BUSINESS AND POLITICAL RESEARCHES

e-ISSN: 2564-7466 | Cilt:8, Sayı:20, Şubat 2023
https://dergipark.org.tr/tr/pub/iktisad | Vol:8, No:20, February 2023

A Comparative MCDA Application on The Long-Term Performance of IPOs During the Pandemic on Borsa Istanbul

♦♦♦

Borsa İstanbul'da Pandemi Dönemindeki Uzun Vadeli İHA Performansına İlişkin Karşılaştırmalı Bir ÇKKA Uygulaması

DOI: https://doi.org/10.25204/iktisad.1242437

Orhan Emre ELMA*

Article Info

Paper Type: Research Paper

Received: 25.01.2023

Accepted: 05.02.2023

Abstract

The aim of the study is to help financial decision makers by making long-term performance analysis of initial public offerings with a comparative analysis perspective. Multi-criteria decision analysis (MCDA) methods are used in problems with complex answers. The pandemic, which spreads throughout the world in the first quarter of 2020, created a short-term shock effect in the capital markets, but capital markets survived this shock with new investors. While the number of shareholders in Borsa Istanbul was 1.3 million before the pandemic, this number exceeded 3.3 million afterwards. An increase in this number also means an increase in the number of financial decision makers. At this research, the long-term performance of 49 initial public offerings, which took place in Borsa Istanbul before the pandemic is analyzed with a comparative MCDA perspective. To that end, the study, in which CRITIC weighting technique and ARAS, MOORA, TOPSIS, COPRAS and ELECTRE III methods were used, examined 10 periods during the pandemic process. As a result of the research, which is the most comprehensive MCDA study in the field of IPOs, the MOORA method has been recommended to financial decision makers because it produced superior results compared to other 4 methods analyzed.

Keywords: MCDA, capital markets, long-term performance, IPO.

Makale Bilgileri

Makale Türü: Araştırma Makalesi

Geliş Tarihi: 25.01.2023

Kabul Tarihi: 05.02.2023

Öz

Bu çalışmanın amacı, halka arzların uzun vadeli performans analizlerini karşılaştırmalı bir analiz sistemiyle yaparak finansal karar vericilere bir referans yol haritası sunmaktır. Karmaşık cevapları olan problemlerde çok kriterli karar analizi (ÇKKA) yöntemleri kullanılmaktadır. 2020 yılının ilk çeyreğinde tüm dünyaya yayılan pandemi, sermaye piyasalarında kısa süreli bir şok etkisi yaratsa da sermaye piyasaları bu şoku yeni yatırımcılarla atlatmıştır. Pandemi öncesi Borsa İstanbul'daki hissedar sayısı 1,3 milyon iken bu sayı sonrasında 3,3 milyonu geçmiştir. Bu sayının artması aynı zamanda finansal karar vericilerin sayısının da artması anlamına gelmektedir. Bu araştırmada, Borsa İstanbul'da pandemi öncesi gerçekleşen 49 adet ilk halka arzın uzun dönem performansı karşılaştırmalı ÇKKA perspektifiyle incelenmektedir. Bu amaçla CRITIC ağırlıklandırma tekniği ile ARAS, MOORA, TOPSIS, COPRAS ve ELECTRE III yöntemlerinin kullanıldığı çalışmada pandemi sürecindeki 10 dönem incelenmiştir. Halka arz alanında yapılmış en kapsamlı ÇKKA çalışması olan araştırma sonucunda, analiz edilen diğer 4 yönteme göre üstün sonuçlar ürettiği için MOORA yöntemi finansal karar vericilere önerilmiştir.

Anahtar Kelimeler: ÇKKA, sermaye piyasaları, uzun dönem performansı, ilk halka arz.

Atıf/ to Cite (APA): Elma, O.E. (2023). A comparative MCDA application on the long-term performance of IPOs during the pandemic on Borsa Istanbul. *Journal of Economics Business and Political Researches, 8*(20), 269-293. https://doi.org/10.25204/iktisad.1242437

* ORCID Assist. Prof., Necmettin Erbakan University, Faculty of Applied Sciences, Accounting & Finance Management Department, Türkiye, oeelma@erbakan.edu.tr

1. Introduction

The transformation process in which private companies change their shell and open a certain part of their capital to shareholders is called the initial public offering. Therefore, this exciting process, which brings the advantages of expanding abroad, increasing brand prestige, increasing investments, improving consumer perception and finding easier creditors for larger debts, is a crucial turning point for companies. It is just as important for companies to find new investors as it is for investors to diversify their portfolios with new stocks. For investors, choosing new financial instruments is a complex situation that requires analysis of many variables. In such cases, where many alternatives are evaluated and there are various options, multi-criteria decision analysis (MCDA) applications are used (Kumaraswamy and Ramaswamy, 2016).

MCDA applications have a vital function in making important real-life decisions such as finance, personnel selection or business location preference. Especially in recent years, there has been a noticeable increase in studies on MCDAs, which function as a decision support system for decision makers to make the most optimal decision in complex scenarios. However, there is no consensus yet on choosing the most ideal MCDA method that can be applied to different types of problems among hundreds of methods (Baydaş et al., 2022).

The research motivation is to propose the most appropriate methods to financial decision makers by calculating the financial performance of IPOs with a comparative MCDM analysis approach. As a result of this study, the success of the methods was determined based on the relationship between the final scores produced by the methods and the stock returns. Share returns are realized by the consensus formed by millions of investors on the capital markets. For this purpose, in this study, the final scores produced by the methods were evaluated according to their relations with the stock returns. The method that produces the highest correlation with the highest statistical stability has been proposed to financial decision makers. In this sense, MOORA, which produced a 43.64% relationship with a higher statistical significance ($p<0.01$), was recommended to financial decision makers because it differed from other methods with its capacity and capability.

The long-term performance in the post-IPO process, which represents a very vital period for companies, will be examined in terms of 10 quarters before and during the pandemic, at this research. For this purpose, 49 public offerings that had occurred in Borsa Istanbul, which realized a record number of public offerings during the pandemic, were scrutinized. In addition, CRITIC weighting method was used in order to find stable results by increasing objectivity and recalculation. While analyzes were carried out on one method in previous impactful studies (Yalçın and Ünlü, 2018; Kumaran, 2022), comparative analyzes will be made for the first time, using 5 practical and user-friendly methods all at once, which are ARAS, COPRAS, MOORA, TOPSIS and ELECTRE III, in this research. In this respect, this study fills the gap in previous studies and makes an important contribution to the literature.

The paper is structured as follows: In the second section, previous studies on financial performance and the methods used in these studies will be summarized together with the results they produced. In the third section, the criteria and methods used in this study will be explained, and their usage areas in the literature will be revealed. In the fourth section, the comparative analysis will be made for all 5 methods and the final results will be examined thoroughly. In the fifth section, the interpretation of the study results will be expressed, and in the sixth section, the managerial implications will be given. Ultimately, in the seventh section conclusive remarks and suggestions for future studies will be delivered.

2. Literature Review

In scenarios involving various criteria, each alternative is tried to be evaluated on more than one occasion. For this purpose, hundreds of multi-criteria decision analysis (MCDA) methods have been developed. Each of these methods has a different mathematical background that is more functional in solving different types of problems. For example, while some MCDA methods apply different types of normalization steps, some methods do not prefer normalization at all. For this purpose, the ARAS method, which has an infrastructure based on evaluating different types of units by giving the optimum criterion rating, has been developed (Zavadskas and Turskis, 2010). In the related study, the criteria weights were determined subjectively by the pairwise comparison method based on the estimation of the experts. Afterwards, the ARAS-F model, which can be used in studies in the fields of finance, economy and sustainable development, was developed (Turskis and Zavadskas, 2010).

In capital markets, where uncertainty is an important factor, taking the right financial decision in terms of creditors, shareholders, partners and shareholders depends on many factors. The systematic or the functionality of the calculation algorithm of the methods to be preferred at this stage will increase the confidence of decision makers in the model. In this sense, in a study on the right personnel selection, ARAS and ARAS-F methods were applied with the SWARA weighting technique and statistically strong results were obtained (Kersuliene and Turskis, 2011).

High-cited publications, which examine the post-2000 period, when the Internet and high technologies developed at an incredible pace and therefore the analysis of financial markets evolved, and which were indexed in Web of Science and TR Dizin, were examined in the literature part of this study. Since this research will focus on financial performance analysis, attention has been paid to the fact that all publications investigated are on financial performance. The main framework of this study was established by focusing on the lack of comparative MCDA analysis in related studies. In addition, in order to assist financial decision makers in the uncertainty brought by the pandemic process, the long-term financial performance of initial public offerings in the pandemic constitutes the motivation of this research. The relevant literature that inspired this study is given below.

A study compared the financial performance of airline companies operating in Taiwan with the fuzzy TOPSIS method (Wang, 2008). As a result of the research, it was stated that it would be appropriate for the less successful airline firms to strengthen their soft spots by trying to implement the financial policies of the successful companies. In another study, the financial performance scores obtained from the financial data, the non-financial performance statistics derived from the surveys on subjects such as customer satisfaction and service quality, and the general performance of 5 commercial banks traded in Borsa Istanbul in 2007 were analyzed (Seçme et al., 2009). In the study, in which FAHP was preferred as the weighting technique and TOPSIS as the MCDA method, only one bank produced stable results and came first in all performance levels. The data on non-financial performance are found to be very subjective and affected the results, according to the study.

In another research, financial performance analysis was carried out using the TOPSIS method with 8 accounting ratios obtained from the data of the companies traded in the Borsa Istanbul corporate governance index for the years 2007 and 2008 (Conkar et al., 2011). When ranking results were examined, it has been observed that the first company has been consistently the same for both years. In another study, the financial data of 19 companies listed in the Borsa Istanbul food sector were analyzed for the years between 2005 and 2008 (Bülbül and Köse, 2011). In the research in which TOPSIS and ELECTRE methods were preferred, the rankings of the two methods produced similar results. In addition to these, financial performance analysis was made with TOPSIS and data envelopment analysis techniques, via 7 criteria obtained from the financial data of a total of 54 companies traded in Borsa Istanbul for the period between 2008 and 2010 (Soba et al., 2012). It has been suggested that these two models are successful for financial performance measurement and can be used with other techniques in the future studies.

A study examining the performance of banks operating in Iran, fuzzy AHP was preferred as the weighting technique and TOPSIS was preferred as the MCDA method (Azimi et al., 2012). As a result of the study, the performance of banks that give more importance to customer service and invest in this field is found to be much higher. In another research, the financial performance of 4 participation banks operating in Türkiye was analyzed with the TOPSIS method using financial data between 2005 and 2011 (Yayar and Baykara, 2012). Accordingly, although effective and efficient banks were identified, increasing the variety of financial products were found to be positively accelerated efficiency and productivity.

The methods used for financial performance analysis in previous research and the results of these studies are summarized in Table 1 below.

Table 1. Previous Literature that used MCDA methods for Financial Performance Analysis

Authors	The Subject of the Study	Key Findings	MCDA Method	Period	Sector
Wang (2008)	Financial Performance	Financial performance rankings of 3 airline companies have been done	TOPSIS	2001-2005	Airline
Seçme et al. (2009)	Performance Analysis	Only 1 bank produced stable results	TOPSIS	2007	Banking
Conkar et al. (2011)	Financial Performance	First company has found to be consistently the same for all the periods analyzed	TOPSIS	2007-2008	BIST Corporate Governance Index
Bülbül and Köse (2011)	Financial Performance	Both methods produced similar results	TOPSIS, ELECTRE III	2005-2008	BIST Food
Soba et al. (2012)	Financial Performance	Both methods are found to be successful in terms of their capacity	TOPSIS, DEA	2008-2010	54 Selected BIST Companies
Azimi et al. (2012)	Financial Performance	The performance of banks that give more importance to customer service is found to be much higher	TOPSIS	2012	Banking
Yayar and Baykara (2012)	Financial Performance	Increasing the variety of financial products were found to be positively accelerated efficiency and productivity	TOPSIS	2005-2011	Banking
Topaloğlu (2014)	Financial Performance	This method is suggested to the company managers and partners for financial performance analysis	TOPSIS	2000-2012	BIST Metal Goods
Ergül (2014)	Financial Performance	As a result, it is suggested that it would be appropriate to use them in performance analysis.	ELECTRE III, TOPSIS	2005-2012	BIST Tourism
Rabbani et al. (2014)	Performance Analysis	COPRAS method is recommended as an appropriate tool for evaluation of alternatives	COPRAS	2014	Oil Companies
Zolfani and Bahrami (2014)	Financial Performance	Nanotechnology has been found to be the top priority for Iran, among high tech industries analyzed.	COPRAS	2014	High Technology
Ghadikolaei and Esbouei (2014)	Financial Performance	ARAS method is effective and efficient in measuring financial performance.	ARAS	2002-2011	Automotive
Ecer (2019)	Performance Analysis	Giving importance to social issues is found to be vital for banks in their corporate sustainability	ARAS	2019	Banking
Dahooie (2019)	Financial Performance	Debt ratios have been found to be most impactful on analysis	ARAS	2016-2018	58 Manufacturing companies in Iran
Rao et al. (2021)	Financial Performance	Banks are ranked accoding to their performance	MOORA, ARAS	2020	Banking

For an MCDA analysis conducted on 18 companies traded in the Borsa Istanbul metal goods and machinery index, financial performance analysis was made with the TOPSIS method using 9 accounting ratios obtained from the data between 2000 and 2012 (Topaloğlu, 2014). As a result of the study, this method is suggested to the company managers and partners for financial performance analysis, since it produces instructive data. In a study examining 7 companies traded in the tourism sector of Borsa Istanbul, 11 accounting ratios obtained from the financial data between 2005 and 2012 were preferred as criteria and financial performance analysis was accomplished according to ELECTRE and TOPSIS methods (Ergül, 2014). As a result of the study, the results obtained from the two methods were found to be compatible with each other and it would be appropriate to use them in performance analysis.

In a study conducted in Iran, the financial performance of companies traded in the automotive sector on the Tehran Stock Exchange was analyzed using the FAHP weighting technique and the F-ARAS method (Ghadikolaei and Esbouei, 2014). It has been determined that the F-ARAS method is effective and efficient in measuring financial performance. In another research conducted to measure the corporate sustainability performance of banks operating in Türkiye, Entropy was preferred as the weighting technique and ARAS was preferred as the MCDA method (Ecer, 2019). As a result of the evaluation, taking measures to reduce greenhouse gas use by giving importance to social issues is found to be vital for banks in their corporate sustainability.

At a work that focuses on revealing the financial performance analysis of the applicant companies by evaluating their ability in paying their debts to creditors, 58 manufacturing companies that applied for a loan to a bank in Iran were analyzed with 8 criteria (Dahooie et al., 2019). This analysis was made using the CCSD weighting technique and the FCM-ARAS method, and as a result, the debt ratio and the share of equity in total assets and ROA came to the fore as the most important criteria in this evaluation. In a study measuring the financial performance of banks in India, ARAS and MOORA methods with standard deviation and CRITIC weighting techniques were used together, and the highest and lowest performing banks were identified via implementing the determined criteria (Rao et al., 2021).

3. Methodology

3.1. Decision Criteria

As in every research area, financial performance studies are also about which data will be processed and how the most optimum decision will be made accordingly. Although there are many ratios used for this purpose, these ratios are divided into two categories, which are accounting- and valuation-based. While popular and classical ratios such as return on assets (ROA) and return on equity (ROE) are evaluated under accounting-based ratios, ratios such as market value added (MVA) and market-to-book (M/B) ratios are evaluated under valuation-based ratios. In recent years, the more valuation-centric development of finance science has pushed researchers to work in this field and valuation ratios have been used together with accounting ratios in different studies. Financial performance analysis, which indicates areas that companies should pay great attention to, gives the most consistent results when measured together with retrospective accounting ratios and future valuation ratios (Visalakshmi et al., 2015). For this purpose, various ratios have been used in previous financial performance studies (Halkos and Tzeremes, 2002; Zamani et al., 2014). All accounting and valuation-based ratios used in this study are summarized in Table 2 below. The increase in the relations of the criteria with each other necessitated the inclusion of only one of the criteria in the relevant category. In this study, the conceptual framework is to perform comprehensive MCDA analyzes on the criteria that can summarize a firm as much as possible. Taking some and leaving similar criteria can be summarized as a clustering behavior, and it is used in the literature to reduce the number of criteria in subjective problem sets with multiple criteria such as financial performance (Oliveira et al., 2017).

Since subjective weighting and experts were not used in this study, clustering was not done, but the ratios with higher correlations were not included in the study so that it would not affect the results of the study. To illustrate, although ROE is included in this study, return on assets (ROA) is not among the operating criteria, because of the fact that there is a high correlation between these ratio.

Table 2. Performance Metris Used in this Study with Their Description and Relevant Sources

Code	Criteria	Short Description	Sources
ROE	Return on Equity	Measures how a company effectively creates earnings when compared to its shareholders' equity.	Kalakkar (2012), Lee et al. (2016), Al-Homaidi et al. (2018)
M/B	Market-to-Book	Measures how the market value of the firm is changing when compared to its accounting book value.	Miralles-Quiros et al. (2018), Makan and Kabra (2021), Abdi et al. (2022)
MVA	Market Value Added	Measures how a company effectively uses scarce resources and ultimately creates value for shareholders.	Zhao and Murrell (2016), Ganda (2018)
CGS/NS	Cost of Goods Sold/ Net Sales	Measures how effective a company in minimizing its stock-related costs in terms of net sales.	Naz et al. (2016), Elking et al. (2017), Xie et al. (2019)
NSG	Net Sales Growth	Measures how effective a company in accumulating its net sales.	Qiu et al. (2016), Miroshnychenko et al. (2017), Cho et al. (2019)
STL/NS	Short-Term Liabilities/Net Sales	Measures how effective a company in managing its short-term liabilities in terms of net sales.	Saeed and Badar (2013), Ahmad et al. (2015)

The popular ratio ROE, which shows how efficiently the money put forward by the shareholders turns into returns, has been preferred as a criterion in the analysis of the financial performance of commercial banks in India (Kalakkar, 2012). In another study measuring the financial performance of companies operating in South Korea, ROE was integrated into the application as an indicator (Lee et al., 2016). In another study in which the profitability of financial institutions was analyzed, also ROE ratio was preferred as an indicator (Al-Homaidi et al., 2018).

In a study examining the financial performance of 38 airline companies, the M/B ratio as a financial performance indicator was integrated into the practice (Abdi et al., 2022). This pivotal ratio, which shows how much the company can improve its market value compared to equity, was preferred in another study in the analysis of the financial performance of 73 companies traded on the Sao Paolo Stock Exchange (Miralles-Quiros et al., 2018). Moreover, in a study examining the performance of 38 companies traded on the Bombai Stock Exchange, the M/B ratio was taken as the financial performance criterion (Makan and Kabra, 2021).

In a study that analyzed the financial performance of cement companies operating in India, MVA was chosen as a criterion because it is a critical ratio that measures the appreciation capacity of shareholders (Reddy et al., 2011). In another study, it was stated that EVA and MVA, which are used as financial performance indicators, are very successful in terms of the outputs they produce (Artikis, 2008). In a study that analyzed the financial and environmental performance of 63 companies operating in South Africa, MVA was integrated into the study as a criterion (Ganda, 2018). Additionally, in another study where corporate social performance and corporate financial performance were analyzed together, MVA was integrated into the application as a financial performance criterion (Zhao and Murrell, 2016).

Cost of Goods Sold/Net Sales ratio (CGS/NS), which is a different indicator of gross profit, was used as a criterion in the financial performance analysis conducted on 18 cement companies traded in Pakistan Karachi Stock Exchange (Naz et al., 2016). In a comprehensive performance study in which financial dependency is examined from the buyer and seller perspectives and 3638 buyer-supplier relationships are analyzed, CGS in the buyer perspective and sales ratio in the supplier perspective are integrated into the study (Elking et al., 2017). In another study in which corporate financial performance analysis was conducted, income and CGS criteria were integrated into the DEA method in the MCDA study separately (Xie et al., 2019).

Net Sales Growth (NSG) is one of the indicators used in financial performance analysis. Since the company's ability to create value depends on profitability and profitability on sales, this ratio is often preferred in researches. In a study examining the effect of eco-friendly policies implemented by companies on financial performance, NSG was taken as one of the financial performance indicators (Miroshnychenko et al., 2017). In a study in which 191 companies traded on the Korean Stock Exchange were analyzed, NSG was preferred as one of the financial performance indicators (Cho et al., 2019). In another study in which the corporate financial performance of companies traded in the FTSE350 Index was measured, NSG was again taken as an indicator (Qiu et al., 2016). In another study examining the short and long-term financial performance of 242 companies operating in the USA, NSG was integrated into the analysis as a performance indicator (Ortiz-de-Mandojana et al., 2016).

In the short-term liabilities/net sales (STL/NS) ratio, it is stated that how much of net sales, which has a crucial effect on profitability, goes to short-term debts. In a study conducted on companies operating in the textile industry in Pakistan, STL and NS ratios were taken as separate criteria and their effect on profitability was observed (Ahmad et al., 2015). In a financial performance study conducted on companies operating in the sugar industry and traded in the Pakistan Karachi Stock Exchange, short-term and long-term debts were integrated into the analyzes as indicators (Saeed and Badar, 2013). Results of the research showed that while long-term debts had a positive effect on firm performance, short-term debts had a negative effect on it. The MCDA methods and weighting technique used in this study are explained below, along with their application stages and areas of use.

The selected methods below have been preferred due to their mathematical practicality to help financial decision makers in a process where quick and easy calculation is important, such as initial public offerings, and that they have been tested and approved in financial performance studies before. Methods that are not frequently used in financial performance analysis were not preferred in this study.

3.2. Additive Ratio Assessment (ARAS)

ARAS method has been used in many researches such as sustainability assessment (Medineckiene et al., 2015), civil engineering evaluations (Zavadskas et al., 2010; Zavadskas et al., 2012), energy policy studies (Balezentis and Streimikiene, 2017; Ghenai et al., 2020) , optimum logistics route selection (Zavadskas et al., 2015), personnel selection (Karabasevic et al., 2016; Dahooie et al., 2018), supplier preference (Petrovic et al., 2019; Matic et al., 2019), and financial performance analysis (Ghadikolaei et al., 2014). The steps of the method are summarized below.

Stage 1: Based on the criteria and alternatives, a decision matrix is created. Unlike other methods, the optimal value for each criterion is also integrated into this decision matrix. If the optimal value is not known, the maximum value for utility functions and the minimum value for cost functions in the criterion are taken.

Stage 2: For normalization, if the criterion is utility-oriented, the following formula is applied:

$$X_{ij} = \frac{x_{ij}}{\sum_{i=0}^{m} x_{ij}} \quad (1)$$

On the other hand, if the criterion is cost oriented, then the following formula is applied:

$$X_{ij} * = \frac{1}{x_{ij}} \quad (2)$$

And normalized decision matrix is created by applying the following equation:

$$X_{ij} = \frac{x_{ij*}}{\sum_{i=0}^{m} x_{ij*}} \tag{3}$$

Stage 3: The weighted normalized decision matrix is created by multiplying the previously determined weights for each criterion with the normalized decision matrix:

$$\hat{x}_{ij} = x_{ij}.w_{ij} \tag{4}$$

Stage 4: The optimality function value is calculated for each criterion:

$$S_i = \sum_{j=1}^{n} \hat{x}_{ij} \tag{5}$$

Stage 5: Ultimately, these values are proportioned to the optimal function value and the final utility scores are computed, by the following equation, and alternatives are ranked in a descending order:

$$K_i * = \frac{S_i}{S_0} \tag{6}$$

3.3. Complex Proportional Assessment (COPRAS)

The COPRAS method has been used in applications in civil engineering (Kaklauskas et al., 2006; Uzsilaityte and Martinaitiss, 2010), in evaluating the decisions to be made by companies operating in the manufacturing sector (Chatterjee and Chakraborty, 2012), in evaluating company performances (Rabbani et al., 2014), in rating the performance of high-tech industries (Zolfani and Bahrami, 2014) and in financial analysis of investment projects (Popovic et al., 2012). The stages of the method are summarized below.

Stage 1: Normalized objective matrix is created by:

$$F_{ij} = \frac{f_{ij}}{\sum_{k=1}^{m} f_{kj}} \quad i \in \{1,2,\dots,m\};\ j \in \{1,2,\dots,n\} \tag{7}$$

Stage 2: Weighted normalized objective matrix is created by:

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

Stage 3: The sums of weighted normalized values for both benefit and cost objectives, for each solution is calculated by:

$$S_{i+} = \sum_{j=1}^{g} v_{ij} \quad i \in \{1,2,\dots,m\} \tag{9}$$

$$S_{i-} = \sum_{j=g+1}^{n} v_{ij} \quad i \in \{1,2,\dots,m\} \tag{10}$$

Stage 4: The relative importance of each solution is determined by:

$$Q_i = \begin{cases} S_{i+} + \dfrac{\sum_{i=1}^{m} S_{i-}}{S_{i-} \sum_{i=1}^{m} \frac{1}{S_{i-}}} & for\ both\ benefit\ and\ cost \\ S_{i+} & for\ only\ benefit \\ \dfrac{\sum_{i=1}^{m} S_{i-}}{S_{i-} \sum_{i=1}^{m} \frac{1}{S_{i-}}} & for\ only\ cost \end{cases} \tag{11}$$

Stage 5: By comparing the priorities of all alternatives with the most efficient one, the degree of utility for each alternative is calculated.

$$N = \frac{Q_i}{Q_{max}} \tag{12}$$

3.4. Multi-Objective Optimization on the basis of Ratio Analysis (MOORA)

MOORA method uses a system of dividing the performance scores of the alternatives for each criterion into a score representing the overall criteria. This representation score is the square root of the sum of the squares of all alternative values in the relevant criterion (Brauers and Zavadskas, 2012). Then the values found are normalized. In the last step, the usefulness and ineffectiveness scores of each alternative are calculated, and ranking is made so that the alternative with the highest difference between the two parameters is placed at the top.

In an analysis on project management, the MOORA method was used and the MULTIMOORA method was explained over this method (Brauers and Zavadskas, 2010). The MOORA method has been used in many studies such as measuring and comparing productivity in the agricultural sector (Balezentis and Balezentis, 2011b), port selection (Brauers, 2013) and road design (Brauers et al., 2008).

This method has been used in the field of economics (Balezentis et al., 2010), in determining priority in the manufacturing industry systems (Jana et al., 2013), in assessing country risk (Stankeviciene and Sviderske, 2012), in evaluating investment projects (Brauers, 2012), in strategic management evaluations (Balezentis and Balezentis, 2011a), and in ranking the economic performance of countries (Brauers, 2004). The steps of the method are summarized below.

Stage 1: Normalized objective matrix is created by applying vector normalization, with the following equation:

$$F_{ij} = \frac{f_{ij}}{\sqrt{\sum_{k=1}^{m} {f_{kj}}^2}} \tag{13}$$

Stage 2: Weighted normalized objective matrix is created by:

$$v_{ij} = F_{ij} \times w_j \tag{14}$$

Stage 3: The performance scores for each solution is calculated by:

$$P_i = \sum_{j=1}^{g} v_{ij} - \sum_{j=g+1}^{n} v_{ij} \qquad i \in \{1,2,\dots,m\} \tag{15}$$

3.5. Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS, the most popular American school method, is one of the most frequently used analysis methods in studies due to its simplicity and ease of application. In a study measuring the performance of bank branches over financial ratios, the TOPSIS method with interval data was used (Jahanshahloo et al., 2006). In addition, in a study on estimating the failures of businesses operating in China, TOPSIS was determined as the method to be analyzed (Li et al., 2011). In a study on choosing the right investment alternative, the TOPSIS method was preferred (Tan, 2011). The application stages of the method are summarized below.

Stage 1: The normalized decision matrix is created by:

$$F_{ij} = \frac{f_{ij}}{\sqrt{\sum_{i=1}^{m} f_{ij}^2}} \tag{16}$$

Stage 2: The weighted normalized matrix is created by:

$$v_{ij} = F_{ij} \times w_j \tag{17}$$

Stage 3: The positive (A^+) and negative (A^-) ideal solutions are found by:

$$A^+ = \left\{\left(Max_i\left(v_{ij}\right) \middle| j \in J\right), \left(Min_i\left(v_{ij}\right) \middle| j \in J'\right) \middle| i \in 1,2,\dots,m\right\} = \left\{v_1^+, \dots, v_j^+, \dots, v_n^+\right\} \tag{18}$$

$$A^- = \left\{\left(Min_i\left(v_{ij}\right) \middle| j \in J\right), \left(Max_i\left(v_{ij}\right) \middle| j \in J'\right) \middle| i \in 1, 2, \dots, m\right\} = \left\{v_1^-, \dots, v_j^-, \dots, v_n^-\right\} \quad (19)$$

Stage 4: The positive and negative ideals solutions' distance values are computed by:

$$S_{i+} = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^+\right)^2} \qquad i = 1, 2, 3, \dots, m \quad (20)$$

$$S_{i-} = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^-\right)^2} \qquad i = 1, 2, 3, \dots, m \quad (21)$$

Stage 5: Ultimately, the relative proximity to ideal solution is calculated by:

$$C_i = \frac{S_{i-}}{S_{i-} + S_{i+}} \quad (22)$$

3.6. Elimination and Choice Expressing Reality (ELECTRE III)

ELECTRE, which is the oldest of the outranking methods, makes use of pairwise comparisons of alternatives (Roy, 1990). It has been used as an analysis method in research conducted in different areas such as measuring sector performance (Augusto et al., 2008), assessing personnel selection (Wu and Chen, 2011) and determining the optimum location for an enterprise (Ashayeri and Rongen, 1997). The application steps of the method are summarized below (Wang and Rangaiah, 2017):

Stage 1: After modifying the objective matrix as in ELECTRE II, computation of an element of the concordance matrix of *m* rows and columns is done by the following formulas:

$$C(a, b) = \sum_{j=1}^{n} w_j C_j(a, b) \quad (23)$$

$$\text{where } C_j(a, b) = \begin{Bmatrix} 1 & if\ F_j(b) - F_j(a) \le Q_j \\ 0 & if\ F_j(b) - F_j(a) > P_j \\ \frac{P_j - [F_j(b) - F_j(a)]}{P_j - Q_j} & if Q_j < F_j(b) - F_j(a) \le P_j \end{Bmatrix} \quad (24)$$

Stage 2: The elements of discordance matrix is calculated by:

$$D_j(a, b) = \begin{Bmatrix} 1 & if\ F_j(b) - F_j(a) > V_j \\ 0 & if\ F_j(b) - F_j(a) \le P_j \\ \frac{F_j(b) - F_j(a) - P_j}{V_j - P_j} & if P_j < F_j(b) - F_j(a) \le V_j \end{Bmatrix} \quad (25)$$

Stage 3: The credibility matrix of m rows and columns is given by the following rules:

$$S(a, b) = \begin{cases} C(a, b) & if\ D_j(a, b) \le C(a, b) \forall j \\ C(a, b) \prod_{j \in J(a,b)} \frac{1 - D_j(a,b)}{1 - C(a,b)} & otherwise \end{cases} \quad (26)$$

Stage 4: Equalize λ_0 to the maximum value of $S(a, b)$ in the credibility matrix (A) by:

$$\lambda_0 = \max S(a, b) \qquad where\ a, b \in S \quad (27)$$

Stage 5: A cut-off level of λ_1 is defined as the biggest outranking score which is less than the maximum outranking score minus the discrimination threshold.

$$\lambda_1 = \max S(a, b) \qquad where\ (S(a, b) < \left(\left(\lambda_0 - s(\lambda_0)\right)\right) \in S \quad (28)$$

$$S(\lambda_0) = \alpha + \beta\lambda \quad (29)$$

Ultimately, the selection is made based on credibility matrix, by calculating difference between the strength (*sum of row*) and weakness (*sum of column*) of each solution, with or without cut-off values.

3.7. Criteria Importance Through Intercriteria Correlation (CRITIC)

CRITIC, which is among the objective weighting techniques, bases its calculations on standard deviation and correlation. The application stages of the technique are summarized below.

Stage 1: The decision matrix is created and then normalized by:

$$r_{ij} = \frac{x_{ij} - x_j min}{x_j max - x_j min} \tag{30}$$

Stage 2: After computing the standard deviation and multiple correlations for each criterion, the correlation density is calculated by the following equation:

$$C_j = \sigma_j \sum_{i=1}^{m} (1 - r_{ij}) \tag{31}$$

Stage 3: Ultimately, the calculated correlation density is normalized and weights are computed for each criterion, by the following formula:

$$w_j = \frac{c_j}{\sum_{i=1}^{m} c_i} \tag{32}$$

4. Application

In this study, the long-term financial performance of 49 initial public offerings, which took place in Borsa Istanbul between 2005 and 2015, in the 10 quarters during the pandemic process was examined. Analyzes were made comparatively with ARAS, COPRAS, MOORA, ELECTRE III and TOPSIS methods. For this purpose, the 6 most frequently used financial ratios were regarded as criteria. CRITIC, one of the objective weighting techniques, was used as the weighting technique. Finally, the relationship between MCDA rankings and share return rankings was calculated by Spearman correlation coefficient. MCDA methods, which can create a significant correlation with stock returns, have been proposed to financial decision makers, in this financial performance study. The steps of the approach used in this research are shown in Figure 1.

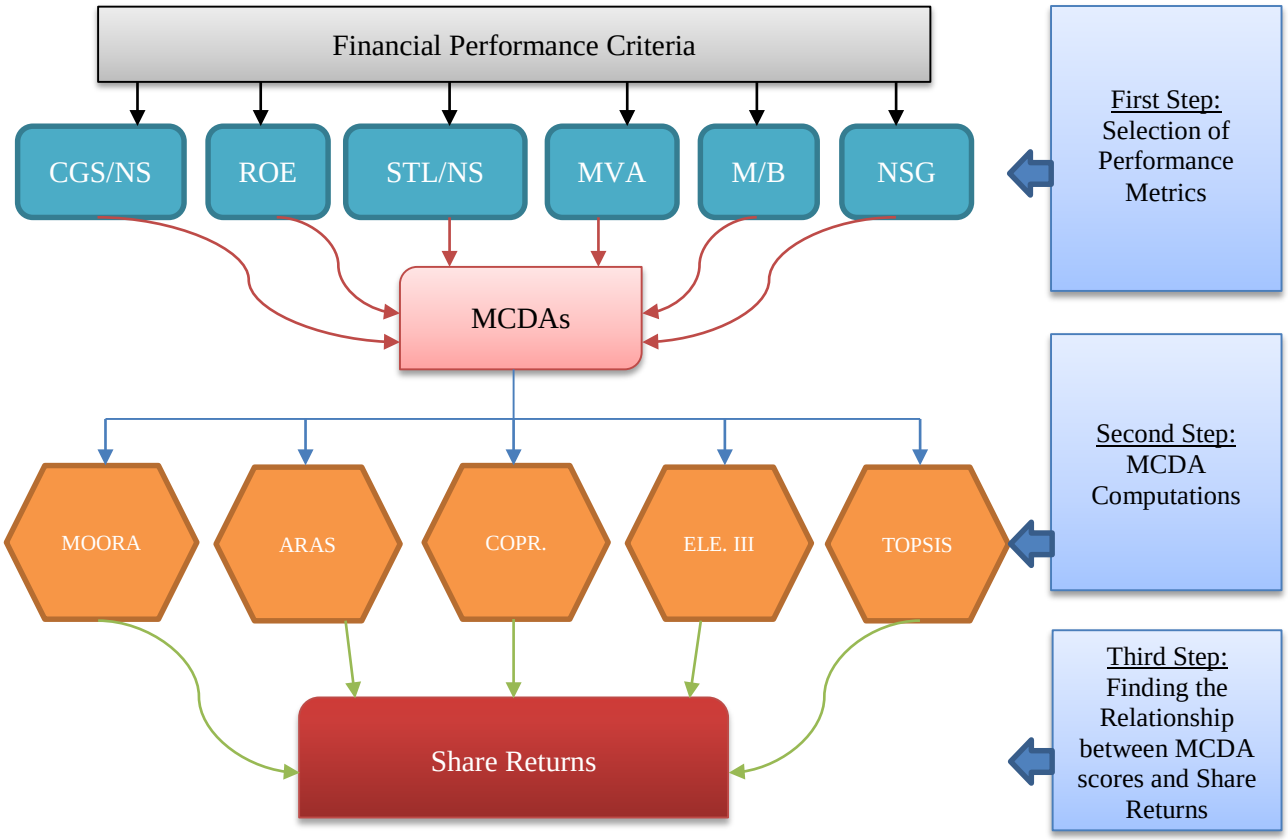

Figure 1. The Application Framework of the Study

The data of share returns and 6 financial ratios of the initial public offering firms were obtained through FINNET. Objective weights were calculated with CRITIC for each quarter. With the aforementioned data, the decision matrix was created for each quarter and MCDA calculations were performed. The long-term performance of 49 initial public offerings in 10 quarters during the pandemic period (2020/1-2022/2) was carried out separately for ARAS, COPRAS, MOORA, ELECTRE III and TOPSIS. Excel software was used for these intensive calculations. Finally, the MCDA scores and the stock returns of the relevant companies in the relevant quarter were compared, and ultimately successful MCDA methods were recommended to the financial decision makers.

4.1. Findings and Results

In this study, in which the long-term performance of initial public offerings during the pandemic process was evaluated through different MCDA methods, 49 initial public offering companies were examined. With the financial data obtained for this purpose, a decision matrix was created for each period as in Table 3.

Table 3. Decision Matrix for the Second Quarter of 2022, Last Quarter of the Analysis

Alternatives	ROE	M-to-B	MVA	CGS/Net Sales	Net Sales Growth	STL/Net Sales
BIMAS	1.282050151	0.788176194	0.928242432	0.003563381	0.15488233	-0.463196344
ARMDA	0.459477827	1.495247434	3.107510656	0.007818256	0.982761456	-0.335336598
CCOLA	1.574540867	-0.040684452	0.059571691	0.010199354	0.097670357	-0.452274542
DGATE	1.743894385	-0.084996948	-0.143336444	-0.004688593	0.652819943	-0.353691321
KAREL	-0.605257883	-0.075105945	0.015737381	0.100372531	0.101970532	-0.196465234
RYSAS	4.992557155	0.762905604	25.03766123	-0.158475723	0.293876101	-0.613753788
SELEC	0.658282238	1.146353537	3.592064038	0.020909758	0.262634858	-0.480473483
VESBE	1.214516732	0.138374031	0.240685028	0.004036566	-0.07113545	-0.439621761
TAVHL	-1.946769613	0.047615787	-0.397752201	-0.065477944	0.041184874	-0.472909384
KOZAL	0.592540239	0.011896104	0.089213287	0.09878965	-0.454116554	-0.488990056
AKSEN	0.757934033	0.388693408	1.415123462	0.116804884	0.657562099	-0.63865997
IHGZT	0.552989028	-0.079344755	0.102016036	0.038928018	0.016825601	-0.566389521
ANELE	2.009801755	0.502474834	-4.819757868	0.006910617	-0.160253376	-0.401400815
CEMAS	0.723797946	0.809393981	-2.492970693	-0.037566533	0.486876558	-0.47491349
EKIZ	-3.166256814	-0.292896136	-0.695992524	-0.001510724	-0.078438176	-0.384042988
KATMR	1.725210272	0.018308599	0.094842925	-0.06299468	-0.101350033	-0.480392738
DESPC	1.567292219	-0.099483912	-0.203049878	0.003675405	0.36753083	-0.409038906
HATEK	0.664051393	0.479134203	-5.650360261	0.006284715	-0.135604139	-0.345716211
LKMNH	0.66515553	0.222065558	0.392164019	0.062548687	0.319470749	-0.32634131
BRKSN	0.719420668	0.774169793	1.441118975	0.014167977	-0.144189962	-0.465515609
BLCYT	1.044094492	-0.272703652	-0.471063156	-0.003982	-0.192379231	-0.312746966
DAGI	-3.926552562	0.040374201	0.324322133	-0.039467597	1.011316023	-0.574523639
MEPET	2.792188854	0.043805042	0.133139603	0.001487581	0.232189223	-0.542288438
SAMAT	-4.144907476	0.034932895	0.245869558	0.042718965	-3.396633523	-0.676563606
VANGD	-1.268065282	-0.184751874	-0.373720148	-0.006322712	-0.181061735	0.034356861
ADESE	0.92939969	0.522579065	-0.253055646	0.197877432	0.307860999	-0.495958642
NIBAS	3.063177029	-0.158304514	-0.213305667	0.048177095	9.542904136	-0.845819823
SANFM	1.643669252	-0.041544755	0.106492222	-0.033884857	0.056931685	-0.525409462
OYLUM	0.052476702	0.95372022	43.98428639	0.016591129	-0.190046863	-0.563120303
PRZMA	-0.814377721	-0.161794461	-0.362430571	0.111970086	-1.524956868	-0.641577471
ORGE	1.365630813	1.791957647	6.909104592	0.028446406	-0.450136961	-0.516685556
TKNSA	1.274595344	-0.305993573	-0.108555936	-0.002496907	0.157693246	-0.481471648
TGSAS	1.094645364	-0.063088988	-0.059987658	0.422497653	0.05000003	-0.503006033
FLAP	2.399589838	0.482197112	2.009738449	0.088292341	0.062739474	-0.494986541
ETILR	1.061644614	-0.176925713	-0.091392953	0.084047591	0.059564674	-0.289798471
TMSN	1.449401064	2.853533791	7.965173949	0.025691099	0.461374998	-0.639131565
ROYAL	-1.211738884	0.715387601	2.378030637	-0.035248281	-0.175881871	-0.323941126
ODAS	1.081759935	3.538449634	-6.177668637	-0.011967377	0.194339433	-0.489877356
SAYAS	0.644056498	-0.096087342	0.097944577	0.067719383	1.138501006	-0.455507687
SEKUR	-1.469383163	0.278851334	1.401308708	-0.016557221	-0.190477531	-0.444588051
YAYLA	-6.506935636	0.740718638	2.76351183	0.136152036	-0.086516519	-0.407076317
SANEL	-0.696368607	1.36211421	1.105711004	0.006718217	-0.444358421	-0.387267153
TMPOL	0.782828523	0.667304283	1.060135193	-0.008385488	-0.346977258	-0.42630056
RTALB	1.093998414	0.104392944	0.410686204	0.03838681	1.070952632	-0.539993129
TUCLK	0.566462138	0.016351509	0.109930513	-0.004944107	0.207069825	-0.581232848
PSDTC	1.289530973	0.043477524	-0.107542177	0.088283945	-0.113402204	-0.346953428
ULUUN	0.444619573	2.317534975	10.20866069	0.005306743	-0.306709728	-0.382717111
SENKRN	0.624563813	-0.385219928	-0.469952608	-0.069638536	-1.253657571	-0.086242184
SEYKM	0.661322012	-0.134757621	-0.075255291	-0.010712271	-0.198599273	-0.347108229

Six performance criteria calculated with CRITIC, one of the objective weighting techniques, for each year during the analysis period are shown in Table 4. Among these ratios, the ratios related to current liabilities and cost of goods sold are cost-based, while the other 4 ratios are benefit-based. When 10 quarters are analyzed, it is seen that generally the benefit-based valuation ratio, M/B, and the cost-based accounting ratios, CGS/NS and STL/NS, come to the fore. Among the valuation-based ratios, MVA was first only in the first period of the pandemic, while the other accounting-based ratios, ROE and NSG, did not take the first weight in any period.

Table 4. CRITIC Objective Weighting Scores of the Criteria of the Study for each Quarter

	ROE	M-to-B	MVA	CGS/Net Sales	Net Sales Growth	STL/Net Sales
	Max	Max	Max	Min	Max	Min
2020/I	0.136734376	0.16673	0.21558113	0.190405942	0.13453566	0.156013179
2020/II	0.156338687	0.192661	0.172502686	0.151902966	0.127197161	0.199397329
2020/III	0.146712598	0.166601	0.168120613	0.229366496	0.136155534	0.153044135
2020/IV	0.17526787	0.193153	0.160496854	0.146152405	0.16645929	0.158470657
2021/I	0.141993531	0.214141	0.132686782	0.198706382	0.152778191	0.159694592
2021/II	0.151802103	0.164021	0.167825195	0.183601816	0.162931036	0.169818751
2021/III	0.16610194	0.163384	0.140211419	0.17548702	0.15003853	0.204777337
2021/IV	0.150192792	0.185339	0.170358206	0.160270883	0.147062936	0.18677602
2022/I	0.168791409	0.158974	0.13707726	0.152312237	0.147662702	0.235182619
2022/II	0.166849068	0.222556	0.155380804	0.162143039	0.125085257	0.167985921

In this study, which examines the long-term performance of 49 initial public offerings that have taken place during the uncertainty caused by the pandemic, although the MOORA method came first in a year, it didn't take the last place in any year and therefore achieved a sustainable success. In addition, the results produced by this method are statistically strong and significant. Since the ARAS method produced very volatile results, it took the last place among the methods examined. The results produced by the methods in the last quarter examined are shown in Table 5.

Table 5. Final Scores Generated by the Methods for the last Quarter of the Analysis

Alternatives	ARAS	COPRAS	MOORA	ELECTRE III	TOPSIS
BIMAS	0.771798	0.002829	0.070036	6.2068134	0.444756
ARMDA	0.477557	0.016677	0.092709	5.9038776	0.471664
CCOLA	0.30903	-0.0028	0.039472	-3.826655	0.418917
DGATE	-0.38407	-0.01383	0.044922	-5.405725	0.429605
KAREL	0.055023	-0.00949	-0.02568	-19.00127	0.343802
RYSAS	0.388361	0.097121	0.236605	36.300151	0.605583
SELEC	0.246884	0.014503	0.079904	7.8116519	0.451166
VESBE	0.648378	-0.00939	0.040789	-3.086972	0.418901
TAVHL	-0.0812	0.00253	0.018555	-7.232898	0.400468
KOZAL	0.049619	-0.00637	0.001012	-8.342391	0.366221
AKSEN	0.117093	0.017649	0.035675	0.1143218	0.393238
IHGZT	0.095104	-0.00445	0.022858	-2.993025	0.393463
ANELE	0.422349	-0.00872	0.044874	0.3123406	0.426445
CEMAS	0.029603	0.09511	0.069566	6.7796521	0.447326
EKIZ	-1.64577	-0.05737	-0.03208	-14.8166	0.347545
KATMR	0.043844	0.031034	0.062137	0.4717066	0.445711
DESPC	0.721394	-0.00514	0.039308	-4.759908	0.421296
HATEK	0.406662	-0.02327	0.022772	-4.337638	0.404089
LKMNH	0.118794	0.005199	0.020546	-8.389761	0.393892
BRKSN	0.254589	-0.00036	0.057887	5.0146547	0.429908
BLCYT	-0.53715	-0.038	0.016724	-8.877054	0.403903
DAGI	-0.13732	0.157602	0.005601	-6.764615	0.381951
MEPET	1.692666	0.008152	0.066043	3.6112294	0.444686
SAMAT	-0.20524	-0.08699	-0.06592	-12.05318	0.302765
VANGD	-0.73524	0.05807	-0.02522	-22.00959	0.369722
ADESE	0.102437	0.013897	0.004607	-5.365005	0.358791
NIBAS	0.528073	0.151408	0.173333	32.996786	0.538647
SANFM	0.010553	0.593825	0.055449	0.2719064	0.435942
OYLUM	0.479876	0.067932	0.181833	42.07087	0.55905
PRZMA	-0.06116	-0.03435	-0.03191	-10.24817	0.324352
ORGE	0.26713	0.023962	0.111925	14.743083	0.484423
TKNSA	-0.87362	-0.01365	0.031706	-4.065928	0.41332
TGSAS	0.063576	0.007088	-0.0758	-23.72571	0.28784
FLAP	0.172214	0.02263	0.054168	1.4598951	0.424525
ETILR	0.094262	0.001043	-0.00041	-13.02419	0.376992
TMSN	0.370271	0.051095	0.170323	33.06295	0.543351
ROYAL	-0.03249	0.040618	0.040473	-3.654873	0.41877
ODAS	0.012122	0.004552	0.148253	33.852996	0.519356
SAYAS	0.119821	0.013927	0.023198	-6.992865	0.395074
SEKUR	-0.15355	-0.06405	0.020353	-7.43378	0.39393

Table 5 (Cont.). Final Scores Generated by the Methods for the last Quarter of the Analysis

YAYLA	-0.1373	-0.04331	-0.06321	-18.78215	0.28572
SANEL	0.406529	-0.01577	0.054364	2.8413296	0.42672
TMPOL	-0.19782	-0.02409	0.055545	3.3530613	0.431474
RTALB	0.167933	0.016907	0.047899	-1.090664	0.419799
TUCLK	-0.42237	-0.01203	0.04107	-0.005628	0.415018
PSDTC	0.099433	0.003042	0.009702	-10.22506	0.383558
ULUUN	0.650528	0.018752	0.12933	18.506533	0.509469
SENKRN	0.039248	-0.00814	0.001322	-11.82553	0.405799
SEYKM	-0.17822	-0.05559	0.021396	-7.348952	0.405465

In recent studies, the success of the methods is determined by associating the results of the methods with real life outcomes (Yaakob et al., 2016; Zaidan et al., 2017; Kizielewicz et al., 2021). In this study, the relationship of the methods with the share returns, created by the consensus of millions of shareholders, is taken as a proxy for determining the success of a method. In this sense, results are consistent with the existing literature (Baydaş et al., 2022).

According to the Spearman correlation coefficient, the 5 MCDA methods were examined comparatively according to the scores they produced and analyzed on the basis of their relations with stock returns. The relationship between the methods and their stock returns are shown in Table 6, with their p-values. From this perspective, in this period of increased uncertainty and volatility, the MOORA method has achieved the most sustainable success. While TOPSIS method took the second place, ARAS method took the last place. In the realization of this result, it can be said that the use of benefit-based and cost-based criteria together reduced the success of the ARAS method significantly.

Table 6. The Relationship between the Final Scores Produced by Each Method and Share Returns for Each Quarter, in terms of Spearman's Rho

Quarters	ARAS	COPRAS	MOORA	ELECTRE III	TOPSIS
2020/1	59.40%	52.20%	28.20%	16.60%	28.70%
	0.00	*0.00*	*0.05*	*0.25*	*0.04*
2020/2	8.50%	14.60%	42.90%	46.30%	42.60%
	0.56	*0.32*	*0.00*	*0.00*	*0.00*
2020/3	1.30%	30.70%	26.60%	15.30%	13.70%
	0.93	*0.03*	*0.06*	*0.29*	*0.35*
2020/4	35.70%	28.30%	58.80%	46.80%	51.70%
	0.01	*0.05*	*0.00*	*0.00*	*0.00*
2021/1	64.00%	74.00%	63.20%	70.30%	56.00%
	0.00	*0.00*	*0.00*	*0.00*	*0.00*
2021/2	14.70%	7.00%	41.20%	44.60%	36.10%
	0.31	*0.61*	*0.00*	*0.00*	*0.01*
2021/3	52.40%	57.00%	45.10%	33.00%	46.70%
	0.00	*0.00*	*0.00*	*0.02*	*0.00*
2021/4	28.20%	31.00%	28.90%	38.00%	31.80%
	0.05	*0.03*	*0.04*	*0.00*	*0.02*
2022/1	69.30%	62.50%	53.10%	42.60%	60.90%
	0.00	*0.00*	*0.00*	*0.00*	*0.00*
2022/2	35.90%	23.00%	48.40%	53.60%	42.10%
	0.01	*0.11*	*0.00*	*0.00*	*0.00*
Whole Period	36.94%	38.03%	**43.64%**	40.71%	41.03%
	0.19	*0.11*	***0.01***	*0.06*	*0.04*

The application steps of the MOORA method, which produced the most successful and sustainable results in the applied analysis, are summarized below. First of all, just like other methods, the decision matrix given in Table 3 is integrated into the MOORA method. Afterwards, the normalized decision matrix given in Table 7, in which the normalization specific to the MOORA method was performed, was calculated.

Table 7. Finding the Square and Sum of the Square Root of the Alternatives in the MOORA method for the Last Quarter of the Analysis

Alternatives	ROE	M-to-B	MVA	CGS/Net Sales	Net Sales Growth	STL/Net Sales
BIMAS	1.643652589	0.621221712	0.861634013	1.26977E-05	0.023988536	0.214550853
ARMDA	0.211119874	2.235764888	9.65662248	6.11251E-05	0.965820079	0.112450634
CCOLA	2.479178941	0.001655225	0.003548786	0.000104027	0.009539499	0.204552262
DGATE	3.041167627	0.007224481	0.020545336	2.19829E-05	0.426173877	0.125097551
KAREL	0.366337105	0.005640903	0.000247665	0.010074645	0.010397989	0.038598588
RYSAS	24.92562695	0.58202496	626.88448	0.025114555	0.086363163	0.376693712
SELEC	0.433335505	1.314126432	12.90292405	0.000437218	0.068977069	0.230854768
VESBE	1.475050893	0.019147372	0.057929283	1.62939E-05	0.005060252	0.193267292
TAVHL	3.789911924	0.002267263	0.158206813	0.004287361	0.001696194	0.223643285
KOZAL	0.351103935	0.000141517	0.007959011	0.009759395	0.206221844	0.239111275
AKSEN	0.574463998	0.151082565	2.002574411	0.013643381	0.432387914	0.407886558
IHGZT	0.305796866	0.00629559	0.010407272	0.001515391	0.000283101	0.32079709
ANELE	4.039303094	0.252480958	23.2300659	4.77566E-05	0.025681144	0.161122614
CEMAS	0.523883467	0.655118617	6.214902876	0.001411244	0.237048783	0.225542823
EKIZ	10.02518221	0.085788147	0.484405593	2.28229E-06	0.006152547	0.147489017
KATMR	2.976350482	0.000335205	0.00899518	0.00396833	0.010271829	0.230777183
DESPC	2.456404899	0.009897049	0.041229253	1.35086E-05	0.135078911	0.167312826
HATEK	0.440964252	0.229569585	31.92657107	3.94976E-05	0.018388483	0.119519699
LKMNH	0.442431879	0.049313112	0.153792618	0.003912338	0.10206156	0.10649865
BRKSN	0.517566098	0.599338869	2.076823899	0.000200732	0.020790745	0.216704782
BLCYT	1.090133308	0.074367282	0.221900497	1.58563E-05	0.037009769	0.097810665
DAGI	15.41781503	0.001630076	0.105184846	0.001557691	1.022760098	0.330077412
MEPET	7.796318596	0.001918882	0.017726154	2.2129E-06	0.053911835	0.29407675
SAMAT	17.18025798	0.001220307	0.06045184	0.00182491	11.53711929	0.457738313
VANGD	1.607989559	0.034133255	0.139666749	3.99767E-05	0.032783352	0.001180394
ADESE	0.863783783	0.273088879	0.06403716	0.039155478	0.094778395	0.245974974
NIBAS	9.383053512	0.025060319	0.045499308	0.002321032	91.06701934	0.715411174
SANFM	2.701648611	0.001725967	0.011340593	0.001148184	0.003241217	0.276055103
OYLUM	0.002753804	0.909582259	1934.617449	0.000275266	0.03611781	0.317104476
PRZMA	0.663211072	0.026177448	0.131355919	0.0125373	2.32549345	0.411621652
ORGE	1.864947517	3.211112209	47.73572627	0.000809198	0.202623283	0.266963964
TKNSA	1.624593291	0.093632067	0.011784391	6.23455E-06	0.02486716	0.231814948
TGSAS	1.198248473	0.00398022	0.003598519	0.178504266	0.002500003	0.253015069
FLAP	5.758031391	0.232514055	4.039048632	0.007795538	0.003936242	0.245011675
ETILR	1.127089287	0.031302708	0.008352672	0.007063998	0.00354795	0.083983154
TMSN	2.100763443	8.142655097	63.44399604	0.000660033	0.212866889	0.408489157
ROYAL	1.468311122	0.511779419	5.65502971	0.001242441	0.030934432	0.104937853
ODAS	1.170204558	12.52062581	38.16358978	0.000143218	0.037767815	0.239979824
SAYAS	0.414808772	0.009232777	0.00959314	0.004585915	1.296184541	0.207487253
SEKUR	2.159086879	0.077758067	1.963666096	0.000274142	0.03628169	0.197658535
YAYLA	42.34021137	0.5486641	7.636997634	0.018537377	0.007485108	0.165711128
SANEL	0.484929237	1.855355121	1.222596825	4.51344E-05	0.197454406	0.149975847
TMPOL	0.612820496	0.445295007	1.123886628	7.03164E-05	0.120393218	0.181732167
RTALB	1.196832529	0.010897887	0.168663158	0.001473547	1.146939539	0.29159258
TUCLK	0.320879354	0.000267372	0.012084718	2.44442E-05	0.042877912	0.337831624
PSDTC	1.66289013	0.001890295	0.01156532	0.007794055	0.01286006	0.120376682
ULUUN	0.197686564	5.370968362	104.216753	2.81615E-05	0.094070857	0.146472387
SENKRN	0.390079956	0.148394393	0.220855454	0.004849526	1.571657304	0.007437714
SEYKM	0.437346804	0.018159616	0.005663359	0.000114753	0.039441671	0.120484123
r	***13.57407673***	***6.435201917***	***54.10888956***	***0.606254043***	***10.68116605***	***3.3121712***

Sum of the square roots of the alternatives are calculated and shown as *r* in the Table above. At the last stage, the values in the decision matrix were divided by the *r* values calculated in the table above. Ultimately, the benefit-based criteria were multiplied by their weights given in Table 4 and added, and the cost-based criteria were multiplied by their weights and subtracted. Financial performance rankings showing the final scores of the method were thus obtained. The relevant final step is shown in Table 8 given below.

Table 8. The Final Step and Rankings for the MOORA Method in the Last Quarter of the Analysis

Alternatives	ROE	M-to-B	MVA	CGS/Net Sales	Net Sales Growth	STL/Net Sales	Scores	Rank
BIMAS	0.094448424	0.12247886	0.017155082	0.005877702	0.014500508	-0.13984674	0.070036	10
ARMDA	0.033849656	0.232354393	0.057430686	0.012896006	0.092008817	-0.10124374	0.092709	8
CCOLA	0.115996167	-0.006322172	0.001100959	0.016823564	0.009144166	-0.136549265	0.039472	25
DGATE	0.128472413	-0.013208125	-0.002649037	-0.00773371	0.06111879	-0.106785338	0.044922	20
KAREL	-0.044589249	-0.011671109	0.000290846	0.165561834	0.00954676	-0.059316147	-0.02568	44
RYSAS	0.367800864	0.118551929	0.462727316	-0.261401511	0.027513485	-0.185302556	0.236605	1
SELEC	0.048495544	0.178137928	0.066385839	0.034490092	0.024588594	-0.145062998	0.079904	9
VESBE	0.089473248	0.021502671	0.004448161	0.006658208	-0.006659895	-0.132729178	0.040789	23
TAVHL	-0.143418197	0.007399269	-0.007350958	-0.108004136	0.003855841	-0.142779269	0.018555	35
KOZAL	0.043652342	0.001848598	0.001648773	0.162950914	-0.042515635	-0.147634294	0.001012	41
AKSEN	0.055836876	0.060401121	0.026153253	0.192666565	0.061562763	-0.192822149	0.035675	27
IHGZT	0.040738611	-0.0123298	0.001885384	0.064210736	0.001575259	-0.17100249	0.022858	30
ANELE	0.148061765	0.078082217	-0.089075158	0.01139888	-0.01500336	-0.121189634	0.044874	21
CEMAS	0.053322076	0.125776004	-0.046073219	-0.061965002	0.045582716	-0.143384343	0.069566	11
EKIZ	-0.233257619	-0.045514677	-0.012862813	-0.0024919	-0.007343597	-0.115949015	-0.03208	46
KATMR	0.127095957	0.00284507	0.001752816	-0.103908058	-0.009488667	-0.145038619	0.062137	13
DESPC	0.11546216	-0.01545933	-0.003752616	0.006062483	0.034409242	-0.123495701	0.039308	26
HATEK	0.048920557	0.074455193	-0.104425729	0.01036647	-0.012695631	-0.104377519	0.022772	31
LKMNH	0.049001899	0.034507939	0.007247682	0.103172403	0.029909726	-0.098527911	0.020546	33
BRKSN	0.052999602	0.120302331	0.026633682	0.023369703	-0.013499459	-0.140546965	0.057887	14
BLCYT	0.076918269	-0.04237686	-0.008705837	-0.006568203	-0.01801107	-0.094423551	0.016724	36
DAGI	-0.289268481	0.00627396	0.005993879	-0.065100756	0.094682174	-0.173458316	0.005601	38
MEPET	0.205700094	0.006807097	0.002460587	0.002453726	0.021738191	-0.163725969	0.066043	12
SAMAT	-0.305354652	0.005428407	0.004543977	0.070463802	-0.318002127	-0.204265892	-0.06592	48
VANGD	-0.093418161	-0.028709569	-0.006906816	-0.010429147	-0.016951495	0.010372912	-0.02522	43
ADESE	0.068468722	0.08120632	-0.004676785	0.326393588	0.028822789	-0.149738227	0.004607	39
NIBAS	0.225663748	-0.024599774	-0.003942156	0.079466843	0.893432804	-0.255367181	0.173333	3
SANFM	0.121088843	-0.006455859	0.00196811	-0.055892174	0.0053301	-0.158629923	0.055449	16
OYLUM	0.00386595	0.14820362	0.812884662	0.027366628	-0.017792708	-0.170015458	0.181833	2
PRZMA	-0.059995073	-0.025142096	-0.006698171	0.184691694	-0.142770636	-0.193702992	-0.03191	45
ORGE	0.100605797	0.278461759	0.1276889	0.046921593	-0.042143054	-0.155996029	0.111925	7
TKNSA	0.093899229	-0.047549957	-0.00200625	-0.004118583	0.014763673	-0.14536436	0.031706	28
TGSAS	0.080642344	-0.009803731	-0.001108647	0.696898697	0.00468114	-0.151865952	-0.0758	49
FLAP	0.176777389	0.074931155	0.037142482	0.145635881	0.005873841	-0.149444733	0.054168	18
ETILR	0.078211184	-0.027493421	-0.001689056	0.138634277	0.005576608	-0.087495016	-0.00041	42
TMSN	0.106777138	0.443425681	0.147206384	0.042376789	0.04319519	-0.192964532	0.170323	4
ROYAL	-0.089268604	0.111167856	0.043948982	-0.058141107	-0.016466542	-0.097803255	0.040473	24
ODAS	0.079693077	0.54985837	-0.114171048	-0.019739872	0.01819459	-0.147902184	0.148253	5
SAYAS	0.047447536	-0.014931519	0.001810138	0.11170133	0.10658958	-0.137525405	0.023198	29
SEKUR	-0.108249216	0.043332181	0.025897939	-0.027310698	-0.017833028	-0.134228584	0.020353	34
YAYLA	-0.479364878	0.11510418	0.051073157	0.224579181	-0.008099913	-0.122903163	-0.06321	47
SANEL	-0.051301361	0.211666118	0.020434923	0.011081522	-0.041602052	-0.116922444	0.054364	17
TMPOL	0.057670849	0.103695936	0.019592625	-0.013831641	-0.032484961	-0.128707284	0.055545	15
RTALB	0.080594683	0.016222171	0.007589995	0.063318028	0.100265517	-0.163032977	0.047899	19
TUCLK	0.041731173	0.002540947	0.002031653	-0.008155174	0.019386444	-0.175483939	0.04107	22
PSDTC	0.094999535	0.006756202	-0.001987514	0.145622031	-0.010617025	-0.104751055	0.009702	37
ULUUN	0.032755051	0.360133995	0.188668826	0.008753333	-0.028715004	-0.11554871	0.12933	6
SENKRN	0.046011513	-0.059861358	-0.008685312	-0.114866922	-0.117370853	-0.026037961	0.001322	40
SEYKM	0.048719484	-0.020940698	-0.001390812	-0.017669608	-0.018593407	-0.104797792	0.021396	32

Each MCDA method has a different mathematical background and is used to find the most suitable alternative within its own setup. In this sense, it is natural that methods applying different normalization techniques and aggregation methods produced different sorting results. In addition, negative values were replaced with positive ones during the normalization process. Thus, a homogeneous evaluation was achieved between all methods. As a result, negative values had no effect on the results. The crucial point here is that the most appropriate method for a particular complex problem should be chosen by the decision makers. The success of MCDA methods has been compared based on the stock movements realized by millions of investors in Turkey, which is created by an unnamed consensus. Comparative results of the methods are shown in Figure 2 below.

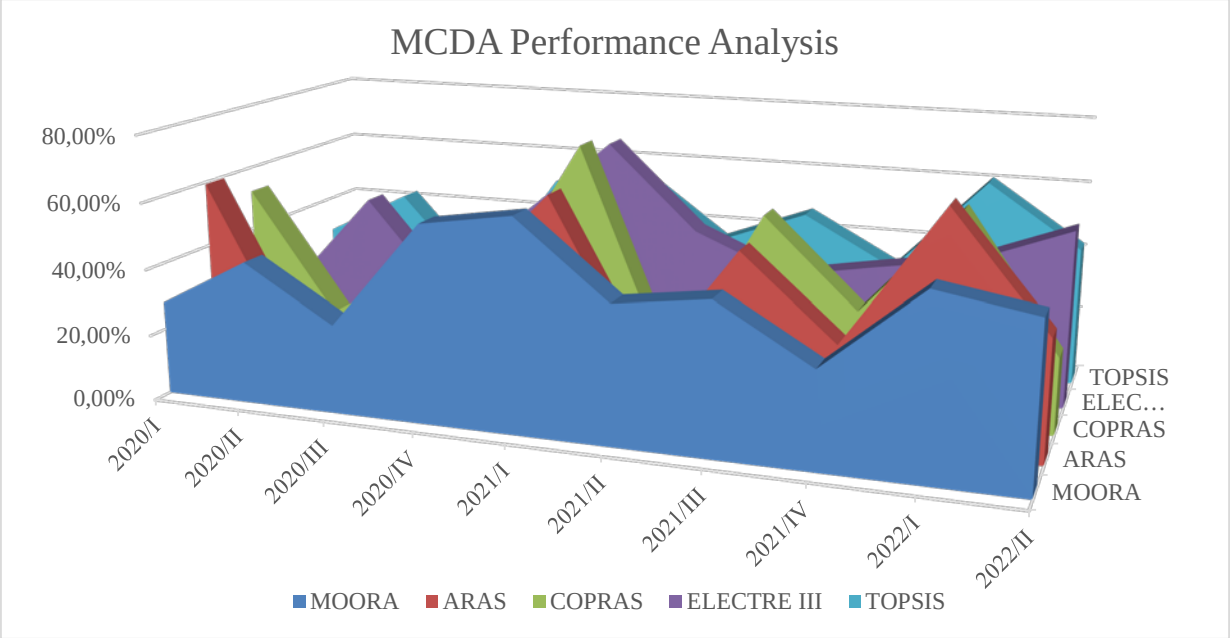

Figure 2. Line chart showing the rankings of analyzed 5 MCDA methods based on their relationship with stock returns over a given period

The results obtained in this study, in which the long-term financial performance analysis of initial public offerings is made in the pandemic period, are in line with the previous MCDA studies on capital markets (Baydaş and Elma, 2021; Baydaş et al., 2022).

The ranking order of the ELECTRE III, ARAS, MOORA, TOPSIS, COPRAS methods is from largest to smallest. Thus, the company with the highest score proves to be a top performer, while the company with the lowest score becomes a bottom performer. According to this criterion, rankings were made in the descending order, the alternative with the highest score was shown as top performer, and the company with the lowest score was shown as bottom performer, in Table 9 below.

Table 9. Top and Bottom Performer Companies for the MCDA Methods Analyzed for any given Quarter

Quarters	IPO Firm Performance	MOORA	ARAS	COPRAS	ELECTRE III	TOPSIS	Overall
2020/1	Top Performer	DGATE	RYSAS	BRKSN	DGATE	DGATE	DGATE
	Bottom Performer	TMSN	ROYAL	OYLUM	TMSN	TMSN	TMSN
2020/2	Top Performer	SNKRN	EKIZ	VESBE	SNKRN	SNKRN	SNKRN
	Bottom Performer	ROYAL	ANELE	VANGD	ROYAL	ROYAL	ROYAL
2020/3	Top Performer	*VANGD*	ULUUN	KAREL	KAREL	KAREL	*KAREL*
	Bottom Performer	PRZMA	EKIZ	TKNSA	PRZMA	PRZMA	PRZMA
2020/4	Top Performer	TKNSA	SNKRN	RYSAS	TKNSA	TKNSA	TKNSA
	Bottom Performer	VANGD	HATEK	SELEC	VANGD	VANGD	VANGD
2021/1	Top Performer	VANGD	DESPC	TMSN	VANGD	VANGD	VANGD
	Bottom Performer	EKIZ	IHGZT	NIBAS	EKIZ	EKIZ	EKIZ
2021/2	Top Performer	IHGZT	KATMR	MEPET	IHGZT	IHGZT	IHGZT
	Bottom Performer	PSDTC	HATEK	HATEK	VANGD	PSDTC	PSDTC
2021/3	Top Performer	OYLUM	DAGI	TKNSA	ETILR	OYLUM	OYLUM
	Bottom Performer	TGSAS	IHGZT	OYLUM	TGSAS	TGSAS	TGSAS
2021/4	Top Performer	ETILR	ARMDA	BLCYT	ETILR	ETILR	ETILR
	Bottom Performer	ROYAL	ROYAL	PSDTC	ODAS	ROYAL	ROYAL
2022/1	Top Performer	AKSEN	SAMAT	EKIZ	AKSEN	ETILR	AKSEN
	Bottom Performer	TGSAS	ANELE	SAMAT	TGSAS	TGSAS	TGSAS
2022/2	Top Performer	RYSAS	MEPET	SANFM	OYLUM	RYSAS	RYSAS
	Bottom Performer	TGSAS	EKIZ	SAMAT	TGSAS	YAYLA	TGSAS

In Table 9, the companies with the most and least successful financial performance are listed for each quarter and MCDA method. When the results are examined, it is seen that the companies whose success is mostly approved by all methods are also detected in the MOORA method in all periods, except for one period. This statistically significant success has not been observed in other analyzed methods. Other models that give similar results, though not identical to the MOORA method, are the ELECTRE III and TOPSIS. Because of the mathematical background and normalization differences, ARAS and COPRAS methods generally determined different companies as successful or less successful.

5. Discussion

In modern markets, the ultimate goal of a company is to create sustainable shareholder value. In this way, the firm will always be desired by the investors, and the company will hold on to a higher market value as the increasing demand raises the share prices. To explain this situation, a new term entered our lives on August 2, 2018: the trillion-dollar company. Apple was the first company to cross the trillion-dollar psychological threshold in terms of market capitalization on this very date. But the shareholder value creation function does not end at the top. Because Alphabet, Amazon, Tesla and Meta companies, although they had the chance to cross this psychological threshold once, could not hold on. For this reason, keeping shareholder value alive is vital for companies.

The change and development of various decision-making techniques over time has undoubtedly added new dimensions to the decision makers' toolbox of solving financial problems. MCDA techniques are used in complex scenarios with more than one criterion. Investment preferences of investors in capital markets with their hard-earned money brings thousands of combinations. From this perspective, the need to use MCDA analyzes has also increased in processes that are carefully followed by investors, such as portfolio diversification or IPO investments. To the best of authors' knowledge, there is no study in the literature that examines the long-term performance of initial public offerings with a comparative MCDA analysis framework.

While accounting-based ratios are generally used in financial performance analyses, valuation-based ratios also find their place in modern studies. Valuation-based ratios, which are in line with the shareholder value approach mentioned above, are more focused on the future cash flows of the firm, on the other hand accounting-based ratios are based on historical data. In this study, a total of 6 ratios, both accounting and valuation-based, were used as criteria in order to draw a more comprehensive approach.

Especially in the process of increasing uncertainty affecting the capital markets such as the COVID-19 period, the long-term performance of the IPOs that took place before the pandemic was analyzed through 5 MCDA methods at this intensive study. In the study, weightings were computed with CRITIC. The results showed that MOORA, a member of the European school methods, was in fact more suitable for financial decision-makers, in terms of its capacity. MOORA is a method that stands out with its ease of use, simplicity in mathematical background, effectiveness in numerical analysis, and sensitivity to cost and benefit-based criteria. In this study, in which 49 IPOs on Borsa Istanbul were examined, MOORA showed its effectiveness compared to the other analyzed 4 methods.

6. Managerial Implications

The initial public offering is a process experienced by companies that have just entered the capital markets. From this point of view, it is very important to increase the number of new companies, as well as increasing the number of shareholders who trust and invest in the markets, in order for the

financial markets to function properly. In initial public offerings, underpricing and valuation are the most researched topics. On the other hand, there is next to none MCDM analysis in the literature about IPOs, where uncertainty is intense. However, IPOs are of interest to creditors, legislators, partners and potential shareholders. All these financial decision makers can benefit from MCDA analyzes as a decision support system in their evaluations regarding the performance of the initial public offering. For this purpose, in this study, a comprehensive and comparative analysis of the long-term performance of initial public offerings has been implemented for the first time. In terms of the results it produces, it has been revealed that the long-term performance of the IPOs is calculated more suitable with the MOORA method. In future studies, a wider-research can be done by adding more complex and different methods to the comparative analysis. In this sense, this study sets an example for future studies on the performance of the initial public offering. Besides, the subject of this study is not on different normalization techniques. It is about the final results obtained in the original form of the methods to guide the financial decision makers, in a practical fashion. In a future study, different normalization techniques can be applied on various methods, and the capacity of various normalization techniques can be investigated in terms of their suitability for financial performance analysis.

7. Conclusion

MCDA methods produce different results depending on the normalization techniques they use, the addition methodologies they apply, and whether they are simple or complex in terms of their mathematical background. There is an MCDA model that can model some crucial problem and meet the needs of different types of decision makers. However, this abundance creates a paradox in itself and brings another bigger issue of choosing the right MCDA method for the right problem. For this purpose, comparative MCDA analyzes were conducted to determine the most appropriate method in order to meet the modern needs of financial decision makers in a sensitive and volatile area such as the long-term performance of initial public offerings. Over the analyzed period of 10 quarters, MOORA method has been recommended to financial decision makers due to its sustainable success in producing strong and meaningful relationship with stock returns, in terms of Spearman's Rho. Although TOPSIS and ELECTRE III shared second and third places close by, the statistical power and significance of MOORA dramatically outrun these aforementioned methods.

These results are important in terms of the insights they reveal. At this study, without fine-tuning the mathematical background of the methods as in for normalization or rank reversal, the methods were taken in their original form and the success and capacity of the methods were determined according to the relationship of method scores with stock returns. For shareholders, practicality and speed are paramount when it comes to initial public offerings investments. For this purpose, this study searched an answer to the question of which method is more capable in terms of IPOs when taking the practical, user-friendly and previously used methods on financial performance as they are.

In future studies, a more comprehensive IPO picture can be taken by increasing the number of methods. In addition, by conducting studies on initial public offerings in developed country markets, financial reactions in markets with different efficiency levels can be observed more clearly.

8. Limitations of the Study

Developing countries are known to react more quickly to crises. To illustrate, during the period when COVID-19 cases first started to be seen in Europe and North America and the capital markets depreciated seriously, while full recovery took 6 months for the USA markets, this situation took only 4.5 months for Borsa Istanbul. This study analyzed IPOs in Borsa Istanbul, an emerging capital market, although it has its advantages, it is also a limitation. Examining the initial public offerings in

developed and emerging capital markets together, rather than in a single capital market, may reveal different characteristics related to the long-term performance of initial public offerings. In addition, although much more methods were used in this study compared to the studies in the literature, the findings of this study are limited to these methods. In future analyzes, the number of methods can be increased and more decisive results can be obtained.

References

Abdi, Y., Li, X., and Càmara-Turull, X. (2022). Exploring the impact of sustainability (ESG) disclosure on firm value and financial performance (FP) in airline industry: the moderating role of size and age. *Environment, Development and Sustainability*, *24*(4), 5052-5079.

Ahmad, W., Ahmed, T. and Shabbir, G. (2015). Determinants of textile firms' profitability in Pakistan. *Forman Journal of Economic Studies*, *11*(1), 87-101.

Al-Homaidi, E. A., Tabash, M. I., Farhan, N. H., and Almaqtari, F. A. (2018). Bank-specific and macro-economic determinants of profitability of Indian commercial banks: A panel data approach. *Cogent Economics & Finance*, *6*(1): 1548072.

Artikis, P. G. (2008). Wealth Added Financial Management Research. *Mibes E-book*.

Ashayeri, J. and Rongen, J. M. (1997). Central distribution in Europe: A multi-criteria approach to location selection. *The International Journal of Logistics Management*, *8*(1), 97-109.

Augusto, M., Lisboa, J., Yasin, M., and Figueira, J. R. (2008). Benchmarking in a multiple criteria performance context: An application and a conceptual framework. *European Journal of Operational Research, 184*(1), 244-254.

Azimi, F. A., Jalali, A. A., and Farahi, A. (2012). Comparison of multiple criterion decision making methods for evaluation Parsian banks e-readiness for ECRM implementation. *Australian Journal of Basic and Applied Sciences*, *6*(9), 251-263.

Balezentis, A., and Balezentis, T. (2011a). Framework of strategic management model for strategy Europe 2020: Diachronic analysis and proposed guidelines. *Inžinerinė ekonomika-Engineering Economics, 22*(3), 271–282.

Balezentis, A., Valkauskas, R., and Balezentis, T. (2010). Evaluating situation of Lithuania in the European Union: structural indicators and MULTIMOORA method. *Technological and Economic Development of Economy, 16*(4), 578–602.

Balezentis, T. and Streimikiene, D. (2017). Multi-criteria ranking of energy generation scenarios with Monte Carlo simulation. *Applied Energy, 185*, 862-871. https://doi.org/10.1016/j.apenergy.2016.10.085.

Balezentis, T., and Balezentis, A. (2011b). A multi-criteria assessment of relative farming efficiency in the European Union Member States. *Žemės ūkio mokslai, 18*(3), 125–135.

Baydaş, M., and Elma, O. E. (2021). An objective criteria proposal for the comparison of MCDM and weighting methods in financial performance measurement: An application in Borsa Istanbul. *Decision Making: Applications in Management and Engineering, 4*(2), 257–279. https://doi.org/10.31181/dmame210402257b

Baydaş, M., Elma, O. E., and Pamučar, D. (2022). Exploring the specific capacity of different multi criteria decision making approaches under uncertainty using data from financial markets. *Expert Systems with Applications, 197*, 116755. https://doi.org/10.1016/j.eswa.2022.116755

Brauers, W. K. M. (2012). Project management for a country with multiple objectives. *Czech Economic Review, 6*(1), 80–101.

Brauers, W. K. M. (2013). Multi-objective seaport planning by MOORA decision making. *Annals of Operations Research, 206*(1), 39-58.

Brauers, W. K. M. and Zavadskas, E. K. (2010). Project management by MULTIMOORA as an instrument for transition economies. *Technological and economic development of economy, 16*(1), 5-24.

Brauers, W. K. M., and Zavadskas, E. K. (2012). Robustness of MULTIMOORA: A method for multi-objective optimization. *Informatica, 23*(1), 1–25.

Brauers, W. K. M., Zavadskas, E. K., Peldschus, F., and Turskis, Z. (2008). Multi-objective decision-making for road design. *Transport*, *23*(3), 183-193.

Brauers, W.K.M. (2004). Optimization methods for a stakeholder society, a revolution in economic thinking by multi-objective optimization. Boston: Kluwer Academic Publishers.

Bülbül, S., and Köse, A. (2011). Türk Gıda Şirketlerinin Finansal Performansının Çok Amaçlı Karar Verme Yöntemleriyle Değerlendirilmesi. *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi*, *25*, 71-97.

Chatterjee, P., and Chakraborty, S. (2012). Material selection using preferential ranking methods. *Materials & Design, 35*, 384–393.

Cho, S. J., Chung, C. Y., and Young, J. (2019). Study on the Relationship between CSR and Financial Performance. *Sustainability*, *11*(2), 343.

Conkar, K., Elitas, C., and Atar, G. (2011). İMKB Kurumsal Yönetim Endeksi'ndeki (XKURY) Firmaların Finansal Performanslarının TOPSIS Yöntemi ile Ölçümü ve Kurumsal Yönetim Notu ile Analizi. *İstanbul Üniversitesi İktisat Fakültesi Mecmuası*, *61*(1), 81-115.

Dahooie, J. H., Abadi, E. B. J., Vanaki, A. S. and Firoozfar, H. R. (2018). Competency-based IT personnel selection using a hybrid SWARA and ARAS-G methodology. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *28*(1), 5-16. https://doi.org/10.1002/hfm.20713.

Dahooie, J. H., Zavadskas, E. K., Vanaki, A. S., Firoozfar, H. R., Lari, M. and Turskis, Z. (2019). A new evaluation model for corporate financial performance using integrated CCSD and FCM-ARAS approach. *Economic Research-Ekonomska Istrazivanja*, *32*(1), 1088-1113. https://doi.org/10.1080/1331677X.2019.1613250.

Ecer, Fatih (2019). A Multi-criteria Approach Towards Assessing Corporate Sustainability Performances of Privately-owned Banks: Entropy-ARAS Integrated Model. *Eskisehir Osmangazi Universitesi Iibf Dergisi-Eskisehir Osmangazi University Journal Of Economics And Administrative Sciences*, *14*(2), 365-390. https://doi.org/10.17153/oguiibf.470336.

Elking, I., Paraskevas, J. P., Grimm, C., Corsi, T. and Steven, A. (2017). Financial dependence, lean inventory strategy, and firm performance. *Journal of Supply Chain Management*, *53*(2), 22-38.

Ergül, N. (2014). BİST-Turizm sektöründeki şirketlerin finansal performans analizi. *Çankırı Karatekin Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, *4*(1), 325-340.

Ganda, F. (2018). The effect of carbon performance on corporate financial performance in a growing economy. *Social Responsibility Journal*, *14*(4), 895-916.

Ghadikolaei, A. S. and Esbouei, S. K. (2014). Integrating FAHP and Fuzzy ARAS for evaluating financial performance. *Boletim Sociedade Paranaense De Matematica*, *32*(2), 163-174. https://doi.org/10.5269/bspm.v32i2.21.378.

Ghadikolaei, A. S., Esbouei, S. K. and Antucheviciene, J. (2014). Applying Fuzzy MCDM For Financial Performance Evaluation of Iranian Companies. *Technological and Economic Development of Economy*, *20*(2), 274-291. https://doi.org/10.3846/20294913.2014.913274.

Ghenai, C., Albawab, M. and Bettayeb, M. (2020). Sustainability indicators for renewable energy systems using multi-criteria decision-making model and extended SWARA/ARAS hybrid method. *Renewable Energy*, *146*, 580-597. https://doi.org/10.1016/j.renene.2019.06.157.

Halkos, G.E. and Tzeremes, N.G. (2002). Industry performance evaluation with the use of financial ratios: An application of bootstrapped DEA. Expert System with Applications, *39*, 5872–5880.

Jahanshahloo, G. R., Lotfi, F. H. and Izadikhah, M. (2006). An algorithmic method to extend TOPSIS for decision-making problems with interval data. *Applied mathematics and computation*, *175*(2), 1375-1384.

Jana, T. K., Bairagi, B., Paul, S., Sarkar, B., and Saha, J. (2013). Dynamic schedule execution in an agent based holonic manufacturing system. *Journal of Manufacturing Systems, 32*(4), 801–816.

Kaklauskas, A., Zavadskas, E. K., Raslanas, S., Ginevicius, R., Komka, A., and Malinauskas, P. (2006). Selection of low-e windows in retrofit of public buildings by applying multiple criteria method COPRAS: A Lithuanian case. *Energy and Buildings, 38*(5), 454–462.

Kalakkar, S. (2012). Key factors in determining the financial performance of the Indian banking sector. *Available at SSRN 2121351*.

Karabasevic, D., Zavadskas, E. K., Turskis, Z. and Stanujkic, D. (2016). The Framework for the Selection of Personnel Based on the SWARA and ARAS Methods Under Uncertainties. *Informatica*, *27*(1), 49-65. https://doi.org/10.15388/Informatica.2016.76.

Kersuliene, V. and Turskis, Z. (2011). Integrated Fuzzy Multiple-Criteria Decision-Making Model for Architect Selection. *Technological and Economic Development of Economy*, *17*(4), 645-666. https://doi.org/10.3846/20294913.2011.635718.

Kizielewicz, B., Shekhovtsov, A., Sałabun, W., and Piegat, A. (2021). *Decision-Making Problems with Local Extremes: Comparative Study Case*. Poster session presentation at the meeting of International Conference on Artificial Intelligence and Soft Computing, Zakopane, Poland.

Kumaran, S. (2022). Financial performance index of IPO firms using VIKOR-CRITIC techniques. *Finance Research Letters, 47*, 102542.

Kumaraswamy, M., and Ramaswamy, R. (2016). Performance evaluation of software projects using criteria importance through inter–criteria correlation technique. *International Journal of Soft Computing and Software Engineering*, *6*(3), 28-36.

Lee, K. H., Cin, B. C., and Lee, E. Y. (2016). Environmental responsibility and firm performance: The application of an environmental, social and governance model. *Business Strategy and the Environment*, *25*(1), 40-53.

Li, H., Adeli, H., Sun, J. and Han, J. G. (2011). Hybridizing principles of TOPSIS with case-based reasoning for business failure prediction. *Computers & Operations Research*, *38*(2), 409-419.

Makan, L. T. and Kabra, K. C. (2021). Carbon Emission Reduction and Financial Performance in an Emerging Market: Empirical Study of Indian Firms. *Indonesian Journal of Sustainability Accounting and Management*, *5*(1), 23-32.

Matic, B., Jovanovic, S. D., Dillip K., Zavadskas, E. K., Stevic, Z., Sremac, S. and Marinkovic, M. (2019). A New Hybrid MCDM Model: Sustainable Supplier Selection in a Construction Company. *Symmetry-Basel*, *11*(3), 353. https://doi.org/10.3390/sym11030353.

Medineckiene, M., Zavadskas, E. K., Bjork, F., and Turskis, Z. (2015). Multi-criteria decision-making system for sustainable building assessment/certification. *Archives Of Civil And Mechanical Engineering*, *15*(1), 11-18. https://doi.org/10.1016/j.acme.2014.09.001.

Miralles-Quiros, M. M., Miralles-Quiros, J. L., and Valente Gonçalves, L. M. (2018). The value relevance of environmental, social, and governance performance: The Brazilian case. *Sustainability*, *10*(3), 574.

Miroshnychenko, I., Barontini, R., and Testa, F. (2017). Green practices and financial performance: A global outlook. *Journal of Cleaner Production*, *147*, 340-351.

Naz, F., Ijaz, F., and Naqvi, F. (2016). Financial performance of firms: evidence from Pakistan cement industry. *Journal of Teaching and Education*, *5*(01), 81-94.

Oliveira, R. M., Chaves, A. A., and Lorena, L. A. N. (2017). A comparison of two hybrid methods for constrained clustering problems. *Applied Soft Computing*, *54*, 256-266.

Ortiz-de-Mandojana, N., and Bansal, P. (2016). The long-term benefits of organizational resilience through sustainable business practices. *Strategic Management Journal*, *37*(8), 1615-1631.

Petrovic, G., Mihajlovic, J., Cojbasic, Z., Madic, M. and Marinkovic, D. (2019). Comparison Of Three Fuzzy MCDM Methods For Solving The Supplier Selection Problem. *Facta Universitatis-Series Mechanical Engineering*, *17*(3), 455-469. https://doi.org/10.22190/FUME190420039P.

Popovic, G., Stanujkic, D., and Stojanovic, S. (2012). Investment project selection by applying copras method and imprecise data. *Serbian Journal of Management*, *7*(2), 257–269.

Qiu, Y., Shaukat, A., and Tharyan, R. (2016). Environmental and social disclosures: Link with corporate financial performance. *The British Accounting Review, 48*(1), 102-116.

Rabbani, A., Zamani, M., Yazdani-Chamzini, A., and Zavadskas, E. K. (2014). Proposing a new integrated model based on sustainability balanced scorecard (SBSC) and MCDM approaches by using linguistic variables for the performance evaluation of oil producing companies. *Expert Systems with Applications, 41*(16), 7316–7327.

Rao, S. H., Kalvakolanu, S. and Chakraborty, C. (2021). Integration of ARAS and MOORA MCDM Techniques for Measuring the Performance of Private Sector Banks in India. *International Journal of Uncertainty Fuzziness and Knowledge-Based Systems, 29*, 279-295. https://doi.org/10.1142/S0218488521400158.

Reddy, N. R., Rajesh, M., and Reddy, T. N. (2011). Valuation through EVA and traditional measures an empirical study. *International Journal of Trade, Economics and Finance, 2*(1), 19.

Roy, B. (1990). The outranking approach and the foundations of ELECTRE methods. In *Readings in multiple criteria decision aid*, 155-183. Springer: Berlin, Heidelberg.

Saeed, R. B. A., and Badar, R. (2013). Impact of capital structure on performance empirical evidence from sugar sector of Pakistan. *European Journal of Business and Management, 5*(5), 78-86.

Seçme, N. Y., Bayrakdaroğlu, A., and Kahraman, C. (2009). Fuzzy performance evaluation in Turkish banking sector using analytic hierarchy process and TOPSIS. *Expert systems with applications, 36*(9), 11699-11709. https://doi.org/10.1016/j.eswa.2009.03.013

Soba, M., Akcanli, F., and Erem, I. (2012). İMKB'ye kayıtlı seçilmiş işletmelere yönelik etkinlik ölçümü ve performans değerlendirmesi: Veri zarflama analizi ve TOPSIS uygulaması. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, (27), 229-243.

Stankeviciene, J., and Sviderske, T. (2012). Country risk assessment based on MULTIMOORA. In The 7th international scientific conference Business and Management, 530–536.

Tan, C. (2011). A multi-criteria interval-valued intuitionistic fuzzy group decision making with Choquet integral-based TOPSIS. *Expert Systems with Applications, 38*(4), 3023-3033.

Topaloğlu, E. E. (2014). Finansal Krizlerin BIST Metal Eşya, Makina Endeksi'nde Faaliyet Gösteren Firmaların Finansal Performanslarına Etkisinin TOPSIS Yöntemi ile Ölçülmesi. *Yönetim ve Ekonomi Araştırmaları Dergisi, 12*(22), 286-305. https://doi.org/10.11611/JMER230.

Turskis, Z. and Zavadskas, E. K. (2010). A New Fuzzy Additive Ratio Assessment Method (ARAS-F). Case Study: The Analysis of Fuzzy Multiple Criteria in Order to Select the Logistic Centers Location. *Transport, 25*(4), 423-432. https://doi.org/10.3846/transport.2010.52.

Uzsilaityte, L., and Martinaitis, V. (2010). Search for optimal solution of public building renovation in terms of life cycle. *Journal of Environmental Engineering and Landscape Management, 18*(2), 102–110.

Visalakshmi, S., Lakshmi, P., Shama, M. S. and Vijayakumar, K. (2015). An integrated fuzzy DEMATEL-TOPSIS approach for financial performance evaluation of GREENEX industries. *International Journal of Operational Research, 23*(3), 340-362.

Wang, J. (2008). Applying FMCDM to evaluate financial performance of domestic airlines in Taiwan. *Expert Systems with Applications, 34*(3), 1837-1845. https://doi.org/10.1016/j.eswa.2007.02.029.

Wang, Z. and Rangaiah, G. P. (2017). Application and analysis of methods for selecting an optimal solution from the Pareto-Optimal front obtained by multi-objective optimization. *Industrial & Engineering Chemistry Research, 56*, 560–574. https://doi.org/10.1021/acs.iecr.6b03453.

Wu, M. C. and Chen, T. Y. (2011). The ELECTRE multicriteria analysis approach based on Atanassov's intuitionistic fuzzy sets. *Expert Systems with Applications, 38*(10), 12318-12327.

Xie, J., Nozawa, W., Yagi, M., Fujii, H., and Managi, S. (2019). Do environmental, social, and governance activities improve corporate financial performance?. *Business Strategy and the Environment, 28*(2), 286-300.

Yaakob, A. M., and Gegov, A. (2016). Interactive TOPSIS based group decision making methodology using Z-Numbers. *International Journal of Computational Intelligence Systems*, *9*(2), 311–324. https://doi.org/10.1080/18756891.2016.1150003.

Yalçın, N. and Ünlü, U. (2018). A multi-criteria performance analysis of Initial Public Offering (IPO) firms using CRITIC and VIKOR methods. *Technological and Economic development of Economy*, *24*(2), 534-560.

Yayar, R., and Baykara, H. V. (2012). An Implementation upon Efficiency and Productivity of Participation Banks with TOPSIS Method. *Business and Economics Research Journal*, *3*(4), 21.

Zaidan, B. B., Zaidan, A. A., Abdul Karim, H., and Ahmad, N. N. (2017). A new approach based on multi-dimensional evaluation and benchmarking for data hiding techniques. *International Journal of Information Technology & Decision Making*, *16*, 1–42. https://doi.org/10.1142/S0219622017500183.

Zamani, L., Beegam, R. and Borzoian, S. (2014). Portfolio selection using Data Envelopment Analysis (DEA): A case of select Indian investment companies. *International Journal of Current Research and Academic Review*, *2*(4), 50-55.

Zavadskas, E. K. and Turskis, Z. (2010). A New Additive Ratio Assessment (ARAS) Method In Multicriteria Decision-Making. *Technological and Economic Development of Economy*, *16*(2), 159-172. https://doi.org/10.3846/tede.2010.10.

Zavadskas, E. K., Turskis, Z. and Bagocius, V. (2015). Multi-criteria selection of a deep-water port in the Eastern Baltic Sea. *Applied Soft Computing*, *26*, 180-192. https://doi.org/10.1016/j.asoc.2014.09.019.

Zavadskas, E. K., Turskis, Z., and Vilutiene, T. (2010). Multiple criteria analysis of foundation instalment alternatives by applying Additive Ratio Assessment (ARAS) method. *Archives of Civil and Mechanical Engineering*, *10*(3), 123-141. https://doi.org/10.1016/S1644-9665(12)60141-1.

Zavadskas, E. K., Vainiunas, P., Turskis, Z. and Tamosaitiene, J. (2012). Multiple Criteria Decision Support System for assessment of projects managers in construction. *International Journal of Information Technology & Decision Making*, *11*(2), 501-520. https://doi.org/10.1142/S0219622012400135.

Zhao, X., and Murrell, A. J. (2016). Revisiting the corporate social performance-financial performance link: A replication of Waddock and Graves. *Strategic Management Journal*, *37*(11), 2378-2388.

Zolfani, S. H., and Bahrami, M. (2014). Investment prioritizing in high tech industries based on SWARA-COPRAS approach. *Technological and Economic Development of Economy*, *20*(3), 534–553.