
TÜRK ANA METAL SANAYİ FİNANSAL PERFORMANS DEĞERLENDİRMESİ: AHP VE TOPSIS UYGULAMASI

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Öz

Finansal performans, şirketlerin hem finansal hem de finansal olmayan politikalarının sonuçlarını yansıtarak kaynakların etkin kullanımını ve riskliliklerini değerlendirir. Bu nedenle, rekabetçi iş dünyasında finansal performans değerlendirmesi çok önemlidir. Çelik ve demir endüstrisi hem makine hem de emek yoğun bir endüstridir ve buna bağlı olarak bu endüstri firmaları oldukça rekabetçi bir ortamda faaliyet göstermektedir. Dolayısıyla bu çalışmanın amacı, Türk demir-çelik sektörünün finansal performansını değerlendirmektir. Bu amaç doğrultusunda, Borsa İstanbul'da 2017 yılı içinde işlem gören 17 ana metal sanayi firmasının finansal oranları hesaplanmaktadır. Çalışmada likidite, verimlilik, kârlılık ve sermaye yapısı oranları finansal performansın ana ölçütü olarak kabul edilmiştir. Analitik Hiyerarşik Süreç (AHP) kullanılarak, bu kriterler ve her birinin ilgili alt kriterleri değerlendirilmiş ve ağırlıklandırılmıştır. Ardından TOPSIS aracılığı ile bu ağırlıklar 17 firmayı sıralamak için kullanılmıştır. Elde edilen sıralama, 2017 yılında şirketlerin kapanış fiyatlarına göre sıralama ile karşılaştırılmış ve 15 şirkette (%88.235) iki sıralamanın çok yakın sonuçlar verdiği görülmüştür. Bu nedenle, AHP ve TOPSIS'in birleştirilmesinin finansal performans değerlendirmesinde kullanılabileceği sonucuna varılmıştır.

Anahtar Kelimeler: Finansal Performans, Ana Metal Sanayi, TOPSIS, AHP

Jel Classification: C02, M41

FINANCIAL PERFORMANCE EVALUATION OF TURKISH BASIC METAL INDUSTRY: COMBINING AHP AND TOPSIS

Abstract

Financial performance evaluation is crucial for competitive business world. Steel and iron industry is both high-tech heavy machine and labor-intensive industry, which makes it operating in a highly competitive environment. Therefore, the aim of this study is to evaluate the financial performance of Turkish steel and iron sector. For this aim, financial ratios of 17 basic metal industry firms listed in Borsa Istanbul in 2017 are calculated. Liquidity, efficiency, profitability, and capital structure ratios are considered as main criteria of financial performance. By using Analytical Hierarchic Process (AHP), these criteria and related sub-criteria of each of them are assessed and weighted. These weights are then used in Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) for ranking. Obtained ranking is compared with ranking based on companies' closing prices and results reveal that for 15 companies (88.235%) two rankings are very close. Therefore, it is concluded that combining AHP and TOPSIS should be used in financial performance evaluation.

Keywords: Financial Performance, Basic Metal Industry, TOPSIS, AHP

Jel Sınıflandırması: C02, M41

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1. Introduction

Financial performance evaluation has always been and will always be one of the most important and debatable issues both for academics and practitioners. It is important because decision makers both inside and outside of the company try to give wise decisions depending on financial results. On the other hand, it is debatable because in literature there are many ways to measure financial performance. Among all, financial ratios that are derived from financial statements, have always been a valuable tool to indicate financial performance. Financial ratios provide useful quantitative information about liquidity, profitability, efficiency and capital structure of the firms to all decision makers. Financial ratios do not only provide insight only about the financial performance of a firm, but also give chance to compare the firm's position in the competing industry. However, in order to survive in today's competitive environment there must be further steps to be taken about measure of financial performance. Only evaluating a company's financial performance via ratios and ignoring what the industry doing as a whole would not be suitable. Therefore, both insider and outsider decision makers must evaluate the firm and must evaluate the industry that the firm operates. In this context, TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method confronts us meeting the need for evaluate and rank firms' financial performance depending on financial ratios.

TOPSIS is one of the Multi Criteria Decision-Making Techniques and widely used in financial performance evaluation. While some studies in literature focus on traditional multi-criteria decision-making techniques, some focus on fuzzy methods. In the research of Yilmaz and Konyar (2013), lodging firms listed in BIST were considered and those firms were ranked depending on their financial performance via TOPSIS method for the period 2008-2011. Similarly, Demireli (2010) used TOPSIS method to evaluate the financial performance of seven Turkish state-owned commercial banks for the period 2001-2007. Another study used TOPSIS to evaluate financial performance was performed by Bülbül and Köse in 2011. They considered Food, Beverage and Tobacco industry and used TOPSIS and ELECTRE comparatively for financial performance evaluation for the period 2005-2008. Dumanoğlu (2010) studied cement firms listed in BIST for financial performance evaluation for the period 2004-2009 and used TOPSIS method similar to others. Ömürbek and Kınay (2013) focused on airline industry and used TOPSIS. Different from other studies, they compared two airline firms' financial performances for the year 2012, which one is listed in Borsa Istanbul, and the other one is listed in Frankfurt Stock Exchange. Topaloğlu (2014) focused on Metal Products, Mach Index in Borsa Istanbul and evaluated the effect of financial crisis on firm's financial performances by using TOPSIS. The results are compared for three periods that are crisis period, pre-crisis period and post-crisis period. Yıldırım et al (2019) studied financial performance of Basic Metal Industry firms listed in Borsa Istanbul between the years 2008 and 2017 and they found that 2008 was the most and 2015 was the least successful year for the industry. Fai et al. (2016) applied TOPSIS to financial companies listed in Malaysia Stock Exchange for the period 2012-2014. Another study held for Malaysian companies was performed by Abd Rahim et al (2020) for construction industry. They used financial ratios as a tool for financial performance and TOPSIS method for the ranking.

However, while making decision, since choosing the important criterions or factors, and assigning weights to each of them properly is very important, many of the literature studies aimed to combine TOPSIS with Analytical Hierarchic Process (AHP) to reach more accurate results depending on weighted ranking. AHP, firstly introduced by Saaty (1990), is a hierarchical method explaining the relationship between main goals, criteria, sub-criteria, and various alternatives in multi-criteria decision making and weighting criteria and sub-criteria in terms of the main goal. Yurdakul and Ic (2005) developed a performance measurement model for manufacturing companies by using AHP. Sharma and Bhagwat (2007) used AHP to assess financial performance of supply chains. Bhandari and Nakarmi (2016) applied AHP in evaluating performance of commercial banks in Nepal. Pakkar (2015) also used AHP in a case study for assessing the financial performance of eight listed companies in steel industry.

More advanced techniques are also developed in this context. Eyüboğlu and Çelik (2016) used financial data of 13 energy firms listed in Borsa Istanbul (BIST) for the period of 2008-2013. They used 5 main and 15 sub-main criteria, and the weights of the ratios are determined by Fuzzy AHP and firms are ranked by Fuzzy TOPSIS. Gümüş (2009) focused on hazardous waste problem and thereby choosing the most proper transportation firm. In a similar vein, Gümüş uses Fuzzy AHP weights as its input weight as the first step and then TOPSIS methodology starts as the second step. Shaverdi et al (2016) studied Iranian petrochemical industry and used Fuzzy AHP to determine the weights of the criteria and after that ranked the companies both by Fuzzy AHP and Fuzzy TOPSIS. Wang (2008) applied grey relation analysis to cluster financial ratios and then Fuzzy multi criteria decision making method to evaluate financial performance of domestic airlines in Taiwan. Another combined has been performed by Yalçın et al in 2012 for Turkish manufacturing industry. They used Fuzzy AHP to determine the weights of the criteria and following that they ranked companies by using TOPSIS and VIKOR comparatively. Ertuğrul and Karakaşoğlu (2009) aimed to evaluate financial performance of Turkish cement firms listed in BIST. They used Fuzzy AHP and TOPSIS methods together as well. Fuzzy AHP was utilized for determining the weights of the criteria and TOPSIS was applied to rank the firms. Another study that combines Fuzzy AHP and TOPSIS was conducted by Ban et al (2020) for manufacturing companies listed in Bucharest Stock Exchange. They not only used financial indicators to rank the companies but also considered non-financial indicators and concluded that overall performance of companies significantly influenced by non-financial indicators. Moreover, Omrani et al (2019) again combined Fuzzy AHP and TOPSIS but this time for cement industry listed in Tehran Stock Exchange. Omrani et al considered financial ratios as indicator of financial performance and also considered preferences of different decision makers.

Whether the study uses only TOPSIS or combines TOPSIS with other traditional techniques such as AHP or advanced ones such as Fuzzy AHP, they meet at a common point that is they all use financial ratios to evaluate financial performance of companies. Besides, many of the researchers and practitioners may choose using AHP since it is simple and convenient technique. The aim of this study is to evaluate the performance of basic metal industry firms listed in Borsa Istanbul mainly depending on financial ratios for the year 2017. AHP and TOPSIS are applied to achieve study objectives.

We preferred to evaluate basic metal industry financial performance because of several reasons. Initially due to its role of providing direct input to industrial production, the iron and steel industry namely basic metal industry emerges as a locomotive sector worldwide. Moreover, basic metal industry has a strengthening role on industrialization process of any country and its power of entering competitive worldwide markets. In Turkey, especially steel industry has become one of the most developed sectors. According to the statistics of Steel Exporters' Association, with 15.6-billion-dollar export value steel industry has 9.3% share in total export and counts as the fourth largest contributor to the Turkish economy. In addition, Turkey is the world's 8th and Europe's 2nd largest steel producer and world's 6th biggest steel exporter. Considering the role of steel and iron industry in economy and Turkey's power in this industry, it would be meaningful to select basic metal industry for the measure of financial performance.

In this study, different financial ratios are defined as main and sub-criteria in financial performance evaluation of companies operating in basic metal industry. AHP is applied in determining the weights of these criteria appropriately. By using these weights, companies are ordered based on their performance by using TOPSIS. Obtained ranking with combined AHP TOPSIS approach is compared with actual performance of companies depending on their closing prices. Thus, this company contributes to literature, not only by applying widely used multi-criteria decision-making models (AHP and TOPSIS) to a real-life data set, but also evaluating the performance of these models by comparing the obtained ranking with actual ranking of companies.

The remainder of this paper is organized as follows. Section 2 clarifies financial performance measures namely sub-criteria and main-criterion measures of the study. Section 3 explains

research methodology. Section 4 displays empirical results along with some discussions and concluding remarks.

2. Financial Performance Measures

Traditional accounting-based ratios are widely used in measuring financial performance of firms. This study focuses on four different classifications of accounting-based ratios, which are liquidity, profitability, efficiency, and capital structure ratios. Those groups are identified as main criterion, and each has sub criteria. Below the sub-criteria measures of each main criterion are explained briefly.

2.1. Liquidity Ratios

Liquidity ratios are used to measure riskiness of the firm in terms of its existing liquid assets. This study uses following liquidity ratios as sub-criteria measures.

Current Ratio: This measure indicates the ability of the firm to meet its current obligations from current assets. A widely accepted rule of thumb is 2:1. The higher the ratio the more liquid the business. The ratio is calculated using the following formula.

$$\text{Current Ratio (CR)} = \frac{\text{Current Assets}}{\text{Current Liabilities}}$$

Acid-Test Ratio: This ratio is also known as quick ratio and aims to measure the ability of a firm to meet its current obligations from quick assets except inventory. Inventory is not considered as a quick asset unless inventory turnover is very high. Therefore, the following formula is used to calculate acid-test ratio;

$$\text{Acid-Test Ratio (AtR)} = \frac{\text{Current Assets} - \text{Inventories}}{\text{Current Liabilities}}$$

Cash Ratio: This ratio measures the ability of a firm to meet its current obligations only from cash and cash equivalents. Comparing to above liquidity ratios cash ratio is more conservative and stricter because it only considers cash and cash equivalents. The ratio is calculated by the following formula;

$$\text{Cash Ratio (CshR)} = \frac{\text{Cash and Cash Equivalents}}{\text{Current Liabilities}}$$

2.2. Profitability Ratios

Profitability ratios are used to assess a firm's ability to use its resources to generate revenues. Among several profitability ratios this study uses following ones as sub-criteria measures.

Return-on-Assets: This ratio aims to measure a firm's ability to use its assets to generate earnings. A high Return-on-Asset ratio means that the company is utilizing its economic resources more productive and efficient. The ratio is calculated by the following formula;

$$\text{Return-on-Assets (ROA)} = \frac{\text{Net Income}}{\text{Total Assets}}$$

Return-on-Equity: This ratio measures profitability of a firm related to equity. It specifically aims to indicate a firm's ability to generate return to its shareholders from their investments. This ratio is expressed as a percentage. The ratio is calculated using the formula below;

$$\text{Return-on-Equity (ROE)} = \frac{\text{Net Income}}{\text{Total Equity}}$$

Operating Profit Margin: Operating profit is the difference between net sales and operating expenses. In this context, operating profit margin aims to indicate the strength of a firm's on operations and covering its expenses by operating activities. This ratio is also referred as return on sales. The ratio is calculated by the following formula;

$$\text{Operating Profit Margin (OPM)} = \frac{\text{Operating Profit}}{\text{Net Sales}}$$

2.3. Efficiency Ratios

Efficiency ratios that are characterized by mostly turnover ratios aim to measure a firm's ability to use its assets to generate revenues and manage current liabilities. This study uses following efficiency ratios as sub-criteria measures.

Inventory Turnover Ratio: This ratio gives information about how many times inventory has been sold in a period namely sale speed of inventory. A high inventory turnover ratio is desirable. This ratio is calculated by the formula below;

$$\text{Inventory Turnover Ratio (ITOR)} = \text{Cost of Goods Sold} / \text{Average Inventory}$$

Asset Turnover Ratio: This ratio measures a firm's ability to generate revenues from its assets. The gives information about whether a company's management using its assets efficiently or not. This ratio is calculated by the formula below;

$$\text{Asset Turnover Ratio (ATOR)} = \text{Net Sales} / \text{Total Assets}$$

Receivables Turnover Ratio: This ratio shows how efficient a firm at collecting its receivables. A higher ratio means a more liquid firm. This ratio is calculated by the formula below;

$$\text{Accounts Receivables Turnover (AtR)} = \text{Net Credit Sales} / \text{Average Receivables}$$

2.4. Capital Structure Ratios

Capital structure ratios aim to indicate how a firm is funded and how well those funds are being used. Capital structure ratios give information about long-term liquidity, as their measures are long-term liabilities and equity. This study uses following capital structure ratios as sub-criteria measures.

Debt-to-Equity Ratio: This ratio aims to demonstrate the proportion of a firm's debt financing to equity financing. A high debt-to-equity ratio means that the firm is using debt financing rather than equity financing. The ratio is calculated by the following formula;

$$\text{Debt-to-Equity Ratio (DtE)} = \text{Total liabilities} / \text{Shareholders' Equity}$$

Debt Ratio: This ratio aims to indicate the proportion of assets that are financed by external funds namely liabilities. A higher debt ratio means a higher debt financing. The ratio is calculated by the following formula;

$$\text{Debt Ratio (DtR)} = \text{Total Liabilities} / \text{Total Assets}$$

Below the table summarizes the performance criteria and formulas, which are explained in detail above.

Table 1. Performance Criteria

Main Criteria	Code	Sub Criteria	Ratio
Liquidity Ratios	LR	Current Ratio	Current Assets / Current Liabilities
		Acid-Test Ratio	(Current Assets – Inventories) / Current Liabilities
		Cash Ratio	(Cash and Cash Equivalent) / Current Liabilities
Profitability Ratios	PR	Return on Assets	Net Income / Total Assets
		Return on Equity	Net Income / Total Equity
		Oper. Profit Margin	Operating Profit / Net Sales
		Inv. Turnover Ratio	Cost of goods sold / Average inventory
Efficiency Ratios	ER	Asset Turnover Ratio	Net Sales / Total Assets
		Rec. Turnover Ratio	Net Credit Sales / Average Accounts Receivable
Capital Structure Ratios	CSR	Debt to Equity	Total Liabilities/Shareholders' Equity
		Debt Ratio	Total Liabilities/Total Assets

3. Research Methodology

The aim of this study is to evaluate the financial performance of Basic Metal Industry firms listed in Borsa Istanbul by combining AHP and TOPSIS. AHP is used for determining the weights of the criteria and TOPSIS for ranking the firms. While applying TOPSIS, weighted ranks are used. In this section, AHP and TOPSIS techniques are described.

3.1. AHP Method

In first step of AHP, hierarchical model structure is developed to define problem's main goal, model criteria and sub-criteria and alternatives. In the second step, the decision criteria are compared by the decision maker in a pairwise manner. A scale developed by Saaty (1990) which uses the values between 1 and 9 is used in comparing model criteria. Table 2 summarizes this scale.

Table 2. Pairwise Comparison Scale in AHP

Importance	Definition
1	Equal
3	Moderate
5	Strong
7	Very strong
9	Extreme
2, 4, 6, 8	Intermediate between two adjacent values

Based on the values determined by the decision maker, pairwise comparisons of the criteria and pairwise comparison matrix are then formed respectively as shown in Table 3 and equation (1).

Table 3. Pairwise Comparisons

	Criterion 1	Criterion 2	...	Criterion m
Criterion 1	w_1/w_1	w_1/w_2	...	w_1/w_m
Criterion 2	w_2/w_1	w_2/w_2	...	w_2/w_m
...
Criterion m	w_m/w_1	w_m/w_2	...	w_m/w_m

$$A = [a_{ij}]_{m \times m} \quad (1)$$

Symbol a_{ij} in equation (1) shows the pairwise comparison of the i^{th} and j^{th} criteria. Since symmetricity holds, the pairwise comparison of the j^{th} and i^{th} criteria has the value of $1/a_{ij}$.

The obtained comparison matrix is then normalized, and weights of the criteria are calculated by using the normalized vector as in Equations (2) and (3).

$$a'_{ij} = \frac{a_{ij}}{\sum_{i=1}^m a_{ij}} \quad (2)$$

$$w_j = \frac{\sum_{i=1}^m a'_{ij}}{m} \quad (3)$$

Evaluating the consistency of the matrix is required in AHP. To do so, consistency indicator (CI) is calculated as:

$$CI = \frac{\lambda_{max} - m}{m - 1} \quad (4)$$

In equation (4) λ_{max} shows the largest eigenvalue of the vector.

Finally, consistency ratio (CR) is calculated as follows:

$$CR = \frac{CI}{RI} \quad (5)$$

In equation (5) RI represents the random consistency index designed by Saaty (1990) for multi-criteria decision models having at most 15 criteria. If the obtained CR value is less than 0.1, the matrix is identified as consistent, and thus decision is labelled as valid. Otherwise, a new weighting needs to be done by decision maker/s.

3.2. TOPSIS Method

TOPSIS method involves a six-step solution process. These steps are summarized as follows:

Step 1: Forming the decision matrix (A): The rows of decision matrix show the decision points, and columns show the evaluation factors used in decision making.

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}$$

Step 2: Normalization of decision matrix (R): By using the formula shown in equation (6), normalized or standardized decision matrix is obtained.

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^m a_{kj}^2}} \quad (6)$$

$$R_{ij} = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix}$$

Step 3: Forming the weighted standard decision matrix (V): Importance ratings (w_i) for the evaluation criteria are determined where;

$$\sum_{i=1}^n w_i = 1 \quad (7)$$

Then, V is formed by multiplying the values in column of the R matrix (obtained in Step 2) by the importance ratings.

$$V_{ij} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \dots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \dots & w_n r_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ w_1 r_{m1} & w_2 r_{m2} & \dots & w_n r_{mn} \end{bmatrix}$$

Step 4: Forming positive ideal (A^*) and negative ideal (A^-) solutions: Minimum and maximum values are determined for each column in the weighted normalized decision matrix (V_{ij}).

$$A^* = \left\{ (\max_i v_{ij} \mid j \in J), (\min_i v_{ij} \mid j \in J') \right\} \quad (8)$$

$$A^- = \left\{ (\min_i v_{ij} \mid j \in J), (\max_i v_{ij} \mid j \in J') \right\} \quad (9)$$

Step 5: Calculating differential measurements: Distances to minimum and maximum ideal points are calculated

$$S_i^* = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^*)^2} \quad (10)$$

$$S_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \quad (11)$$

Step 6: Calculation of relative distance to the ideal solution: The ranking of each alternative according to the ideal solution is made with the help of the following formula:

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*} \quad (12)$$

4. Empirical Study

As the aim of the study is to evaluate the financial performance of iron and steel industry, a questionnaire is prepared and applied to three experts in the field to make a pairwise comparison between the defined criteria and sub-criteria in financial performance evaluation. These experts are informed in detail on the purpose and content of the study. Sample applications are also presented to make sure that the scale is understood and graded correctly by these experts. The experts in the field made the comparison by using the scale shown in Table 2.

In order to form the comparison matrix, geometric mean of the given scores by three experts are calculated. The calculated scores of the comparison matrixes are presented in Table 4. In the last column of Table 4, the calculated consistency index and consistency ratio values of matrixes are also presented. Since only two sub-criteria are defined for capital structure ratios, it is not required to calculate these values. For all other matrixes, since consistency ratios are smaller than 0.1, pairwise comparisons are determined as valid.

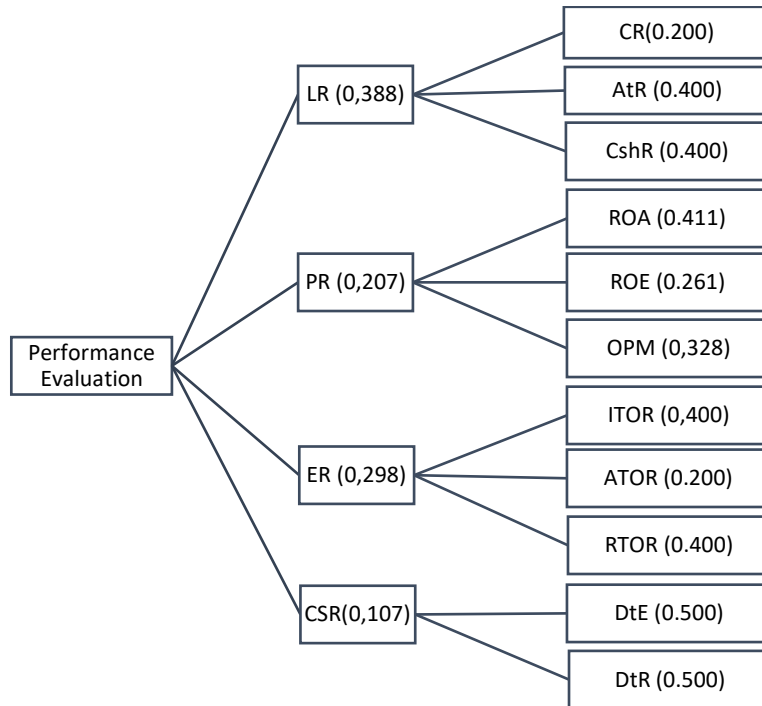
Table 4 Pairwise Comparison Matrix for Criteria and Sub-Criteris and Fig. 1 Calculated Weights for AHP are presented below.

Table 4. Pairwise Comparison Matrix for Criteria and Sub-Criteria

Criteria		E1	E2	E3	Geo. Mean	Consensus	Criteria	CI and R Values
Main criteria	LR	3	3	3	3	3	PR	CI=0.039 R=0.044
	LR	0,33	0,33	5	0.82	1	ER	
	LR	1	5	7	3.27	3	CSR	
	PR	0.33	0.2	3	0.58	1	ER	
	PR	0.33	3	5	1.70	2	CSR	
	ER	2	7	3	3.48	3	CSR	
LR sub-criteria	CR	0.33	1	0.33	0.48	½	AtR	CI=0 R=0
	CR	0.2	3	0.33	0.58	1	CshR	
	AtR	0.33	3	1	0.99	1	CshR	
PR sub-criteria	ROA	3	3	1	2.08	2	ROE	CI=0.027 R=0.046
	ROA	1	0.33	5	1.18	1	OPM	
	ROE	0.33	0.2	5	0.69	1	OPM	
ER sub-criteria	ITOR	0.33	3	7	1.91	2	ATOR	CI=0 R=0
	ITOR	1	0.33	1	0.69	1	RTO	
	ATOR	3	0.2	0.14	0.44	½	RTO	
CSR sub-criteria	DtE	3	1	0.33	0.99	1	DtR	NA

CI: Consistency Index R Values: Ratio Values

Fig. 1: Calculated weights with AHP



From Fig.1, it is observed that while liquidity ratios have the highest weight capital structure ratios have the lowest between main criteria. Cash ratio and acid-test ratio have equal importance on liquidity ratios of a company where current ratio has lower importance. While return on assets has the highest weight on companies' profitability ratios, return on equity has the lowest. Inventory turnover ratio and receivables turnover ratio has equal weights on efficiency ratios and asset turnover ratio has the lower weight. Finally, debt to equity and debt ratio have equal weights on capital structure ratio of the company. When the weights are compared, it should also be noted that, weights between main criteria had high differences. Similarly, weights between subcriteria of profitability ratio had also differing weights.

In the empirical part of this study, calculated weights presented in Fig.1 are than used to obtain weighted ranking of Basic Metal Industry firms listed in Borsa Istanbul.

The dataset for the year 2017 is used for evaluation. Firms those subject to application are listed in Table 5 below.

Table 5. Basic Metal Industries Listed in Borsa Istanbul

CODE	Company
BRSAN	BORUSAN MANNESMANN BORU SANAYİ VE TİCARET A.Ş
BURCE	BURÇELİK BURSA ÇELİK DÖKÜM SANAYİİ A.Ş.
BURVA	BURÇELİK VANA SANAYİ VE TİCARET A.Ş
CELHA	ÇELİK HALAT VE TEL SANAYİİ A.Ş
CEMAS	ÇEMAŞ DÖKÜM SANAYİ A.S
CEMTS	ÇEMTAŞ ÇELİK MAKİNA SANAYİ VE TİCARET A.Ş
CUSAN	ÇUHADAROĞLU METAL SANAYİ VE PAZARLAMA A.Ş
DMSAS	DEMİSAŞ DÖKÜM EMAYE MAMÜLLERİ SANAYİ A.Ş
DOKTA	DÖKTAŞ DÖKÜMCÜLÜK TİCARET VE SANAYİ A.Ş
ERBOS	ERBOSAN ERCİYAS BORU SANAYİİ VE TİCARET A.Ş
EREGL	EREĞLİ DEMİR VE ÇELİK FABRİKALARI T.A.Ş
ISDMR	İSKENDERUN DEMİR VE ÇELİK A.Ş
IZMDC	İZMİR DEMİR ÇELİK SANAYİİ A.Ş
KRDMA,KRDMB,KRDMD	KARDEMİR KARABÜK DEMİR ÇELİK SANAYİ VE TİCARET A.Ş
OZBAL	ÖZBAL ÇELİK BORU SANAYİ TİCARET VE TAAHHÜT A.Ş
SARKY	SARKUYSAN ELEKTROLİTİK BAKIR SANAYİ VE TİCARET A.Ş
TUCLK	TUĞÇELİK ALÜMİNYUM VE METAL MAMÜLLERİ SANAYİ VE TİCARET A.Ş.

In the study data set, values of the listed firms for each of the considered sub-criteria exist. Before applying TOPSIS for ranking the firms, their values for main criteria are obtained by using the obtained weights of related sub-criteria. Used formulations in this step are presented in Equations (13)-(16)

$$LR_i = 0.200 * CR_i + 0.400 * AtR_i + 0.200 * CshR_i \text{ for all } i=1, \dots, 17 \quad (13)$$

$$PR_i = 0.411 * ROA_i + 0.261 * ROE_i + 0.328 * OPM_i \text{ for all } i=1, \dots, 17 \quad (14)$$

$$ER_i = 0.400 * ITOR_i + 0.200 * ATOR_i + 0.400 * RTOR_i \text{ for all } i=1, \dots, 17 \quad (15)$$

$$CSR_i = 0.500 * DtE_i + 0.500 * DtR_i \text{ for all } i=1, \dots, 17 \quad (16)$$

CR, AtR, CshR, ROA, ROE, OPM, ITOR, ATOR, RTOR, DtE, and DtR values for year 2017 of these 17 companies are then collected to evaluate their performances. These values are then plugged-in places in equations (13)-(16) to calculate weighted values of main criteria of these companies. The

obtained weighted values for the main criteria LR, PR, ER, CSR are then as summarized in Table 6 below.

Table 6. Weighted Main Criteria Values of Listed Companies

Firm Code	LR	PR	ER	CSR
BRSAN	0.624	5.335	0.094	0.918
BURCE	0.763	3.368	0.122	1.274
BURVA	0.494	3.762	-0.018	0.884
CELHA	0.550	4.246	0.121	1.622
CEMAS	0.575	4.248	-0.164	1.353
CEMTS	1.012	4.043	0.217	0.453
CUSAN	0.287	6.877	0.018	2.113
DMSAS	0.658	4.929	0.063	1.745
DOKTA	0.359	8.220	0.442	10.982
ERBOS	1.294	3.776	0.169	0.491
EREGL	1.756	4.547	0.194	0.399
ISDMR	1.217	8.068	0.222	0.334
IZMDC	1.026	4.000	0.039	0.524
KRDMA,KRDMB,KRDMD	0.618	4.626	0.083	1.239
OZBAL	0.190	5.922	0.155	-3.718
SARKY	0.618	9.080	0.084	1.513
TUCLK	0.667	4.509	0.059	0.816

TOPSIS steps are then applied, respectively. The normalized decision matrix is obtained, and this normalized matrix are then multiplied with weights of main criteria ($LR = 0.388, PR = 0.207, ER = 0.298, CSR = 0.107$) obtained by AHP, in order to form weighted standard decision matrix. Table 7 presents weighted standard decision matrix.

Table 7. Weighted Standard Decision Matrix (V) Of TOPSIS

Firm Code	$V_{ij} = w_i R_{ij}$ values			
BRSAN	0.070	0.070	0.029	0.008
BURCE	0.085	0.044	0.037	0.011
BURVA	0.055	0.049	-0.005	0.008
CELHA	0.061	0.055	0.036	0.014
CEMAS	0.064	0.055	-0.049	0.012
CEMTS	0.113	0.053	0.065	0.004
CUSAN	0.032	0.090	0.005	0.018
DMSAS	0.074	0.064	0.019	0.015
DOKTA	0.040	0.107	0.133	0.094
ERBOS	0.145	0.049	0.051	0.004
EREGL	0.196	0.059	0.059	0.003
ISDMR	0.136	0.105	0.067	0.003
IZMDC	0.115	0.052	0.012	0.005
KRDMA,KRDMB,KRDMD	0.069	0.060	0.025	0.011
OZBAL	0.021	0.077	0.047	-0.032
SARKY	0.069	0.119	0.025	0.013
TUCLK	0.074	0.059	0.018	0.007

For each column of this V matrix, minimum and maximum values are obtained to calculate positive and negative ideal solutions. Positive and negative ideal solution matrix are then obtained properly as in Equations (8) and (9) which should be represented in Table 8.

Table 8. Forming Positive Ideal (A^*) And Negative Ideal (A^-) Solutions

Firm Code	A^*				A^-			
BRSAN	0.016	0.002	0.011	0.007	0.002	0.001	0.006	0.002
BURCE	0.012	0.006	0.009	0.007	0.004	0.000	0.007	0.002
BURVA	0.020	0.005	0.019	0.008	0.001	0.000	0.002	0.002
CELHA	0.018	0.004	0.009	0.006	0.002	0.000	0.007	0.002
CEMAS	0.017	0.004	0.033	0.007	0.002	0.000	0.000	0.002
CEMTS	0.007	0.004	0.005	0.008	0.008	0.000	0.013	0.001
CUSAN	0.027	0.001	0.016	0.006	0.000	0.002	0.003	0.003
DMSAS	0.015	0.003	0.013	0.006	0.003	0.000	0.005	0.002
DOKTA	0.024	0.000	0.000	0.000	0.000	0.004	0.033	0.016
ERBOS	0.003	0.005	0.007	0.008	0.015	0.000	0.010	0.001
EREGL	0.000	0.004	0.006	0.008	0.031	0.000	0.012	0.001
ISDMR	0.004	0.000	0.004	0.008	0.013	0.004	0.014	0.001
IZMDC	0.007	0.004	0.015	0.008	0.009	0.000	0.004	0.001
KRDMA	0.016	0.003	0.012	0.007	0.000	0.006	0.002	0.010
OZBAL	0.031	0.002	0.008	0.016	0.001	0.009	0.000	0.010
SARKY	0.016	0.000	0.012	0.007	0.006	0.006	0.002	0.015
TUCLK	0.015	0.004	0.013	0.008	0.000	0.005	0.002	0.009

Finally, for each listed companies, differential measurements and relative distance to ideal solutions are calculated. The obtained values are shown in Table 9.

Table 9. Obtained S_i^* , S_i^- , C_i^* Values for Each Listed Companies

Firm Code	S_i^*	S_i^-	C_i^*
BRSAN	0.192	0.103	0.350
BURCE	0.185	0.116	0.385
BURVA	0.227	0.068	0.232
CELHA	0.195	0.106	0.352
CEMAS	0.248	0.062	0.200
CEMTS	0.155	0.152	0.494
CUSAN	0.224	0.088	0.282
DMSAS	0.193	0.100	0.341
DOKTA	0.157	0.232	0.597
ERBOS	0.150	0.163	0.521
EREGL	0.132	0.209	0.614
ISDMR	0.129	0.178	0.580
IZMDC	0.184	0.118	0.390
KRDMA	0.196	0.100	0.337
OZBAL	0.236	0.102	0.301
SARKY	0.186	0.124	0.401
TUCLK	0.198	0.095	0.325

Based on the last column of Table 9 the weighted ranking of listed companies are obtained. It was also decided that, comparing this obtained ranking with a real-life ranking should increase the impact of the obtained ranking by the use of AHP and TOPSIS hybrid approach.

Thus, finally, obtained ranking in this study is compared with closing price of these listed companies in 2017. The ranking of companies based on weighted ranking of AHP-TOPSIS hybrid model and closing prices are presented comparatively in Table 10.

Table 10. Rankings of Listed Companies

Firm Code	Weighted ranking of TOPSIS	Rank based on companies' closing price
EREGL	1	4
DOKTA	2	3
ISDMR	3	5
ERBOS	4	1
CEMTS	5	6
SARKY	6	9
IZMDC	7	10
BURCE	8	8
CELHA	9	7
BRSAN	10	2
DMSAS	11	15
KRDMA	12	13
TUCLK	13	11
OZBAL	14	17
CUSAN	15	12
BURVA	16	16
CEMAS	17	14

Based on the results of Table 10, it is seen that companies ranking are very close in both of the approaches. For the two companies (BURCE and BURVA) two ranks obtained by TOPSIS and closing price are the same. For the other three companies (CEMTS, DOKTA and KRDMA.KRDMB.KRDMD) ranking based on two approaches differ just by one. In three of the companies (CELHA, ISDMR and TUCKL) the ranking of the approaches differs by two. For seven of the others (CEMAS, CUSAN, ERBOS, EREGL, IZMDC, OZBAL and SARKY) three differences exist between the considered two rankings. For the remaining two companies (BRSAN and DMSAS) the differences between two ranking are more than 3. In this study, observing up to three differences is determined as acceptable when discussed with field experts. Thus, in 15 of the 17 companies (88.235%), it is concluded that AHP and TOPSIS hybrid approach works well in financial performance evaluation.

5. Conclusion

Evaluating financial performance of companies attract considerable attention of researchers and practitioners. Since assessing financial performance only based on companies' ratios is not compatible in today's competitive environment, decision makers apply techniques where company itself and the industry which the company operates should be collectively and comparatively evaluated. TOPSIS is a leading one among these multi-criteria decision-making techniques. In TOPSIS, different criteria are defined related with the context, company values or numbers on these criteria are collected, and by using step by step approach of this technique, companies operating in the same industry are evaluated. However, traditional TOPSIS applications assign same weights to each criteria. But it is well known that criteria weights differ in real life applications, where while some criteria may have significant impact on the decision, the impacts of the others may be smaller. AHP is another widely used technique in multi-criteria decision-making context in evaluating criteria weights. Since, it is believed that combining AHP and TOPSIS methods provide better solutions, as in literature studies, we combine TOPSIS and AHP to reach more accurate results depending on the weighted ranking. On the other hand, not only by applying this combined method to a real-life data set of a specific and important manufacturing industry, but also by identifying and weighting different scores of financial performance evaluation and

implementing these scores for firm's performance evaluation operating in this industry, we contribute the literature.

In this paper, AHP and TOPSIS are applied in financial performance evaluation of the firms operating in basic metal industries listed in Borsa Istanbul. The results of the AHP showed that weights of considered main criteria are decreasingly ordered as liquidity ratios, efficiency ratios, profitability ratios and capital structure ratios. The considered sub-criteria are also evaluated and compared. Acid-test and cash ratio are considered as highly and equally important on companies' liquidity ratios. The weights of return on asset, operating profit margin, and return on equity have decreasing weights on profitability ratios. Inventory turnover ratio and receivables turnover ratio have equal weights which are higher than asset turnover ratio. Debt to equity and debt ratio have equal weights on capital structure ratios. By using these weights, 17 listed companies operating in basic metal industries are ordered based on their financial performance by using TOPSIS. Obtained ranking is than compared with companies' closing prices. It is observed that for 15 of these companies, TOPSIS and actual closing prices give close rankings. Thus, it is concluded that AHP and TOPSIS hybrid approach can be used in financial performance evaluation.

Our study has some limitations. The first limitation is related to the sample. The sample is acceptable, but it should be probably expanded to other industries in order to examine the differences among industries. Second limitation is related to the year of data, which is only limited only by one-year 2017. The data should be expanded to more than one year and thus there will be possibility to make comparison between years.

Despite such limitations, our study has several contributions both at theoretical and practical level. On the theoretical side, first the study extends the prior research on the field of Multi Criteria Decision-Making Techniques by combining TOPSIS and AHP. Second, the study compares obtained ranking of firms with their actual closing prices. This comparison shows most of the firms' rankings are close with rankings depending on their closing prices. Thus, this study offers that combining AHP and TOPSIS would be a logical approach to evaluate firms' performance. At practical level, such a result provides useful insights for all level decision-makers. For instance, decision-makers could find it useful for their portfolio management.

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