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Profitability Based Financial Performance Analysis in BIST Basic Metal Industry Sector: LOPCOW-RSMVC Hybrid Multi-Criteria Decision Making Model

(BİST Ana Metal Sanayi Sektöründe Kârlılığa Dayalı Finansal Performans Analizi: LOPCOW-RSMVC Hibrit Çok Kriterli Karar Verme Modeli)

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Abstract

In this study, it is aimed to measure the financial performance of the companies traded in the BIST basic metal industry sector for the period 2020-2023 by using MCDM methods. In the study, five profitability criteria obtained from the balance sheets and income statements of the companies were included, and the importance levels of the criteria were determined by the LOPCOW method and the performance scores of the alternatives were determined by the RSMVC method. According to the LOPCOW method, the criterion with the highest degree of importance was found to be return on equity for 2020 and 2021, EBITDA margin for 2022 and net profit margin for 2023. The criterion with the lowest degree of importance is EBITDA margin for 2020, net profit margin for 2021 and 2022 and gross profit margin for 2023. According to the RSMVC technique, when the four periods are evaluated in general, CEMTS, PNLSN, KCAER companies ranked in the first three places in terms of average rank values, while CELHA, BMSCH, MEGMT companies ranked in the last three places.

Anahtar Kelimeler:
BİST Ana Metal Sanayi, LOPCOW, RSMVC, Çok Kriterli Karar Verme

Makale türü:
Araştırma

Öz

Bu araştırmada, BİST ana metal sanayi sektöründe işlem gören şirketlerin 2020-2023 dönemi finansal performansının ÇKKV yöntemleri ile ölçülmesi amaçlanmıştır. Şirketlerin bilanço ve gelir tablolarından elde edilen beş kârlılık kriterinin yer verildiği araştırmada, kriterlerin önem dereceleri LOPCOW yöntemi ile alternatiflerin performans skorları ise RSMVC yöntemi ile belirlenmiştir. LOPCOW yöntemine göre önem derecesi en yüksek kriter 2020 ve 2021 yılları için özsermaye kârlılığı, 2022 yılı için FAVÖK marjı ve 2023 yılı için net kâr marjı olduğu görülmüştür. En düşük önem derecesine sahip kriter 2020 yılı için FAVÖK marjı, 2021 ve 2022 yılları için net kâr marjı ve 2023 yılı için ise brüt kâr marjı olarak tespit edilmiştir. RSMVC tekniğine göre dört dönem genel olarak değerlendirildiğinde ortalama sıra değerleri bakımından CEMTS, PNLSN, KCAER şirketleri ilk üç sırada yer alırken, CELHA, BMSCH, MEGMT şirketleri son üç sırada yer almıştır.

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Introduction

The occurrence of economic crises with worldwide ramifications, the expansion of financial markets on a global scale, societal and technical shifts, and the implementation of new rules by legal authorities have all contributed to a rise in the level of uncertainty around commercial and financial decision-making issues. In this situation, there may be new obstacles that need to be addressed in accordance with the existing financial needs (Marqués et al., 2020: 171). During challenging periods, it is crucial for firms to prioritize the evaluation of their financial performance. The financial results serve as a quantifiable reflection of the company's progress in achieving its goals. Furthermore, firm executives utilize current financial performance data to create cautious budgets and make strategic decisions that aim to position the organization advantageously in both the home and foreign marketplaces. During the process, investors are placing greater emphasis on the financial performance of a firm to assess their willingness to offer initial or ongoing support. This assessment considers the evaluation of risks and potential returns (Lam et al., 2023: 397).

In the stock market, investors aim to minimize risks and generate high returns. Nevertheless, achieving this objective is growing progressively challenging because of diverse reasons including the worldwide economy, political occurrences, and security apprehensions. To navigate this intricate situation, investors must consider certain variables to effectively lead their decision-making process (Alsanousi et al., 2024: 258). Although performance measurement is crucial for a logical and effective investment management system, there is a lack of agreement on the suitable criteria for selecting appropriate measurement methods or their practical use (Tavana et al., 2015: 590). It is of great importance that scientific methods are used in the decisions that may be taken on behalf of the companies, that these decisions are supported by objective evaluation results and that rational and rational decisions are taken by minimizing the possible risks and losses to be encountered (Akyüz et al., 2011: 75). In this framework, Multi-Criteria Decision Making (MCDM) methods are becoming increasingly important to evaluate the performance of companies in a more comprehensive and scientific way, and the diversity of these methods is also increasing. While MCDM methods provide practitioners with the opportunity to analyze more than one criterion simultaneously in financial performance evaluations, they can enable company stakeholders to make rational decisions in their financial evaluations at the point of aiming to achieve the optimum result according to different alternative decision criteria and weights.

Currently, the evaluation of financial performance holds significant significance not just for company executives or investors, but also for all firms within the same industry. Financial performance encompasses multiple dimensions, including profitability, productivity, economic growth, and the use of financial measures as a suitable tool for assessing both enterprises and their respective industries. Often companies are interested in knowing their ranking among competitors in the same industry for appropriate strategies (Abdel-Basset et al., 2020: 193). Events that have the power to change the performance rankings of companies and create a paradigm shift in world economies continue to occur. The COVID-19 pandemic posed a significant

threat to human life and had a ripple impact on the economy and various other sectors of life, presenting a serious problem for governments and enterprises. The economies of countries that lacked the necessary resources to cope with the COVID-19 crisis, combined with the consequences of the pandemic and decreased business operations due to preventive measures such as company closures, trade limitations, and social distancing protocols, have negatively affected the financial performance of companies in all sectors of the economy (Makki and Alqahtani, 2023: 61). While the implemented safeguards have effectively curtailed the transmission of the pandemic, numerous industries have seen significant impacts. The cessation of operations in factories, companies, and shops has had a substantial effect on the manufacturing, retail, and tourism industries, as well as other sectors that depend on brick-and-mortar establishments. Additionally, both voluntary and involuntary limitations on people's physical mobility have likely resulted in a decrease in consumer expenditure. The duration of the limits on individuals' mobility directly correlates with the magnitude of the consequences experienced at both personal and organizational levels. Hence, it is imperative to evaluate the extent to which industry sectors have been impacted by the worldwide COVID-19 epidemic, given that various industries have seen distinct effects from the pandemic (Alon, 2020: 76; Lu et al., 2021: 1).

This study aims to assess the financial performance of 27 firms listed in the Borsa Istanbul (BIST) Basic Metal Industry Index (XMANA) from 2020 to 2023. The evaluation will be based on profitability utilizing MCDM approaches. Measuring the financial performance of base metal industry companies using annual data from 2020 to 2023 has several motives. The iron and steel industry, also known as the basic metal industry, plays a crucial role in supplying raw materials for industrial production. Therefore, it is considered a leading sector globally. Moreover, the fundamental metal industry plays a crucial role in enhancing a nation's industrialization process and its capacity to access global markets with a competitive edge. In Türkiye, specifically, the steel industry has emerged as one of the most advanced industries (Acar and Sarıyer, 2021: 115). The Metal Basic Industry, which is among the dominant sectors in the industrial index, is of great importance with its volume in production, its contribution to the national economy, its impact on the stock market index in terms of weight and its large companies. The main business lines of the sector are mineral processing and production of consumer goods. These mines are iron steel, aluminum, copper, lead, chromium, zinc, tin and precious metals such as gold, platinum and silver. In this respect, the Metal Main Industry sector has a special importance in terms of supplying raw materials to many sectors. This research was motivated by the interest surrounding the profitability-based financial performance behaviors and performance rankings of the main corporations in the metal industry sector during and after the COVID-19 pandemic era, considering the significance of this sector. Upon reviewing the existing literature, it has been shown that there is a significant lack of studies that specifically investigate the relationship between profitability performance and MCDM approaches. Within the scope of this study, five profitability criteria were derived from the balance sheets and income statements of the companies. The significance levels of these criteria were determined using the LOPCOW method, while the performance

scores of the alternatives were determined using the RSMVC method. The LOPCOW-RSMVC hybrid MCDM model was used for the first time to assess the financial performance of companies in the BIST XMANA Index. This study aimed to enhance existing literature by employing these infrequently used methodologies in financial performance evaluation.

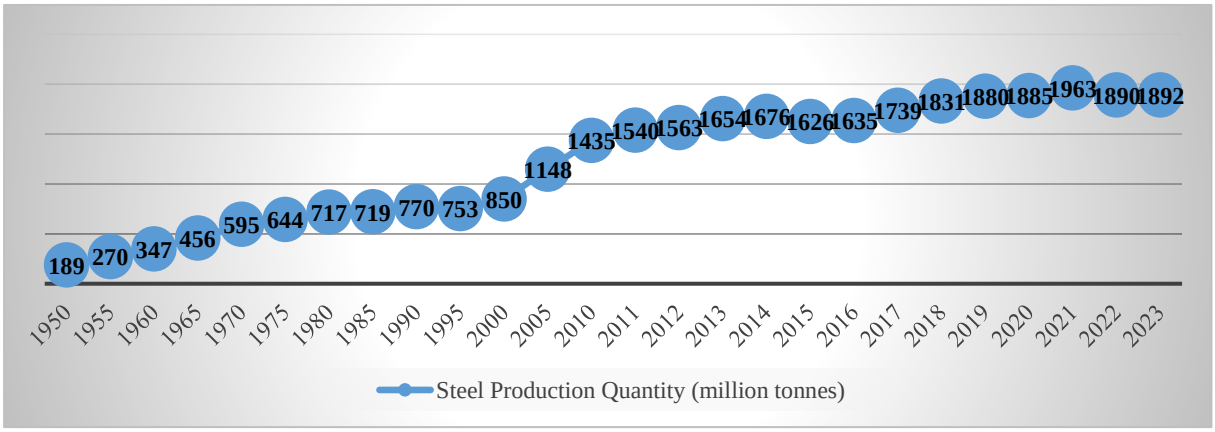
The remaining stages of the research are organized in the following manner. Following the introduction, a comprehensive economic analysis of the global and Turkish metal industrial sector is provided. Subsequently, the literature review, research methodology, and application process are thoroughly elucidated. The research has concluded with the final round of evaluation and drawing conclusions.

1. General Economic Outlook of Basic Metal Industry Sector in The World and Türkiye

The basic metal industry plays a crucial role in economic development due to its heavy reliance on scarce natural resources and their provision of materials to other industries. The basic metal industry, which encompasses the manufacturing of iron-steel and other non-ferrous metals, is classified as a medium/low technology intensive sector by the Organization for Economic Co-operation and Development (OECD) (Akdogan et al., 2019: 2). Iron and steel are essential components in various industries, including construction, chemicals, energy, and automobiles. It has also become an indispensable part of research and development projects worldwide, creating opportunities for innovative solutions in other sectors (Özden and Haçikoğlu, 2017: 2; World Steel Association, 2019: 3).

The steel industry has redirected its attention towards emerging economies, which demand substantial amounts of steel for the purposes of urbanization and industrialization. When the World Steel Association (WSA) was established in 1967, known then as the International Iron and Steel Institute, the United States of America (USA), Western European countries, and Japan collectively produced 61.9 percent of the world's steel. By the year 2000, the percentage had decreased to 43.8%. The growth of China in the steel sector led to an increased rate of this trend in the 2000s. By 2011, developing countries, especially China, were responsible for over 70% of steel consumption and production. China, one of the world's most dynamic economies, clearly demonstrates the close relationship between steel output and economic development. While the origins of steel manufacturing in China, like India, can be traced back to a distant past, the industry did not experience significant development until the latter half of the 20th century. However, it was only after the economic reforms of the 1980s that the industry really took off. These reforms facilitated international trade, leading to substantial economic growth and a significant increase in steel output. China emerged as the leading global steel producer by the conclusion of 2011, manufacturing a total of approximately 680 million tons (World Steel Association, 2013: 41-43). According to the World Steel Association's 2023 reports, the world crude steel production amount followed a steady course between 1950 and 2023 and recorded significant increases. The crude steel output witnessed a steady growth,

rising from 189 million tons in 1950 to 850 million tons in 2000, further increasing to 1540 million tons in 2011, and ultimately reaching 1892 million tunes in 2023.



Source: (www.worldsteel.org). Prepared by the authors.

Figure 1. World Crude Steel Production 1950-2023

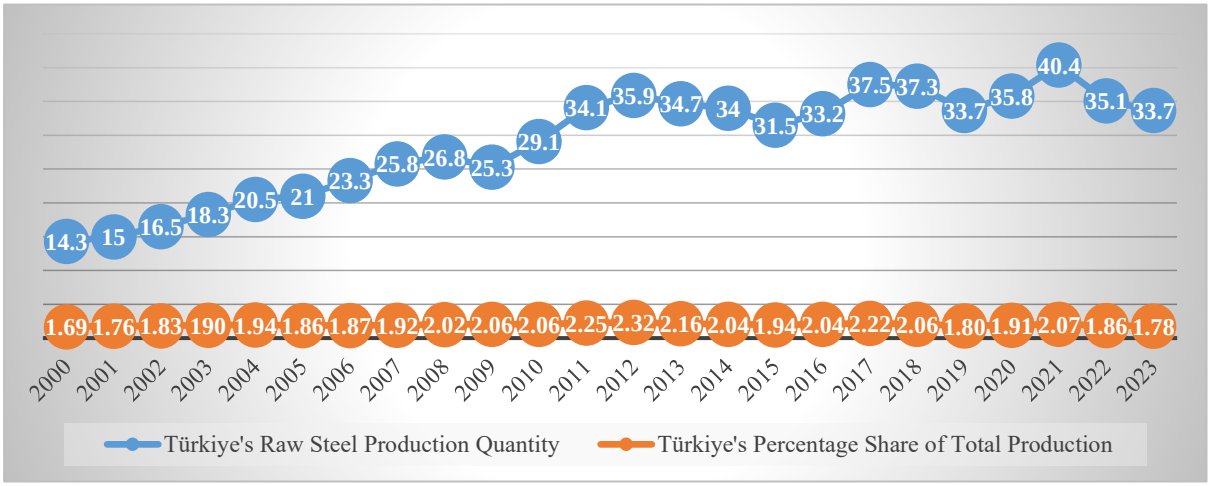
The following table, Table 1, displays the leading 10 nations in global crude steel production and their corresponding steel production figures in million tones for the period of 2019-2023. China continues to be the clear production leader in crude steel production, which it has maintained over the years. In the 2019-2023 period, it is observed that the growth in world crude steel production has followed a horizontal course in percentage terms over the years. China's crude steel production growth rates were 6.97% in 2020, -2.77% in 2021, -1.66% in 2022 and 0.10% in 2023. In the 2019-2023 period, China, India, Japan, the USA, Russia, South Korea, Brazil and Iran maintained their production ranking. As of 2023, China's share of total production is 53.85 per cent, second-ranked India 7.44 per cent, third-ranked Japan 4.59 per cent and Türkiye 1.78 per cent. It is seen that Germany and Türkiye are in competition in the ranking of crude steel production amount. While Germany ranked seventh in 2023, 2022 and 2019, Türkiye ranked eighth in the same years. Although there are slight changes in the ranking of the countries in the top ten, it is seen that the countries in production have not changed.

Table 1. Ranking of the World's Top 10 Countries in Crude Steel Production (million tons)

Country	2023		2022		2021		2020		2019	
	Product	Order	Product	Order	Product	Order	Product	Order	Product	Order
China	1019.1	1	1018.0	1	1035.2	1	1064.8	1	995.4	1
India	140.8	2	125.4	2	118.2	2	100.3	2	111.4	2
Japan	87.0	3	89.2	3	96.3	3	83.2	3	99.3	3
USA	81.4	4	80.5	4	85.8	4	72.7	4	87.8	4
Russia	76.0	5	71.7	5	77.0	5	71.6	5	71.7	5
South Korea	66.7	6	65.8	6	70.4	6	67.1	6	71.4	6
Germany	35.4	7	36.9	7	40.2	8	35.7	8	39.6	7
Türkiye	33.7	8	35.1	8	40.4	7	35.8	7	33.7	8
Brazil	31.8	9	34.1	9	36.1	9	31.0	9	32.6	9
Iran	31.0	10	30.6	10	28.3	10	29.0	10	25.6	10
World	1892.2		1890.2		1962.3		1877.5		1874.4	

Source: (www.worldsteel.org). Prepared by the authors.

Figure 2 displays the quantity of crude steel production in Türkiye and its proportion in the global total production from 2000 to 2023. The amount of crude steel production increased rapidly until 2012 and followed a fluctuating horizontal course in the 2013-2023 period. Türkiye 's share in total production peaked in 2012 with 2.32 per cent.



Source: (www.worldsteel.org). Prepared by the authors.

Figure 2. Türkiye's Crude Steel Production Amount (million tonnes) and % Share in Total Production (2000-2023)

Türkiye, a prominent global steel manufacturer and exporter, operates a total of 27 electric arc furnace, 11 induction furnace, and 3 basic oxygen furnace steel mills. Every steel company in Türkiye is privately owned. The steel industry, which is highly advanced, currently ranks as the fifth largest sector in terms of export revenue for the Türkiye economy. Türkiye steel companies export their products globally due to their competitive pricing and successful marketing methods. According to 2023 steel export and import data, Türkiye ranked ninth in world steel exports with 12.7 million tones and fifth with 18 million tons of imports (World Steel Association, 2024; Türkiye Steel Exporters' Association, 2024). According to the Türkiye Exporters' Association (TEA) 2023 year-end data, Türkiye earned 14.87 billion dollars from steel exports (TEA, 2024). This revenue accounts for around 6.7% of Türkiye's overall exports, which amount to $221.7 billion. On the other hand, the ferrous and non-ferrous metals sector also makes a major contribution to Türkiye's exports. This sector ranks sixth in the sectoral export ranking with a revenue of USD 12.47 billion. In 2023, the steel sector and the ferrous and non-ferrous metals sector contributed a total of USD 27.34 billion to Türkiye's exports. In the ranking of total export revenue, the steel sector ranks fifth after the automotive, chemical and chemical products, ready-to-wear clothing and apparel, electrical and electronics sectors, while the ferrous and non-ferrous metals sector ranks sixth.

2. Literature Review

In this literature review, some research summaries are presented on the MCDM research that measure financial performance by using LOPCOW and RSMVC methods in various application areas, where companies in the metal industry and related sectors are sampled.

Uygurtürk and Korkmaz (2012), The financial performance of 13 basic metal industry companies traded on the Istanbul Stock Exchange (ISE) over the period 2006-2010 was analyzed using the TOPSIS approach. Within the study, a comprehensive set of 8 financial ratios were employed to assess liquidity, operating efficiency, financial structure, and profitability. The research findings revealed that the financial performance of the organizations exhibited variability during the analyzed period.

Bakırcı et al. (2014), The researchers have used Data Envelopment Analysis (DEA) and TOPSIS methodologies to assess and compare the financial performances of 14 companies in the metal major industry sector listed on BIST from 2009 to 2011. In the research, input variables were used as fixed assets and operating expenses, while output variables included operating profit and cash flow data generated from operations. According to the performance evaluation results conducted using the VZA method, it has been observed that Burçelik Vana Industry and Trade Co. (BURVA), Erbosan Erciyas Pipe Industry and Trade Co. (ERBOS), Ereğli Iron and Steel Factories Inc. (EREGL), and İzmir Iron and Steel Industry Inc. (IZMDC) have been effective in all three periods. According to the VZA method, the super efficiency method has been used to rank effective companies in terms of being more efficient among themselves. According to the results of the super event, EREGL company has ranked first every three years. The companies that yielded positive outcomes from the VZA approach were evaluated based on their closeness to the ideal solution using the TOPSIS method. Among these results, the EREGL company achieved the highest score.

Eş and Çobanoğlu (2017), a financial performance measurement of 14 firms in the iron and steel sector listed on BIST for the period of 2013-2015 has been carried out. In the research, the weighting process was carried out in three different ways: equal weighting, entropy, and nonlinear programming. The ranking performance after weighting has also been addressed using the TOPSIS method. The research findings utilized 16 financial/accounting data points to compare the annual change in companies' market value. The TOPSIS approach produced highly effective rankings for companies.

Şit et al. (2017), an analysis has been conducted on the financial performances of 16 businesses listed in the BIST XMANA ındex using the TOPSIS approach for the period of 2011-2015. In this context, the research utilized 11 financial ratio indicators related to companies, including liquidity, operational efficiency, financial structure, profitability, and stock market performance. The research findings suggest that when constructing an efficient portfolio, investors should prioritize the following companies: Erbosan Erciyas Boru Industry and Trade Co. (ERBOS), Çuhadaroğlu Metal Industry and Marketing Co. (CUSAN), Ereğli Iron and Steel Factories Inc. (EREGL), Kardemir Karabük Iron Steel Industry and Trade Co. (KRDMA, KRDMB,

KRDMD), and Sarkuysan Electrolytic Copper Industry and Trade Co. (SARKY). These companies exhibit varying financial performance over the years.

Yıldırım et al. (2019) did a study on a manufacturing company that was included in the BIST Basic Metal Industry Index. The study conducted a comprehensive analysis of the company's cost and profitability ratios from 2008 to 2017, employing the TOPSIS technique. After analyzing the cost and profitability ratios, it was concluded that 2008 was the most successful year, while 2015 was the least successful year.

Eyüboğlu and Bayraktar (2019), the objective was to assess the financial performance of the sub-sectors within the Turkish metal industry from 2014 to 2016 by employing the Analytic Hierarchy Process (AHP) and TOPSIS techniques. The analysis utilized a comprehensive set of 19 financial ratios, encompassing liquidity, financial structure, operational efficiency, and profitability measures. Research findings have conclusively shown that the manufacturing sector specializing in secondary steel processing consistently achieves the highest level of success each year.

Söylemez (2020), an analysis has been conducted on the financial performance of 18 enterprises in the primary metal sector of BIST from 2010 to 2019. The analysis utilized the TOPSIS and Grey Relational Analysis (GRA) techniques. In the research, a total of 25 financial indicators have been used, including liquidity, operational efficiency, size, financial structure, and profitability. Research has demonstrated that the TOPSIS and GIA techniques yield comparable outcomes when assessing financial performance. The companies that demonstrate the highest financial performance in both methods are Ereğli Iron and Steel Factories Inc. (EREGL), Erbosan Erciyas Pipe Industry and Trade Co. (ERBOS), and Çemtaş Steel Machinery Industry and Trade Inc. (CEMTS), while the companies with the lowest financial performance are Burçelik Bursa Steel Casting Industry Inc. (BURCE) and Burçelik Vana Industry and Trade Inc. (BURVA).

Özcan and Ömürbek (2020), they have evaluated the overall performance of a steel production company in Türkiye based on criteria such as capacity utilization rate, energy consumption, net sales, production, sales, imports, exports, number of employees and operating profit from 2000 to 2018. The study employed the Entropy approach to determine the weights of the criterion. Subsequently, the TOPSIS, MULTIMOORA, and MAUT methods were employed to rank the performance based on these weights. According to the findings of the three methods, it has been observed that the year 2018 had the best performance.

Korkmaz and Öztel (2020), a study was conducted to assess the financial performance of 17 heavy metal sector businesses listed on BIST from 2014 to 2018. The Entropy and Promethee methodologies were utilized for this analysis. The research utilized a comprehensive set of 12 financial ratios, encompassing profitability ratios, financial structure ratios, activity efficiency ratios, and liquidity ratios. Due to the application of the entropy approach for weighting, it has been observed that return on equity and net working capital turnover are the most important criteria. Although the research findings vary by year, in the ranking made using the Promethee method, Ereğli Iron and Steel Works Inc. (EREGL) and Erbosan Erciyas Pipe Industry and

Trade Inc. (ERBOS) are the most successful companies, while Çemaş Casting Industry Inc. (CEMAS) has been the least successful company throughout the entire period.

Çanakçıoğlu (2020), a financial performance measurement has been conducted for 17 main metal industry companies listed on BIST for the period of 2013-2018. In the research, a total of 13 financial ratios have been used, including profitability ratios, activity, financial structure, and liquidity. The criteria weights have been computed using the Entropy approach, and the performance ranking has been conducted using the WASPAS method. Then, using the Borda method, companies have been re-ranked based on performance across all years. The findings of the entropy weighting method indicate that profitability indicators, particularly pre-tax return on equity, are among the most important criteria. In the ranking criteria, it has been determined that İskenderun Iron and Steel Company (ISDMR) ranked first in performance in all years, Ereğli Iron and Steel Works Inc. (EREGL) ranked second, and Çemaş Casting Industry Inc. (CEMAS) ranked third.

Yıldırım et al. (2021), the objective was to assess the financial performance of four iron and steel businesses listed on the BIST XMANA Index from 2011 to 2019, employing the GIA approach. In the research, seven financial ratios focused on cost and profitability have been used. According to the research, the companies that performed the best were Ereğli Iron and Steel Factories Inc. (EREGL) in 2011 and 2013, Kardemir Karabük Iron Steel Industry and Trade Co. (KRDMD) in 2012, and İskenderun Iron and Steel Co. (ISDMR) from 2014 to 2019.

Acar and Sarıyer (2022), the financial performance of 17 prominent metal sector companies listed on BIST for the year 2017 has been analyzed using AHP and TOPSIS methodologies. The research utilized a total of 11 financial ratios, encompassing measures of liquidity, operational efficiency, profitability, and financial structure. The research findings indicate that the TOPSIS technique yielded a ranking in which the results for 15 companies were closely aligned based on their stock closing prices in 2017.

Gönüllü (2022), during the Covid-19 epidemic period, it conducted a financial analysis of 20 companies included in the BIST XMANA Index. During the research conducted from June 2020 to June 2021, a comprehensive set of 15 distinct criteria was employed. These criteria encompassed liquidity, profitability, cost, stock market performance, growth, financial structure, and operational efficiency ratios. The criteria have been weighed up using the entropy approach and the ranking performance has been demonstrated by the MARCOS method. Research findings indicate that Çemtaş Steel Machinery Industry and Trade Inc. (CEMTS) had the highest financial performance during the pandemic era, followed by Kardemir Karabük Iron Steel Industry and Trade Inc. (KRDMD) and Ayes Steel Mesh and Fence Industry Inc. (AYES).

Çolak (2023), BIST Main Metal (XMANA) has analyzed the financial performance of enterprises in the sector using the TOPSIS approach, utilizing data from the period 2017-2021. The research utilized a comprehensive set of 12 financial ratio measurements, which were classified into 4 primary categories: liquidity, profitability,

financial structure, and activity ratios. Each category consisted of three sub-ratios. The research comprised 17 companies in 2017, 18 companies in 2018, 20 companies in 2019, and ultimately, 22 companies were included in the analysis for the years 2020 and 2021. In the research findings, Ereğli Iron and Steel Works Inc. (EREGL) recorded the best performance in the years 2017 and 2018, Çemtaş Steel Machinery Industry and Trade Inc. (CEMTS) in the years 2019 and 2020, and Çemaş Casting Industry Inc. (CEMAS) in the year 2021. Furthermore, the research findings indicate that variations in liquidity and financial structure ratios significantly affect the financial performance of organizations.

Güçlü and Muzac (2024), the financial performance of four firms manufacturing raw iron and steel included in the BIST XMANA Index for the period of 2017-2021 was analyzed using the Gri MULTIMOORA-Copeland hybrid approach and the net numbers using the MULTIMOORA method. According to research findings that utilized 10 financial ratio metrics, the most successful company was found to be Kardemir Karabük Iron Steel Industry and Trade Inc. (KRDMD), while the least successful was identified as Ereğli Iron and Steel Works Inc. (EREGL).

Arslan Gürdal and Durmuş (2024), The financial performance measurement of five steel sector businesses listed on Borsa Istanbul for the period of 2016-2022 has been analyzed using the GIA approach. In the research, a total of 11 financial ratio indicators related to liquidity, profitability, financial structure, and operational efficiency have been used. Based on research findings, Çemtaş Steel Machinery Industry and Trade Inc. (CEMTS) has demonstrated the highest level of financial performance when considering various financial ratios. However, the performance of the remaining four companies has been ranked as follows: Erbosan Erciyas Pipe Industry and Trade Inc. (ERBOS), İskenderun Iron and Steel Company (ISDMR), Ereğli Ereğli Iron and Steel Works Inc. (EREGL), and Kardemir Karabük Iron Steel Industry and Trade Inc. (KRDMD).

In general, when examining the literature on measuring financial performance in the primary metal and related sectors with the Turkish sample, it is observed that methods such as GIA, MULTIMOORA, MAUT, Entropy, Promethee, WASPAS, BORDA, MARCOS, AHP, TOPSIS and Copeland's MCDM have been utilized. During the period covered by this research (2020-2023), it has been observed in the literature that Gönüllü (2022) identified CEMTS, KRDMD, and AYES as the best performers from June 2020 to June 2021; Çolak (2023) highlighted EREGL, CEMTS, and CEMAS for the period 2017-2021; Güçlü & Muzac (2024) noted KRDMD for 2017-2021; and Aslan Gürdal & Durmuş (2024) found that CEMTS, ERBOS, ISDMR, EREGL, and KRDMD exhibited the best financial performance from 2016 to 2022. On the other hand, although very limited, there are international research examples such as Li et al. (2010), AHP and GIA for investment decisions regarding the stocks of 8 companies in the Chinese steel industry; Mojtaba et al. (2016), an analysis was conducted on the financial performance of eight prominent metal sector companies that are listed on the Tehran Stock Exchange. The analysis employed Fuzzy AHP, VIKOR, and TOPSIS methodologies; Raikar (2019a) evaluated the economic efficacy of 24 steel corporations

in India by employing the Promethee methodology; Raikar (2019b) conducted a financial analysis of 24 steel manufacturing businesses in India by employing SVD, ARAS, SAW, and TOPSIS; Abdel-Basset et al. (2020), an analysis was conducted on the financial performances of 10 steel businesses operating in Egypt utilizing AHP, VIKOR, and TOPSIS methodologies; Dwivedi et al. In 2020, the performance measurement of steel businesses featured in the BSE 200 index on the Bombay Stock Exchange was analyzed using the CRITIC and MARCOS techniques. Table 2 displays research summaries that utilize the LOPCOW and RSMVC methodologies in several application domains, as employed in this study.

Table 2. Some Research Summaries Conducted with LOPCOW and RSMVC Methods

Research	**Application**
LOPCOW	
Ecer and Pamucar (2022)	Evaluation of banks' corporate sustainability performance.
Demir (2022)	Evaluation of the advancements in information and communication technology in G8 nations.
Biswas et al. (2022)	Evaluating the capacity of firms in the fast-moving consumer products industry to distribute dividend payments.
Ulutaş et al. (2023)	Choosing insulating materials to optimize energy efficiency.
Kahreman (2023)	Evaluation of the economic performance of G20 countries.
Rong et al. (2023)	Evaluation of the potential hazards and uncertainties associated with research and development programs.
Dhruva et al. (2024)	Supplier selection.
Öztaş and Öztaş (2024)	Evaluation of the extent of innovation attained by the G20 nations.
Çelebi Demirarslan et al. (2024)	Comparison of quality-of-life metrics in Asian countries throughout the years.
Sumrit and Keeratibhubordee (2024)	Risk assessment for reverse logistics in the recycling sector.
RSMVC	
Van Dua and Thinh (2023)	Vehicle selection
Keleş and Ersoy (2023)	An analysis of the climate change performance of G20 nations throughout the past five years.
Özekenci (2024)	International market selection

Although limited in literature, there are some studies in the field of finance that have been addressed using the LOPCOW and RSMVC methods. In studies addressed using the LOPCOW method, Bektaş (2022) analyzed the performance of the insurance industry in Türkiye; Taşçı (2023) analyzed the stock market performance of BIST Insurance Index companies based on market multiples; Yılmaz (2023) focused on the performance of the Romanian banking sector; Biswas and Joshi (2023) examined the success of initial public offers (IPOs) in the Indian stock market; Kahraman (2023) assessed company performance based on profitability in the BIST Forestry, Paper, and Printing Index; Yılmaz Özekenci (2024) evaluated the financial performance of BIST Energy Index companies; Gülcemal and İzci (2024) studied the performance of the participation banking sector in Türkiye; and finally, Asker (2024) addressed the financial performance of BIST firms in relation to the Kahramanmaraş earthquakes. The applications of the RSMVC method in the finance field are virtually nonexistent. In one of these rare research examples, Ersoy (2023) employed the LOPCOW-RSMVC

hybrid model to analyze the financial performance of retail trade enterprises listed on BIST. The financial performance of BIST's key metal industry businesses has not been evaluated utilizing the LOPCOW-RSMVC hybrid MCDM model in a comprehensive review. In this context, this research has conducted an analysis of financial performance based on profitability using a large sample set of companies (27 main metal industry companies) with data from the period of 2020-2023.

3. Methodology

This section provides detailed descriptions of the methodologies employed in the study.

3.1. Z-Skor Standardization Method

Negative values in the decision matrix are infrequently observed in MCDM approaches. When proceeding with the decision matrix containing negative valued data, the normalized matrix still includes negative values, leading to difficulties in the processing steps (Zhang et al., 2014: 2-3). To tackle this problem, Zhang et al. (2014) introduced the Z-score standardization approach. The procedure consists of the following steps (Zhang et al., 2014: 3).

Step 1: The elements of the choice matrix are normalized using equality (1).

$$x_{ij}=\frac{X_{ij}-\bar{X}_i}{S_i} \tag{1}$$

x_{ij} indicates the normalized data for the *i.* index in the *j.* area, while X_{ij} symbolizes the raw data. $\bar{X}_i$ and $S_i$represent the mean and standard deviation values, respectively.

Step 2: The elements of the choice matrix are transformed into positive values using the equation (2).

$$x_{ij}^{'}=x_{ij}+A \qquad A>\left|minx_{ij}\right| \tag{2}$$

The variable x'_{ij} reflects the value that has been normalized following the transformation. The inequality $x'_{ij}>0$ must be satisfied.

3.2. LOPCOW Method

The LOPCOW methodology, proposed by Ecer and Pamucar (2022), is an objective method for finding criterion weights. It considers both correlation and standard deviation values while calculating the weights. The procedure consists of the following steps (Ecer and Pamucar, 2022: 4-5):

Step 1: A decision matrix is formulated.

Step 2: The decision matrix has been standardized.

$$r_{ij}=\frac{x_{max}-x_{ij}}{x_{max}-x_{min}}, \; cost \tag{3}$$

$$r_{ij}=\frac{x_{ij}-x_{min}}{x_{max}-x_{min}}, \; benefit \tag{4}$$

Step 3: The percentage values (PV) for each criterion are computed.

$$PV_{ij}=\left| ln\left(\frac{\sqrt{\frac{\sum_{i=1}^{m} r_{ij}^{2}}{m}}}{\sigma} \right) *100 \right| \quad (5)$$

The symbols σ and m, it denotes the values, the standard deviation and the number of choices.

Step 4: Weights for the criteria are computed.

$$w_j=\frac{PV_{ij}}{\sum_{i=1}^{n} PV_{ij}} \quad (6)$$

$$\sum_{i=1}^{n} w_j = 1$$

3.3. RSMVC Method

The RSMVC methodology, pioneered by Van Dua and Thinh (2023), allows for the prioritization of options, even in cases where the decision matrix contains interval values. This distinguishing feature differentiates it from prior MCDM techniques. The procedure consists of the following steps (Thinh and Van Dua, 2023: 168; Ersoy, 2023: 424-425):

Step 1: A decision matrix is generated.

$$\begin{matrix} A1 \\ A2 \\ A3 \\ A4 \\ \vdots \\ Am \end{matrix} \begin{bmatrix} a_{11} \div b_{11} \dots a_{1n} \div b_{1n} \\ a_{21} \div b_{21} \dots a_{2n} \div b_{2n} \\ a_{31} \div b_{31} \dots a_{3n} \div b_{3n} \\ \vdots \quad \vdots \quad \vdots \\ \vdots \quad a_{ij} \div b_{ij} \quad \vdots \\ a_{m1} \div b_{m1} \cdots a_{mn} \div b_{mn} \end{bmatrix}$$

Step 2: The mean values of the criteria are computed using Equality (7).

$$\bar{x}_{ij}=\frac{a_{ij}+b_{ij}}{2} \quad (7)$$

The concept of equality (7) is applied when the value of the criterion is within the specified range of [a_{ij}, b_{ij}]. If the criterion value is an odd number, the same method is applied, considering the constraint $a_{ij}=b_{ij}$.

Step 3: The ranking of each criterion is established based on its mean value.

Cost-Oriented Criteria: The answer with the lowest means is rated first, while the solution with the greatest mean is placed last.

Benefit-Oriented Criteria: The answer with the highest mean rankings is ranked first, while the solution with the lowest mean ranks is ranked last.

If there is a criterion n, the solutions must be generated within a sorting time of n.

Step 4: The total score for each alternative is determined using the Equality criterion, which has a weight of (8).

$$S_i=r_{ij}*w_j \quad (8)$$

The term r_{ij} denotes the prioritization of the criteria established in step 3. The variable w_j denotes the weight allocated to the criterion.

Step 5: A compilation of alternative options is presented. The response with the lowest score is the most advantageous option.

4. Results

The study aims to measure the financial performance based on profitability ratios of firms operating in the main metal industry sector of BIST for the period from 2020 to 2023 using MCDM methods. The LOPCOW methodology was utilized to assess the significance degree of the criteria, whereas the RSMVC method was implemented to establish the ranking of the alternatives. Both methods have been preferred due to their novelty and the fact that they have been used in a very limited integration of manner before. The first step of the MCDM methods begins with the identification of alternatives and criteria. Therefore, it is imperative to initially ascertain the available options and the specific standards by which they will be evaluated. There are 27 companies listed in the BIST metal industry sector. Within the specified period, Koç Metalurgy Co. (KOCMT) and Özyaşar Wire and Galvanising Industry Co. (OZYSR), which could not provide their data, were excluded from the analysis only in 2020, resulting in a total of 27 companies forming the alternatives for the study. Table 3 displays the companies identified in the BIST primary metal industrial sector that serve as the options for the study.

Table 3. BIST Ana Metal Industry Sector Companies

CODE	Company
AYES	Ayes Steel Mesh and Fence Industry Inc.
BMSTL	Bms United Metal Industry and Trade Inc.
BMSCH	Bms Steel Hasir Industry and Trade Inc.
BRSAN	Borusan United Pipe Factories Industry and Trade Inc.
BURCE	Burçelik Bursa Steel Casting Industry Inc.
BURVA	Burçelik Vana Industry and Trade Inc.
CELHA	Çelik Rope and Wire Industry Inc.
CEMAS	Çemaş Casting Industry Inc.
CEMTS	Çemtaş Steel Machinery Industry and Trade Inc.
CUSAN	Çuhadaroğlu Metal Industry and Marketing Inc.
DMSAS	Demisaş Casting Enamel Products Industry Inc.
DOFER	Dofer Construction Materials Industry and Trade Inc.
DOKTA	Döktaş Foundry Trade and Industry Inc.
ERBOS	Erbosan Erciyas Pipe Industry and Trade Inc.
ERCB	Erciyas Steel Pipe Industries Inc.
EREGL	Ereğli Iron and Steel Factories Inc.
ISDMR	İskenderun Iron and Steel Inc.
IZMDC	İzmir Iron and Steel Industry Inc.
KRDMD	Karademir Karabük Iron Steel Industry and Trade Inc.
KCAER	Kocaer Steel Industry and Trade Inc.
KOCMT	Koç Metallurgy Inc.
MEGMT	Mega Metal Industry and Trade Inc.
OZYSR	Özyaşar Wire and Galvanizing Industry Inc.

PNLSN	Panelsan Roof Facade Systems Industry and Trade Inc.
SARKY	Sarkuysan Electrolytic Copper Industry and Trade Inc.
TUCLK	Tuğçelik Aluminum and Metal Products Industry and Trade Inc.
YKSLN	Yükselen Steel Inc.

The criteria have been determined based on the most used profitability ratios following a comprehensive literature review and are presented in Table 4. The financial ratios necessary for the analysis have been calculated using data obtained from the Public Disclosure Platform (PDP) (PDP, 2024).

Table 4. Evaluation Criteria

Financial Ratio Group	**Financial Ratios**	**Code**	**Explanation**	**Opt.**
Profitability Ratios	Gross Profit Margin	C_1	Gross Profit/Sales	Maximum
	EBITDA Margin	C_2	EBITDA/Sales	Maximum
	Net Profit Margin	C_3	Net Profit/Sales	Maximum
	Return on Equity	C_4	Net Profit/Equity	Maximum
	Return on Assets	C_5	Net Profit/Total Assets	Maximum

A decision matrix has been created using the alternatives and criteria determined within the scope of the study, and it is presented in Table 5. To maintain the integrity of the study, only the analysis steps for the year 2023 have been detailed, while the results for all years are presented at the end of the study.

Table 5. Decision Matrix for the 2023 Year

Company	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**
AYES	7.96	5.64	1.5	17.24	5.54
BMSTL	17.51	10.08	1.22	2.19	1.26
BMSCH	7.73	3.93	1.13	3.61	2.40
BRSAN	16.81	14.36	9.73	22.29	9.82
BURCE	24.65	16.04	8.01	8.54	4.96
BURVA	4.21	-6.32	1.85	6.52	2.32
CELHA	12.15	4.81	2.16	11.61	2.48
CEMAS	8.65	2.73	-18.29	-10.04	-8.62
CEMTS	17.90	15.52	1.65	2.10	1.79
CUSAN	13.65	2.19	-13.29	-24.01	-8.35
DMSAS	5.90	2.65	4.21	16.80	5.01
DOFER	4.18	3.75	5.98	21.10	11.01
DOKTA	18.34	14.32	4.91	14.23	5.06
ERBOS	16.75	10.34	-3.92	-6.90	-4.42
ERCB	17.66	7.22	1.12	3.81	1.24
EREGL	9.63	10.53	2.73	2.67	1.66
ISDMR	7.03	8.41	5.19	6.68	4.38
IZMDC	3.31	4.00	3.08	8.07	3.45
KRDMD	4.24	6.22	3.08	4.02	2.36
KCAER	19.65	14.77	7.86	17.32	9.15
KOCMT	7.26	7.46	0.72	1.47	0.98
MEGMT	9.32	7.29	2.56	16.72	5.76
OZYSR	14.61	8.20	4.03	16.07	5.41
PNLSN	21.78	19.39	8.76	18.45	9.32
SARKY	4.79	3.86	3.21	22.54	8.38
TUCLK	13.14	10.98	21.66	21.35	9.29
YKSLN	23.60	15.46	-10.44	-18.69	-7.18

As can be seen from Table 5, the decision matrix contains negative values in all years. During the evaluation, normalization is performed to make indicators of

different sizes comparable to each other (Zhang et al., 2014: 2). Normalization is a procedure that removes variations in units and converts values to a predetermined range, such as 0-1, for all criteria (Aytekin, 2021: 2). Due to the negative values it leads to in the normalized decision matrix, linear normalization transformation cannot be applied to the decision matrix containing negative index values (Zhang et al., 2014: 2-3). At the same time, there are difficulties in the application of techniques such as vector normalization (Milani et al., 2005), logarithmic normalization (Zavadskas and Turskis, 2008), and max-min normalization (Asgharpour, 1999). To prevent these difficulties, the Z-Score standardization method is used to convert a decision matrix with negative values into a matrix with positive values (Ersoy, 2023: 427).

4.1. Application of the Z-Score Standardization Method

The first phase of the process involves a simple two-step approach in which the components of the 2023 decision matrix are normalized using Equation 1. The standardized components are then presented in Table 6.

Table 6. Standardized Decision Matrix

Company	C_1	C_2	C_3	C_4	C_5
AYES	-0.684	-0.475	-0.101	0.811	0.464
BMSTL	0.817	0.321	-0.139	-0.458	-0.360
BMSCH	-0.720	-0.782	-0.151	-0.338	-0.140
BRSAN	0.707	1.089	1.023	1.237	1.289
BURCE	1.940	1.390	0.788	0.078	0.353
BURVA	-1.274	-2.621	-0.053	-0.093	-0.156
CELHA	-0.025	-0.624	-0.011	0.337	-0.125
CEMAS	-0.576	-0.997	-2.803	-1.490	-2.262
CEMTS	0.879	1.297	-0.080	-0.466	-0.258
CUSAN	0.210	-1.094	-2.120	-2.668	-2.210
DMSAS	-1.008	-1.012	0.269	0.774	0.362
DOFER	-1.278	-0.814	0.511	1.137	1.518
DOKTA	0.948	1.082	0.365	0.558	0.372
ERBOS	0.698	0.368	-0.841	-1.225	-1.454
ERCB	0.841	-0.192	-0.153	-0.321	-0.364
EREGL	-0.422	0.402	0.067	-0.418	-0.283
ISDMR	-0.830	0.022	0.403	-0.079	0.241
IZMDC	-1.415	-0.770	0.115	0.038	0.062
KRDMD	-1.269	-0.371	0.115	-0.304	-0.148
KCAER	1.154	1.162	0.768	0.818	1.160
KOCMT	-0.794	-0.149	-0.207	-0.519	-0.414
MEGMT	-0.470	-0.179	0.044	0.768	0.507
OZYSR	0.361	-0.016	0.245	0.713	0.439
PNLSN	1.488	1.991	0.891	0.913	1.192
SARKY	-1.182	-0.795	0.133	1.259	1.011
TUCLK	0.130	0.483	2.652	1.158	1.187
YKSLN	1.775	1.286	-1.731	-2.219	-1.985

The value of A in equation 2 has been taken as 2.899.

The second stage involves transforming the choice matrix, which has been standardized using Equality 2, into a positive form. The resulting matrix is then displayed in Table 7.

Table 7. Positive Decision Matrix

Company	C_1	C_2	C_3	C_4	C_5
AYES	2.215	2.424	2.798	3.710	3.363
BMSTL	3.716	3.220	2.760	2.441	2.539
BMSCH	2.179	2.117	2.748	2.561	2.759
BRSAN	3.606	3.988	3.922	4.136	4.188
BURCE	4.839	4.289	3.687	2.977	3.252
BURVA	1.625	0.278	2.846	2.806	2.743
CELHA	2.874	2.275	2.888	3.236	2.774
CEMAS	2.323	1.902	0.096	1.409	0.637
CEMTS	3.778	4.196	2.819	2.433	2.641
CUSAN	3.109	1.805	0.779	0.231	0.689
DMSAS	1.891	1.887	3.168	3.673	3.261
DOFER	1.621	2.085	3.410	4.036	4.417
DOKTA	3.847	3.981	3.264	3.457	3.271
ERBOS	3.597	3.267	2.058	1.674	1.445
ERCB	3.740	2.707	2.746	2.578	2.535
EREGL	2.477	3.301	2.966	2.481	2.616
ISDMR	2.069	2.921	3.302	2.820	3.140
IZMDC	1.484	2.129	3.014	2.937	2.961
KRDMD	1.630	2.528	3.014	2.595	2.751
KCAER	4.053	4.061	3.667	3.717	4.059
KOCMT	2.105	2.750	2.692	2.380	2.485
MEGMT	2.429	2.720	2.943	3.667	3.406
OZYSR	3.260	2.883	3.144	3.612	3.338
PNLSN	4.387	4.890	3.790	3.812	4.091
SARKY	1.717	2.104	3.032	4.158	3.910
TUCLK	3.029	3.382	5.551	4.057	4.086
YKSLN	4.674	4.185	1.168	0.680	0.914

4.2. Determining Criteria Weights Using the LOPCOW Technique

The initial stage of the LOPCOW technique involves normalizing the decision matrix (Table 7) using Equation 4. This normalization process considers the benefit, which represents the optimization direction of the criterion, and the results are displayed in Table 8.

Table 8. Normalized Decision Matrix

Company	C_1	C_2	C_3	C_4	C_5
AYES	0.218	0.465	0.495	0.886	0.721
BMSTL	0.665	0.638	0.488	0.563	0.503
BMSCH	0.207	0.399	0.486	0.593	0.561
BRSAN	0.633	0.804	0.701	0.995	0.939
BURCE	1.000	0.870	0.658	0.699	0.692
BURVA	0.042	0.000	0.504	0.656	0.557
CELHA	0.414	0.433	0.512	0.765	0.565

CEMAS	0.250	0.352	0.000	0.300	0.000
CEMTS	0.684	0.849	0.499	0.561	0.530
CUSAN	0.485	0.331	0.125	0.000	0.014
DMSAS	0.121	0.349	0.563	0.877	0.694
DOFER	0.041	0.392	0.608	0.969	1.000
DOKTA	0.704	0.803	0.581	0.821	0.697
ERBOS	0.630	0.648	0.360	0.368	0.214
ERCB	0.672	0.527	0.486	0.598	0.502
EREGL	0.296	0.655	0.526	0.573	0.524
ISDMR	0.174	0.573	0.588	0.659	0.662
IZMDC	0.000	0.401	0.535	0.689	0.615
KRDMD	0.044	0.488	0.535	0.602	0.559
KCAER	0.766	0.820	0.655	0.888	0.905
KOCMT	0.185	0.536	0.476	0.547	0.489
MEGMT	0.282	0.529	0.522	0.875	0.733
OZYSR	0.530	0.565	0.559	0.861	0.715
PNLSN	0.866	1.000	0.677	0.912	0.914
SARKY	0.069	0.396	0.538	1.000	0.866
TUCLK	0.461	0.673	1.000	0.974	0.912
YKSLN	0.951	0.847	0.196	0.114	0.073

Equation 5 was utilized to compute the percentage values (PV) of each criterion in the second stage. In the third step, Equation 6 was used to rank the alternatives. The findings are displayed in Table 9.

Table 9. PV Values and Criteria Weights

		C_1	C_2	C_3	C_4	C_5
2020	PV	81.152	65.082	89.318	147.797	103.591
	w	0.167	0.134	0.183	0.304	0.213
2021	PV	75.116	50.073	34.831	148.674	84.871
	w	0.191	0.127	0.089	0.378	0.216
2022	PV	151.478	155.712	89.796	119.507	99.981
	w	0.246	0.253	0.146	0.194	0.162
2023	PV	54.969	103.141	109.046	104.712	90.562
	w	0.119	0.223	0.236	0.226	0.196

According to Table 9, the highest priority criterion for the year 2020 is C4 (return on equity), for 2021 it is C4 (return on equity), for 2022 it is C2 (EBITDA margin), and for 2023 it is C3 (net profit margin). The criterion with the lowest importance level has been identified as C2 (EBITDA margin) for the year 2020, C3 (net profit margin) for the year 2021, C3 (net profit margin) for the year 2022, and C1 (gross profit margin) for the year 2023.

4.3. Application of RSMVC Technique

The RSMVC approach was used to evaluate the alternatives based on the criteria supplied in Table 7. These criteria were ordered considering the optimization elements and are displayed in Table 10. Since there is no interval value present, the decision matrix has been considered as it is.

Table 10. Ranking of Criteria

Company	C_1	C_2	C_3	C_4	C_5
AYES	18	18	19	7	8
BMSTL	8	11	20	21	21
BMSCH	19	21	21	19	16
BRSAN	9	6	2	2	2
BURCE	1	2	4	13	12
BURVA	25	27	17	16	18
CELHA	14	19	16	12	15
CEMAS	17	24	27	25	27
CEMTS	6	3	18	22	19
CUSAN	12	26	26	27	26
DMSAS	22	25	9	8	11
DOFER	26	23	6	4	1
DOKTA	5	7	8	11	10
ERBOS	10	10	24	24	24
ERCB	7	16	22	18	22
EREGL	15	9	14	20	20
ISDMR	21	12	7	15	13
IZMDC	27	20	12	14	14
KRDMD	24	17	12	17	17
KCAER	4	5	5	6	5
KOCMT	20	14	23	23	23
MEGMT	16	15	15	9	7
OZYSR	11	13	10	10	9
PNLSN	3	1	3	5	3
SARKY	23	22	11	1	6
TUCLK	13	8	1	3	4
YKSLN	2	4	25	26	25

During the second phase, a weighted matrix was generated utilizing Equality 8, and the alternatives were subsequently ranked. The findings are displayed in Table 11.

Table 11. Weighted Matrix and Ranking Results

Company	C_1	C_2	C_3	C_4	C_5	Σ	Rank
AYES	2.140	4.015	4.480	1.585	1.567	13.787	12
BMSTL	0.951	2.453	4.716	4.755	4.113	16.988	19
BMSCH	2.259	4.684	4.952	4.302	3.133	19.330	23
BRSAN	1.070	1.338	0.472	0.453	0.392	3.724	2
BURCE	0.119	0.446	0.943	2.944	2.350	6.802	5
BURVA	2.972	6.022	4.009	3.623	3.525	20.151	24
CELHA	1.664	4.238	3.773	2.717	2.938	15.330	15
CEMAS	2.021	5.353	6.367	5.661	5.288	24.689	27
CEMTS	0.713	0.669	4.245	4.982	3.721	14.330	14
CUSAN	1.426	5.799	6.131	6.114	5.092	24.562	26
DMSAS	2.615	5.576	2.122	1.812	2.154	14.279	13
DOFER	3.091	5.130	1.415	0.906	0.196	10.737	8
DOKTA	0.594	1.561	1.886	2.491	1.958	8.491	6
ERBOS	1.189	2.230	5.659	5.435	4.700	19.213	22
ERCB	0.832	3.569	5.188	4.076	4.308	17.973	21
EREGL	1.783	2.007	3.301	4.529	3.917	15.537	16

ISDMR	2.496	2.676	1.651	3.397	2.546	12.766	11
IZMDC	3.209	4.461	2.830	3.170	2.742	16.412	17
KRDMD	2.853	3.792	2.830	3.849	3.329	16.653	18
KCAER	0.475	1.115	1.179	1.359	0.979	5.108	4
KOCMT	2.377	3.123	5.424	5.208	4.504	20.636	25
MEGMT	1.902	3.346	3.537	2.038	1.371	12.194	10
OZYSR	1.308	2.900	2.358	2.264	1.763	10.592	7
PNLSN	0.357	0.223	0.707	1.132	0.588	3.007	1
SARKY	2.734	4.907	2.594	0.226	1.175	11.636	9
TUCLK	1.545	1.784	0.236	0.679	0.783	5.028	3
YKSLN	0.238	0.892	5.895	5.887	4.896	17.809	20

Based on Table 11, as of 2023, the companies PNLSN, BRSAN, and TUCLK are the top three ranked in terms of financial performance, specifically in relation to profitability ratios. Table 12 displays the comparative results for all years.

Table 12. Comparative Results

	2020		**2021**		**2022**		**2023**	
Company	**Value**	**Rank**	**Value**	**Rank**	**Value**	**Rank**	**Value**	**Rank**
AYES	11.711	13	13.573	13	15.636	17	13.787	12
BMSTL	17.754	19	9.839	11	7.062	5	16.988	19
BMSCH	12.321	14	16.992	17	24.169	26	19.330	23
BRSAN	21.965	24	24.632	26	13.494	15	3.724	2
BURCE	19.342	21	19.794	23	4.456	2	6.802	5
BURVA	19.433	22	18.476	19	3.436	1	20.151	24
CELHA	21.465	23	18.669	20	21.298	25	15.330	15
CEMAS	7.824	5	9.955	12	16.982	18	24.689	27
CEMTS	5.003	1	3.554	2	6.221	3	14.330	14
CUSAN	7.930	6	9.364	9	12.781	12	24.562	26
DMSAS	14.182	16	18.381	18	26.854	27	14.279	13
DOFER	17.391	18	23.047	24	20.673	24	10.737	8
DOKTA	6.268	3	9.519	10	19.321	22	8.491	6
ERBOS	6.071	2	8.864	6	11.657	11	19.213	22
ERCB	8.574	8	19.256	22	14.766	16	17.973	21
EREGL	9.289	9	7.283	5	6.982	4	15.537	16
ISDMR	6.877	4	9.050	8	10.532	10	12.766	11
IZMDC	23.630	25	24.201	25	10.393	9	16.412	17
KRDMD	17.911	20	3.216	1	18.642	19	16.653	18
KCAER	8.189	7	14.933	14	9.583	7	5.108	4
KOCMT	-	-	15.442	16	13.240	14	20.636	25
MEGMT	15.513	17	25.173	27	20.485	23	12.194	10
OZYSR	-	-	19.060	21	19.079	20	10.592	7
PNLSN	10.563	10	7.021	4	12.883	13	3.007	1
SARKY	11.395	11	15.350	15	19.123	21	11.636	9
TUCLK	12.715	15	8.989	7	9.932	8	5.028	3
YKSLN	11.683	12	4.368	3	7.996	6	17.809	20

According to Table 12, it can be observed that the rankings of companies based on profitability ratios have changed over the years. When assessing the four periods included in the study, based on the average rank values, the company CEMTS (5.0),

PNLSN (7.0), and KCAER (8.0) occupy the top three positions, while the company's CELHA (20.75), BMSCH (20.0), and MEGMT (19.25) are in the bottom three positions. It has been determined that the CEMTS company has ranked high in most periods (2020, 2021, 2022). The high importance levels of the criteria mentioned during the specified periods (C2, C3, C4) have ensured that the CEMTS company ranks among the top. Another noteworthy result is the high performance exhibited by the companies PNLSN, BRSAN, and TUCLK in 2023 compared to previous years. When examining the decision matrices, the high profitability ratios of the companies PNLSN, BRSAN, and TUCLK in 2023 compared to other firms have had an impact on this result.

According to the results presented in Table 12, when examining the changes in the profitability performance rankings of firms during the COVID-19 period (2020-2021) and post-COVID-19 period (2021, 2022), the average rank values indicate the following shifts: the firms CEMAS, ERBOS, CUSAN, BMSCH, DOKTA, KRDMD, DMSAS, ERCB, ISDMR, KOCMT, CEMTS, YKSLN, SARKY, AYES, EREGL, and CELHA have fallen in the rankings, while BURCE, BRSAN, IZMDC, TUCLK, BURVA, OZYSR, KCAER, MEGMT, BMSTL, DOFER, and PNSLN firms are in a better position compared to the first period.

5. Sensitivity Analysis

Sensitivity analysis facilitates the comparison of many scenarios and their potential results by considering shifting variables. (Goodridge, 2016: 27). Through sensitivity analysis, the effects of changes in inputs on multi-criteria models can be observed, and the robustness of the model can be tested (Karande et al., 2016: 406). In this section, the sensitivity analysis of the RSMVC method has been conducted using two different approaches. Firstly, the RSMVC method has been compared with different MCDM methods (PIV, WASPAS, SAW). Afterwards, the acquired results utilizing various criterion weights (Equal Weighting (EW), Entropy) were compared to assess the reliability of the given model. The methods have been chosen based on their ease of implementation and their appropriateness for solving real-world situations. The outcomes acquired through various cross-validation procedures are displayed in Table 13.

Table 13. Rankings Obtained Based on Different MCDM Techniques

	2020				2021				2022				2023			
Company	**PIV**	**WASPAS**	**SAW**	**RSMVC**	**PIV**	**WASPAS**	**SAW**	**RSMVC**	**PIV**	**WASPAS**	**SAW**	**RSMVC**	**PIV**	**WASPAS**	**SAW**	**RSMVC**
AYES	15	15	15	13	13	13	13	13	16	17	17	17	12	12	12	12
BMSTL	19	19	19	19	12	12	12	11	7	6	6	5	15	14	15	19
BMSCH	16	16	16	14	17	17	17	17	26	26	26	26	22	22	22	23
BRSAN	23	22	23	24	24	24	24	26	14	14	14	15	3	3	3	2
BURCE	21	21	21	21	23	23	23	23	2	2	2	2	5	5	5	5
BURVA	20	20	20	22	19	19	19	19	1	1	1	1	24	24	24	24
CELHA	24	24	24	23	18	18	18	20	25	25	25	25	16	16	16	15

CEMAS	4	5	5	5	5	5	5	12	24	24	24	18	26	27	26	27
CEMTS	1	1	1	1	1	1	1	2	4	4	4	3	9	10	11	14
CUSAN	8	8	8	6	10	11	11	9	12	13	12	12	27	26	27	26
DMSAS	14	13	14	16	21	21	20	18	27	27	27	27	14	15	14	13
DOFER	22	23	22	18	26	26	26	24	22	22	22	24	8	8	7	8
DOKTA	5	4	2	3	11	10	10	10	20	20	20	22	6	6	6	6
ERBOS	3	3	4	2	8	8	8	6	13	12	13	11	23	23	23	22
ERCB	7	7	6	8	20	22	22	22	17	16	16	16	18	18	18	21
EREGL	6	6	7	9	4	4	4	5	5	5	5	4	17	17	17	16
ISDMR	2	2	3	4	6	6	6	8	10	10	10	10	13	13	13	11
IZMDC	25	25	25	25	27	27	27	25	3	3	3	9	19	19	19	17
KRDMD	17	17	17	20	2	2	2	1	21	21	21	19	20	20	20	18
KCAER	9	9	9	7	15	15	15	14	11	11	11	7	4	4	4	4
KOCMT	-	-	-	-	16	16	16	16	6	8	8	14	21	21	21	25
MEGMT	18	18	18	17	25	25	25	27	23	23	23	23	11	9	10	10
OZYSR	-	-	-	-	22	20	21	21	19	18	18	20	7	7	8	7
PNLSN	12	12	12	10	7	7	7	4	15	15	15	13	1	1	1	1
SARKY	13	14	13	11	14	14	14	15	18	19	19	21	10	11	9	9
TUCLK	11	11	11	15	9	9	9	7	9	9	9	8	2	2	2	3
YKSLN	10	10	10	12	3	3	3	3	8	7	7	6	25	25	25	20

Table 13 shows that the rankings derived using various MCDM algorithms have exhibited slight variations from one another. While the same company ranked first in the years 2020, 2021, 2022, and 2023, a strong positive correlation has been identified among the overall rankings. For the year 2020, the highest correlation coefficient was found between PIV and WASPAS (0.997), while for 2021, it was between WASPAS and SAW (0.999), for 2022 again between WASPAS and SAW (0.999), and for 2023, it was between PIV and WASPAS (0.997) as the methods with the highest correlation coefficients. The lowest correlation coefficient for the year 2022 was found between PIV and RSMVC (0.940). The outcomes derived from employing various algorithms of the MCDM technique on identical datasets may exhibit variation. Within the realm of literature, numerous research exist that can be utilized as exemplars of this particular circumstance (Ecer and Pamucar, 2022; Goswami et al. 2021; Mathew and Sahu, 2018; Nguyen et al., 2022). The results obtained using different criteria for weighting techniques are presented in Table 14.

Table 14. RSMVC Rankings Achieved with Different Weighting Techniques

	2020			**2021**			**2022**			**2023**		
Company	**EW**	**Entropy**	**LOPCOW**	**EW**	**Entropy**	**LOPCOW**	**EW**	**Entropy**	**LOPCOW**	**EW**	**Entropy**	**LOPCOW**
AYES	14	14	13	15	14	13	17	17	17	13	12	12
BMSTL	19	19	19	11	11	11	4	5	5	17	17	19
BMSCH	15	15	14	16	17	17	26	26	26	23	23	23
BRSAN	24	24	24	26	26	26	14	15	15	2	2	2
BURCE	22	22	21	22	23	23	2	2	2	5	5	5
BURVA	21	21	22	19	19	19	1	1	1	24	24	24
CELHA	23	23	23	23	22	20	25	25	25	15	15	15
CEMAS	5	6	5	9	10	12	20	18	18	27	27	27

CEMTS	1	1	1	1	2	2	3	3	3	12	13	14
CUSAN	6	5	6	9	9	9	16	12	12	26	26	26
DMSAS	16	16	16	19	18	18	27	27	27	14	14	13
DOFER	20	20	18	25	24	24	23	24	24	8	8	8
DOKTA	4	2	3	12	12	10	21	21	22	6	6	6
ERBOS	3	3	2	7	8	6	12	11	11	22	22	22
ERCB	7	7	8	17	20	22	15	16	16	19	21	21
EREGL	7	9	9	4	4	5	5	4	4	16	16	16
ISDMR	2	4	4	5	6	8	10	9	10	11	11	11
IZMDC	25	25	25	24	25	25	6	10	9	20	18	17
KRDMD	17	18	20	1	1	1	19	19	19	20	19	18
KCAER	9	8	7	13	13	14	8	7	7	3	3	4
KOCMT	-	-	-	14	15	16	11	14	14	25	25	25
MEGMT	18	17	17	27	27	27	24	23	23	9	10	10
OZYSR	-	-	-	21	21	21	21	20	20	7	7	7
PNLSN	12	10	10	8	5	4	13	13	13	1	1	1
SARKY	13	13	11	17	16	15	18	22	21	10	9	9
TUCLK	11	12	15	6	7	7	7	8	8	4	4	3
YKSLN	10	11	12	3	3	3	9	6	6	18	20	20

As can be seen from Table 14, the RSMVC rankings obtained based on the three weighting techniques differ from each other and show slight deviations. The rankings obtained using EA and Entropy methods are more homogeneous compared to the rankings obtained using the LOPCOW technique. Different rankings of the Weighted Sum Model (WSM) obtained based on different weights can vary when using the same dataset, and here are numerous instances of this scenario in the literature (Žižović et al. 2020; Hafezparast et al. 2015; Zavadskas and Podvezko, 2016).

6. Conclusion

The basic metal industrial sector holds a significant and key place in the Turkish economy. It maintains close connections with numerous other sectors, contributes to economic development, and actively participates in the economy through its extensive job opportunities. The growth of the sector by maintaining its current situation depends on the ability of these companies to compete with their competitors. For organizations to be competitive, it is imperative that their financial state is sound. In this context, the strategic aspect of basic metal industry companies in terms of the Turkish economy requires the continuous evaluation of their performance. This framework examines, evaluates, and interprets the financial performance of the leading corporations in the metal industry by considering their financial condition.

The objective of this study is to evaluate the financial performance of 27 companies operating in the BIST basic metal industrial sector throughout the period from 2020 to 2023. The assessment will be based on profitability ratios using the LOPCOW-RSMVC hybrid MCDM model. The study utilized metrics such as return on assets, EBITDA margin, return on equity, net profit margin, and gross profit margin. These indicators were derived from a thorough literature analysis. The LOPCOW methodology was employed to ascertain the weights of the criteria, while the RSMVC method was utilized to rank the options.

The LOPCOW-RSMVC model revealed that the profitability-based financial performance of the enterprises exhibited fluctuations over the years. Considering the average rank values of the four periods, CEMTS (5.0), PNLSN (7.0), KCAER (8.0) ranked in the top three, while CELHA (20.75), BMSCH (20.0), MEGMT (19.25) ranked in the bottom three. To assess the durability of the model employed in the study, a sensitivity analysis was conducted, which comprised of two steps. Firstly, the results obtained by using different MCDM methods (PIV, WASPAS, SAW, RSMVC) were compared, and secondly, the results obtained based on different criteria weighting techniques (EA, Entropy, LOPCOW) were compared. While the rankings obtained based on different MCDM methods and different criteria weighting techniques generally differed with small deviations, a high positive relationship was found between the results.

A Spearman correlation analysis was conducted to ascertain the presence of a relationship between the rankings obtained using five distinct methodologies. For 2020, the highest correlation coefficient was determined between PIV and WASPAS (0.997), while WASPAS and SAW (0.999) for 2021, WASPAS and SAW (0.999) for 2022, and PIV and WASPAS (0.997) for 2023 were determined as the methods with the highest correlation coefficient. The lowest correlation coefficient was found between PIV and RSMVC (0.940) for 2022. The rankings obtained with Entropy and EA methods were found to be more homogenous than the rankings obtained with LOPCOW technique.

In this study, it is seen that there is a similarity between the companies found to be efficient and the companies found to be efficient in the studies in the literature. CEMTS, which exhibits the most favourable financial performance in this study, is likewise ranked highly in the investigations conducted by Gönüllü (2022), Çolak (2023), and Aslan Gürdal and Durmuş (2024). In other words, the findings of this study produced similar results to those of Gönüllü (2022), Çolak (2023) and Aslan Gürdal and Durmuş (2024).

The results of the study provide significant insights into the financial performance of companies in the basic metal sector. The findings show that particularly the gross profit margin and EBITDA margin ratios play a decisive role in the ranking results of the companies. Companies with higher gross profit margin and EBITDA margin ratios rank higher compared to others, indicating their success in operational efficiency and cost control. The basic metal sector has a strategic importance in the Turkish economy, making significant contributions to economic growth through its close ties with numerous other sectors and providing extensive job opportunities. In this context, having a solid financial position is critical for companies to gain a competitive advantage. The research shows that companies with strong financial performance offer more attractive investment options for investors. It is believed that investors can minimize their risks by focusing on companies with solid financial statements and high profitability ratios. For sector stakeholders and regulatory institutions, it is crucial to regularly assess the financial performance of companies and implement transparent reporting standards. In this regard, incentives such as government support, tax

reductions, credit facilities, and sector-based financial auditing mechanisms can help increase the competitiveness of the industry. Furthermore, the development of investor information platforms could effectively contribute to enhancing the reliability of the sector. In conclusion, the findings of the study provide valuable support for strategic decision-making processes regarding the dynamics of the basic metal sector. Investors, sector stakeholders, and regulatory institutions can take more informed steps in planning, auditing, and policy development processes using these data, thereby ensuring the sector's competitiveness and sustainable growth.

In this study, the LOPCOW-RSMVC model was utilized for the first time to evaluate the financial performance of the basic metal industry. In future research, the aforementioned model can be applied to address many issues, encompassing both non-financial and financial variables within the area of analysis. Furthermore, the RSMVC method can be effectively utilized in conjunction with subjective weighting procedures such as FUCOM, BWM, and AHP. The outcomes derived from this integration can then be compared.

Contribution Rate and Conflict of Interest Statement

All stages of the study were designed by the author(s) and contributed equally. There is no conflict of interest in this article.

Ethics Statement and Financial Support

Ethics committee principles were followed in the study. Ethics Committee Report is not required in the study. There has been no situation requiring permission within the framework of intellectual property and copyrights.

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