Fiscaoeconomia

E-ISSN: 2564-7504

2024, Volume 8, Issue 3, 938-967

https://dergipark.org.tr/tr/pub/fsecon

Submitted/Geliş: 06.03.2024
Accepted/Kabul: 23.05.2024
Doi: 10.25295/fsecon.1447540

Research Article/Araştırma Makalesi

Entropy-TOPSIS Method Approach: A Comprehensive Quarterly Assessment with Application in Turkey's Cement Sector

Entropi-TOPSIS Yöntemi Yaklaşımı: Türkiye'nin Çimento Sektöründe Uygulamalı Kapsamlı Çeyreklik Değerlendirme

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Abstract

The objective of this research is to determine the financial performance of Turkish cement firms using quarterly data from the period between 1997 and 2022 through the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The research takes into account company mergers that occurred in 2020 and analyzes two distinct periods: from 1997 to 2020, and post-2020. Fourteen companies were examined in the first period, while ten companies were assessed in the latter period. To measure financial performance, ten common financial ratios selected based on literature were utilized. Determining the importance of these financial ratios is a crucial step in multi-criteria decision-making techniques; hence, the entropy method was employed to address this issue. According to empirical results, before the company mergers, UNYE and MARDIN cement firms were observed to consistently perform well financially, often ranking at the top based on the financial parameters considered. However, after the merger, it has been noted that BUCIM consistently held the top position in every quarter.

Jel Kodları: *C44, L25, L61*
Keywords: *Cement Firms, Financial Ratios, Entropy-based TOPSIS Method*

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Citation/Atıf: Özarı, Ç. & Demirkale, Ö. (2024). Entropy-TOPSIS Method Approach: A Comprehensive Quarterly Assessment with Application in Turkey's Cement Sector. *Fiscaoeconomia, 8*(3), 938-967. Doi: 10.25295/fsecon.1447540

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Öz

Bu çalışmanın amacı, 1997 ile 2022 yılları arasında elde edilen çeyreklik verileri kullanarak Türk çimento sektöründeki firmaların finansal performanslarını Benzerlik İdeal Çözüme Tercih Sırası Tekniği (TOPSIS) ile değerlendirmektir. Araştırma, 2020 yılında yaşanan şirket birleşmelerini de göz önünde bulundurarak, 1997-2020 ve 2020 sonrası olmak üzere iki farklı dönemi kapsamaktadır. İlk dönemde 14, ikinci dönemde ise 10 şirket incelenmiştir. Finansal performans analizi için literatüre dayalı olarak seçilen on temel finansal oran kullanılmıştır. Finansal oranların önem derecesini belirlemek çok kriterli karar verme süreçlerinde hayati bir rol oynar; bu nedenle, bu hususu ele almak amacıyla entropi yöntemi tercih edilmiştir. Ampirik sonuçlara göre, şirket birleşmelerinden önce UNYE ve MARDIN'in, baz alınan finansal parametreler açısından en çok ilk sırada yer alarak iyi bir finansal performans sergilediği belirlenmiştir; ancak birleşmeden sonraki dönemde, BUCIM'ın her çeyrekte sürekli olarak ilk sırada yer aldığı tespit edilmiştir.

Jel Codes: *C44, L25, L61*
Anahtar Kelimler: *Çimento Firmaları, Finansal Oranlar, Entropi Temelli TOPSIS Yöntemi*

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1. Introduction

The performance evaluation process of companies is a leading process in terms of maintaining their presence in the sector and determining their competitiveness. Today's competitive conditions, as well as the dramatic developments in information technologies, have made it mandatory for companies operating in capital markets to evaluate their financial performance and create a competitive strategy accordingly. Various financial analysis methods are used to ensure that the companies listed on the stock exchanges can continue their activities following their goals and maintain their position in the sector. These methods include traditional and mathematical methods. Traditional methods are used to evaluate the financial performance of the company using the financial statements of the firms may be insufficient or incomplete. Depending on the results obtained from these methods, making decisions and predictions about future periods can lead to misleading decisions for both the business and the investor. Therefore, the use of mathematical methods in combination with traditional methods will open the way for the firm and the investor to make more accurate decisions.

Traditional methods can be a guide for determining the financial structure of a firm from the point of view of business managers, business lenders, and investors. Traditional methods, widely utilized for evaluating companies' financial performance, rely on the analysis of companies' financial statements from previous periods. When studies in the literature are examined, the most used of these methods are ratio analysis, vertical analysis, comparative analysis, trend analysis, and fund flow analysis (Ceylan & Korkmaz, 2015: 35). In this research, ratios that test the liquidity, activity, and profitability of the assets owned by cement companies in maintaining their operations by using ratio analysis were used in the first step.

Methods of financial analysis are important not only for the firm but also for other firms involved in the sector. In this context, Multi-Criteria Decision Making (MCDM) techniques based on traditional analysis methods are used to measure financial performance to determine the position of firms in the sector and their competitiveness. MCDM techniques include methods such as TOPSIS, Fuzzy TOPSIS, ELECTRE, Analytical Hierarchy Process (AHP), Fuzzy Logic, Artificial Intelligence, and Genetic Algorithms" (Sakarya & Akkuş, 2015: 110).

The TOPSIS method, initially introduced by Hwang and Yoon in 1981 and grounded on the principle that the chosen alternative should be nearest to the positive ideal solution and farthest from the negative ideal solution, as outlined by Feng & Wang (2000: 138). In employing the TOPSIS method, decision-makers assign weights to each criterion and evaluate the options by calculating the distances between each option and both the positive and negative ideal outcomes based on these criteria. According to Huang et al. (2011: 17), the superiority of the TOPSIS method over others is attributed to its advantages, including its user-friendly approach, consistent reliability, low computational demand, and the ability to be programmed.

In this research, 22-year quarterly data of 14 cement firms operating in Turkey and whose shares are traded on the Borsa Istanbul were used. The effectiveness of firms' performance in the process is measured using the TOPSIS method based on entropy. In this context, the

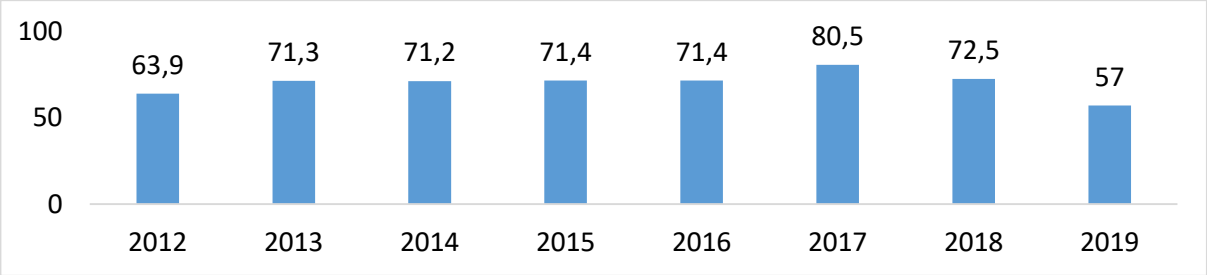
research aims to provide a comprehensive assessment of the quarterly data of each year of the firms between 1997 and 2020, in both their financial performance and their activities.

The remainder of this research is structured as follows: Section Two provides a brief overview of the background of cement firms. Section Three briefly explains the financial ratios used in evaluating financial Performance. The theoretical framework, including the entropy-based TOPSIS method and its literature, is detailed in Section Four. Section Five presents the application of ranking cement firms using the entropy-based TOPSIS method, along with key findings. Finally, Section Six presents the findings and results of the analysis and offers suggestions for future studies.

2. Background of the Cement Firms

Cement firms, like those in other sectors, aim to profit from their activities, develop, grow, increase their market values, and ensure continuity. In Turkey, the cement sector plays a critical role in the construction industry and has been rapidly growing in recent years due to the increasing need for housing. As shown in Fig. 1, the sector experienced growth at certain rates from 2012 to 2017 but entered a downward trend starting in 2018.

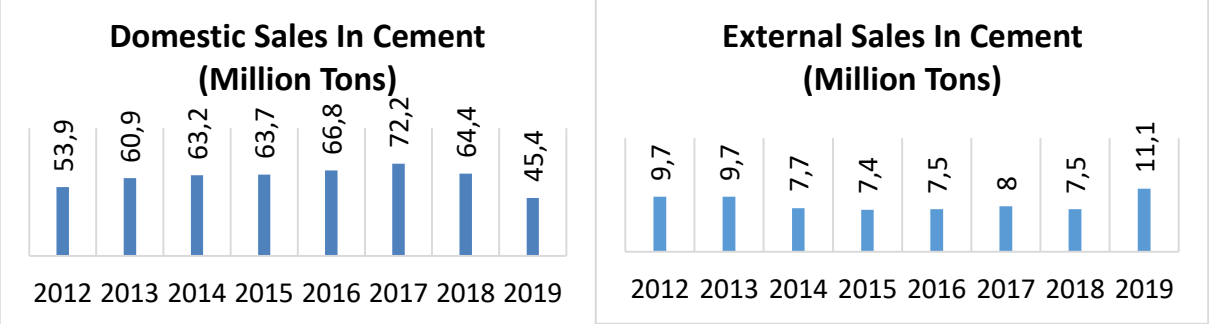
Fig. 1: Turkey Cement Production (Million Tons)



Source: https://www.turkcimento.org.tr/tr/istatistikler

Despite the contraction experienced by the sector in the domestic market as of 2019, it is observed that the share of exports has increased. It is believed that the declining demand for housing in Turkey in recent years has caused the sector's share of the domestic market to decline. Positive developments in the foreign market are expected to negatively affect the cement sector as in many sectors with the Covid-19 outbreak. The shrinking trend of the sector in the domestic market is expected to reduce its share of exports due to the negative impact of the global epidemic. As in other sectors, the dynamic process, and the uncertainty of when the outbreak will end is among the most crucial problems in the cement sector (Fig. 2).

Fig. 2: Domestic and Foreign Sales of Cement



Source: Çimento Sektörü Raporu, 2020.

The cement sector efficiently utilizes its resources in terms of raw materials and meets the country's needs through its production. With a relatively small share in imports, this sector exports to 155 countries worldwide. According to the Cement Sector Report published in Turkey in 2020, African countries like Cameroon, Ghana, and Ivory Coast are among the most developed in this sector, while the United States and Israel represent its most critical markets. Presently, the sector faces no issues in satisfying domestic demand and ranks as the fifth-largest cement exporter globally. Turkey holds the top position in cement production in Europe and the sixth worldwide. By producing high-quality, affordable cement for both domestic use and international markets, Turkey has enhanced its efficiency in the cement industry and is poised for future growth without dependency (Çimento Sektörü Raporu, 2020).

It is important for firms operating in the cement sector to successfully continue their activities. Determining the competitiveness of firms and evaluating their financial performance are vital for the development of the country's economy. Furthermore, conducting a comparative analysis of firms in the sector will help them maintain market values and create long-term strategic plans.

3. Financial Ratios

One of the most preferred and popular methods for evaluating the financial performance of firms is the rate analysis method, defined as a simple mathematical expression of the relationship between any two items contained in the financial statements. By using the financial items contained in the financial statements of the firms with rate analysis, it helps to obtain detailed information about the liquidity status, operating activities, financial structures, and profitability of the firm (Akgüç, 1995: 345). Usually, rates in the four groups are taken into account.

Liquidity ratios investigate the ability of a business to pay short-term debts. It is a ratio that represents the ability of a business to convert its assets into cash and the like in the short term by establishing a relationship between its current assets and short-term debts. Current assets are assets that can be converted into cash within one year. These assets consist of cash, receivables, inventories, and securities Bae et al., 2021: 363).

Liquidity ratios consist of the current ratio, acid-test ratio, stock dependency ratio, cash ratio, and ready values ratios (Karapınar & Zaif, 2013: 207).

Financial structure ratios include the extent to which the business is financed with debt, the extent to which it is financed with equity, and the rates used to measure long-term debt payment performance. As certain headings of the rates related to the financial structure, the leverage ratio, the equity ratio, and the debt ratio of the equity can be considered (Ceylan & Korkmaz, 2015: 52-53).

Activity ratios refer to rates that measure the extent to which the entity effectively uses the assets that it owns and uses to carry out its activities. The rates in this group are stock turnover rate, receivables turnover rate, current assets turnover rate, fixed assets turnover rate, asset turnover rate, equity turnover rate, and property, plant, and equipment turnover rate (Akdoğan & Tenker, 1997: 543).

Profitability ratios are metrics used to assess the extent to which the firm's profit is measurable and sufficient relative to its investments and sales. Key profitability ratios include the gross margin ratio, operating profit ratio, net profit margin ratio, return on equity, and return on assets (Akdoğan & Tenker, 1997: 593).

4. Theoretical Framework

Determining the financial performance ranking of companies in any industry involves treating the task as an essential aspect of Multi-Criteria Decision Making (MCDM). This evaluation process is flexible, allowing it to be applied across different sectors and accommodate a variety of financial indicators. The methodology is structured around key steps, ensuring a thorough and adaptable analysis.

Step 1: Identification of Key Financial Ratios: Identify the most critical financial ratios that measure the financial performance of cement firms.

Step 2: Quarterly Calculation of Financial Ratios: Calculate these financial ratios for each cement firm on a quarterly basis.

Step 3: Weight Calculation Using the Entropy Method: Use the entropy method to calculate the weights of each financial ratio for every quarter.

Step 4: Refinement of Financial Ratios and Adjustment of Weights: Examine the weights derived from the entropy method. If the volatility of the weights, calculated on a quarterly basis using the entropy method, is not high, proceed to refine the model by removing financial ratios with low importance. If the volatility is too high, consider employing an alternative method, such as CRITIC, to calculate the importance levels of financial ratios. Following either scenario, determine new weights by calculating the average importance rankings of the remaining ratios across all quarters.

Step 5: Application of the TOPSIS Method: Apply the TOPSIS method to evaluate and rank the financial performance of all cement firms using the refined set of financial ratios and their new quarterly average weights.

4.1. Entropy-based TOPSIS Method

We observed that among the various MCDM techniques, the TOPSIS method was most widely used in various fields due to its simplicity. This method was first proposed by Hwang & Yoon in 1981. According to this method, a positive ideal solution maximizes/minimizes the benefit/cost criteria, whereas a negative ideal solution maximizes/minimizes the cost/benefit criteria. Entropy is among the frequently used methods in MCDM approaches, aiming to determine the importance levels of evaluation criteria. A review of the literature reveals that studies frequently utilize the TOPSIS method alongside entropy (Altan & Yıldırım, 2019; Ding et al., 2016; Huang et al., 2018; Karakaş & Öztel, 2020; Turunç & Ersoy, 2018). Additionally, it is noteworthy that entropy can also be applied in conjunction with methods other than TOPSIS, demonstrating its versatility across various decision-making frameworks (Eş & Kocadağ, 2020; Fajdek-Bieda, 2021; Liu & Ming, 2019; Sümerli Sarıgül et al., 2023; Ünvan & Ergenç, 2022; Vaid et al., 2022). The entropy-based TOPSIS method has seven steps, as follows:

Step 1: Calculation of Decision Matrix

The decision matrix [DM] for the annual financial ratios of cement firms can be expressed as follows:

$$DM_{n\times m} = \begin{bmatrix} d_{11} & \cdots & d_{1m} \\ \vdots & \ddots & \vdots \\ d_{n1} & \cdots & d_{nm} \end{bmatrix} \quad (1)$$

n represents the number of alternatives (cement firms) and m represents the number of criteria (financial ratios).

Step 2: Calculation of Normalized Decision Matrix

$$NDM_{n\times m} = \begin{bmatrix} z_{11} & \cdots & z_{1m} \\ \vdots & \ddots & \vdots \\ z_{n1} & \cdots & z_{nm} \end{bmatrix}, \text{ where } z_{ij} = \frac{d_{ij}}{\sqrt{\sum_{i=1}^{n} d_{ij}^2}} \quad (2)$$

where z_{ij} represents the normalized value of d_{ij}

Step 3: Calculation of the weights of each criterion with entropy method

The entropy method was developed by Shannon (1948). This method is widely used to evaluate index weights (Hsu, 2013: 449). The entropy weight is applied to calculate the importance level of financial ratios that are used as criteria to measure financial performance.

$$r_{ij} = \frac{d_{ij}}{\sum_{i=1}^{n} d_{ij}}, \text{ i=1, 2, ..., n and j=1, 2, ..., m} \quad (3)$$

$$e_j = \frac{-1}{\ln(m)} \sum_{i=1}^{m} r_{ij} \ln(r_{ij}), \text{ i=1, 2, ..., m and j=1, 2, ..., n} \quad (4)$$

$$w_j = \frac{1-e_j}{\sum_{j=1}^{n}(1-e_j)}, \text{ j=1, 2, ..., n} \quad (5)$$

where r_{ij} denotes the ratio of d_{ij} in the evaluation indicator j, e_j denotes the entropy value of the evaluation indicator, j and w_j denotes the weight of indicator j.

Step 4: Determination of the Weighted Normalized Decision Matrix

The weighted normalized decision matrix $WNDM_{n\times m}$is obtained from matrix NDM.

$$WNDM_{n\times m} = \begin{bmatrix} w_{11} & \cdots & w_{1m} \\ \vdots & \ddots & \vdots \\ w_{n1} & \cdots & w_{nm} \end{bmatrix}, \text{where } w_{ij} = w_j z_{ij} \quad (6)$$

Step 5: Determination of Ideal Solution (Positive and Negative)

The positive ideal vector P^+ and the negative ideal vector P^- can be calculated as follows.

$$P^+ = (p_1^+, p_2^+, \dots, p_n^+) \text{ where } p_i^+ = \{max(w_{ij}), j \in J, min(w_{ij}), j \in J'\} \quad (7)$$

$$P^- = (p_1^-, p_1^-, \dots, p_n^-) \text{ where } p_i^- = \{min(w_{ij}), j \in J, max(w_{ij}), j \in J'\} \quad (8)$$

Step 6: Calculation of the separation measures for each alternative

The separation from positive ideal alternative is:

$$S_i^+ = [\sum_{i=1}^{m}(p_i^+ - w_{ij})^2]^{1/2} \quad (9)$$

The separation from negative ideal is:

$$S_i^- = [\sum_{i=1}^{m}(p_i^- - w_{ij})^2]^{1/2} \quad (10)$$

Step 7: Calculation of relative closeness to the ideal solution

$$C_i^* = {S_i^-}/{(S_i^+ + S_i^-)} \quad (11)$$

4.2. Literature of TOPSIS Method

It is known that in the literature, MCDM techniques are utilized to evaluate the financial performance of companies across various sectors. Below is a summary of some of the significant studies in this area.

Feng & Wang (2000) analyzed the performance of five airlines operating in Taiwan using the TOPSIS method. The research considered 22 variables representing transportation and financial indicators to rank the companies' performance. Another study by Feng & Wang (2001) focused on companies in the transportation sector in Taiwan. The researchers ranked four bus companies based on their financial performance across 16 variables. In another study conducted by Wang & Hsu (2004), the financial ratios of 10 firms traded on the Taiwan Stock Exchange were investigated using the TOPSIS method. The study suggests that the financial ratios and method used could be beneficial for investors in making decisions and determining investment strategies.

Kalogeras et al. (2005) examined the performance of 12 food companies operating in Greece over 5 years. In the study, they ranked companies according to their financial performance using 11 financial ratios with the assistance of PROMETHEE-II.

Bo & Haidong (2008) examined 112 companies listed on the Chinese stock exchange, and 11 financial ratios using the TOPSIS method. Researchers have found that the TOPSIS method can be used as an early warning system for companies during times of crisis.

Wang et al. (2010) ranked 13 businesses listed on the Vietnam Stock Exchange by financial ratios using the TOPSIS method. The researchers found that the TOPSIS method can be useful for investors to build portfolios by evaluating businesses among themselves according to their financial performance.

Mandic et al. (2014) examined 35 banks operating in Serbia between 2005 and 2010 using AHP and TOPSIS methods. 5 financial indicators were used in the analysis. In the first phase of the study, the criteria were weighted by the Fuzzy AHP (FAHP) method. In the second stage, the performance ranking of the banks with the relevant financial indicators was carried out using the TOPSIS method. According to the results from the study, Banca Intesa bank was the best performing bank.

Moghimi & Anvari (2014) investigated 8 cement firms operating on the Tehran Stock Exchange using FAHP and TOPSIS methods. In the study, the financial performance of the companies was evaluated over 16 financial ratios, and performance rankings were performed. In the study, criterion weights were found to have a significant effect. Rezaie et al. (2014) examined 27 cement companies operating on the Tehran Stock Exchange between 2008-2009 using FAHP and VIKOR methods. In the study, the FAHP method was used to determine the weight of 13 financial ratios. The companies were compared with each other with the VIKOR method, and the most successful cement company was tried to be determined for the years studied. Shaverdi et al. (2016) evaluated 7 petro-chemical companies listed on the Tehran Stock Exchange using the fuzzy TOPSIS method. The study was conducted using 15 financial ratios between 2003 and 2013. According to the results of the analysis, it was found that the weight ratios of the 7 companies are very close to each other.

Raikar (2018) used the AHP and the VIKOR method to evaluate the financial performance of Indian cement companies from 2013 to 2017. Based on the results of the analysis, Ambuja Cement was determined to rank first.

Liu et al. (2019) examine the maturities of China’s seven carbon markets from 2013 to 2018 with the help of the entropy-based TOPSIS method. In other words, they proposed an entropy-based TOPSIS model to measure the maturity of the carbon market. Finally, some targeted policy implications are put forward to improve the maturity of the carbon market.

Bae et al. (2021) aimed to decipher the relationship between the financial and operational performance criteria of airlines, as well as to create an evaluation system to help determine the strengths and weaknesses of airlines in their performance measurement. For this purpose, they tested a hybrid method combining FAHP, and TOPSIS methods. To compare the findings, they also conduct FAHP and TOPSIS methods. They stated that with this modeling, the

systematic relationship between the financial and operational criteria of airlines can be better measured.

Sun & Yu (2021) employed simple normalization, entropy-based TOPSIS, and K-means methods to propose an improved data-driven method for evaluating building energy performance and ranking urban-scale office buildings. The entropy-based TOPSIS method assesses and evaluates the energy performance of buildings, while the K-means method ranks the assessed buildings.

Yurdakul & İç (2003) examined the performance of 5 automotive companies in Turkey whose shares are traded in BIST and operating in the automotive sector using the TOPSIS method. The research was conducted between 1998 and 2001 using financial ratios. The result found that firm performance showed a similar consistency relative to share prices.

Akkaya (2004) investigated the performance of an airline using the TOPSIS method. Three titles were identified: production, marketing, and activity, and 13 ratios were identified to represent each group using gray relationship analysis and TOPSIS methods. According to the results of the analysis, it was determined that the airline is in an important position in the national competition with the help of the relevant ratios.

Ertuğrul & Karakaşoğlu (2009) evaluated 15 cement firms whose shares are traded in BIST by using FAHP and TOPSIS methods. After determining the weights of the criteria with FAHP in the analysis using financial ratios, the performance ranking of the companies was determined by the TOPSIS method. In the study, it was determined that ADANA Cement Company took first place in the performance ranking.

Dumanoğlu (2010) evaluated 15 cement companies whose shares were traded in BIST using the TOPSIS method between 2004 and 2009. In the study, which used eight financial ratios; MARDIN cement ranked first in the performance rankings between 2004 and 2005, and ADANA cement ranked first in 2006-2007. BOLU cement was found to be the first in 2008 and KONYA cement was found to be the first in 2009.

Tayyar & Şimşek (2011) evaluated the financial performance of cement companies for 2009 using AHP, FAHP, and TOPSIS methods. In the study, they used AHP and FAHP methods to weigh the 5 main criteria and 17 sub-criteria selected. The results obtained from the research determined that the company with the best financial performance is ADANA cement followed by KONYA and BOLU cement companies, respectively.

Özden et al. (2012) assessed the financial performance of 16 cement companies whose shares were traded in BIST using the VIKOR method for the year 2011. Eight financial indicators were used to evaluate the financial performance of firms in the study. In addition, the stock returns of firms were calculated. According to the results obtained from the analysis, Konya Cement was found to have the highest performance. The study also found that there was no significant relationship between the rankings obtained with VIKOR and the rankings of returns obtained per share.

Sakarya & Akkuş (2015) examined the financial performance of cement companies whose shares were traded on BIST between 2010 and 2013 using the TOPSIS method. In the study,

traditional ratios and cash flow ratios of firms were used and compared with the result. The findings showed that the ranking with traditional rates differs from the ranking with cash flow rates.

Güleç & Özkan (2018) evaluated the financial performance of 16 cement companies whose shares were traded in BIST between 2005 and 2016 using the gray relational analysis method. 17 financial ratios were used to evaluate the financial performance of firms in the study. In the study, it was found that the most successful company was ÜNYE Cement, which ranked first for four years.

Kızıl (2019) examined the stock market performance and financial performance of cement companies whose shares were traded in BIST between 2015 and 2017 using the TOPSIS method. In the study, it was determined that KONYA cement ranked first in the financial performance rankings in 2015 and 2017 and ADANA cement ranked first in 2016. It also concluded that there was a significant correlation between the financial performance of businesses and stock market performance in 2015 and 2017, while there was no meaningful correlation in 2016.

Atukalp (2019) examined the performance of 15 cement companies based on 7 financial ratios between 2013 and 2017 using the Multi-MOORA method. It was found that the company with the best financial performance was ÜNYE cement.

Akbulut (2020) examined the financial performance of cement companies traded on BIST between 2014 and 2018, utilizing the Criteria Importance Through Intercriteria Criteria Importance Through Intercriteria Correlation (CRITIC) and Multi-Attributive Border Approximation Area Comparison (MABAC) methods. According to the results from the CRITIC method, the main performance criteria for these companies varied from year to year. Additionally, the MABAC method revealed that ADANA, ADBGR, and KONYA were the three most financially successful companies. However, in terms of stock return rankings, ADNAC, ADANA, and ADBGR are the three most successful companies.

Lam et al. (2023) introduced an entropy-fuzzy TOPSIS model designed to evaluate the financial performance of companies based on various financial ratios, with the goal of identifying the most viable candidates for portfolio investment. Utilizing Shannon's entropy for determining the weights of financial ratios and the fuzzy TOPSIS method for company assessment and ranking, the model highlights HD as the leading company, followed by NKE, UNH, MSFT, WMT, INTC, and AAPL, for portfolio selection purposes.

5. Application and Discussion

The main objective of this research is to evaluate and compare the financial performance of cement firms operating in BIST with the help of financial ratios. The research covers quarterly data from 1997 to 2022 (102 Quarters). Due to the merger of five companies (ADANA, BOLU,

LAFARGE, MARDIN, UNYE) under the OYAK Group after 2020-Q1, the application section has been divided into two subperiods. In addition, the financial performance of 14 firms will be examined through the sample 93 quarters, and the financial performance of 10 firms will be examined individually in the last 9 quarters.

14 firms from the cement sector operating in BIST, whose data for the relevant period (93 Quartes, 1997-Q1 to 2020-Q1) can be accessed continuously, were included in the study. The data was obtained from the financial statements of the firms in the Public Disclosure Platform (KAP) and Finnet. The data on the financial statements of the companies before 2009 were obtained from Borsa Istanbul.

For Step 1 and Step 2 of the proposed approach, financial ratios which are illustrated in Table 1 are used to evaluate the financial performance of the cement firms that can provide information about companies' profitability and financial structure.

Table 1: Financial Ratios for the Cement Firms

Symbols of Financial Ratios	Target	Financial Ratios
C1	Max	Current Ratio
C2	Max	Acid-Test Ratio
C3	Max	Treasury Rate
C4	Max	Total Asset Turnover Rate
C5	Min	Short-Term Foreign Resources / Total Assets
C6	Max	Profitability of Sales
C7	Max	The Ratio of Active Profitability
C8	Min	Average Collection Period of Receivables
C9	Min	Standby Time In Stock
C10	Min	Average Debt Duration

Since we need to determine the importance level of each criterion for Step 3 of the proposed approach, firstly the weights of the financial ratios are calculated using the entropy method for every period. The data pertaining to the weights for the year 1997, 1998 and 2019 are presented in Table 2, while the corresponding data for the other years are included in the appendix.

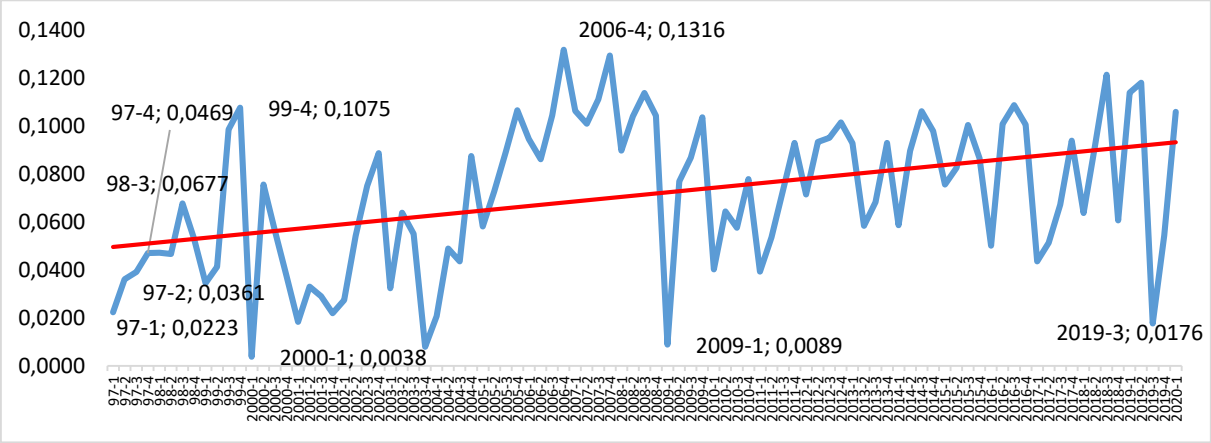
Table 2: Importance Level of Financial Ratios for 1997 and 1998

Weight	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
97-Q1	0.0223	0.0607	0.1375	0.0516	0.0257	0.1881	0.2611	0.0243	0.1461	0.0826
97-Q2	0.0361	0.0669	0.2559	0.0452	0.0446	0.1805	0.1817	0.0406	0.0895	0.0590
97-Q3	0.0391	0.0652	0.2201	0.0700	0.0375	0.1838	0.1725	0.0487	0.0984	0.0647

97-Q4	0.0469	0.0796	0.1958	0.1158	0.0398	0.1733	0.1399	0.0396	0.0896	0.0797
98-Q1	0.0472	0.1209	0.2361	0.0417	0.0344	0.0878	0.1847	0.0411	0.1371	0.0691
98-Q2	0.0466	0.0796	0.3230	0.0406	0.0409	0.1522	0.1528	0.0517	0.0768	0.0357
98-Q3	0.0677	0.0833	0.3116	0.0345	0.0775	0.1386	0.1302	0.0463	0.0621	0.0483
98-Q4	0.0530	0.0663	0.3193	0.0492	0.0710	0.1312	0.1304	0.0572	0.0593	0.0633
99-Q1	0.1138	0.1297	0.1377	0.1102	0.1113	0.0932	0.0863	0.0035	0.1036	0.1107
19-Q2	0.1179	0.1181	0.1171	0.1182	0.0083	0.1011	0.0965	0.1193	0.0959	0.1076
19-Q3	0.0176	0.0233	0.0342	0.1890	0.1917	0.1712	0.1621	0.0132	0.0106	0.1870
19-Q4	0.0543	0.0410	0.1251	0.1024	0.1250	0.1071	0.1055	0.1062	0.1174	0.1159
20-Q1	0.1058	0.0993	0.1378	0.1356	0.1378	0.1164	0.1209	0.0036	0.0090	0.1338

Figure 3 illustrates the weights assigned to the financial ratio C1, demonstrating the variations in its importance over time. Furthermore, the importance levels of other variables exhibit analogous changes across the same period. Due to the methodological framework employed in this study, these variations are deemed insignificant, resulting in their exclusion from the study.

Fig. 3: Importance Level of Financial Ratio C1



The separation from the positive ideal alternative, the separation from the negative ideal alternative, and the relative closeness to the ideal solution are illustrated in Table 3 for the first, second quarters of the year 1997.

Table 3: TOPSIS Findings for Year 1997 (Q1, Q2)

	1997-Q1				1997-Q2			
Company	S_i^+	S_i^-	C_i^*	**Rank**	S_i^+	S_i^-	C_i^*	**Rank**
ADANA	0.1730	0.1449	0.4558	7	0.1882	0.0969	0.3399	8
AFYON	0.2259	0.1077	0.3229	14	0.2072	0.0857	0.2925	11
AKCNS	0.1735	0.1369	0.4411	10	0.2106	0.0867	0.2915	12

BTCIM	0.0736	0.2586	0.7783	1	0.0518	0.2437	0.8246	1
BOLU	0.1369	0.1534	0.5285	4	0.1968	0.1007	0.3385	9
BUCIM	0.1066	0.1932	0.6444	2	0.1755	0.1235	0.4131	5
CMBTN	0.1613	0.1649	0.5056	6	0.2103	0.0951	0.3115	10
CMENT	0.1847	0.1323	0.4173	12	0.2248	0.0734	0.2462	14
CIMSA	0.1405	0.1528	0.5210	5	0.1724	0.1005	0.3682	6
GOLTS	0.1174	0.1820	0.6077	3	0.2034	0.1063	0.3433	7
KONYA	0.2074	0.0999	0.3251	13	0.2000	0.0681	0.2539	13
LAFARGE	0.1750	0.1388	0.4424	9	0.1486	0.1295	0.4656	4
MARDIN	0.1787	0.1324	0.4256	11	0.1187	0.1655	0.5823	2
UNYE	0.1752	0.1430	0.4495	8	0.1429	0.1360	0.4876	3

The separation from the positive ideal alternative, the separation from the negative ideal alternative, and the relative closeness to the ideal solution are illustrated in Table 4 for the fthird, fourth, quarters of the year 1997.

Table 4: TOPSIS Findings for Year 1997 (Q3, Q4)

	1997-Q3				1997-Q4			
Company	S_i^+	S_i^-	C_i^*	**Rank**	S_i^+	S_i^-	C_i^*	**Rank**
ADANA	0.1282	0.1225	0.4886	6	0.1396	0.1175	0.4568	6
AFYON	0.1391	0.1157	0.4541	8	0.1636	0.1063	0.3940	9
AKCNS	0.1650	0.0962	0.3683	13	0.1763	0.0878	0.3324	13
BTCIM	0.0752	0.1851	0.7112	2	0.1137	0.1550	0.5768	3
BOLU	0.1560	0.1078	0.4088	11	0.1785	0.0964	0.3508	12
BUCIM	0.1275	0.1347	0.5136	5	0.1579	0.1178	0.4272	7
CMBTN	0.1705	0.1059	0.3832	12	0.1773	0.1203	0.4042	8
CMENT	0.1977	0.0712	0.2648	14	0.1998	0.0700	0.2595	14
CIMSA	0.1382	0.1033	0.4277	9	0.1573	0.0915	0.3676	11
GOLTS	0.0691	0.1758	0.7178	1	0.1097	0.1345	0.5507	4
KONYA	0.1372	0.0973	0.4148	10	0.1521	0.0936	0.3810	10
LAFARGE	0.1283	0.1091	0.4595	7	0.1164	0.1191	0.5056	5
MARDIN	0.1052	0.1596	0.6026	4	0.0972	0.1670	0.6321	2
UNYE	0.1087	0.1812	0.6252	3	0.0943	0.2032	0.6830	1

For the fourth step of the proposed approach, the TOPSIS method is employed to obtain the financial performance of all cement firms. The closeness coefficient values, and the order of the cement firms are shown in Table 5.

Table 5: Rankings of Cement Firms According to Closeness Coefficient Values: 1997

Company	**CC-1997-Q1**	**1997-Q1**	**CC-1997-Q2**	**1997-Q2**	**CC-1997-Q3**	**1997-Q3**	**CC-1997-Q4**	**1997-Q4**
ADANA	0.4558	7	0.3399	8	0.4886	6	0.4568	6

AFYON	0.3229	14	0.2925	11	0.4541	8	0.3940	9
AKCNS	0.4411	10	0.2915	12	0.3683	13	0.3324	13
BTCIM	0.7783	1	0.8246	1	0.7112	2	0.5768	3
BOLU	0.5285	4	0.3385	9	0.4088	11	0.3508	12
BUCIM	0.6444	2	0.4131	5	0.5136	5	0.4272	7
CMBTN	0.5056	6	0.3115	10	0.3832	12	0.4042	8
CEMENT	0.4173	12	0.2462	14	0.2648	14	0.2595	14
CIMMSA	0.5210	5	0.3682	6	0.4277	9	0.3676	11
GOLTS	0.6077	3	0.3433	7	0.7178	1	0.5507	4
KONYA	0.3251	13	0.2539	13	0.4148	10	0.3810	10
LAFARGE	0.4424	9	0.4656	4	0.4595	7	0.5056	5
MARDIN	0.4256	11	0.5823	2	0.6026	4	0.6321	2
UNYE	0.4495	8	0.4876	3	0.6252	3	0.6830	1

As seen from Table 5, BTCIM cement is determined to be in the first order in the period Q1 and Q2 for 1997, while GOLTS cement is in the first order in the period Q3 and UNYE is in the first order in the period Q4. AFYON cement is determined to be in the last order in the period Q1, whereas CMENT cement is determined to be in the last order in the following Q2, Q3, and Q4 periods.

Table 6 provides the scores for each company evaluated by the TOPSIS method from the first quarter of 1997 to the fourth quarter of 1999.

Table 6. TOPSIS Findings for 1997-Q1: 1999-Q4

	1997-Q1	1997-Q2	1997-Q3	1997-Q4	1998-Q1	1998-Q2	1998-Q3	1998-Q4	1999-Q1	1999-Q2	1999-Q3	1999-Q4
ADANA	7	8	6	6	3	4	3	3	1	2	2	3
AFYON	14	11	8	9	14	11	7	5	10	8	6	7
AKÇANSA	10	12	13	13	11	9	8	4	3	4	5	5
BATIAND	**1**	**1**	**2**	**3**	**1**	**1**	**4**	**6**	**2**	**5**	**12**	**12**
BOLU	4	9	11	12	10	12	13	12	9	13	10	10
BURSA	2	5	5	7	6	8	9	9	5	10	9	13
ÇİMBETON	6	10	12	8	7	10	12	13	7	9	11	6
ÇİMENTAŞ	12	14	14	14	12	14	14	14	13	14	14	14
ÇİMSA	5	6	9	11	8	7	11	8	4	6	8	4
GÖLTAŞ	3	7	1	4	4	5	6	10	8	7	7	9
KONYA	13	13	10	10	13	13	10	11	14	12	4	8
LAFARGE	9	4	7	5	2	3	5	7	11	11	13	11
MARDİN	11	2	4	2	5	2	2	2	6	1	3	2
ÜNYE	8	3	3	1	9	6	1	1	12	3	1	1

According to Table 6, it can be observed that some companies demonstrate consistent performance, while others experience fluctuations across different periods in terms of financial performance. For instance, certain companies like BATIAND consistently rank at the top during specific periods, whereas others, such as KONYA, exhibit more variable

performance across periods. Table 7 provides the scores for each company evaluated by the TOPSIS method from the first quarter of 1997 to the fourth quarter of 1999.

Table 7. TOPSIS Findings for 2000-Q1: 2002-Q4

	2000-Q1	2000-Q2	2000-Q3	2000-Q4	2001-Q1	2001-Q2	2001-Q3	2001-Q4	2002-Q1	2002-Q2	2002-Q3	2002-Q4
ADANA	4	3	3	3	3	4	4	4	5	4	8	10
AFYON	14	11	8	6	11	11	9	11	14	13	7	5
AKÇANSA	7	10	10	11	10	10	10	8	12	10	13	14
BATIAND	6	6	5	8	6	6	6	6	6	5	9	4
BOLU	11	9	9	7	4	3	3	3	2	3	5	7
BURSA	5	12	12	10	7	7	7	7	8	11	11	11
ÇİMBETON	9	8	11	12	9	9	11	10	11	12	14	6
ÇİMENTAŞ	10	13	13	13	12	12	13	13	7	8	10	13
ÇİMSA	8	4	4	4	5	5	5	5	4	6	6	3
GÖLTAŞ	3	5	6	5	8	8	8	9	10	7	3	9
KONYA	13	7	7	9	13	13	12	12	13	14	4	8
LAFARGE	12	14	14	14	14	14	14	14	9	9	12	12
MARDİN	2	2	2	2	2	1	1	1	1	1	1	1
ÜNYE	1	1	1	1	1	2	2	2	3	2	2	2

The findings for the other years are included in the attachment. To facilitate a more comprehensive analysis of long-term trends, a frequency of rank orders table, Table 8, has been constructed for the entire period.

Table 8 gives the information of each company's number of orders during 93 quarters. From the first column of Table 8, it is seen that ADANA cement firm is determined to be in the first order 6 times and has never been in the last.

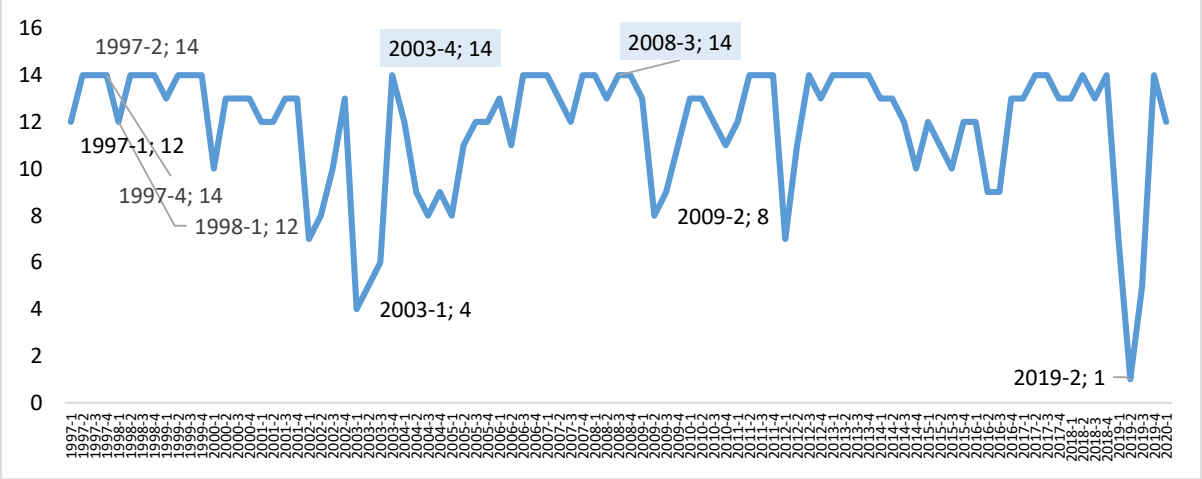
Table 8: Frequency of Rank Orders

Rank	ADANA	AFYON	AKCNS	BTCIM	BOLU	BUCIM	CMBTN	CMENT	CIMSA	GOLTS	KONYA	LAFARGE	MARDIN	UNYE
1	6	4	0	4	0	1	2	1	1	3	5	0	19	47
2	10	1	1	4	4	3	0	0	0	4	20	1	25	20

3	18	3	1	2	13	0	1	0	4	7	10	2	19	13
4	24	3	4	3	12	2	5	1	8	7	6	5	12	1
5	9	7	4	11	5	7	0	2	13	9	7	9	9	1
6	9	13	4	12	6	10	4	1	11	9	10	1	2	1
7	5	12	8	10	8	12	4	3	6	17	3	4	1	0
8	4	10	12	13	7	10	5	4	9	9	3	3	2	2
9	3	5	13	7	10	12	7	5	9	10	4	7	0	1
10	3	6	18	7	8	13	12	4	6	6	6	3	1	0
11	1	8	9	6	7	13	17	6	9	5	2	9	1	0
12	0	6	7	4	4	6	18	15	7	4	5	14	1	2
13	1	6	11	3	6	4	10	21	5	1	9	14	0	2
14	0	9	1	7	3	0	8	30	5	2	3	21	1	3

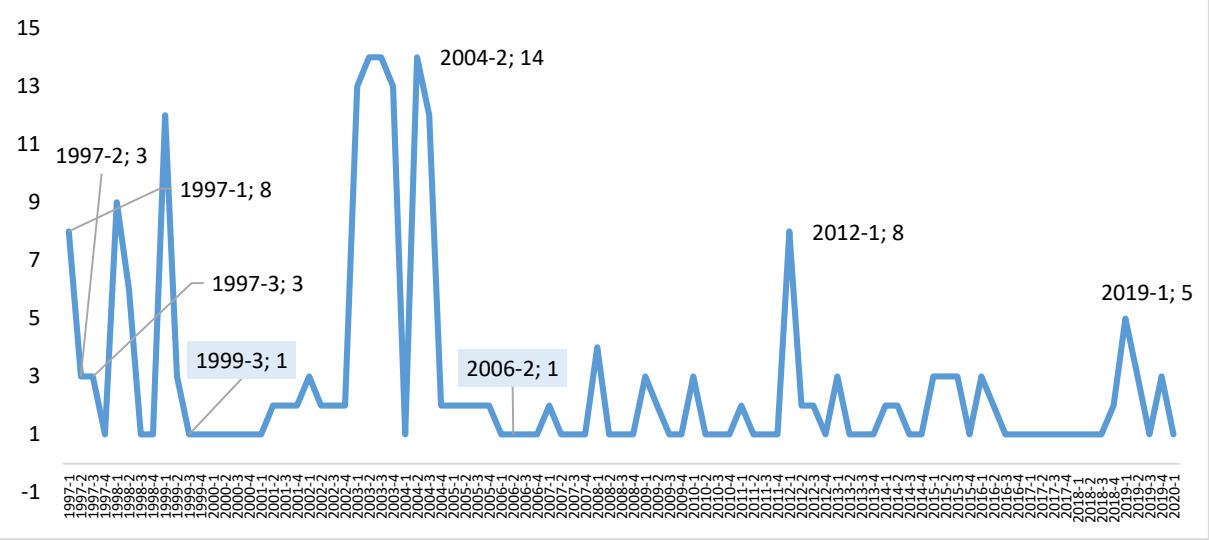
Throughout the duration of the study, CMENT cement firm was most often ranked last, appearing in this position 30 times and only once in the first order during 2019-Q2. The frequent occurrence of the firm in the lower rankings indicates that it is far from the ideal solution based on the analyzed financial ratios, thereby demonstrating a lower level of performance within the sector. To further investigate the firm's quarterly rankings, Figure 5 is constructed.

Fig. 5: CMENT Cement Ranking



UNYE cement firm is determined to be in the first order 47 times and only one time occurs in the last order (2003-Q1). The frequent attainment of first order by the firm signifies that it closely approximates the ideal solution based on the analyzed financial ratios, thereby exhibiting the highest level of performance within the sector. To examine the order of this firm in all quarters Fig. 6 is constructed.

Fig. 6: UNYE Cement Ranking



This finding indicates that the company exhibited consistently high and stable performance throughout the observed periods. Such a result suggests that the firm maintained a superior financial performance relative to its competitors and achieved competitive advantages based on the evaluated criteria.

In consideration of the advent of the Covid-19 pandemic, recognized for its significant impact on global socio-economic activities commencing towards the latter part of the 2020-Q1, we have made the decision to partition the dataset. Specifically, we have segregated the data pertaining to the 2020-Q1 from subsequent quarters (2020-Q2 onwards) into distinct tables. This methodological approach is adopted to facilitate a nuanced analysis of temporal trends, acknowledging the delineation between pre-pandemic and post-pandemic periods.

In the second sample of the study, which covers the period between 2020-Q2 and 2022-Q2, the weights of the annual financial parameters calculated with entropy are presented in Table 9.

Table 9: Importance Level of Financial Ratios-2020-Q2: 2022-Q2

Weight	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
00-Q2	0.0763	0.0716	0.1163	0.0566	0.0602	0.2519	0.1771	0.0559	0.0735	0.0608
00-Q3	0.0591	0.0565	0.0996	0.0446	0.0496	0.1948	0.3460	0.0443	0.0545	0.0510
00-Q4	0.0590	0.0543	0.0880	0.0446	0.0483	0.4230	0.1305	0.0444	0.0517	0.0563
21-Q1	0.0896	0.0841	0.1731	0.0604	0.0688	0.1633	0.1549	0.0602	0.0743	0.0714
21-Q2	0.0855	0.0812	0.1939	0.0599	0.0706	0.1441	0.1601	0.0602	0.0734	0.0712
21-Q3	0.0917	0.0901	0.2130	0.0641	0.0768	0.1115	0.1376	0.0637	0.0759	0.0756

21-Q4	0.1062	0.1032	0.2069	0.0734	0.0854	0.0424	0.1275	0.0739	0.0916	0.0896
22-Q1	0.0754	0.0777	0.1711	0.0498	0.0570	0.2791	0.1109	0.0498	0.0724	0.0568
22-Q2	0.0946	0.0931	0.1964	0.0757	0.0852	0.0965	0.1027	0.0763	0.0970	0.0824

Table 10 illustrates the separation from the positive ideal alternative, the separation from the negative ideal alternative, and the relative closeness to the ideal solution for the second and third quarters of 2020.

Table 10: TOPSIS Findings for Year 2020 (Q2, Q3, and Q4)

	2020-Q2				2020-Q3				2020-Q4			
Company	S_i^+	S_i^-	C_i^*	**Rank**	S_i^+	S_i^-	C_i^*	**Rank**	S_i^+	S_i^-	C_i^*	**Rank**
AFYON	0.1144	0.2611	0.6954	6	0.1384	0.3056	0.6883	5	0.1012	0.4067	0.8007	5
AKCNS	0.0831	0.2821	0.7725	3	0.0911	0.3503	0.7936	4	0.0852	0.4132	0.8291	4
BTCIM	0.1987	0.2073	0.5106	9	0.4246	0.0245	0.0545	10	0.4836	0.0263	0.0516	10
BUCIM	0.0369	0.3198	0.8966	1	0.0291	0.4258	0.9360	1	0.0298	0.4851	0.9421	1
CMBTN	0.1574	0.2541	0.6174	7	0.2525	0.2093	0.4533	8	0.1416	0.3910	0.7342	6
CMENT	0.1580	0.2217	0.5839	8	0.2585	0.1714	0.3987	9	0.2809	0.2082	0.4257	9
CIMSA	0.2695	0.1402	0.3422	10	0.1625	0.3160	0.6604	7	0.1958	0.2954	0.6014	8
GOLTS	0.1029	0.2777	0.7296	5	0.1484	0.2949	0.6653	6	0.1376	0.3654	0.7265	7
KONYA	0.0772	0.2660	0.7751	2	0.0698	0.3630	0.8386	2	0.0679	0.4260	0.8625	3
OYAKC	0.0898	0.2779	0.7558	4	0.0837	0.3686	0.8150	3	0.0596	0.4641	0.8862	2

Table 11 provides the scores for each company evaluated by the TOPSIS method from the second quarter of 2020 to the second quarter of 2022.

Table 11: TOPSIS Findings for 2020-Q2: 2022-Q2

	2020-Q2	**2020-Q3**	**2020-Q4**	**2021-Q1**	**2021-Q2**	**2021-Q3**	**2021-Q4**	**2022-Q1**	**2022-Q2**
AFYON	6	5	5	2	3	4	5	3	4
AKCNS	**3**	**4**	**4**	**5**	**6**	**6**	**6**	**4**	**5**
BTCIM	9	10	10	10	10	10	10	8	10
BUCIM	1	1	1	1	1	1	1	1	1
CMBTN	7	8	6	4	5	5	8	6	6
CMENT	8	9	9	9	8	9	7	10	8
CIMSA	10	7	8	6	2	3	4	7	3
GOLTS	5	6	7	8	9	8	9	5	7
KONYA	2	2	3	7	7	7	3	9	9

OYAKC	4	3	2	3	4	2	2	2	2

BUCIM cement firm consistently achieves the best performance across all quarters, maintaining the top ranking, indicating it aligns closest to the ideal financial parameters. Conversely, BTCIM cement firm frequently scores a 10, placing it at the lowest rank and suggesting it is the furthest from the ideal financial parameters. CIMSA cement firm shows variability in its rankings, initially performing poorly, improving in the middle quarters, but then declining again, suggesting fluctuating financial stability.

OYAKC cement firm generally scores lower, indicating better performance and closer alignment to the ideal conditions. Other cement firms like AKCNS, AFYON, and GOLTS exhibit mid to high scores, reflecting moderate to poor alignment with ideal financial scenarios. CMBTN and CMENT cement firms experience significant fluctuations in their scores, indicating inconsistent financial strength over time. Meanwhile, KONYA cement firm demonstrates a clear trend of declining performance, starting better, and worsening over time, which might suggest deteriorating financial management or operational challenges.

6. Conclusion, Limitations, And Future Directions

In this research, the TOPSIS method, a well-known multi-criteria decision-making method, is used for evaluating the performances of cement firms by using financial ratios. The proposed approach is used in determining the ranking of the cement firms in the same sector. The entropy method is used to identify the quarterly weights of the financial ratios for the specified sector (cement). In future studies, other methods can be used to identify the importance level of indicators.

Table 12 summarizes the findings of the research, including detailed data from the first quarter of 1997 to the first quarter of 2020, providing detailed information about the number of firms in the specified order and the names of cement firms that have never been in the specified order. The first row of Table 6 indicates that 11 cement firms have been in the first order during at least one period. Additionally, AKÇANSA, BOLU, and LAFARGE cement firms have never been in the first order. The findings obtained from the study show similarities with the studies conducted using similar financial ratios in the literature (Dumanoğlu, 2010; Tayyar & Şimşek, 2011; Soysal et al., 2017; Güleç & Özkan, 2018).

Table 12: Frequency of Ranking of Cement Firms: 1997-2020 (93 Quarters)

Rank	Cement Firm Number	Cement Firm
1	11	AKCNS, BOLU, LAFARGE

2	11	CMBTN, CMENT, CIMSA
3	12	BURSA, CMBTN
4	14	-
5	13	CMBTN
6	13	-
7	14	UNYE
8	13	-
9	13	MARDIN
10	13	UNYE
11	13	UNYE
12	13	ADANA
13	13	MARDıN
14	13	ADANA

Following the consolidation of cement firms ADANA, BOLU, ASLAN, UNYE, AND MARDIN, BUCIM cement firm consistently demonstrates superior performance across all quarters, consistently securing the highest rankings and most closely adhering to the ideal financial benchmarks. In contrast, BTCIM Cement regularly attains the lowest scores, evidenced by its frequent rating of 10, which positions it as significantly deviating from the desired financial parameters.

For future research, other MCDM techniques can be employed to assess the financial performance of cement companies. As financial ratios can influence the outcome of the analysis, future studies can consider using different financial ratios or other financial indicators to evaluate and rank financial performance.

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Çıkar Beyanı: Yazarlar arasında çıkar çatışması yoktur.

Etik Beyanı: Bu çalışmanın tüm hazırlanma süreçlerinde etik kurallara uyulduğunu yazarlar beyan eder. Aksi bir durumun tespiti halinde Fiscaoeconomia Dergisinin hiçbir sorumluluğu olmayıp, tüm sorumluluk çalışmanın yazarlarına aittir.

Yazar Katkısı: Yazarların katkısı aşağıdaki gibidir;

Giriş: 1. yazar

Literatür: 1. ve 2. yazar

Metodoloji: 1. Ve 2. yazar

Sonuç: 2. yazar

1. yazarın katkı oranı: %50. 2. yazarın katkı oranı: %50

Conflict of Interest: The authors declare that they have no competing interests.

Ethical Approval: The authors declare that ethical rules are followed in all preparation processes of this study. In the case of a contrary situation, Fiscaoeconomia has no responsibility, and all responsibility belongs to the study's authors.

Author Contributions: author contributions are below.

Introduction: 1. author

Literature: 1. and 2. author

Methodology: 1. and 2. author

Conclusion: 2. author

1st author's contribution rate: %50, 2nd author's contribution rate: %50

ATTACHMENT

Özarı, Ç. & Demirkale, Ö. (2024). Entropy-TOPSIS Method Approach: A Comprehensive Quarterly Assessment with Application in Turkey's Cement Sector. *Fiscaoeconomia, 8*(3), 938-967. Doi: 10.25295/fsecon.1447540.

Table 1: Importance Level of Financial Ratios-1999-Q1: 2018-Q4

Weight	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
99-Q1	0.0344	0.0600	0.2419	0.0636	0.0275	0.1380	0.1271	0.1076	0.1530	0.0469
99-Q2	0.0412	0.0600	0.3344	0.0467	0.0537	0.1848	0.1435	0.0515	0.0460	0.0382
99-Q3	0.0984	0.1207	0.2909	0.0421	0.0597	0.1591	0.1243	0.0373	0.0289	0.0386
99-Q4	0.1075	0.1539	0.2981	0.0522	0.0368	0.1689	0.1023	0.0272	0.0248	0.0283
2000-Q1	0.0038	0.0090	0.0197	0.0114	0.0020	0.7226	0.2026	0.0041	0.0164	0.0083
2000-Q2	0.0755	0.1081	0.2872	0.0467	0.0368	0.2309	0.1163	0.0243	0.0391	0.0352
2000-Q3	0.0560	0.0779	0.2740	0.0533	0.0419	0.2354	0.1418	0.0354	0.0402	0.0440
2000-Q4	0.0374	0.0520	0.2231	0.0647	0.0467	0.2812	0.1434	0.0557	0.0499	0.0459
2001-Q1	0.0184	0.0389	0.1262	0.0434	0.0202	0.3319	0.2369	0.0459	0.0813	0.0569
2001-Q2	0.0330	0.0567	0.1869	0.0600	0.0441	0.2883	0.1379	0.0518	0.0799	0.0615
2001-Q3	0.0291	0.0461	0.1723	0.0805	0.0295	0.3020	0.1459	0.0598	0.0716	0.0632
2001-Q4	0.0220	0.0377	0.1400	0.0745	0.0331	0.3139	0.2067	0.0574	0.0578	0.0569
2002-Q1	0.0275	0.0405	0.1488	0.1096	0.0507	0.1467	0.1117	0.0559	0.1172	0.1914
2002-Q2	0.0542	0.0538	0.2000	0.1028	0.1381	0.0000	0.0921	0.0730	0.1256	0.1602
2002-Q3	0.0749	0.0711	0.1678	0.0893	0.1234	0.0000	0.1533	0.0638	0.1313	0.1252
2002-Q4	0.0886	0.0993	0.1892	0.1157	0.1364	0.0000	0.0000	0.0812	0.1435	0.1461
2003-Q1	0.0323	0.0563	0.0545	0.1939	0.0573	0.0000	0.0774	0.0976	0.2528	0.1780
2003-Q2	0.0638	0.0886	0.1680	0.1596	0.1035	0.0000	0.0000	0.1035	0.2020	0.1109
2003-Q3	0.0550	0.0766	0.1961	0.1261	0.0863	0.0095	0.1120	0.1005	0.1708	0.0669
2003-Q4	0.0079	0.0092	0.0191	0.0182	0.0169	0.0219	0.0177	0.2888	0.3066	0.2937
2004-Q1	0.0208	0.0333	0.0727	0.0558	0.0224	0.3702	0.1896	0.0259	0.1229	0.0865
2004-Q2	0.0488	0.0589	0.1220	0.0430	0.0492	0.2377	0.2260	0.0750	0.1061	0.0333
2004-Q3	0.0436	0.0586	0.1365	0.0496	0.0528	0.1834	0.1817	0.1645	0.0788	0.0506
2004-Q4	0.0873	0.1045	0.1897	0.0690	0.0766	0.1699	0.1408	0.0511	0.0761	0.0350
2005-Q1	0.0581	0.0661	0.1609	0.1060	0.0913	0.1795	0.0906	0.0606	0.1079	0.0791
2005-Q2	0.0728	0.0847	0.1938	0.0817	0.0839	0.1576	0.1407	0.0544	0.0722	0.0583
2005-Q3	0.0891	0.0992	0.2087	0.0817	0.0848	0.1475	0.1198	0.0591	0.0703	0.0398
2005-Q4	0.1064	0.1199	0.2189	0.0715	0.1217	0.1142	0.0999	0.0495	0.0611	0.0367
2006-Q1	0.0944	0.1049	0.2134	0.0882	0.1048	0.1256	0.0779	0.0460	0.0709	0.0737
2006-Q2	0.0861	0.0923	0.2215	0.0794	0.1073	0.1287	0.1153	0.0396	0.0589	0.0709
2006-Q3	0.1043	0.1192	0.2369	0.0858	0.0773	0.1337	0.1111	0.0371	0.0605	0.0340
2006-Q4	0.1316	0.1475	0.2537	0.0698	0.0900	0.0925	0.0707	0.0302	0.0619	0.0522
2007-Q1	0.1061	0.1242	0.2437	0.0785	0.0559	0.1364	0.0824	0.0263	0.0845	0.0619
2007-Q2	0.1009	0.1067	0.2448	0.0743	0.0854	0.1275	0.0786	0.0299	0.0649	0.0870
2007-Q3	0.1110	0.1236	0.2550	0.0822	0.0802	0.1137	0.0748	0.0337	0.0640	0.0618
2007-Q4	0.1293	0.1438	0.2380	0.0648	0.0660	0.1310	0.0999	0.0247	0.0573	0.0452
2008-Q1	0.0896	0.0849	0.2075	0.1155	0.0472	0.1068	0.1079	0.0361	0.1272	0.0774
2008-Q2	0.1039	0.1145	0.2434	0.0550	0.0760	0.1382	0.1244	0.0229	0.0715	0.0502
2008-Q3	0.1136	0.1219	0.2395	0.0584	0.0907	0.1317	0.1038	0.0208	0.0480	0.0715
2008-Q4	0.1042	0.1080	0.1911	0.0523	0.0986	0.1544	0.1314	0.0247	0.0503	0.0850

Table 2: Importance Level of Financial Ratios-2009-Q1: 2018-Q4

Weight	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
2009-Q1	0.0089	0.0076	0.0143	0.0068	0.0050	0.8800	0.0535	0.0052	0.0137	0.0051
2009-Q2	0.0768	0.0770	0.1556	0.0424	0.1047	0.1269	0.2383	0.0284	0.0786	0.0712
2009-Q3	0.0866	0.0859	0.1438	0.0379	0.1112	0.1623	0.1972	0.0227	0.0475	0.1049
2009-Q4	0.1035	0.1046	0.1770	0.0352	0.1261	0.1529	0.1511	0.0217	0.0385	0.0895
2010-Q1	0.0402	0.0427	0.0960	0.0282	0.0352	0.1702	0.5282	0.0130	0.0246	0.0217
2010-Q2	0.0644	0.0692	0.1975	0.0462	0.0855	0.2237	0.2194	0.0218	0.0361	0.0362
2010-Q3	0.0575	0.0584	0.1478	0.0532	0.1111	0.2450	0.2293	0.0209	0.0389	0.0378
2010-Q4	0.0777	0.0894	0.2271	0.0460	0.0838	0.2113	0.1938	0.0179	0.0326	0.0203
2011-Q1	0.0393	0.0430	0.1578	0.0785	0.0442	0.1300	0.4250	0.0175	0.0411	0.0235
2011-Q2	0.0536	0.0653	0.2492	0.0706	0.0457	0.1518	0.2650	0.0181	0.0459	0.0348
2011-Q3	0.0731	0.0845	0.2614	0.0848	0.0495	0.1291	0.1981	0.0250	0.0478	0.0466
2011-Q4	0.0929	0.1061	0.2709	0.0744	0.0673	0.1211	0.1520	0.0262	0.0456	0.0436
2012-Q1	0.0714	0.0597	0.2617	0.2038	0.0731	0.0000	0.0000	0.0682	0.1806	0.0815
2012-Q2	0.0932	0.0899	0.2799	0.0798	0.0716	0.1287	0.0952	0.0297	0.0715	0.0605
2012-Q3	0.0950	0.1016	0.2932	0.0677	0.0677	0.1498	0.0723	0.0302	0.0614	0.0610
2012-Q4	0.1013	0.1104	0.2805	0.0598	0.0688	0.1610	0.0841	0.0186	0.0574	0.0580
2013-Q1	0.0926	0.0919	0.3418	0.1651	0.0724	0.0000	0.0000	0.0406	0.1009	0.0947
2013-Q2	0.0583	0.0598	0.2244	0.0685	0.0524	0.2238	0.1864	0.0211	0.0503	0.0549
2013-Q3	0.0682	0.0721	0.2121	0.0745	0.0464	0.2103	0.1762	0.0182	0.0555	0.0663
2013-Q4	0.0928	0.1018	0.2306	0.0705	0.0789	0.1655	0.1342	0.0161	0.0548	0.0547
2014-Q1	0.0586	0.0594	0.2561	0.0898	0.0465	0.1797	0.1653	0.0173	0.0736	0.0537
2014-Q2	0.0896	0.0912	0.2929	0.0732	0.0702	0.1263	0.1081	0.0153	0.0678	0.0655
2014-Q3	0.1060	0.1122	0.2844	0.0781	0.0621	0.1108	0.0888	0.0153	0.0677	0.0747
2014-Q4	0.0977	0.1041	0.3216	0.0728	0.0700	0.1025	0.0731	0.0204	0.0764	0.0614
2015-Q1	0.0755	0.0762	0.2924	0.0754	0.0342	0.1762	0.1370	0.0176	0.0782	0.0374
2015-Q2	0.0824	0.0957	0.3623	0.0655	0.0380	0.1182	0.1102	0.0145	0.0640	0.0491
2015-Q3	0.1003	0.1272	0.3817	0.0572	0.0317	0.1092	0.1041	0.0088	0.0425	0.0373
2015-Q4	0.0865	0.0969	0.3495	0.0727	0.0669	0.1088	0.1058	0.0128	0.0599	0.0402
2016-Q1	0.0500	0.0604	0.3366	0.1091	0.0417	0.1356	0.1269	0.0148	0.0804	0.0445
2016-Q2	0.1007	0.0923	0.2631	0.1003	0.0781	0.1033	0.0977	0.0156	0.0807	0.0681
2016-Q3	0.1086	0.1038	0.2424	0.0920	0.0767	0.0971	0.1102	0.0129	0.0595	0.0968
2016-Q4	0.1005	0.0964	0.1997	0.0800	0.0606	0.1295	0.1393	0.0128	0.0389	0.1424
2017-Q1	0.0435	0.0418	0.1419	0.0734	0.0226	0.1838	0.1624	0.0093	0.0593	0.2620
2017-Q2	0.0512	0.0479	0.1593	0.0736	0.0273	0.2089	0.2164	0.0114	0.0419	0.1620
2017-Q3	0.0671	0.0618	0.1818	0.0732	0.0368	0.2001	0.1833	0.0074	0.0419	0.1466
2017-Q4	0.0938	0.0812	0.1537	0.0688	0.0522	0.1919	0.1748	0.0069	0.0499	0.1268
2018-Q1	0.0637	0.0507	0.1859	0.0914	0.0400	0.2002	0.1807	0.0122	0.0681	0.1071
2018-Q2	0.0919	0.0697	0.1777	0.0787	0.0465	0.1956	0.1593	0.0121	0.0625	0.1059
2018-Q3	0.1212	0.0921	0.1518	0.1123	0.0714	0.1091	0.1255	0.0228	0.0749	0.1189
2018-Q4	0.0606	0.0510	0.1282	0.0524	0.0243	0.2431	0.1634	0.0106	0.0334	0.2329

Table 3. TOPSIS Findings for 2003-Q1: 2005-Q4

	2003-Q1	2003-Q2	2003-Q3	2003-Q4	2004-Q1	2004-Q2	2004-Q3	2004-Q4	2005-Q1	2005-Q2	2005-Q3	2005-Q4
ADANA	8	10	9	2	9	2	2	5	1	4	4	4
AFYON	11	8	5	4	14	7	5	8	13	10	5	7
AKÇANSA	6	7	8	8	2	4	4	7	9	5	7	6
BATIAND	3	2	2	5	8	8	7	10	7	9	10	9
BOLU	10	9	10	3	5	3	3	4	4	3	3	3
BURSA	7	11	12	6	11	11	10	12	11	8	9	8
ÇİMBETON	1	3	4	7	10	12	13	11	14	13	13	13
ÇİMENTAŞ	4	5	6	14	12	9	8	9	8	11	12	12
ÇİMSA	5	1	3	10	7	5	9	6	6	7	8	10
GÖLTAŞ	2	6	11	9	4	10	11	13	5	12	11	11
KONYA	14	12	7	12	13	6	6	3	3	6	6	5
LAFARGE	9	13	13	11	6	13	14	14	12	14	14	14
MARDİN	12	4	1	1	3	1	1	1	10	1	1	1
ÜNYE	13	14	14	13	1	14	12	2	2	2	2	2

Table 4. TOPSIS Findings for 2006-Q1: 2008-Q4

	2006-Q1	2006-Q2	2006-Q3	2006-Q4	2007-Q1	2007-Q2	2007-Q3	2007-Q4	2008-Q1	2008-Q2	2008-Q3	2008-Q4
ADANA	2	3	4	4	1	3	3	3	5	2	3	4
AFYON	7	7	6	7	6	7	7	6	2	7	6	7
AKÇANSA	5	8	8	10	13	12	13	12	11	10	10	11
BATIAND	8	5	7	9	8	10	11	10	8	8	8	9
BOLU	3	4	3	3	4	2	2	4	7	4	4	5
BURSA	11	10	10	8	10	9	8	7	9	9	9	8
ÇİMBETON	10	12	11	11	11	11	10	11	10	11	13	13
ÇİMENTAŞ	13	11	14	14	14	13	12	14	14	13	14	14
ÇİMSA	12	13	12	13	9	8	9	9	13	12	11	12
GÖLTAŞ	9	9	9	6	3	5	5	8	3	6	7	6
KONYA	6	6	5	5	5	6	6	5	6	3	2	3
LAFARGE	14	14	13	12	12	14	14	13	12	14	12	10
MARDİN	4	2	2	2	7	4	4	2	1	5	5	2
ÜNYE	1	1	1	1	2	1	1	1	4	1	1	1

Table 5. TOPSIS Findings for 2009-Q1: 2011-Q4

	2009-Q1	2009-Q2	2009-Q3	2009-Q4	2010-Q1	2010-Q2	2010-Q3	2010-Q4	2011-Q1	2011-Q2	2011-Q3	2011-Q4
ADANA	2	3	3	4	1	4	4	4	5	6	7	6
AFYON	14	13	13	6	11	5	10	6	8	9	12	9
AKÇANSA	9	7	8	9	9	10	9	10	11	13	13	13
BATIAND	7	5	10	7	7	7	8	7	6	5	5	11
BOLU	4	6	4	5	8	9	6	5	14	12	11	8

BURSA	8	10	11	12	10	11	13	13	10	10	9	10
ÇİMBETON	10	12	14	14	14	14	14	14	1	4	4	4
ÇİMENTAŞ	13	8	9	11	13	13	12	11	12	14	14	14
ÇİMSA	11	11	6	8	5	8	5	9	9	11	10	12
GÖLTAŞ	5	4	7	10	6	6	7	8	7	7	6	7
KONYA	6	9	5	3	4	2	3	2	4	2	2	2
LAFARGE	12	14	12	13	12	12	11	12	13	8	8	5
MARDİN	1	1	2	2	2	3	2	3	3	3	3	3
ÜNYE	3	2	1	1	3	1	1	1	2	1	1	1

Table 6. TOPSIS Findings for 2012-Q1: 2014-Q4

	2012-Q1	2012-Q2	2012-Q3	2012-Q4	2013-Q1	2013-Q2	2013-Q3	2013-Q4	2014-Q1	2014-Q2	2014-Q3	2014-Q4
ADANA	10	5	6	5	4	6	7	4	3	4	6	3
AFYON	9	12	13	14	8	8	8	12	10	6	3	5
AKÇANSA	6	9	10	9	12	11	9	13	8	12	13	13
BATIAND	5	7	8	11	10	9	10	8	6	8	7	11
BOLU	13	13	9	6	11	7	6	7	9	10	9	9
BURSA	2	6	7	7	7	13	12	6	5	5	4	6
ÇİMBETON	4	10	12	12	6	12	11	10	11	11	8	8
ÇİMENTAŞ	7	11	14	13	14	14	14	14	13	13	12	10
ÇİMSA	12	14	11	10	13	3	4	5	12	14	14	14
GÖLTAŞ	1	3	4	8	1	4	5	9	7	7	10	7
KONYA	3	1	1	2	2	2	2	2	1	1	2	2
LAFARGE	11	8	5	4	9	10	13	11	14	9	11	12
MARDİN	14	4	3	3	5	5	3	3	4	3	5	4
ÜNYE	8	2	2	1	3	1	1	1	2	2	1	1

Table 7. TOPSIS Findings for 2015-Q1: 2017-Q4

	2015-Q1	2015-Q2	2015-Q3	2015-Q4	2016-Q1	2016-Q2	2016-Q3	2016-Q4	2017-Q1	2017-Q2	2017-Q3	2017-Q4
ADANA	4	5	7	4	5	4	4	4	7	3	6	6
AFYON	1	1	1	3	1	3	6	6	6	10	4	4
AKÇANSA	9	9	8	10	11	10	10	8	8	11	11	10
BATIAND	5	6	9	6	4	8	11	14	14	13	12	14
BOLU	10	13	11	11	14	14	13	11	10	8	8	7
BURSA	7	8	6	8	6	6	5	9	11	9	10	11
ÇİMBETON	11	10	12	9	9	7	8	12	12	12	13	12
ÇİMENTAŞ	12	11	10	12	12	9	9	13	13	14	14	13
ÇİMSA	13	7	5	7	7	11	14	10	4	6	9	8
GÖLTAŞ	8	12	14	14	10	12	12	7	5	7	7	9
KONYA	2	2	2	2	2	1	2	3	9	5	3	3
LAFARGE	14	14	13	13	13	13	7	5	3	4	5	5
MARDİN	6	4	4	5	8	5	3	2	2	2	2	2

ÜNYE	3	3	3	1	3	2	1	1	1	1	1	1

Table 8. TOPSIS Findings for 2018-Q1: 2020-Q1

	2018-Q1	2018-Q2	2018-Q3	2018-Q4	2019-Q1	2019-Q2	2019-Q3	2019-Q4	2020-Q1
ADANA	2	2	5	1	1	13	8	9	11
AFYON	14	8	12	12	13	12	14	10	6
AKÇANSA	8	7	7	9	12	6	9	7	10
BATIAND	11	13	14	5	14	14	13	12	14
BOLU	6	6	8	7	8	8	7	2	4
BURSA	9	10	6	11	4	7	6	1	2
ÇİMBETON	12	12	10	13	9	11	12	11	13
ÇİMENTAŞ	13	14	13	14	7	1	5	14	12
ÇİMSA	10	11	9	6	6	5	3	6	5
GÖLTAŞ	7	9	11	8	2	2	2	4	3
KONYA	4	4	2	10	10	10	11	8	9
LAFARGE	5	5	4	4	11	9	10	13	7
MARDİN	3	3	3	3	3	4	4	5	8
ÜNYE	1	1	1	2	5	3	1	3	1