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COMPARATIVE EMPIRICAL ANALYSIS OF FINANCIAL FAILURES OF ENTERPRISES IN ISE CHEMICAL, PETROL, AND PLASTIC INDEX*

BİST Kimya, Petrol ve Plastik Endeksi'nde Yer Alan İşletmelerin Finansal Başarısızlıklarının Karşılaştırmalı Ampirik Analizi

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Keywords:
Financial Failure, Altman Z-Score, MABAC Method.

JEL Codes:
G17, G32, G39, M40.

Abstract

Businesses can make more accurate financial decisions by taking the right steps in areas such as strategic, financial, operational, and human resource management, and by effectively carrying out financial planning activities. In this way, they can enhance their ability to achieve financial objectives and reduce the risk of financial failure. The aim of this study is to predict the financial failures of the companies listed in the BIST Chemistry, Petroleum, and Plastic Index, to compare their financial performances, and to measure the correlation between the two methods employed. In this study, using the annual data of 40 enterprises for 2019-2023, financial failure was measured using the Altman Z-Score model, and financial performance was measured using the MABAC method. Although there are variations in the financial failure and financial performance of the enterprises over the years, the results are generally similar. In addition, the correlation between the results found according to the Altman Z-score and MABAC method was analysed by Spearman's rank correlation, and it was determined that there was a correlation between the rankings in five of the five years analysed in the study.

Anahtar Kelimeler:
Finansal Başarısızlık, Altman Z Skor, MABAC Yöntemi.

JEL Kodları:
G17, G32, G39, M40.

Öz

İşletmeler; stratejik, finansal, operasyonel ve insan kaynağı yönetimi gibi alanlarda doğru adımlar atarak ve finansal planlama faaliyetlerini doğru bir şekilde gerçekleştirerek daha doğru finansal kararlar alabilmektedirler. Bu sayede işletmeler, finansal amaçlarını gerçekleştirme kabiliyetlerini artırarak finansal başarısızlıklarını azaltabileceklerdir. Çalışmanın amacı BİST Kimya, Petrol ve Plastik endeksinde işlem gören işletmelerin finansal başarısızlıklarının tahmin edilmesi, finansal performanslarının karşılaştırılması ve kullanılan iki yöntem arasındaki korelasyon ilişkisinin ölçülmesidir. Araştırmada, 40 işletmeye ait 2019-2023 yıllarındaki yıllık veriler kullanılarak Altman Z-Skor modeli ile finansal başarısızlık ölçülmüştür. Ayrıca MABAC yöntemi ile işletmelerin finansal performansı da ölçülmüştür. İşletmelerin finansal başarısızlıklarında ve finansal performanslarında yıllara göre değişkenlikler olsa da genel olarak sonuçlar benzer şekilde çıkmıştır. Ayrıca Altman Z skoru ve MABAC yöntemine göre bulunan sonuçlar arasında korelasyon olup olmadığı Spearman sıra korelasyonu ile analiz edilmiş, araştırmada analiz edilen beş yılın beşinde de sıralamalar arasında korelasyon bulunduğu belirlenmiştir.

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1. Introduction

Financial failure refers to the inability of individuals, companies, or countries to achieve their financial objectives. While companies make effort to meet their goals, various challenges may arise, including imbalances between income and expenditures, poor financial planning and structuring, increasing debt levels, and fluctuations in economic factors. These challenges can lead to financial failure, undermining the sustainability of companies' financial structures and overall financial health. Companies experiencing financial failure may become trapped in debt and suffer significant monetary losses. Several factors may contribute to financial failure, including poor budget management, excessive borrowing, inadequate financial structuring and planning, investment misjudgments, unforeseen expenditures, and revenue loss.

Within the scope of financial failure, companies may face difficulties in repaying their maturing debts, maintaining stable operations, or transforming their profitability into a sustainable structure. Insufficient cash flow management, high levels of indebtedness and credit dependency, poor financial planning, bad management, strategic failures, problems in customer and supplier management, and economic downturns may trigger financial failure of enterprises. There are various indicators that signal financial failure in companies, including reporting losses, cash shortages, rising inventory levels alongside stagnating sales, difficulties in paying employee wages, and struggles in fulfilling tax obligations. Companies make use of various tools and methods to improve these indicators and address the associated challenges, including financial reporting, strategic planning, strategic budgeting, cost management, cash flow management, and corporate management, all of which help companies more effectively tackle emerging financial issues.

The chemicals, petroleum, and plastics industries are critically important to the Turkish economy due to their contributions to economic growth, employment, and industrial support. The chemical industry, in particular, serves as a key intermediate goods supplier for many sub-sectors. Its development, especially within Türkiye's organized industrial zones, also contributes to reducing the current account deficit. Given that Türkiye meets a significant portion of its energy needs through petroleum and natural gas, the petrochemical sector holds strategic significance. With the discovery of new energy reserves, Türkiye may be able to minimize its foreign trade deficit. Moreover, Türkiye's geopolitical positioning as a hub for oil pipelines and energy transit routes grants it considerable strategic leverage. Türkiye is the second-largest plastic producer in Europe. This sector is characterized by strong export capabilities and makes a substantial contribution to employment, further enhancing its economic importance. However, various problems arose in recent years due to carbon footprint concerns and commitments under the European Union Green Deal. Overcoming these obstacles could enable the sector to achieve a stronger position within the European market. Overall, the petroleum, chemical, and plastics industries are strategically important and significantly contribute to employment. In light of mounting pressure for green transformation, it is necessary to pay these sectors the strategic attention they require.

This study aims to estimate the financial failure of companies listed on the ISE Chemicals, Petroleum, and Plastics Index. The index includes 44 companies over the period 2019-2023, of which 40 were included in the analysis based on the availability of annual financial data. Four companies were excluded due to incomplete data. Financial failure was analyzed using the Altman Z-Score model, whereas financial performance was measured through the Multi-

Attributive Border Approximation Area Comparison (MABAC) method. Furthermore, if there is a relationship between the results derived from the Altman Z-Score and MABAC methods was determined using Spearman's rank correlation coefficient.

This study provides sufficient findings and insights to contribute to the literature on financial failure and bankruptcy risk among companies listed under the ISE Chemistry, Petroleum, and Plastics Index. By moving beyond analyses that typically rely on a single financial failure prediction model, this study offers valuable comparative data on the predictive power and consistency of multiple methods. Furthermore, the sector-specific focus on the chemical, petroleum, and plastics industries addresses a gap in the literature and offers original insights into the financial dynamics of these sectors. In this regard, this study contributes to the literature in terms of both methodological diversity and sectoral specificity, offering key findings that may serve as a guide for academic research, investors, and policymakers in their decision-making processes.

The present study consists of four main sections. The introduction is followed by a comprehensive review of the relevant literature. The subsequent section outlines the dataset and explains the methodology employed. The results are then discussed in detail. Finally, this study concludes with a summary of results and a set of recommendations.

2. Literature Review

Almansour (2015) analyzed the financial failures of publicly traded companies listed on the Amman Stock Exchange between 2000 and 2003 using regression analysis and the Altman Z-Score model. The results indicated that all predictor variables demonstrated different performance patterns between bankrupt and non-bankrupt firms throughout the study period.

Bağcı (2015) aimed to examine the financial condition of companies operating in the textile and ready-made clothing sectors between 2008 and 2013 by employing the Altman Z-Score and ratio analysis techniques. The study concluded that, across the years analyzed, the financial condition of companies in this sector was poor and that they were exposed to a high level of risk.

Mavengere (2015) aimed to assess the validity of bankruptcy prediction and earnings manipulation for a given institution using data from 2011 to 2014. Utilizing the Altman Z-Score and Beneish M-Score models, the study concluded that the application of these models could help prevent significant investor losses. The findings indicated that the institution was in the grey zone in 2011 and was identified as an earnings manipulator in 2010 and 2014.

Kulalı (2016) carried out a study to estimate the financial failure risk of ISE-listed companies. The analysis included publicly traded companies between 2000 and 2013, and the results revealed that the predictive power of the model was notably high in forecasting financial failure.

Soba et al. (2016) carried out a study to measure the level of financial distress of nine large-scale companies listed on ISE using data from 2011 to 2015. Given the findings, BIMAS was identified as the company with the lowest risk group, indicating no risk in credit payments and a minimal probability of bankruptcy. TKNSA, operating in domestic and foreign trade, was also determined to be among the least risky companies in all years except for 2015.

Altman et al. (2017) carried out a study to analyze Z-scores of firms across 31 European and three non-European countries. Their study aims to determine Z-scores, identify the bankruptcy risks of companies, and classify their performance. The results demonstrated that the Z-score performed reasonably well in most countries. Moreover, the incorporation of country-specific predictors was found to further improve classification accuracy.

Ege et al. (2017) analyzed the relationship between financial failure and financial performance using data from manufacturing companies listed on the ISE 100 index for the period 2011-2015. Various financial ratios were used as input variables. The analysis revealed a positive and significant relationship between the Fulmer H-Score and Tobin's Q ratio, as well as a positive and significant relationship between return on assets (ROA) and the price-to-earnings ratio with Tobin's Q. Additionally, company size, included as a control variable, was found to have no significant effect.

Turaboğlu et al. (2017) investigated the relationship between financial failure and capital structure decisions among companies listed in the ISE 100 index. Financial failure was measured using the Altman Z-Score and Springate S-Score models, while capital structure decisions were assessed via total debt ratio, debt maturity structure, and external equity. Their study reported a statistically significant negative relationship between financial failure scores and total debt ratio, short-term debt ratio, and external equity ratio. Furthermore, a negative relationship was specifically observed between external equity (new stock issuance) and financial failure scores.

Dizgil (2018) analyzed financial failure among companies included in the ISE Trade Index for the period 2012-2017 using the Springate method. Annual data from 18 companies were examined through their financial statements. It was concluded that the companies listed in the index exhibited low bankruptcy risk and were financially successful.

İslamoğlu and Çankaya (2018) measured the relationship between financial failure and financial performance using 2012-2016 data of companies included in the ISE Electricity Index. The results indicated a significant and positive relationship between Tobin's Q ratio and both the Fulmer H-Score and the price-to-earnings ratio, whereas there was a significant but negative relationship with the logarithm of sales.

Karadeniz and Öcek (2019) investigated whether there were statistically significant differences in financial ratios between tourism companies listed on the Istanbul Stock Exchange that were at risk of financial failure and those that were not. Their study covered the period between 2012 and 2017 and employed the Altman Z-Score and Mann-Whitney U Test. The results indicated significant differences between the companies with financial failure risk and those without in terms of current ratio, acid-test ratio, cash ratio, leverage ratio, ROA, return on equity (ROE), net profit margin, and price-to-earnings ratio.

Yürük and Ekşi (2019) carried out a study to predict financial distress among manufacturing companies listed on the Istanbul Stock Exchange using artificial intelligence methods. They analyzed data from companies spanning the years 2008–2016. Based on ROC analysis, two models created using data from three years prior demonstrated good performance, with accuracy rates exceeding 70%. Additionally, the ANN model was found to outperform the SVM model.

A study carried out by Akyüz (2020) aimed to estimate the financial failure risk of companies operating in the stone and soil sector listed on the Istanbul Stock Exchange. The

analysis focused on companies that were active between 2014 and 2018. Among the companies analyzed, ADANA was identified as a financially successful company in each of the examined years.

Erkılıç and Aksoy (2020) carried out a study to develop financial failure prediction models for public hospitals and to identify the most significant predictor variables of financial failure. The analysis covered 92 public hospitals between 2014 and 2016, utilizing the Logistic Regression method. A financial failure prediction model was developed with an accuracy rate of 79.3%. The most effective predictor variables explaining financial failure in the model were found to be Inventory Dependency, Cash Turnover Rate, Inventory/Current Assets, Current Assets/Total Assets, and Trade Payables/Total Liabilities.

Kukreja et al. (2020) conducted an analysis to detect financial misstatements by Comscore Inc., a company operating in the USA, using the Beneish M-Score and Altman Z-Score models. The study, based on financial statements from 2012 to 2018, aimed to detect early signs of fraud. The findings revealed that the Beneish M-Score had a more limited predictive power in identifying financial statement fraud compared to the Altman Z-Score. It was concluded that the effectiveness of the Beneish model in detecting fraudulent financial statements could not be confirmed.

Erol Fidan (2021) carried out a study to estimate the financial failure of companies in the textile, apparel, and leather sector listed on the Istanbul Stock Exchange. Financial failure was assessed using data from the years 2017–2019. The findings indicated that, with the exception of two companies, the majority of companies in this sector were not in good financial condition and exhibited high financial risk.

Yaman and Korkmaz (2021) investigated the impact of working capital investment and financing policies on financial failure among companies operating in the metal goods sector listed on the Istanbul Stock Exchange. Panel data analysis was conducted. The results revealed that working capital management had a significant effect on financial failure across all models tested.

Alcalde et al. (2022) analyzed the financial condition of Spanish firms across different sectors between 2010 and 2023 using the Altman Z-Score. The study identified the construction sector as having the highest probability of bankruptcy. Results indicated that poor supply chain management in this sector increased the likelihood of insolvency and posed numerous types of risks. Additionally, it was found that managers in the construction industry tended to rely more on their professional experience than on analytical tools to mitigate risk.

Kendirli and Çıtak (2022) predicted the financial failure of companies operating in the forest products, paper, and printing industries on the Istanbul Stock Exchange. Financial ratios were calculated based on the balance sheets and income statements of companies between 2016 and 2020. Given the results, 7 out of 15 companies in the index were identified as having a high risk of bankruptcy.

Akdeniz and Güven (2023) predicted financial failure in companies operating in the cement sector on the Istanbul Stock Exchange using various methods. The analysis was based on financial data from 2017 to 2021. Considering the Z-score values, three companies were identified as having poor financial performance.

Medetoğlu and Tutar (2023) carried out a study to determine the financial failure of companies in the textile, apparel, and leather sector listed on the Istanbul Stock Exchange using

the Springate S and Fulmer H score models. They analyzed the financial statements of 23 companies for the period 2017-2021. The year 2018 was identified as the most successful, while 2017 was found to be the least successful in terms of financial performance.

Arslan and Tutkavul (2024) estimated financial failure among companies listed on the Watchlist Market by using the data from Q1-2018 to Q4-2022. The results indicated that companies in this market were exposed to a high risk of bankruptcy. It was also found that these companies could face challenges such as liquidity constraints, excessive indebtedness, and high financial costs in the future. The year 2018 was identified as having the highest bankruptcy risk.

Güzyurdu and Yaman (2024) carried out a study to identify the effects of financial failure risk on firms' sustainable growth policies through econometric analysis and to determine appropriate financial failure models that could be utilized in the process of developing sustainable growth strategies. Their analysis focused on firms listed in the Sustainability Index of the Istanbul Stock Exchange and the data covered the period from 2010 to 2022. They found a positive relationship between financial failure risk and sustainable growth rate (SGR). However, they also noted that these relationships were not statistically significant across all financial failure models. Specifically, the Z', S, and CA scores were found to have no statistically significant effects on sustainable growth policies, whereas the T and H scores were determined to have statistically significant impacts.

Morina et al. (2024) carried out a study to identify the determinants of financial failure among manufacturing and trade enterprises in Kosovo. The sample consisted of 50 firms operating in these sectors, and the study covered a three-year period. The Altman Z-score and Springate models were employed to assess financial failure. The findings revealed that ROA and ROE had a positive effect in reducing the risk of financial failure. Furthermore, variables such as capital, firm size, liquidity, and solvency were found to have a positive correlation and impact on exposure to financial failure risk.

Yapa and Coşkun (2024) evaluated the financial failure performance of companies operating in the Agriculture and Fisheries sector from 2009 to 2019. Given the research findings, among all the definitions of financial failure used, the definition based on profitability and net working capital (FF_5) provided the highest success criteria. Moreover, the most accurate predictions were obtained using the FF_5 definition.

Aksoylu et al. (2024) analyzed the financial failure risk and performance of companies operating in the ISE Textile and Leather Index using the Altman Z-Score and the VIKOR method. The study covered the years 2017-2022 and included 22 companies. They found that the financial failure risks and performance of the companies fluctuated during the analyzed period. The relationship between these variables across the years was examined using Spearman's rank correlation, and a correlation was identified between the years studied.

Sibanda and Tapera (2025) analyzed the potential financial distress of PT Chandra Asri Pacific Tbk for the period between 2019 and 2023, using the Altman Z-score and Zmijewski models. They found that the average EBIT and ROA indicators during these years were notably low. Another key finding of the study was that, despite fluctuations in the company's financial condition, PT Chandra Asri Pacific Tbk was still able to manage its financial performance and mitigate risks.

3. Dataset and Methodology

This study provides an empirical analysis of financial failure among companies operating within the ISE Chemistry, Petroleum, and Plastic Index, specifically focusing on companies in the chemical, petroleum, and plastic sectors. A total of 44 companies were active in this index during the 2019-2023 period. Of these companies, annual data for 40 companies were available and included in the analysis. Four companies were excluded due to the unavailability of data during the reference years. In the literature, the Altman Z-Score model is frequently used to identify financial failure. In addition, the MABAC method is one of the approaches used to assess financial performance. By applying both methods to data from the same period, the study analyzes both financial failure and financial performance. The data pertaining to the examined years were compiled from the Public Disclosure Platform (KAP), the Finnet database, and the official websites of the companies, and were processed to construct the dataset used in the study.

3.1. Altman Z-Score Model

Developed by Altman (1968), the Z-score model was the first multivariate prediction method used to forecast financial failures. Utilizing the multiple discriminant analysis technique, Altman initially examined 22 financial ratios and, through statistical evaluation, reduced this number to five key ratios to construct the model. This simplification relies on the rationale that interactions among too many variables could result in contradictory results. The sample for Altman's study consisted of 33 financially stable companies and 33 bankrupt companies. The model integrates both accounting-based ratios and market data to estimate a company's likelihood of bankruptcy within a two-year horizon. Furthermore, subsequent studies have demonstrated that the model, with minor adaptations, can be effectively applied across various sectors (Kulalı, 2016: 286).

The Altman Z-score, developed using financial statement data, is both user-friendly and practically applicable. While initially intended to predict bankruptcy risks, it is also widely regarded as a useful tool to evaluate a company's financial health and provide information for the decision-making processes of lenders and investors (Hauschild, 2013: 6).

The commonly used ratios in the Altman Z-Score model are as follows (Table 1):

Table 1. Altman Z-Score Used Ratios

Ratio Code	Description
X1	Net Working Capital / Total Assets
X2	Retained Earnings / Total Assets
X3	Earnings Before Interest and Taxes (EBIT) / Total Assets
X4	Market Value of Equity / Total Liabilities
X5	Net Sales / Total Assets

Reference: Altman, 1968.

Using weighted coefficients determined by Altman (1968), the Z-Score is calculated with Equation 1:

$$Z = 0.012 . X1 + 0.014 . X2 + 0.033 . X3 + 0.006 . X4 + 0.999 . X5 \quad (1)$$

Interpretation of the Z-Score is based on the following reference ranges (Table 2):

Table 2. Altman Z- Score Ranges

Z>2.99 Financially healthy
1.8<Z<2.99 Grey zone
Z<1.8 Financially distressed

Reference: Altman, 1968

Originally designed for publicly traded companies, the Z-Score model has since been adapted by Altman for application to private companies as well. As a result, it can now be used for both publicly listed and privately held companies, particularly in emerging market contexts. Today, the Z-score model is widely employed by various institutions as an early warning system to detect potential financial failure (Özdemir, 2014: 152).

The model's ability to classify companies as either financially successful or unsuccessful is largely determined by a detailed analysis of the financial ratios corresponding to the X variables in the formula. These ratios enable companies to identify potential financial risks in advance and lay a more stable foundation for strategic planning. This, in turn, offers a significant advantage in terms of long-term sustainability. Moreover, the Z-score model facilitates the early detection of potential financial distress, thereby supporting the implementation of proactive measures.

Minimum and maximum directions of the criteria used in this study are presented in the Table 3. As the rationale for considering the criteria presented in the table as either maximum or minimum, it is generally accepted that lower values of the criteria may indicate financial distress and increase financial risk. Therefore, they are required to be treated as maximum. Furthermore, there are studies supporting this reasoning. For instance, Aksoylu et al. (2024), as well as Arslan (2019), adopted the criteria in their studies as maximum.

Table 3. Minimum and Maximum Directions of the Criteria Used

Ratio Code	Description	Min/Max
X1	Net Working Capital / Total Assets	Max
X2	Retained Earnings / Total Assets	Max
X3	Earnings Before Interest and Taxes (EBIT) / Total Assets	Max
X4	Market Value of Equity / Total Liabilities	Max
X5	Net Sales / Total Assets	Max

Reference: Aksoylu et al., 2024; Arslan, 2019.

3.2. MABAC Method

The MABAC method is one of the multi-criteria decision-making (MCDM) approaches that has attracted increasing attention in both national and international academic literature in recent years. The fundamental steps of this method are defined by Pamučar and Ćirović (2015: 3019) as follows:

Step 1: Establishing the Decision Matrix (X):

In this initial step, the decision matrix is established based on *m* alternatives and *n* criteria considered in the analysis. The relevant matrix is calculated as shown in Equation (2):

$$C_1 \quad C_2 \quad \dots \quad C_n \tag{2}$$

$$X = \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \cdot & \dots & \cdot \\ \cdot & \cdot & \dots & \cdot \\ x_{m1} & x_{m2} & \vdots\vdots & x_{mn} \end{bmatrix}$$

Step 2: Construction of the Normalized Decision Matrix (N):

Since the criteria in the decision matrix may be expressed in different units or scales, normalization is necessary to ensure comparability. In this step, normalization is performed based on whether the criteria are of a benefit (maximization) or cost (minimization) type, yielding the normalized decision matrix as shown in Equation (3):

$$X = \begin{matrix} & C_1 & C_2 & \dots & C_n \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} n_{11} & n_{12} & \dots & n_{1n} \\ n_{21} & n_{22} & \dots & n_{2n} \\ \vdots & \cdot & \dots & \cdot \\ \cdot & \cdot & \dots & \cdot \\ n_{m1} & n_{m2} & \vdots\vdots & n_{mn} \end{bmatrix} \quad (3)$$

(a) For benefit-type (maximization) criteria, normalization is performed using Equation (4).

$$n_{ij} = \left(\frac{x_{ij} - x_i^-}{x_i^+ - x_i^-}\right) \quad (4)$$

(b) For cost-type (minimization) criteria, normalization is performed using Equation (5).

$$n_{ij} = \left(\frac{x_{ij} - x_i^+}{x_i^- - x_i^+}\right) \quad (5)$$

Step 3: Weighting the Decision Matrix:

After the normalization, each element of the normalized matrix is multiplied by the corresponding criterion weight to reflect the relative importance of each criterion. This produces the weighted normalized decision matrix, defined in Equation (6):

$$v_{ij} = w_i \,.\, (n_{ij} + 1) \quad (6)$$

Step 4: Determination of the Border Approximation Area Matrix (G):

In this step, a reference point is calculated for each criterion, representing the average performance across all alternatives. These values are used to form the border approximation area matrix, calculated using Equation (7):

$$g_i = (\prod_{j=1}^{m} v_{ij})^{1/m} \quad (7)$$

In this equation, v_{ij} is the weighted normalized value from Step 3, and m is the number of alternatives.

Once the, g_i values are calculated for all criteria, the border approximation area vector is formed as shown in Equation (8).

$$\begin{matrix} & C_1 & C_2 & \dots & C_n \\ G = & [g_1 & g_2 & \dots & g_n] \end{matrix} \quad (8)$$

Step 5: Calculation of the Distances from the Border Approximation Area (Q):

This step determines each alternative's position relative to the border approximation area. The values can be positive or negative depending on whether the alternative outperforms or underperforms the reference point. These distances are critical for evaluating the strengths and weaknesses of each alternative. The Q matrix is computed using Equation (9).

$$Q = \begin{bmatrix} q_{11} & q_{12} & \dots & q_{1n} \\ q_{21} & q_{22} & \dots & q_{2n} \\ \vdots & \cdot & \cdots & \cdot \\ \cdot & \cdot & \dots & \cdot \\ q_{m1} & q_{m2} & \vdots\vdots & q_{mn} \end{bmatrix} \quad (9)$$

The distances (q_{ij}) from the border approximation values are calculated as shown in Equation (10).

$$Q = V - G = \begin{bmatrix} v_{11} - g_1 & v_{12} - g_2 & \dots & v_{1n} - g_n \\ v_{21} - g_1 & v_{22} - g_2 & \dots & v_{2n} - g_n \\ \vdots & \cdot & \cdots & \cdot \\ \cdot & \cdot & \dots & \cdot \\ v_{m1} - g_1 & v_{m2} - g_2 & \vdots\vdots & v_{mn} - g_n \end{bmatrix} \quad (10)$$

Step 6: Classification of Alternatives Based on the Border Approximation Area:

Using the values of q_{ij} from the previous step, each alternative (Ai) is categorized considering its proximity to the border approximation area. The classification is defined in Equation (11).

$$A_i \in \begin{cases} G^+ & g_{ij} > 0 \\ G \text{ eğer } & g_{ij} = 0 \\ G^- & g_{ij} < 0 \end{cases} \quad (11)$$

As shown in Equation (10), three options are established to determine the decision alternative. However, there might be 2 different locations, too. G^- refers to the lower approximation area, and G to border approximation.

Step 7: Ranking of Alternatives:

In the final step, the total Q values for each alternative are aggregated to compute an overall performance score. Based on these scores, alternatives are ranked from highest to lowest, providing decision-makers with the final preference order. The total value of each alternative is determined using Equation (12).

$$Si = \sum_{j=1}^{n} g_{ij},\ j = 1, 2, \dots., n, \quad i = 1, 2, \dots., m \quad (12)$$

4. Empirical Findings

This section presents the findings obtained using the Altman Z-Score model and the results and rankings derived from the MABAC method. In addition, a Spearman rank correlation test is included to evaluate the relationship between these two methods.

4.1. Results Related to Altman Z-Score Analysis

In this study, the financial failure risks of companies operating under the Istanbul Stock Exchange (ISE) Chemicals, Petroleum, and Plastics Index were analyzed using the Altman Z-

Score model. The Z-scores were calculated based on the financial ratios of these companies over the past five years. The resulting Z-scores, which reflect the companies' bankruptcy risk, are presented in Table 4.

Table 4. Altman Z-Score Values of Companies

Companies	**Z-Score**				
	2019	**2020**	**2021**	**2022**	**2023**
ACSEL (A1)	6.68790037	6.1145806	6.2806837	5.7532807	2.9864687
AKSA (A2)	1.78323294	3.3470616	2.7198498	4.2260596	3.4005715
ALKIM (A3)	5.03962775	6.6897683	6.321806	7.6250686	5.1571768
ANGEN (A4)	2.65734683	13.521979	14.022002	7.7556177	4.778346
AYGAZ (A5	3.44585626	3.0915577	3.6723505	4.4562092	5.0653759
BAGFS (A6)	1.17417707	1.7409766	2.3543154	2.7088705	0.3780341
BAYRK (A7)	2.38843978	2.5862416	2.6581842	1.7708806	0.7942172
BRISA (A8)	1.09803635	2.2109093	1.6507687	1.6788769	1.9916669
BRKSN (A9)	1.70687974	4.1712839	3.6476753	3.1822015	4.8610854
DEVA (A10)	2.3761663	4.4548326	4.7088309	2.3819043	3.2847576
DNISI (A11)	3.30319425	4.1956174	3.9865269	2.6366287	1.8693658
DYOBY (A12)	1.38724905	3.166242	1.4175652	1.4140173	1.4817775
EGGUB (A13)	1.87317508	3.4989977	3.7589319	5.135057	6.188857
EGPRO (A14)	1.8146082	3.1684317	2.3014623	3.4825747	4.4254679
EPLAS (A15)	2.4781804	4.0792821	0.63756	1.4907983	1.6395659
EUREN (A16)	2.30527033	3.1905199	4.0442083	4.4343828	3.8134897
GEDZA (A17)	3.35440218	5.1836034	7.0011668	6.4569436	4.8787057
GOODY (A18)	4.38923071	4.6639922	4.6437613	2.794436	1.9903209
GUBRF (A19)	1.25992106	2.3919988	1.5899947	2.6144646	2.541098
HEKTS (A20)	2.37031707	2.2541868	0.7367937	1.525377	0.3617866
IZFAS (A21)	1.76604749	2.448563	4.1325038	3.9729024	3.2357197
KMPUR (A22)	2.38181909	2.9214818	4.1237334	4.2527462	4.6156721
KRPLS (A23)	1.8254661	4.7584875	3.6540538	3.0019714	1.6986829
MEDTR (A24)	2.69024977	5.8492601	4.5747339	5.6488751	5.1013746
MERCN (A25)	2.01466614	3.6757311	4.3578894	5.2766038	3.6786652
MRSHL (A26)	2.25953231	2.3157239	0.4141384	1.4835702	1.7748217
ONCSM (A27)	1.51774194	3.6935925	9.0555979	3.2903885	-0.0906638
OZRDN (A28)	1.03535759	2.4777429	4.8921956	5.989479	9.1902093
PETKM (A29)	1.93644044	2.5183936	4.6762351	1.6834509	2.531256
POLTK (A30)	5.60369639	6.8293708	6.9339332	9.2126495	5.6790645
RNPOL (A31)	2.31266591	3.7556542	4.3853705	3.2354767	3.8187764
RTALB (A32)	5.53804664	5.8705227	5.0067746	5.4704887	4.4470035
SANFM (A33)	1.49362001	2.7165802	3.6803705	2.9465166	3.2523136
SASA (A34)	0.48765879	1.6485021	2.0579856	1.8055475	1.2552274
SEKUR (A35)	1.49990186	1.6960555	1.4453444	1.5948777	1.2738433
SEYKM (A36)	3.80413349	5.3822187	4.8968424	5.6898618	3.7430024
TARKM (A37)	2.65056116	2.371854	2.3736847	5.7067671	5.3323055
TMPOL (A38)	2.00171561	2.8990136	3.622247	1.0054365	3.0539297
TRILC (A39)	1.38631747	2.7491849	3.1704887	3.0035735	3.4454409
TUPRS (A40)	2.08265489	1.2264566	1.7610031	5.9484369	5.3108731
AVERAGE	2.47953762	3.7881613	3.9342391	3.8435817	3.3558913

Note: Z > 2.99 = Safe Zone; 1.81< Z < 2.99 = Grey Zone; Z < 1.8 = Distress Zone

Using the Z-score data shown in Table 1, companies were categorized into three groups:

Companies with a Z-score of **2.99 or higher**, indicating **financial soundness**, are marked in *blue*.

Companies with a Z-score of **1.81 or lower**, indicating **a high risk of financial failure**, are marked in *yellow*.

Companies with a Z-score **between 1.81 and 2.99**, indicating **uncertainty**, are marked in *white*.

An analysis of the data reveals that 13 companies operating in the sector had financial failure risk. While 17 companies were positioned in the gray zone, 10 were classified as financially stable. With an average sectoral Z-score of 2.479, the overall industry was situated within the zone of uncertainty. Companies A1 and A30 emerged as the strongest companies in terms of managing financial risks during this period. The lowest financial ratios in the same year were Retained Earnings/Total Assets and EBIT/Total Assets, indicating inefficiencies in asset utilization and operational profitability within the sector. On the other hand, the Equity/Total Liabilities ratio represented the best average performance among the evaluated indicators. More than half of the firms in the sector are either directly at risk or operating under uncertainty, with only one-third considered to be in the safe zone. This indicates that the sector, in general, has a fragile and unbalanced financial structure. While the overall sector may not outwardly appear high-risk, it also does not exhibit financial security. It may be vulnerable to external shocks or economic contractions. This situation suggests that firms in the sector tend to rely more on equity rather than debt to survive, but struggle with utilizing their assets efficiently.

In 2020, the number of companies at financial risk declined to four, whereas 13 companies remained in the gray zone, and 23 companies moved into the financially sound category. The sector's average Z-score rose to 3.788, placing the industry within the financially healthy zone. This reflects a 52% increase in the average Z-score compared to the previous year. Company A4 stood out as the most financially stable enterprise within the sector. The lowest ratios remained EBIT/Total Assets and Retained Earnings/Total Assets, suggesting persistent issues in operational profitability and asset efficiency. The Equity/Total Liabilities ratio continued to be the best-performing indicator. The sectoral analysis for the year 2020 indicates a significant signal of financial improvement and stability, while also revealing the persistence of certain fundamental structural issues. As of 2020, the risk of bankruptcy across the sector had markedly decreased, and a considerable degree of financial stability had been achieved. Compared to 2019, the overall financial performance of the sector showed substantial progress. This development can be attributed to increased sales, reduced costs, external economic improvements (e.g., exchange rates, interest rates), or public sector support measures.

In 2021, 7 companies were classified as high-risk, 7 were in the gray zone, and 26 were considered financially stable. The sector's average Z-score continued its upward trend, reaching 3.934. The lowest financial ratios once again were EBIT/Total Assets and Retained Earnings/Total Assets, pointing to the ongoing structural challenges in the industry. Companies A4 and A30 were identified as the strongest ones. The financial outlook for 2021 reveals key developments, clearly demonstrating that, despite improvements on the surface, underlying structural problems persist. In comparison to the previous year, a limited number of firms have once again become financially vulnerable, indicating that full stability has not yet been achieved. Nevertheless, most firms remain in a sound financial position. The sector appears robust externally, yet exhibits vulnerabilities in terms of sustainable growth. Even though progress has been made in risk management, capital structure, and overall financial health, there remains a pressing need for substantial improvements in long-term resilience and operational efficiency.

As of 2022, the number of companies at financial failure risk increased to 9, while 7 companies remained in the gray zone, and 24 companies were categorized as financially sound. The average sectoral Z-score began to decline, dropping to 3.843. The same financial ratios remained the lowest, indicating continued inefficiencies in operational profitability and asset usage. Once again, companies A4 and A30 came to the fore as the sector's top performers in terms of financial strength. As of 2022, the sector maintains a degree of financial stability; however, signs of slight weakening and the persistence of structural problems continue to be observed. Even though most businesses in the sector remain in a solid position, some degree of deterioration has occurred, and certain firms may have shifted from the safe zone to ambiguous or high-risk categories. This suggests that the observed financial recovery is not sustainable. The growth momentum has slowed, and signs of deterioration in financial performance have begun to emerge. Prolonged periods of low profitability and a shortage of internal financial resources threaten the sustainability of this seemingly stable structure.

In 2023, the number of companies without risk increased to 25. However, the sector's average Z-score declined to 3.355, indicating the beginning of a downward trend. This year, the Net Sales/Total Assets ratio recorded its lowest level, suggesting that the sector faced difficulties stemming from declining sales. Six companies remained in the gray zone, while nine companies were classified as high-risk. Companies A13 and A28 were identified as the most financially resilient in 2023. The sector may be facing challenges such as demand contraction, intensified competitive pressures, or weakened pricing power. A decline in sales may have negatively impacted cash flows and operational profitability. Certain firms have begun to lose strength, exhibiting signs of operational contraction. A decrease in the Z-score and a decline in sales efficiency point toward a period of medium-term financial vulnerability.

4.2. Results Related to MABAC Analysis

The MABAC method, recognized as an effective MCDM approach in decision-making processes, was employed in this study. This method involves a structured analysis process composed of specific and systematic steps. For this study, all relevant computations and data processing were conducted using Microsoft Excel. When calculating the weights of the criteria used in this study, the assumption that the criteria are equal and that none has absolute superiority over the others is also supported by previous studies in the literature. Civan and Dayı (2014), Arslan (2019), Özarı (2023), and Aksoylu et al. (2024) assigned equal and average weights to the criteria in their analyses. For these reasons, and in line with the evidence from the literature, the criteria were assigned equal weights in this study. There are several reasons for applying the MABAC method in this research. Although there are studies employing other MCDM techniques, the MABAC method was chosen to ensure originality and to provide a distinct perspective. Moreover, no study was identified that simultaneously applies both the Altman Z-Score and the MABAC method. For this reason, the MABAC method was preferred, highlighting the novel contribution of this research.

A MABAC analysis was conducted to determine the financial performance of firms included in the ISE Chemical, Petroleum, and Plastic Index for the year 2019. In the study, all steps of the MABAC method were carried out for the year 2019 to establish the general framework of the method. For subsequent years, only the S_i values were provided. First, to employ this

method, a decision matrix was constructed that included the alternatives and the criteria. The decision matrix for the firms analyzed in this study is presented in Table 5.

Table 5. Decision Matrix for Firms Listed in the ISE Chemical, Petroleum, and Plastic Index (2019)

Companies	Net Working Capital / Total Assets	Retained Earnings / Total Assets	EBIT/ Total Assets	Market Value of Equity / Total Liabilities	Net Sales / Total Assets
(A1)	0.29	1.00	0.23	5.54	0.87
(A2)	0.03	0.11	0.12	0.58	0.87
(A3)	0.49	0.30	0.30	2.98	1.25
(A4)	0.26	0.22	0.26	0.96	0.61
(A5)	0.02	0.30	0.10	1.00	2.06
(A6)	0.01	0.15	0.06	0.37	0.53
(A7)	0.15	0.04	0.18	1.11	0.90
(A8)	-0.02	0.05	0.07	0.20	0.69
(A9)	0.06	0.02	0.04	0.63	1.09
(A10)	0.27	0.12	0.20	0.95	0.65
(A11)	0.36	0.17	0.16	1.82	1.01
(A12)	-0.03	-0.10	0.11	0.21	1.05
(A13)	-0.15	0.16	0.12	0.66	1.02
(A14)	0.12	0.16	0.10	0.53	0.80
(A15)	0.18	0.10	0.17	0.64	1.19
(A16)	0.03	0.14	0.10	0.86	1.24
(A17)	0.46	0.21	0.18	2.04	0.71
(A18)	0.34	0.22	0.30	1.31	1.89
(A19)	-0.09	0.08	0.04	0.16	1.01
(A20)	0.47	0.08	0.20	0.71	0.60
(A21)	0.41	-0.05	0.05	0.60	0.82
(A22)	0.23	0.03	0.14	0.57	1.25
(A23)	0.20	0.06	0.13	0.11	1.01
(A24)	0.42	0.11	0.17	0.72	1.05
(A25)	-0.06	-0.05	0.27	0.31	1.07
(A26)	0.09	0.05	0.16	0.39	1.31
(A27)	0.00	0.03	0.08	1.25	0.47
(A28)	0.02	0.01	-0.01	0.37	0.83
(A29)	0.26	0.18	0.09	0.65	0.70
(A30)	0.61	0.39	0.14	4.15	1.37
(A31)	0.50	0.13	0.11	0.47	0.90
(A32)	0.27	0.27	0.04	7.56	0.17
(A33)	-0.01	-0.10	0.14	0.27	1.03
(A34)	-0.23	0.00	0.03	0.50	0.36
(A35)	0.11	-0.11	0.09	0.64	0.84
(A36)	0.47	0.07	0.15	2.93	0.89
(A37)	0.23	0.25	0.19	0.76	0.94
(A38)	0.13	0.03	0.23	0.48	0.75
(A39)	-0.07	0.09	0.18	0.32	0.57
(A40)	0.00	0.10	0.04	0.31	1.61

Based on the decision matrix, the highest and lowest values (the maximum and minimum values) were determined. These values are presented in Table 6.

Table 6. Maximum and Minimum Values for Firms Listed in the ISE Chemical, Petroleum, and Plastic Index (2019)

X_i^+	0,61	1,00	0,30	7,56	2,06
X_i^-	-0,23	-0,11	-0,01	0,11	0,17

After identifying the maximum and minimum values, the normalization procedure was performed. Through normalization, the values were standardized to fall within the interval [0,1]. For normalization, Equation (13) was used for maximization-oriented criteria and Equation (14) for minimization-oriented criteria, as shown below:

$$n_{ij} = \left(\frac{x_{ij} - x_i^-}{x_i^+ - x_i^-}\right) \quad (13)$$

$$n_{ij} = \left(\frac{x_{ij} - x_i^+}{x_i^- - x_i^+}\right) \quad (14)$$

In Equations (12) and (13), x_i^+ denotes the maximum values in the columns, while x_i^- denotes the minimum values in the columns. Since all the criteria used in this study are maximization-oriented, the formula in Equation (12) was applied, and the normalized decision matrix presented in Table 7 was constructed accordingly.

Table 7. Normalized Decision Matrix for Firms Listed in the ISE Chemical, Petroleum, and Plastic Index (2019)

Companies	Net Working Capital / Total Assets	Retained Earnings / Total Assets	EBIT/ Total Assets	Market Value of Equity / Total Liabilities	Net Sales / Total Assets
(A1)	0.618	1.000	0.762	0.729	0.369
(A2)	0.304	0.196	0.411	0.063	0.370
(A3)	0.856	0.368	0.995	0.386	0.571
(A4)	0.588	0.295	0.857	0.115	0.232
(A5)	0.295	0.370	0.369	0.120	1.000
(A6)	0.279	0.228	0.247	0.035	0.191
(A7)	0.455	0.137	0.600	0.134	0.385
(A8)	0.244	0.145	0.274	0.013	0.276
(A9)	0.348	0.116	0.178	0.070	0.485
(A10)	0.595	0.206	0.685	0.113	0.253
(A11)	0.698	0.253	0.556	0.230	0.443
(A12)	0.243	0.009	0.406	0.014	0.466
(A13)	0.099	0.242	0.434	0.074	0.450
(A14)	0.413	0.241	0.363	0.057	0.334
(A15)	0.486	0.189	0.570	0.071	0.541
(A16)	0.307	0.226	0.348	0.102	0.564
(A17)	0.818	0.284	0.600	0.259	0.288
(A18)	0.678	0.294	1.000	0.162	0.911
(A19)	0.162	0.171	0.187	0.007	0.446
(A20)	0.839	0.174	0.679	0.080	0.226
(A21)	0.768	0.055	0.191	0.066	0.345
(A22)	0.544	0.128	0.500	0.062	0.569
(A23)	0.511	0.149	0.455	0.000	0.446
(A24)	0.777	0.195	0.570	0.082	0.467
(A25)	0.200	0.054	0.904	0.027	0.478
(A26)	0.385	0.143	0.558	0.037	0.602
(A27)	0.271	0.127	0.284	0.154	0.159
(A28)	0.292	0.109	0.000	0.035	0.346
(A29)	0.589	0.257	0.317	0.073	0.279
(A30)	1.000	0.453	0.489	0.543	0.633

Table 7. Continue

(A31)	0.871	0.212	0.387	0.048	0.385
(A32)	0.598	0.340	0.171	1.000	0.000
(A33)	0.264	0.008	0.477	0.021	0.456
(A34)	0.000	0.097	0.148	0.053	0.098
(A35)	0.404	0.000	0.329	0.071	0.355
(A36)	0.833	0.157	0.523	0.379	0.381
(A37)	0.547	0.320	0.653	0.088	0.405
(A38)	0.423	0.122	0.785	0.049	0.308
(A39)	0.185	0.180	0.602	0.029	0.211
(A40)	0.268	0.191	0.184	0.027	0.764

After the construction of the normalized decision matrix, the weighting of the decision matrix was carried out. As with earlier discussions, the calculation of the weights of the criteria is based on the assumption of equality, which is supported by studies in the literature indicating that the criteria do not exhibit absolute superiority over one another. Civan and Dayı (2014), Arslan (2019), Özarı (2023), and Aksoylu et al. (2024) also adopted equal and average weights for the criteria in their analyses. For these reasons, and with support from previous studies, the criteria in this study were assigned equal weights. The criteria weights are presented in Table 8.

Table 8. Criteria Weights for Firms Listed in the ISE Chemical, Petroleum, and Plastic Index (2019)

	Net Working Capital / Total Assets	Retained Earnings / Total Assets	EBIT/ Total Assets	Market Value of Equity / Total Liabilities	Net Sales / Total Assets
Criterion Weights	0.20	0.20	0.20	0.20	0.20

The normalized decision matrix is multiplied by the criterion weights calculated using the normalized decision matrix, and the weighted normalized decision matrix is obtained as shown in Table 9.

Table 9. Weighted Normalized Decision Matrix for Firms Listed in the ISE Chemistry, Petroleum, and Plastics Index (2019)

Companies	Net Working Capital / Total Assets	Retained Earnings / Total Assets	EBIT/ Total Assets	Market Value of Equity / Total Liabilities	Net Sales / Total Assets
(A1)	0.324	0.400	0.352	0.346	0.274
(A2)	0.261	0.239	0.282	0.213	0.274
(A3)	0.371	0.274	0.399	0.277	0.314
(A4)	0.318	0.259	0.371	0.223	0.246
(A5)	0.259	0.274	0.274	0.224	0.400
(A6)	0.256	0.246	0.249	0.207	0.238
(A7)	0.291	0.227	0.320	0.227	0.277
(A8)	0.249	0.229	0.255	0.203	0.255
(A9)	0.270	0.223	0.236	0.214	0.297
(A10)	0.319	0.241	0.337	0.223	0.251
(A11)	0.340	0.251	0.311	0.246	0.289
(A12)	0.249	0.202	0.281	0.203	0.293
(A13)	0.220	0.248	0.287	0.215	0.290
(A14)	0.283	0.248	0.273	0.211	0.267

Table 9. Continue

(A15)	0.297	0.238	0.314	0.214	0.308
(A16)	0.261	0.245	0.270	0.220	0.313
(A17)	0.364	0.257	0.320	0.252	0.258
(A18)	0.336	0.259	0.400	0.232	0.382
(A19)	0.232	0.234	0.237	0.201	0.289
(A20)	0.368	0.235	0.336	0.216	0.245
(A21)	0.354	0.211	0.238	0.213	0.269
(A22)	0.309	0.226	0.300	0.212	0.314
(A23)	0.302	0.230	0.291	0.200	0.289
(A24)	0.355	0.239	0.314	0.216	0.293
(A25)	0.240	0.211	0.381	0.205	0.296
(A26)	0.277	0.229	0.312	0.207	0.320
(A27)	0.254	0.225	0.257	0.231	0.232
(A28)	0.258	0.222	0.200	0.207	0.269
(A29)	0.318	0.251	0.263	0.215	0.256
(A30)	0.400	0.291	0.298	0.309	0.327
(A31)	0.374	0.242	0.277	0.210	0.277
(A32)	0.320	0.268	0.234	0.400	0.200
(A33)	0.253	0.202	0.295	0.204	0.291
(A34)	0.200	0.219	0.230	0.211	0.220
(A35)	0.281	0.200	0.266	0.214	0.271
(A36)	0.367	0.231	0.305	0.276	0.276
(A37)	0.309	0.264	0.331	0.218	0.281
(A38)	0.285	0.224	0.357	0.210	0.262
(A39)	0.237	0.236	0.320	0.206	0.242
(A40)	0.254	0.238	0.237	0.205	0.353
w_i	0.20	0.20	0.20	0.20	0.20

After constructing the normalized decision matrix, boundary proximity area values are calculated for all criteria, and the resulting boundary proximity area matrix is presented in Table 10.

Table 10. Boundary Proximity Area Matrix for Firms Listed in the ISE Chemistry, Petroleum, and Plastics Index (2019)

	Net Working Capital / Total Assets	Retained Earnings / Total Assets	EBIT/ Total Assets	Market Value of Equity / Total Liabilities	Net Sales / Total Assets
g_i	0.291	0.240	0.291	0.226	0.280

Once the boundary proximity area matrix is formed, the distances of the decision alternatives from the boundary proximity area are calculated. These distances are computed by taking the differences between the elements of the weighted decision matrix and the boundary proximity matrix, and the resulting matrix of distances to the boundary proximity area is shown in Table 11.

Table 11. Distances to the Boundary Proximity Area for Firms Listed in the ISE Chemistry, Petroleum, and Plastics Index (2019)

Companies	Net Working Capital / Total Assets	Retained Earnings / Total Assets	EBIT/ Total Assets	Market Value of Equity / Total Liabilities	Net Sales / Total Assets
(A1)	0.032	0.160	0.061	0.120	-0.006
(A2)	-0.031	-0.001	-0.009	-0.013	-0.006
(A3)	0.080	0.033	0.107	0.052	0.034
(A4)	0.026	0.019	0.080	-0.003	-0.033
(A5)	-0.032	0.034	-0.018	-0.002	0.120
(A6)	-0.035	0.005	-0.042	-0.019	-0.042
(A7)	0.000	-0.013	0.029	0.001	-0.003
(A8)	-0.042	-0.011	-0.037	-0.023	-0.025
(A9)	-0.022	-0.017	-0.056	-0.012	0.017
(A10)	0.028	0.001	0.045	-0.003	-0.029
(A11)	0.048	0.010	0.020	0.020	0.009
(A12)	-0.043	-0.039	-0.010	-0.023	0.013
(A13)	-0.071	0.008	-0.005	-0.011	0.010
(A14)	-0.009	0.008	-0.019	-0.014	-0.013
(A15)	0.006	-0.003	0.022	-0.011	0.028
(A16)	-0.030	0.005	-0.022	-0.005	0.033
(A17)	0.072	0.016	0.029	0.026	-0.022
(A18)	0.044	0.018	0.109	0.007	0.102
(A19)	-0.059	-0.006	-0.054	-0.024	0.009
(A20)	0.076	-0.006	0.044	-0.010	-0.035
(A21)	0.062	-0.029	-0.053	-0.012	-0.011
(A22)	0.017	-0.015	0.009	-0.013	0.034
(A23)	0.011	-0.011	-0.001	-0.026	0.009
(A24)	0.064	-0.001	0.022	-0.009	0.014
(A25)	-0.051	-0.030	0.089	-0.020	0.016
(A26)	-0.014	-0.012	0.020	-0.018	0.040
(A27)	-0.037	-0.015	-0.035	0.005	-0.048
(A28)	-0.033	-0.019	-0.091	-0.019	-0.011
(A29)	0.026	0.011	-0.028	-0.011	-0.024
(A30)	0.109	0.050	0.006	0.083	0.047
(A31)	0.083	0.002	-0.014	-0.016	-0.003
(A32)	0.028	0.028	-0.057	0.174	-0.080
(A33)	-0.039	-0.039	0.004	-0.021	0.011
(A34)	-0.091	-0.021	-0.062	-0.015	-0.060
(A35)	-0.011	-0.040	-0.026	-0.011	-0.009
(A36)	0.075	-0.009	0.013	0.050	-0.004
(A37)	0.018	0.024	0.039	-0.008	0.001
(A38)	-0.007	-0.016	0.066	-0.016	-0.018
(A39)	-0.054	-0.004	0.029	-0.020	-0.038
(A40)	-0.038	-0.002	-0.055	-0.020	0.073

Following the calculation of distances to the boundary proximity area, the final stage of the method involves summing the distance values in each row for every decision alternative to obtain the respective $S_i$value. Ranking the $S_i$values from the highest to the lowest determines the order of the alternatives, where the alternative with the highest $S_i$value is identified as the best option and the one with the lowest as the worst. The computed values and the performance rankings of the firms are presented in Table 12.

Table 12. MABAC Ranking for Firms Listed in the ISE Chemistry, Petroleum, and Plastics Index (2019)

Companies	S_i	Ranking
(A1)	0.367	1
(A2)	-0.060	28
(A3)	0.307	2
(A4)	0.089	11
(A5)	0.102	8
(A6)	-0.133	36
(A7)	0.014	19
(A8)	-0.138	38
(A9)	-0.089	32
(A10)	0.041	16
(A11)	0.107	7
(A12)	-0.101	34
(A13)	-0.069	29
(A14)	-0.047	27
(A15)	0.043	15
(A16)	-0.019	23
(A17)	0.121	6
(A18)	0.280	4
(A19)	-0.134	37
(A20)	0.071	13
(A21)	-0.044	26
(A22)	0.032	17
(A23)	-0.016	22
(A24)	0.090	10
(A25)	0.004	21
(A26)	0.017	18
(A27)	-0.130	35
(A28)	-0.172	39
(A29)	-0.026	24
(A30)	0.295	3
(A31)	0.052	14
(A32)	0.093	9
(A33)	-0.084	30
(A34)	-0.250	40
(A35)	-0.097	33
(A36)	0.126	5
(A37)	0.074	12
(A38)	0.009	20
(A39)	-0.087	31
(A40)	-0.042	25

As shown in Table 9, the financial performance rankings of the firms included in the ISE Chemistry, Petroleum, and Plastics Index for 2019 were obtained using the MABAC method. Using this method, Company A1 (ACSEL) demonstrated the highest performance with a value of 0.367. Company A3 (ALKIM) ranked second with a value of 0.307. On the other hand, the firms that exhibited the lowest performance in the index were A28 (OZRDN) with a value of -0.172, and A34 (SASA) with a value of -0.250.

The following tables present the S_i values calculated for each alternative using the data obtained for the years under analysis, along with the corresponding rankings. The S_i values were

ranked in descending order each year to reveal the relative performance of the alternatives. Detailed results regarding these rankings are provided in Table 13.

Table 13. Sj Values and Rankings for the Years 2019-2023

Ranking	2019		2020		2021		2022		2023	
	Si	Ranking	Si	Ranking	Si	Ranking	Si	Ranking	Si	Ranking
1	0.367	A1	0.405	A4	0.270	A4	0.410	A30	0.291	A30
2	0.307	A3	0.307	A30	0.267	A30	0.284	A4	0.255	A28
3	0.295	A30	0.289	A1	0.235	A3	0.274	A3	0.228	A37
4	0.280	A18	0.282	A3	0.181	A17	0.202	A17	0.228	A13
5	0.126	A36	0.252	A18	0.153	A27	0.176	A40	0.169	A5
6	0.121	A17	0.218	A24	0.148	A1	0.159	A24	0.160	A40
7	0.107	A11	0.183	A11	0.146	A18	0.153	A1	0.155	A4
8	0.102	A5	0.161	A5	0.130	A24	0.126	A36	0.151	A3
9	0.093	A32	0.145	A15	0.117	A5	0.103	A37	0.146	A24
10	0.090	A24	0.138	A17	0.095	A29	0.100	A32	0.141	A32
11	0.089	A4	0.098	A36	0.075	A32	0.097	A13	0.094	A36
12	0.074	A37	0.086	A32	0.074	A10	0.097	A25	0.066	A9
13	0.071	A20	0.039	A10	0.045	A36	0.074	A28	0.061	A31
14	0.052	A31	0.026	A23	0.044	A31	0.062	A16	0.047	A22
15	0.043	A15	0.026	A31	0.034	A25	0.058	A5	0.041	A14
16	0.041	A10	0.003	A16	0.023	A11	0.036	A22	0.035	A17
17	0.032	A22	-0.011	A29	0.015	A28	0.033	A2	0.031	A10
18	0.017	A26	-0.014	A14	0.011	A13	0.024	A21	0.023	A1
19	0.014	A7	-0.014	A37	0.008	A16	0.024	A31	0.016	A16
20	0.009	A38	-0.018	A9	0.007	A38	0.008	A23	0.010	A18
21	0.004	A25	-0.020	A13	-0.003	A9	0.003	A14	0.005	A39
22	-0.016	A23	-0.030	A2	-0.005	A22	0.001	A27	0.002	A2
23	-0.019	A16	-0.038	A7	-0.007	A23	-0.025	A18	-0.003	A25
24	-0.026	A29	-0.039	A25	-0.014	A39	-0.035	A9	-0.005	A21
25	-0.042	A40	-0.063	A27	-0.027	A21	-0.038	A39	-0.030	A23
26	-0.044	A21	-0.064	A19	-0.039	A7	-0.045	A6	-0.032	A19
27	-0.047	A14	-0.068	A22	-0.052	A14	-0.052	A11	-0.035	A38
28	-0.060	A2	-0.076	A21	-0.053	A40	-0.058	A10	-0.046	A33
29	-0.069	A13	-0.089	A26	-0.057	A15	-0.066	A33	-0.064	A11
30	-0.084	A33	-0.093	A40	-0.063	A2	-0.070	A19	-0.066	A6
31	-0.087	A39	-0.094	A38	-0.070	A33	-0.102	A7	-0.077	A27
32	-0.089	A9	-0.097	A6	-0.074	A37	-0.116	A29	-0.078	A8
33	-0.097	A35	-0.098	A20	-0.089	A19	-0.129	A12	-0.097	A12
34	-0.101	A12	-0.103	A12	-0.096	A6	-0.133	A38	-0.098	A29
35	-0.130	A27	-0.110	A8	-0.106	A8	-0.141	A8	-0.115	A26
36	-0.133	A6	-0.139	A33	-0.115	A34	-0.154	A35	-0.137	A15
37	-0.134	A19	-0.149	A28	-0.116	A12	-0.158	A20	-0.148	A34
38	-0.138	A8	-0.161	A39	-0.149	A26	-0.169	A15	-0.170	A35
39	-0.172	A28	-0.178	A35	-0.182	A35	-0.175	A34	-0.171	A7
40	-0.250	A34	-0.186	A34	-0.208	A20	-0.191	A26	-0.201	A20

As a result of the evaluation conducted using the MABAC method, the annual financial performance levels of the companies were determined. Examining the 2019 data, it was determined that Company A1 demonstrated the highest performance, whereas Company A34 exhibited the lowest. In the 2020 analysis, Company A4 ranked as the top performer, whereas Company A34 again recorded the poorest performance. The 2021 assessment revealed that Company A4 maintained the highest performance, while Company A20 showed the weakest. Given the 2022 results, Company A30 emerged as the top performer, whereas Company A26 recorded the lowest performance. As of 2023, Company A30 once again achieved the highest performance, while Company A20 ended the year with the lowest financial performance.

When evaluating performance trends over the years, it can be seen that Company A4 reached peak performance in 2020 and 2021, whereas Company A30 attained the highest performance in both 2022 and 2023. On the other hand, Company A34 consistently yielded the lowest performance in 2019 and 2020, whereas Company A20 recorded the lowest levels in 2021 and 2023.

The detailed results of the analyses conducted using the Altman Z-score model and the MABAC method are presented in the corresponding tables. A consolidated ranking based on the evaluations of both methods is provided in Table 14, enabling a holistic assessment of companies' periodic and comparative financial performance.

Table 14. Altman Z-Score and MABAC Rankings of Companies

	2019		2020		2021		2022		2023	
	A	**M**	**A**	**M**	**A**	**M**	**A**	**M**	**A**	**M**
A1	1	1	4	3	6	6	7	7	25	18
A2	28	28	19	22	27	30	17	17	20	22
A3	4	2	3	4	5	3	3	3	6	8
A4	11	11	1	1	1	1	2	2	11	7
A5	7	8	23	8	22	9	14	15	8	5
A6	37	36	37	32	30	34	27	26	38	30
A7	14	19	28	23	28	26	32	31	37	39
A8	38	38	36	35	34	35	34	35	28	32
A9	30	32	13	20	24	21	22	24	10	12
A10	16	16	11	13	10	12	30	28	21	17
A11	9	7	12	7	19	16	28	27	30	29
A12	34	34	22	34	37	37	39	33	34	33
A13	25	29	18	21	20	18	13	11	2	4
A14	27	27	21	18	31	27	19	21	14	15
A15	13	15	14	9	39	29	37	38	33	36
A16	19	23	20	16	18	19	15	14	16	19
A17	8	6	8	10	3	4	4	4	9	16
A18	5	4	10	5	12	7	26	23	29	20
A19	36	37	32	26	35	33	29	30	26	26
A20	17	13	35	33	38	40	36	37	39	40
A21	29	26	31	28	16	25	18	18	23	24
A22	15	17	24	27	17	22	16	16	12	14
A23	26	22	9	14	23	23	24	20	32	25
A24	10	10	6	6	13	8	10	6	7	9
A25	22	21	17	24	15	15	12	12	18	23
A26	20	18	34	29	40	38	38	40	31	35
A27	31	35	16	25	2	5	20	22	40	31
A28	39	39	30	37	9	17	5	13	1	2
A29	24	24	29	17	11	10	33	32	27	34
A30	2	3	2	2	4	2	1	1	3	1
A31	18	14	15	15	14	14	21	19	15	13
A32	3	9	5	12	7	11	11	10	13	10
A33	33	30	27	36	21	31	25	29	22	28
A34	40	40	39	40	32	36	31	39	36	37
A35	32	33	38	39	36	39	35	36	35	38
A36	6	5	7	11	8	13	9	8	17	11
A37	12	12	33	19	29	32	8	9	4	3
A38	23	20	25	31	25	20	40	34	24	27
A39	35	31	26	38	26	24	23	25	19	21
A40	21	25	40	30	33	28	6	5	5	6

To determine the degree of correlation between the rankings, Spearman's rank correlation coefficient was used, as it is suitable for ordinal data (Apan et al., 2018: 95). The results derived from the analysis are presented in detail in Table 15.

Table 15. Results of the Spearman's Rank Correlation Test

	A2019	**M2019**	**A2020**	**M2020**	**A2021**	**M2021**	**A2022**	**M2022**	**A2023**	**M2023**
A2019	1.000	0.976**	0.673**	0.840**	0.497**	0.634**	0.450**	0.535**	0.332*	0.415**
	.	0.000	0.000	0.000	0.001	0.000	0.004	0.000	0.037	0.008
M2019	0.976**	1.000	0.668**	0.818**	0.486**	0.612**	0.410**	0.497**	0.297	0.376*
	0.000	.	0.000	0.000	0.001	0.000	0.009	0.001	0.063	0.017
A2020	0.673**	0.668**	1.000	0.845**	0.720**	0.799**	0.493**	0.578**	0.335*	0.457**
	0.000	0.000	.	0.000	0.000	0.000	0.001	0.000	0.035	0.003
M2020	0.840**	0.818**	0.845**	1.000	0.600**	0.767**	0.492**	0.577**	0.353*	0.476**
	0.000	0.000	0.000	.	0.000	0.000	0.001	0.000	0.025	0.002
A2021	0.497**	0.486**	0.720**	0.600**	1.000	0.923**	0.674**	0.692**	0.434**	0.539**
	0.001	0.001	0.000	0.000	.	0.000	0.000	0.000	0.005	0.000
M2021	0.634**	0.612**	0.799**	0.767**	0.923**	1.000	0.632**	0.682**	0.469**	0.574**
	0.000	0.000	0.000	0.000	0.000	.	0.000	0.000	0.002	0.000
A2022	0.450**	0.410**	0.493**	0.492**	0.674**	0.632**	1.000	0.971**	0.794**	0.851**
	0.004	0.009	0.001	0.001	0.000	0.000	.	0.000	0.000	0.000
M2022	0.535**	0.497**	0.578**	0.577**	0.692**	0.682**	0.971**	1.000	0.782**	0.857**
	0.000	0.001	0.000	0.000	0.000	0.000	0.000	.	0.000	0.000
A2023	0.332*	0.297	0.335*	0.353*	0.434**	0.469**	0.794**	0.782**	1.000	0.936**
	0.037	0.063	0.035	0.025	0.005	0.002	0.000	0.000	.	0.000
M2023	0.415**	0.376*	0.457**	0.476**	0.539**	0.574**	0.851**	0.857**	0.936**	01.000
	0.008	0.017	0.003	0.002	0.000	0.000	0.000	0.000	0.000	.

Note: * Correlation is significant at $p<0.05$. ** Correlation is significant at $p<0.01$.

The results presented in Table 15 indicate that, over the five-year period analyzed, there is a significant correlation between the rankings obtained each year. This finding clearly demonstrates that both methods produced largely consistent outcomes during the study period. Therefore, it can be concluded that the Altman Z-score model and the MABAC method can serve as viable alternative tools in most financial performance evaluations.

5. Conclusion

The companies operating in the petroleum, chemical, and plastics sectors are closely interconnected and hold a significant position within the national industry. Türkiye has limited petroleum resources; however, recent discoveries of natural gas and oil exploration in the Black Sea have revitalized these constrained reserves. In recent years, high-value raw material reserves were identified. With this development, Türkiye aims to reduce its dependency on imported petroleum, thereby addressing trade imbalances. The chemical sector is considered strategic due to its extensive connections to various industries such as construction, agriculture, textiles, and pharmaceuticals. It also has substantial relationships with the petroleum sector and is heavily reliant on imported raw materials. Türkiye is one of the leading plastic manufacturers in Europe. As of 2023, the production capacity of the plastics sector in Türkiye reached 10 million tons. Like other sectors, it is highly dependent on the importation of granules and plastic raw materials. With the advent of the green transformation, pressures related to sustainability have increased in the

chemical, petroleum, and plastics sectors. Consequently, these industries are now expected to produce environmentally friendly products that generate less pollution.

The chemical sector features a highly diverse product range. In addition to everyday consumer products such as cleaning agents, paints, cosmetics, and pharmaceuticals, it encompasses fertilizers and agricultural chemicals for the farming industry, as well as industrially used organic and inorganic chemicals, dyes, laboratory equipment, and thermoplastics. One of the major challenges faced by Türkiye's petrochemical industry is the insufficient investment volume despite rapidly growing domestic demand. This shortfall weakens the sector's competitiveness both locally and globally and leads to the outsourcing of high-value-added petrochemical production abroad. Another critical issue the sector faces is the difficulty in securing suitable investment zones. Many goods produced in the chemical sector are hazardous to the environment and human health and thus are often classified as dangerous chemicals. As a result, these investments are frequently associated with environmental pollution, which poses significant obstacles in the investment process. However, such risks can be largely mitigated in organized industrial zones, particularly in specialized organized industrial zones. For this reason, investments made in these designated areas are of great importance for the healthy and sustainable growth of the sector.

In this study, the financial failure risks of companies listed in the Istanbul Stock Exchange (ISE) Petroleum, Chemical, and Plastics Index are empirically analyzed. Using annual data from the 2019-2023 period, the Altman Z-Score model and the MABAC method were applied to evaluate and compare both the financial failure risks and financial performance levels of these companies.

Considering the 2019 data, Company A1, which exhibited the lowest financial failure risk based on the Altman Z-Score model, also ranked among the top performers in terms of financial success as per the MABAC analysis. In contrast, Company A34, which showed the highest financial failure risk in the same year, was positioned at the bottom of the list in terms of financial performance.

Examining the 2020 data, Company A4 demonstrated the lowest financial risk and was also identified as one of the highest-performing companies in the MABAC analysis. Similarly, in the 2021 analysis, A4 again stood out both in terms of low financial failure risk (as indicated by the Z-score model) and high financial performance.

The results for 2022 revealed that Company A30, which had the lowest risk when considering the Altman Z-Score model, also ranked among the most successful companies based on the MABAC method in the same year.

The companies with the lowest financial failure risk were A1 in 2019, A4 in both 2020 and 2021, and A30 in 2022. In general, Company A4 achieved the highest performance levels in 2020 and 2021, while Company A30 led in performance in 2022 and 2023. However, Company A34 recorded the lowest performance in 2019 and 2020, and Company A20 showed the lowest performance in 2021 and 2023.

In terms of financial performance evaluation, A1 achieved the highest performance in 2019, A4 led in 2020 and 2021, and A30 ranked first in both 2022 and 2023. Conversely, the lowest-performing company was A34 in 2019 and 2020, and A20 in 2021 and 2023.

The rankings derived from the Altman Z-Score model and the MABAC method were found to be generally consistent. The Spearman rank correlation test was conducted to statistically assess the significance of this similarity. The analysis revealed a statistically significant positive correlation among all data sets. This finding suggests that the Altman Z-Score model can serve as a useful tool for ranking companies based on financial performance, while the MABAC method can be employed as a complementary or alternative approach in estimating financial failure risk. The results achieved in this study are consistent with the results achieved in the study carried out by Aksoylu et al. (2024).

The results indicate that the findings can be considered complementary, as the analytical methods employed tend to produce similar outcomes. Furthermore, it was observed that certain firms exhibited high levels of financial risk during specific periods, which points to the existence of structural vulnerabilities within the sector. In this context, the following policy recommendations are proposed:

Strengthening Financial Risk Monitoring Systems: A dynamic and integrated risk monitoring infrastructure that combines traditional and MCDM models should be established to enable the timely identification of firms at risk of financial failure. Such a system would allow for the early detection of weak links within the sector and facilitate the prompt implementation of necessary measures.

Developing Sector-Specific Oversight Frameworks: Special audit protocols should be designed for firms operating in the chemicals, petroleum, and plastics sectors, which are characterized by high foreign exchange sensitivity and capital intensity. These firms' financial conditions should be regularly analyzed. This approach would contribute to monitoring the overall financial health of the sector.

Enhancing Corporate Resilience: Corporate governance practices play a central role in preventing financial failure. Therefore, firms should be encouraged to improve transparency, strengthen internal control mechanisms, and implement independent audit processes more effectively.

Capacity-Building Support Programs for SMEs: Considering that small and medium-sized enterprises often experience deficiencies in financial management, it is of great importance to support these firms through targeted training programs, financial consulting services, and early warning systems.

Improving Access to Information and Transparency: In order to support investors' decision-making processes, comprehensive, up-to-date, and accessible databases reflecting firms' financial risk levels should be developed. This data should be integrated into investor information systems and made publicly available.

Designing Performance-Based Incentive Systems: To increase the effectiveness of public support, conditional incentive mechanisms should be developed based on firms' financial soundness and performance indicators. This would enable strategic resource allocation and promote the prominence of financially robust enterprises.

This study covers the 2019-2023 period and analyzes 40 companies from the chemical, petroleum, and plastics sectors and listed on the ISE, based on five financial criteria. The scope of this study is limited to the evaluation period, the number of companies, the criteria used, the geographical coverage, and the applied methodologies. Future studies in this field could be carried

out on the approaches proposed in this study by employing broader sample sizes, alternative sets of criteria, and various weighting techniques. Additionally, MCDM methods may be used to enrich the weighting process and allow for comparative analyses of different methodologies, thereby contributing to the existing literature. The sector and index examined in this study were addressed only in a limited number of studies in the literature. For this reason, studies employing the Altman Z-score model and those utilizing MCDM methods were examined in depth. In his study, Vatansever (2014) measured the financial failure of firms operating in the Food, Beverage, and Tobacco sector on the ISE. The ELECTRE TRI method was applied, and through a discriminant analysis on 43 financial ratios, five ratios were identified as statistically significant at the 5% level in distinguishing financially successful and unsuccessful firms. When the analysis was conducted one year before the occurrence of financial failure, it was found that two out of four firms that would fail the following year were classified as financially successful. In another study, Kulalı (2016) analyzed the financial failure of bankrupt firms listed on ISE using the Altman Z-score model. The findings indicated that the model predicted financial failure with 95% accuracy one year before bankruptcy and with 90% accuracy two years prior. However, differences in the years covered and sectors examined pose challenges for direct comparison with the present study. Nonetheless, the application of a similar method constitutes a commonality, while the implementation of the MABAC method in this study adds a novel dimension. Akdeniz and Güven (2023) investigated financial failures of firms in the ISE stone and soil-based sector. Their analyses revealed that a Z-score of 2.16 placed the firms in the gray area of financial failure risk. In the present study, the Z-score was found to be 3.47, indicating that the firms were positioned within the safe (green) area. Thus, the differences between their study and the present study originate mainly from the years analyzed and the variations in Z-scores. Similarly, Fidan (2021) examined whether firms in the ISE textiles, apparel, and leather sector carried financial risks using the Altman Z-score model. The results demonstrated that most of the firms in the sector experienced financial failure within three years. The main difference compared to the present study arises from the time constraints and the observation that most firms here were located in the green zone, which also highlights the originality of this study. Kendirli and Çıtak (2022) applied the Altman Z-score model to predict the financial failures of firms listed in the ISE forestry, paper, and printing index. The main distinctions between their study and the present study lie in the years covered and the methods applied. While both studies employed the Altman Z-score model, the additional use of the MABAC method in the present study underscores its originality. Finally, Mirgen (2025) analyzed the financial failures of industrial firms listed on ISE using the Altman Z-score model. The similarity with the present study is the use of the same model, while the differences arise from the years examined, again distinguishing the scope of this research.

Declaration of Research and Publication Ethics
This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement
The authors declare that they have contributed equally to the article.

Declaration of Researcher's Conflict of Interest
There are no potential conflicts of interest in this study.

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APPENDIX

Table A1. Decision Matrix Constructed for the Enterprises Listed in the ISE Chemical, Petroleum, and Plastic Index (2020)

Companies	Net Working Capital / Total Assets	Retained Earnings / Total Assets	EBIT/ Total Assets	Market Value of Equity / Total Liabilities	Net Sales / Total Assets
(A1)	0.34	0.28	0.21	5.54	0.78
(A2)	0.17	0.10	0.17	0.61	0.83
(A3)	0.49	0.32	0.32	2.34	1.00
(A4)	0.66	0.00	0.88	5.19	1.07
(A5)	0.06	0.30	0.02	0.75	1.88
(A6)	0.07	0.17	0.06	0.26	0.54
(A7)	0.35	0.07	0.09	1.60	0.43
(A8)	0.11	0.06	0.10	0.31	0.70
(A9)	0.18	0.01	0.23	0.68	1.12
(A10)	0.31	0.16	0.25	1.12	0.60
(A11)	0.60	0.17	0.09	3.76	0.61
(A12)	0.02	-0.06	0.18	0.33	1.20
(A13)	-0.15	0.17	0.18	0.86	1.12
(A14)	0.21	0.14	0.15	0.66	0.76
(A15)	0.40	0.28	0.15	1.06	0.96
(A16)	0.10	0.12	0.13	0.84	1.12
(A17)	0.50	0.21	0.26	1.70	0.61
(A18)	0.35	0.32	0.13	1.21	1.67
(A19)	-0.01	0.12	0.09	0.32	1.05
(A20)	0.14	0.11	0.11	0.57	0.47
(A21)	0.31	-0.03	0.09	0.48	0.86
(A22)	0.18	0.04	0.15	0.35	0.88
(A23)	0.18	0.07	0.28	0.22	1.24
(A24)	0.45	0.26	0.28	1.74	1.05
(A25)	0.16	0.00	0.20	0.36	1.15
(A26)	-0.01	0.07	0.10	0.27	1.04
(A27)	0.04	0.04	0.21	1.32	0.77
(A28)	-0.05	-0.06	0.14	0.33	1.05
(A29)	0.30	0.17	0.08	0.61	0.61
(A30)	0.56	0.27	0.31	2.18	1.30
(A31)	0.37	0.09	0.18	0.66	0.90
(A32)	0.24	0.12	0.35	1.69	0.90
(A33)	0.04	-0.03	0.16	0.27	0.82
(A34)	-0.15	0.10	0.10	0.37	0.47
(A35)	0.02	-0.08	0.07	0.60	0.83
(A36)	0.61	0.01	0.28	1.99	0.74
(A37)	0.25	0.19	0.07	0.45	0.66
(A38)	0.10	0.04	0.16	0.38	0.77
(A39)	0.03	-0.01	0.18	0.59	0.50
(A40)	0.04	0.10	-0.01	0.25	0.99

Table A2. Decision Matrix Constructed for the Enterprises Listed in the ISE Chemical, Petroleum, and Plastic Index (2021)

Companies	Net Working Capital / Total Assets	Retained Earnings / Total Assets	EBIT/ Total Assets	Market Value of Equity / Total Liabilities	Net Sales / Total Assets
(A1)	0.34	0.20	0.34	2.29	0.86
(A2)	0.01	0.06	0.14	0.43	0.88
(A3)	0.45	0.32	0.32	1.62	0.95
(A4)	0.79	-0.01	0.40	22.56	0.48
(A5)	0.09	0.17	0.10	0.48	1.91
(A6)	-0.01	0.09	0.15	0.25	0.53
(A7)	0.25	0.09	0.10	1.10	0.60
(A8)	0.08	0.06	0.06	0.29	0.64
(A9)	0.16	0.06	0.19	0.54	1.04
(A10)	0.34	0.20	0.27	1.16	0.46
(A11)	0.40	0.12	0.07	5.34	0.53
(A12)	-0.02	0.02	0.03	0.38	0.97
(A13)	-0.06	0.19	0.22	0.66	0.83
(A14)	0.14	0.10	0.09	0.44	0.72
(A15)	-0.24	0.25	-0.06	0.30	0.99
(A16)	0.18	0.05	0.21	0.92	1.07
(A17)	0.54	0.22	0.39	2.85	0.58
(A18)	0.27	0.20	0.20	0.70	1.45
(A19)	0.05	0.07	0.04	0.30	0.82
(A20)	0.06	-0.01	0.03	0.55	0.14
(A21)	0.15	0.01	0.26	0.38	0.97
(A22)	0.20	0.03	0.25	0.34	0.98
(A23)	0.33	0.01	0.18	0.64	1.00
(A24)	0.68	0.21	0.12	3.80	0.52
(A25)	0.36	0.05	0.22	1.15	1.00
(A26)	-0.18	0.07	-0.04	0.01	0.92
(A27)	0.32	0.05	0.64	1.55	0.99
(A28)	0.12	-0.01	0.29	0.53	1.39
(A29)	0.39	0.15	0.24	0.72	0.94
(A30)	0.55	0.25	0.33	1.84	1.36
(A31)	0.53	0.05	0.20	1.72	0.74
(A32)	0.30	0.16	0.28	1.49	0.70
(A33)	0.05	0.02	0.25	0.44	0.73
(A34)	-0.01	0.04	0.11	0.23	0.66
(A35)	-0.04	-0.04	0.08	0.43	0.60
(A36)	0.65	0.01	0.20	3.22	0.64
(A37)	0.10	0.09	0.13	0.28	0.56
(A38)	0.20	0.07	0.18	0.40	1.06
(A39)	0.20	0.05	0.12	1.10	1.09
(A40)	0.02	0.04	0.01	0.22	1.44

Table A3. Decision Matrix Constructed for the Enterprises Listed in the ISE Chemical, Petroleum, and Plastic Index (2022)

Companies	Net Working Capital / Total Assets	Retained Earnings / Total Assets	EBIT/ Total Assets	Market Value of Equity / Total Liabilities	Net Sales / Total Assets
(A1)	0.24	0.36	0.23	2.31	1.37
(A2)	0.14	0.15	0.16	1.71	1.36
(A3)	0.45	0.36	0.36	2.64	1.46
(A4)	0.64	0.18	0.26	9.32	0.28
(A5)	0.00	0.35	0.14	2.05	1.56
(A6)	0.14	0.26	0.08	1.34	0.68
(A7)	0.26	-0.02	0.02	0.99	0.81
(A8)	0.00	0.06	0.05	0.55	0.82
(A9)	0.13	0.06	0.12	1.05	1.21
(A10)	0.15	0.32	0.06	1.28	0.42
(A11)	0.21	0.16	0.06	2.59	0.43
(A12)	0.05	0.14	0.00	0.62	0.88
(A13)	0.09	0.34	0.11	7.31	0.55
(A14)	0.16	0.24	0.13	0.85	1.09
(A15)	0.05	-0.14	0.03	2.09	0.58
(A16)	0.38	0.09	0.19	1.74	1.01
(A17)	0.36	0.44	0.28	3.09	0.87
(A18)	0.13	0.15	0.04	0.41	1.71
(A19)	0.00	0.13	0.07	0.51	1.37
(A20)	0.07	0.00	0.07	0.56	0.43
(A21)	0.42	-0.10	0.18	1.45	1.12
(A22)	0.28	0.08	0.21	0.48	1.21
(A23)	0.37	0.12	0.03	2.17	1.11
(A24)	0.51	0.19	0.21	3.95	0.84
(A25)	0.28	0.11	0.25	1.43	1.37
(A26)	-0.11	-0.16	0.07	0.14	1.14
(A27)	0.29	0.15	0.10	1.79	0.84
(A28)	0.27	-0.43	0.37	0.83	2.16
(A29)	0.06	0.13	0.01	0.76	0.95
(A30)	0.67	0.36	0.38	3.54	2.07
(A31)	0.48	0.16	0.09	1.37	0.70
(A32)	0.27	0.24	0.24	5.09	0.14
(A33)	0.12	0.02	0.14	0.65	0.95
(A34)	-0.19	0.05	0.10	0.68	0.62
(A35)	0.04	-0.04	0.06	0.36	0.78
(A36)	0.65	-0.09	0.31	2.75	0.55
(A37)	0.34	0.11	0.35	1.10	0.80
(A38)	0.24	0.10	-0.03	0.67	0.59
(A39)	0.12	0.19	0.10	1.30	0.86
(A40)	0.19	0.26	0.20	1.06	2.64

Table A4. Decision Matrix Constructed for the Enterprises Listed in the ISE Chemical, Petroleum, and Plastic Index (2023)

Companies	Net Working Capital / Total Assets	Retained Earnings / Total Assets	EBIT/ Total Assets	Market Value of Equity / Total Liabilities	Net Sales / Total Assets
(A1)	0.02	0.42	0.06	1.77	0.79
(A2)	-0.06	0.28	0.11	2.02	0.96
(A3)	0.35	0.18	0.18	3.21	1.14
(A4)	0.54	0.04	0.06	8.67	0.18
(A5)	0.02	0.49	0.12	3.74	1.40
(A6)	0.07	0.48	-0.13	1.08	0.32
(A7)	0.03	-0.16	-0.01	0.86	0.82
(A8)	0.13	0.07	0.07	0.57	0.72
(A9)	0.22	0.01	0.22	2.88	1.09
(A10)	0.20	0.32	0.11	1.93	0.50
(A11)	0.16	0.12	0.01	2.59	0.34
(A12)	0.00	0.14	0.02	0.53	0.82
(A13)	0.13	0.51	0.12	9.03	0.49
(A14)	0.12	0.20	0.23	0.97	1.01
(A15)	0.04	-0.17	0.02	3.08	0.56
(A16)	0.20	0.15	0.17	2.07	0.63
(A17)	0.36	-0.15	0.27	2.85	0.72
(A18)	0.05	0.10	-0.04	0.41	1.97
(A19)	0.04	0.25	0.08	0.84	0.84
(A20)	-0.03	0.05	-0.01	0.42	0.24
(A21)	0.29	-0.18	0.13	1.23	1.32
(A22)	0.22	0.07	0.26	0.44	1.20
(A23)	0.26	0.08	-0.01	1.20	0.87
(A24)	0.45	0.17	0.19	3.57	0.77
(A25)	0.11	0.07	0.17	1.29	1.04
(A26)	0.03	-0.23	0.05	0.56	1.44
(A27)	0.31	0.02	-0.19	2.17	0.71
(A28)	0.48	-0.19	0.53	3.74	1.70
(A29)	-0.07	0.12	0.12	1.15	0.63
(A30)	0.55	0.45	0.15	2.07	1.59
(A31)	0.35	0.21	0.16	1.34	0.69
(A32)	0.14	0.49	0.01	8.61	0.08
(A33)	0.02	0.08	0.17	0.67	0.98
(A34)	-0.05	0.16	0.04	0.77	0.31
(A35)	-0.08	-0.01	0.05	0.42	0.68
(A36)	0.61	-0.11	0.07	4.54	0.69
(A37)	0.64	0.40	0.16	3.82	0.44
(A38)	0.21	0.11	0.16	0.55	0.58
(A39)	0.10	0.14	0.13	1.71	0.97
(A40)	0.13	0.31	0.20	1.23	1.87