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TOPSIS ÇOK KRİTERLİ KARAR VERME YÖNTEMİ İLE FİNANSAL PERFORMANSIN ÖLÇÜLMESİ: BİLGİ TEKNOLOJİLERİ SEKTÖRÜ ÜZERİNDE BİR UYGULAMA[1]

Mustafa Özgün Atalay[2]

Meltem Altın[3]

ÖZET

Bu çalışmanın amacı, 2014-2018 yılları arasında Borsa İstanbul'da bilişim sektöründe işlem gören işletmelerin finansal oranlar aracılığıyla TOPSIS yöntemi kullanılarak finansal performansları incelenmiştir. Araştırma sonuçlarına bakıldığında, en üst sırada yer alan iki işletmenin mevcut pozisyonlarını koruma eğiliminde oldukları görülmüştür. Çalışma kapsamında olan şirketler TOPSIS yöntemi aracılığıyla iyi ve kötü performans gösteren şirketler olarak iki gruba ayrılmıştır. İki farklı grupta yer alan firmaların portföy getirileri ile TOPSIS yöntemi ile elde edilen işletme performansları sıralaması arasındaki ilişki incelenmiş, TOPSIS yöntemine göre yüksek performans gösteren işletmelerin portföylerinin düşük performans gösteren şirketlerin portföylerine göre daha fazla getiri sağladığı tespit edilmiştir. Son olarak, TOPSIS yöntemi tarafından 2014-2018 dönemi için önerilen performans sıralamaları arasındaki ilişkiyi incelenmiş ve genel olarak performans değerleri arasında anlamlı ve pozitif bir ilişki bulunmuştur.

Anahtar Kelimeler: TOPSIS, Çok Kriterli Karar Verme Yöntemleri, Finansal Performans.

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[2] Research Assistant, Karadeniz Teknik Üniversitesi, Faculty of Economics and Administrative Sci-ences, Email: ozgun_atalay@hotmail.com, ORCIDs: 0000-0001-6208-4834.

[3] Lecturer, Bursa Uludağ Üniversitesi, Vocational School of Orhaneli, Email: meltemaltin@uludag.edu.tr , ORCIDs: 0000-0001-6673-3627.

THE EVALUATION OF FINANCIAL PERFORMANCE THROUGH THE TOPSIS MULTIPLE CRITERIA DECISION-MAKING METHOD: AN APPLICATION TO INFORMATION TECHNOLOGY INDUSTRIES

ABSTRACT

This study aimed to examine the financial performance of companies in the IT sector in Borsa Istanbul during 2014–2018 by using financial ratios to determine the companies' financial performance and using the TOPSIS method. We found that the top-ranked two companies tended to maintain their current positions. Additionally, the TOPSIS method divided the companies into two groups: high- and low-performance companies. In comparing the relationship between the portfolio returns of the companies in the two different groups and the performance ranking obtained via the TOPSIS method, we found that the portfolios that the TOPSIS method ranked as high-performing produced better returns than the low-performing. Finally, we examined the relationship between the TOPSIS-proposed performance rankings for the given period and found positive relationship between performance values generally.

Keywords: TOPSIS, Multicriteria Decision-Making Methods, Financial Performance.

INTRODUCTION

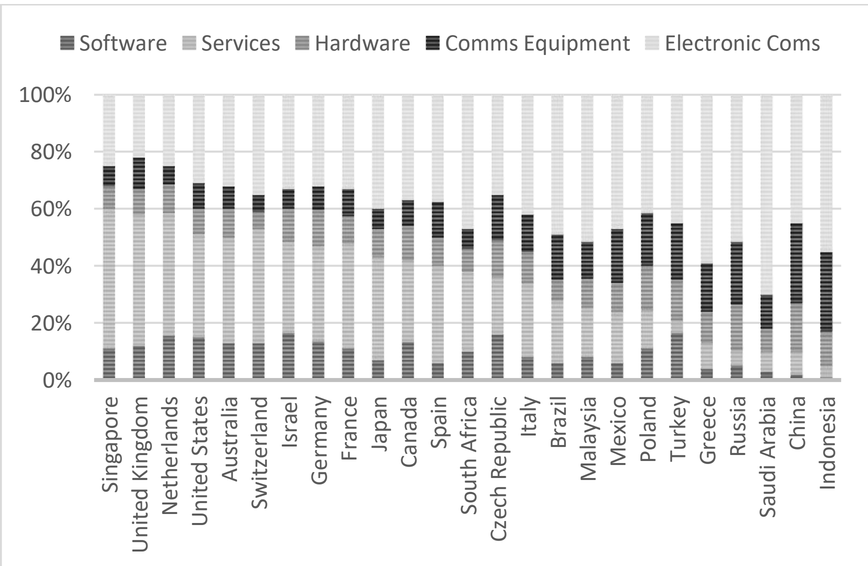
The technological developments of the fourth industrial revolution have had an intense effect on businesses, which are benefiting from the opportunities the IT sector provides by gaining competitive advantages and increasing market performance. For instance, companies use techniques such as industry 4.0, artificial intelligence, cloud technology, big data analytics, augmented virtual reality, and robotics to gain greater global market share. Cloud systems, 5G communication technologies, sensor technologies, cybersecurity, advanced image processing, robotics and robotic automation, artificial intelligence and internet of objects (IoT), industry 4.0, blockchain applications, wearable technology, open source software, digital transformation, and autonomous tools are areas under development all over the world that closely affect humanity.

These developments have greatly affected the IT sector. IT has become more involved both in the world and in national economies. Because of globalization and increasing competition, companies' need for IT has increased (Lee, 2002). Nowadays, businesses have benefited from the IT sector through increased efficiency and performance. Rapid growth and development in the IT sector affects businesses operating in all sectors globally. To operate effectively, companies should optimize their technology investments in the IT sector (Lipaj and Davidavičienė, 2013).

IT has directly affected many fields, especially economics and trade. IT developments have caused changes at the individual and social levels (Antonucci, Ajrouch, and Manalel, 2017). Many governments closely follow information technologies and want to benefit for their development. In this context, the fundamentals of the European Union IT policy were firstly mentioned in the Green Book in 1987, which refers to the creation of an internal market for IT services and tools in Europe (Kuzey, 2007). Later, the E-Europe Action Plan launched at the Lisbon summit in 2000. The main objective of the E-Europe Action Plan was to encourage the use of fast, cheap, and secure internet. In 2001, the e-Europe + Action Plan, launched at the Gothenburg Summit, aimed to ensure proper implementation of the legislation to establish an information technology society. Information technologies have developed rapidly in many countries with the realization of the EU's e-European Action Plan. Sharing information between producers and consumers via the internet has increased the volume of trade between countries with the development of information technologies in EU (Savrul and Kılıç, 2011).

Business activities can be executed effectively through IT. Therefore, to gain an advantage in this competitive environment, companies must follow the technology closely (Lee, 2002). The report published and by the Turkish Informatics Industry Association (TUBISAD) examines the share of the domestic and high value-added services and software sector in all sectors in Figure 1.

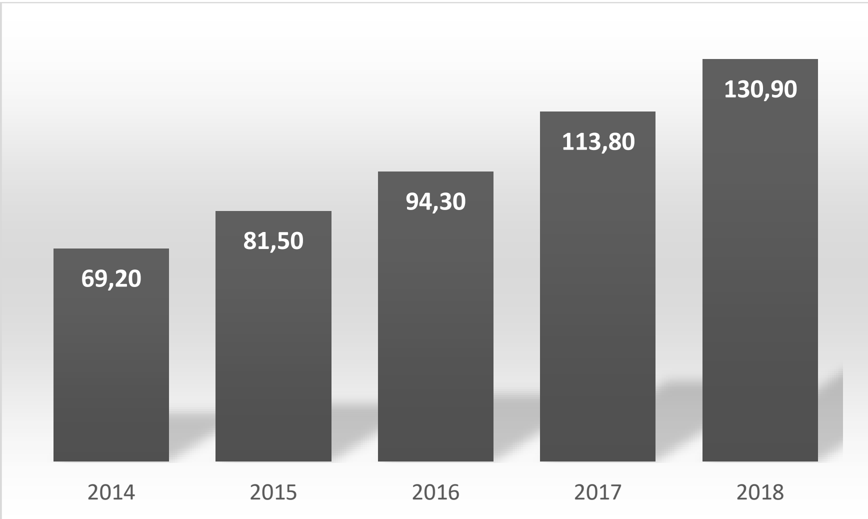
Figure 1: Information and Communication Technologies in Market Components



Source: TUBISAD, 2019.

Global technological developments have also particularly affected companies in the field of information technologies in Turkey, leading to great progress in recent years. The Information Index (XBLSM) was established at Borsa İstanbul, and it aims to manage and operate the IT sector in Turkey (BIST, 2019). Leading companies in the IT sector in Turkey are quoted on the stock exchange to finance their investments. According to a 2019 TUBISAD study, the average growth rate of the IT sector over the last 5 years in Turkey has been 17%. As Figure 2 shows, the market size of the IT sector, which was 113.8 billion Turkish lira (TL) in 2017, reached 130.9 billion TL in 2018. Growth expectation is estimated to be 5–10% in 2019 (TUBISAD, 2019).

Figure 2: The Market Size of Information and Communication Technologies in Turkey



Source: TUBISAD, 2019.

The number of leading companies in the information technology sector in Turkey is insufficient when compared the companies in United States, European Union, South Korea and Japan. (Özlü, 2017). One of the most important problem for companies in the Turkish IT sector is their limited access to financial resources (Yorulmaz, 2013). In this context, evaluating the performance of IT companies is crucial and involves applying financial analysis and performance appraisal techniques to obtain information about these companies and it provides valuable information for investors, managers, financial analysts and lenders for their interest on IT sector. Overall business performance is generally measured through financial performance, such as ratio analysis, which is one of the most widely used financial performance measurement tools (Cebeci and Özbilgin, 2015).

Financial ratios are used to determine the actual financial position of businesses and provide important and valuable information to practitioners. Mathematical relationships between the items in the financial statements of a company in a given period can be measured through financial ratios. Therefore, the relationships between the items that make up the financial statements are explained more clearly and interpreted more accurately (Myšková and Hájek, 2017).

Financial ratios can be used generally to measure profitability, growth status, the ability of companies to pay off debt, and the use of foreign resources (Taani, 2011). Liquidity ratios show whether businesses are able to pay their current liabilities. Operating ratios measure whether businesses can use their assets effectively. Financial leverage ratios show how much capital comes in the form of debt (loans) or assesses the ability of a company to meet its financial obligations. Profitability ratios measure the ability of a business to generate earnings. The ratios enable examinations of business performance by year or comparisons with the performance of other businesses in the same sector. Ratios from previous years are used to compare the performances of businesses in the same time period.

As above-mentioned, the IT industry has a significant share of Turkey's economy, but the leading companies are relatively small, also the number of studies covering this sectors' performance evaluation is limited. These factors encouraged us to carry out this study. Briefly, we aimed to determine the financial performance of 11 companies operating in Turkey and traded in the BIST for the 2014–2018 period using the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) method. The companies' financial statements and stock closing price data came from the Public Disclosure Platform official website (Public Disclosure Platform – KAP, 2019), while we calculated financial ratios separately for each company using the rate analysis method. We used the financial ratios as inputs then applied TOPSIS to obtain the business financial performance rankings. To better demonstrate the practical contribution of the performance ranking that TOPSIS obtained for investors, we created two different portfolios by considering the ranking TOPSIS proposed and testing the method's consistency of performance. Finally, we attempted to determine the relationship between the TOPSIS-proposed performance rankings for the 2014–2018 period.

1. Conceptual Background

1.1. Financial Performance Measures

Financial ratios are one of the most common methods for analyzing financial statements and measuring business performance. Financial ratios are used to determine the actual financial position of businesses and provide important and valuable information to practitioners. Mathematical relationships between the items in the financial statements of a company in a given period can be measured through financial ratios. Therefore, the relationships between the items that make up the financial statements are explained more clearly and interpreted more accurately (Myšková and Hájek, 2017).

Financial ratios can be used to measure profitability, growth status, the ability of companies to pay off debt, and the use of foreign resources (Taani, 2011). The ratios enable examinations of business performance by year or comparisons with the performance of other businesses in the same sector. Ratios from previous years are used to compare the performances of businesses in the same time period. Financial ratios are generally used by creditors, managers, financial analysts, investors, and academics for their interest. Generally, there are four main ratios that are determined as indicators of financial performance of companies in IT sector listed on BIST. These ratios are liquidity ratios, operating ratios, financial leverage ratios and profitability ratios.

1.1.1. Liqiudity Ratios

Liquidity ratios measure whether businesses are able to pay their current debts. The main liquidity ratios are as follows: Current ratio, acid-test ratio, ratio of current assets to total assets. Current ratio is a firm’s ability to counter balance current assets with the current liabilities and shows whether firms are able to pay current debts. It is a good measure of the adequacy of working capital (Price, Hallock and Brock, 1993). Acid-test ratio is a measure of the company’s liqiudity and a measure of the ability of a business to meet short-term liabilities with current assets, even if it cannot liquidate its inventory (Okay and Köse, 2015). Current assets to total assets indicates the extent of total funds invested for the purpose of working capital and throws light on the importance of current assets of a firm. It shows how much of portion of total assets is occupied by the current assets, as current assets are essentially involved in forming working capital.

1.1.2. Operating Ratios

Operating ratios measure whether businesses can use their assets effectively The main operating ratios are as follows: Inventory turnover rate, accounts receivable turnover rate and current assets turnover rate. Inventory Turnover Rate measures the number of times the average inventory had to be replaced during the period. Accounts Receivable Turnover Rate measures how effeciently a company is collecting revenue. This ratio is important especially for creditors (Ertuğrul and Karakaşoğlu, 2009). Current Assets Turnover Ratio can be used as an indicator of the efficiency with which a company is using its assets to generate revenue. (Ertuğrul and Karakaşoğlu, 2009).

1.1.3. Financial Leverage Ratios

Financial leverage ratios measure how much capital comes in the form of debt (loans) or assesses the ability of a company to meet its financial obligations. Short Term Debts/Assets measures the percentage of assets that a business need to liquidate to pay off its short-term debt. Shareholder's Equity/Assets measures what proportion of the firm's assets financed through shareholders' equity. This ratio shows the financial power of the firm to the creditors that give long term loan (Ertuğrul and Karakaşoğlu, 2009). Total Debts/Total Liabilities measures what proportion of the firm's assets is being financed through debt. Debt encompasses all short term liabilities and long term borrowings (Ertuğrul and Karakaşoğlu, 2009).

1.1.4. Profitability Ratios

Profitability ratios show the ability of a business to generate earnings. Net Profit Margin shows how profitable a firm's sales are after taxes. Return on Assets shows how productively a company uses its assets to make profits (Ercan and Ban, 2005). Return on Equity measure a firm's efficiency at generating profits from every dollar of net assets, and shows how well a company uses investment dollars to generate earnings growth (Ertuğrul and Karakaşoğlu, 2009). Operating Profit Margin measure business' profitability from its operation, prior to subtracting taxes and interest charges.

1.2. The TOPSIS Method

The process of reasoning and decision-making is part of people's daily lives. This process is studied by many disciplines, including psychology, philosophy, cognitive science and artificial intelligence. Decision-making processes are generally based on various mathematical and statistical models. (Chater, Oaksford, Nakisa and Redington, 2003). The decision-making problem can be defined as the selection of the most appropriate option from at least one objective or criterion from a set of options. Mshows that although it is sufficient to make many daily decisions intuitively, this path alone is not sufficient for complex and vital decisions (Saaty,1994).

In order for the decision-making to take place, there must be more than one alternative. In order to determine these alternatives, the problem should be defined well. The problem is often complex and contains multiple criteria. The criteria set the standards for decision-making in the solution process. Multi Criteria Decision-Making Analysis Methods have been developed for this structure and consists of multiple criteria.

What is important in the evaluation of alternatives is the selection of evaluation criteria. Why certain criteria are preferred is critical in the evaluation of alternatives. Hwang and Yoon (1981) state that the number of evaluation criteria depends on the nature of the research problem. The criteria should reflect the characteristics of the units being assessed, be independent of each other, and should be neither too small nor too high to make decision-making difficult.

In the study, the preference of criteria is expressed by criteria weights. Generally, criteria weights are values between 0 and 1, and express the relative importance of each criterion in comparison with others. The sum of all criteria is equal to 1. In this study, all criteria have equal importance. The relative importance of each criterion expressed by the criteria weight vector.

We used the TOPSIS method (Technique for Order of Preference by Similarity to Ideal Solution). This method allows us to determine the order of all the alternative solutions. This method is based on the principle of minimization of the distance from the ideal solution and maximization of the distance from the negative-ideal solution (Hwang and Yoon, 1981).

The advantage of TOPSIS is its logicality, rationality and computational simplicity (Jiang et al.,2010). Financial performance evaluation and comparison are complex that requires comprehensive analysis (Fenyves, Tarnóczi and Zsidó, 2015). Multi criteria decision analysis has been regarded as a suitable set of methods to perform financial performance evaluation and comparison Guerrero-Baena, Gómez-Limón and Fruet Cardozo, 2014). Among numerous MCDM methods, TOPSIS method is commonly used across different application areas.

The TOPSIS method consist of the following seven steps:

Step 1: Forming a Decision Matrix

In the decision matrix, the rows contain decision points and the columns contain evaluation factors. Matrix A, generated by the decision maker, is defined as the initial matrix and is shown as follows:

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \\ . & . & . \\ . & . & . \\ . & . & . \\ a_{m1} & a_{m2} & a_{mm} \end{bmatrix} \qquad (1)$$

In the A_{ij} matrix, “m” represents the number of decision points and “n” is the number of evaluation factors.

Step 2: Designing a Normalized Decision Matrix (R)

This process tries to convert the various attribute dimensions into non-dimensional attributes. For the normalization of input values, the TOPSIS method uses an approach based on Euclidian distance formula (formula 2). The normalized decision matrix can be calculating as follows:

$$R_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a^2{}_{ij}}} \qquad i = 1, \ldots\ldots, m \qquad j = 1, \ldots\ldots\ldots, n \qquad (2)$$

$$R_{ij} = \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \\ . & . & . \\ . & . & . \\ . & . & . \\ r_{m1} & r_{m2} & r_{mm} \end{bmatrix} \qquad (3)$$

a_{ij} is the input value of the *i* alternative assessed by the *j* criterion; *p* is the number of alternatives.

Step 3: Creating a Weighted Standard Decision Matrix (V)

The elements in each column of the matrix R are multiplied by the corresponding wj to form the V matrix. The V matrix is as follows:

$$V_{ij} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \ldots & w_n r_{1n} \\ w_2 r_{21} & w_2 r_{22} & \ldots & w_n r_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ . & & & . \\ w_1 r_{m1} & w_2 r_{m2} & \ldots & w_n r_{mn} \end{bmatrix} \qquad (4)$$

Step 4: Determining the Ideal (A+) and Negative Ideal (A–) Solutions

The maximum and minimum values in each column are determined in the weighted matrix. The ideal solution delivers the best values based on each criterion; the negative-ideal solution delivers the worst values based on each criterion.

$A^+ = \{V_1^+, V_2^+, \ldots, V_n^+\}$ (maximum values) (5)

$A^- = \{V_1^-, V_2^-, \ldots, V_n^-\}$ (minimum values) (6)

Step 5: Calculating the Separation Distances of Each Alternative to the Ideal Solution and Negative Ideal Solution

In this step, the distances to the maximum and minimum ideal points are calculated by the following formulas:

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2} \qquad i = 1, 2, \ldots, m \qquad (7)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2} \qquad i = 1, 2, \ldots, m \qquad (8)$$

The numbers of S_i^+ and S_i^- are equal to the numbers of decision points.

Step 6: Calculating the Distances of Each Alternative from the Ideal Solutions

C_i^+ is used to calculate the ideal distinction of the relative proximity of each decision point to the ideal solution. Calculation of the proximity to the ideal solution is carried out with the help of the following formula:

$$C_i^+ = \frac{S_i^-}{S_i^- + S_i^+} \qquad i = 1, 2, \ldots, m \qquad (9)$$

The value C_i^+ in the formula is in the $0 \leq C_i^+ \leq 1$ range. $C_i^+ = 1$ indicates the absolute proximity of the relevant decision point to the ideal solution; $C_i^+ = 0$ indicates the absolute proximity of the corresponding decision point to the negative ideal solution. The order of importance of the decision alternatives is determined from the values obtained.

Step 7: Rank the Preference Order

The alternatives are ranked and sorted by the value of the indicator C_i^+ in decreasing order. The best alternative is the one that has the shortest distance from ideal solution.

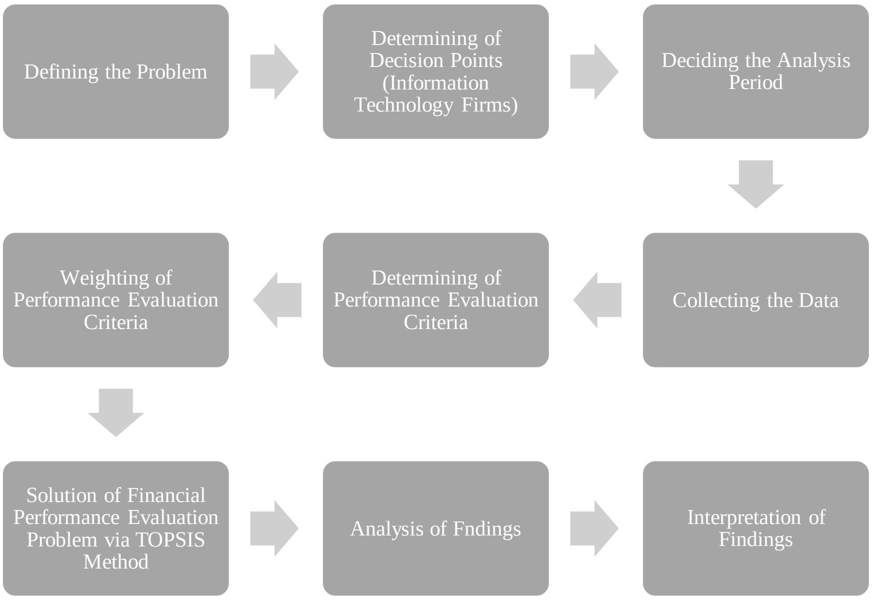
2. Application and Findings

2.1. Application

There are three main purposes in the study. The primary purpose of the study is to evaluate financial performance of the companies listed on the BIST in the IT sector in Turkey, operates between the years 2014-2018. For this purpose, TOP-

SIS method, which is one of the multi-criteria decision making methods is frequently preferred for financial performance evaluations, is used. In the implementation of the study, the path in Figure 3 was followed.

Figure 2: The Path of the Study



In the first stage of the research application process, the problem of the study was identified. Then, the decision points were determined. The decision points in this study are the information technology companies listed on BIST in Turkey. The scope of our study included 11 IT businesses. Table 1 lists the businesses within the scope of the study.

Table 1: Companies Included in the Study

Code	**Company Name**
ARENA	Arena Bilgisayar Sanayi ve Ticaret INC.
ARMDA	Armada Bilgisayar Sistemleri Sanayi ve Ticaret INC.
DESPC	Despec Bilgisayar Pazarlama ve Ticaret INC.
DGATE	Datagate Bilgisayar Malzemeleri Ticaret INC.
ESCOM	Escort Teknoloji Yatırım INC.
FONET	Fonet Bilgi Teknolojileri INC.
INDES	İndeks Bilgisayar Sistemleri Mühendislik Sanayi ve Ticaret INC.
KFEIN	Kafein Yazılım
LINK	Link Bilgisayar Sistemleri Yazılımı ve Donanımı Sanayi ve Ticaret INC.
LOGO	Logo Yazılım Sanayi ve Ticaret INC.
SMART	Smartiks Yazılım INC.

In the next stage of the path, the analysis period was decided. Accordingly, it was decided that the analysis period was 2014-2018 covering a five-year period because of the recency of data and date. The data of the study was obtained from the Public Disclosure Platform (KAP) official website. Afterwards, it is determined which financial ratios should be used in order to evaluate the financial performance of the decision points. We used to determine which criteria should be used to evaluate the financial performance of the IT companies as a result of comprehensive literature review (Ertuğrul and Karakaşoğlu, 2009; Bulgurcu, 2012; Okay and Köse, 2015; Uygurtürk and Korkmaz, 2012; Ertuğrul and Karakaşoğlu, 2009; Türkmen and Çağıl, 2012; Bulgurcu, 2012; Akbulut and Rençber, 2015; Shaverdi et al., 2016; Orçun and Eren, 2017; Konuk, 2018). In the study, the main ratios determined for the financial performance of the firms were weighted equally. TOPSIS method was used to evaluate the financial performance of the decision points during the analysis period. In the last stage, the findings of companies whose performances were determined by TOPSIS method were interpreted.

The second purpose of the study is to determine whether the relationship between stock returns and financial performance of the companies traded in the IT sector at BIST. For this purpose, companies were divided into two different portfolio groups as companies with good and bad financial performance in 2014-2018 period according to the results of the TOPSIS method, Then, the average stock returns of the companies in two different portfolios were calculated. Thus, we tried to answer the question of whether companies with good financial performance have a better stock returns. The main motivation for this analysis is the consistency of the results suggested by the TOPSIS method in practice. Therefore, it can be said that this analysis makes a practical contribution for practitioners.

The third purpose of the study is to determine whether the financial performance rankings proposed by the TOPSIS method are different from each other. Thus, it can be observed to what extent the performances of the companies operating in the information technology sector are similar or differentiated over the years. Spearman rank correlation was used for this analysis.

Four main ratios are determined as indicators of financial performance of companies in IT sector listed on BIST. These ratios are liquidity ratios, operating ratios, financial leverage ratios and profitability ratios. In this study, the main and sub-ratios are shown in Table 2.

Table 2: Financial Ratios Used in the Study

Liquidity Ratios Current Ratio (C) Acid-Test Ratio (AT) Current Assets/Assets (CAA)	Current Assets/Current Liabilities (Current Assets–Inventories)/Current Liabilities Current Assets/Assets
Operating Ratios Inventory Turnover Rate (IT) Accounts Receivable Turnover Rate (ART) Current Assets Turnover Ratio (CAT)	 Costs of Goods Sold/Average Inventory Total Net Sales/Accounts Receivables Net Sales/Current Assets
Financial Leverage Ratios Short Term Debts/Assets (STDA) Shareholder's Equity/Assets (SEA) Total Debts/Total Liabilities (DL)	 Short Term Debts/Assets Shareholder's Equity/Assets Total Debts/Total Liabilities
Profitability Ratios Net Profit Margin Ratio (NPM) Return on Assets (ROA) Return on Equity (ROE) Operating Profit Margin (OPM)	 Earnings after Taxes/Sales Net Income/Average Total Assets Net Profit before Taxes/Net Worth Operating Profit Margin/Sales

2.2. Findings

We used the financial ratios calculated for the 11 companies included in the analysis to determine the financial performance of the businesses separately for the years 2014, 2015, 2016, 2017, and 2018. We converted the calculated financial ratios to a single point showing overall business performance. Afterwards, we ranked the performance of the businesses and completed the rating process.

Step 1: Forming a Decision Matrix (A)

The study included 11 decision points (businesses) and 13 evaluation factors (financial ratios). Therefore, we created an 11 x 13 dimensional standard decision matrix. As an example, Table 3 shows only the data for 2018.

Table 3: Decision Matrix for Criteria for 2018 (A)

2018	**Criteria**						
Companies	C	AT	CAA	IT	ART	CAT	ST
ARENA	1.6	1.2	97	9.7	4.8	2.51	59
ARMDA	1.9	1.7	99	13.5	2.9	2.10	50.8
DGATE	1.7	1.6	92	19.3	5.6	2.29	54.3
DESPC	2.8	2.1	98	8	4.6	3.08	34.8
ESCOM	4.7	4.6	13	N/A	0.2	0.02	2.8
FONET	1	1	21	35.1	6.9	0.58	21.6
INDES	1.3	1.1	94	11.7	5.0	2.26	71.8
KFEIN	2.6	2.2	53	70.1	2.8	1.42	19.9
LINK	15	14.8	74	173.5	3.6	0.42	5
LOGO	1.7	1.7	40	106.7	2.9	0.68	23.4
SMART	1.1	0.95	33	4.6	2.5	0.64	29.8
Companies	SE	DL	NP	ROA	ROE	OPM	
ARENA	41	59	0.1	0.1	0.22	5.3	
ARMDA	26	73	-0.1	- 0.1	-0.53	5.4	
DGATE	44	56	2.4	5.5	18.24	4	
DESPC	65	35	6	18.5	31	8.3	
ESCOM	97	NA	-634	-11.6	-12	100	
FONET	72	28	34.2	19.9	26.28	43.6	
INDES	24	73	3.1	7.1	35.06	4.7	
KFEIN	63	24	13.9	19.8	30.56	31.3	
LINK	88	12	62.8	26.7	30.13	83.7	
LOGO	52	43	21.0	14.3	26.94	80	
SMART	63	37	25.5	16.3	26.12	77	

Step 2: Designing a Normalized Decision Matrix (R)

We calculated the normalized decision matrix in Table 4 using the elements of matrix A and equation (1).

Table 4: Normalized Decision Matrix

2018	**Criteria**						
Companies	C	AT	CAA	IT	ART	CAT	ST
ARENA	0.04	0.03	0.14	0.02	0.12	0.17	0.17
ARMDA	0.05	0.05	0.14	0.03	0.07	0.14	0.14
DGATE	0.04	0.05	0.13	0.04	0.14	0.15	0.15
DESPC	0.08	0.06	0.14	0.01	0.11	0.21	0.09
ESCOM	0.14	0.15	0.01	NA	0.01	0.01	0.00
FONET	0.02	0.02	0.03	0.08	0.17	0.03	0.06
INDES	0.03	0.03	0.14	0.02	0.12	0.15	0.21
KFEIN	0.07	0.06	0.07	0.16	0.07	0.09	0.05
LINK	0.53	0.58	0.11	0.47	0.09	0.02	0.01
LOGO	0.05	0.05	0.05	0.26	0.07	0.04	0.06
SMART	0.03	0.02	0.04	0.01	0.06	0.04	0.08
Companies	SE	DL	NP	ROA	ROE	OPM	
ARENA	0.060	0.14	0.00	0.01	0.01	0.01	
ARMDA	0.042	0.18	0.00	-0.01	-0.02	0.01	
DGATE	0.072	0.13	-0.01	0.04	0.09	0.00	
DESPC	0.107	0.08	-0.01	0.17	0.15	0.01	
ESCOM	0.165	0.01	4.28	-0.09	-0.05	0.25	
FONET	0.120	0.06	-0.07	0.18	0.13	0.10	
INDES	0.040	0.17	-0.01	0.06	0.18	0.01	
KFEIN	0.105	0.05	-0.03	0.18	0.15	0.07	
LINK	0.149	0.02	-0.12	0.25	0.15	0.20	
LOGO	0.086	0.10	-0.04	0.13	0.13	0.19	
SMART	0.104	0.08	-0.05	0.15	0.13	0.19	

Step 3: Creating a Weighted Standard Decision Matrix (V)

In this step, we determined the weights (w_j) of the evaluation factors. Afterwards, we multiplied the normalized values calculated in the previous step by (w_j) values to obtain the weighted normalized values. We considered the number of categories for financial ratios in the grading of weights. The proportions were equally weighted in each dimension. There are four dimensions for calculating financial performance: liquidity ratios, operating ratios, financial leverage ratios, and profitability ratios. Thus, the weight of each dimension was 25% in estimating financial performance. The sub-criteria were equally weighted. For example, we analyzed profitability rates in four sub-dimensions, with each sub-dimension represented as 25/4 = 6.25%. Accordingly, weights for the evaluation criteria w_1 = 0.083 (0.025 / 3), w_2= 0.083 (0.025 / 3), w_3= 0.083 (0.025 / 3), w_4 = 0.083 (0.025 / 3), w_5= 0.083 (0.025 / 3)), w_6 = 0.083 (0.025 / 3), w_7 = 0.083 (0.025 / 3), w_8 = 0.083 (0.025 / 3), w_9= 0.083 (0.025 / 3), w_{10} = 0.0625 (0.025 / 4), w_{11} = 0.0625 (0.025 / 3), w_{12} = 0.0625 (0.025 / 4), and w_{13} = 0.0625 (0.025 / 4). Table 5 provides the weighted and normalized decision matrix (V) for 2018.

Table 5: Weighted and Normalized Decision Matrix (V) for 2018

2018	Criteria						
Companies	C	AT	CAA	IT	ART	CAT	ST
ARENA	0.05	0.003	0.012	0.001	0.010	0.014	0.014
ARMDA	0.05	0.004	0.012	0.002	0.006	0.011	0.012
DGATE	0.05	0.004	0.011	0.003	0.011	0.012	0.013
DESPC	0.01	0.005	0.012	0.001	0.009	0.017	0.008
ESCOM	0.01	0.012	0.001	NA	0.001	0.000	0.000
FONET	0.01	0.002	0.002	0.006	0.014	0.003	0.005
INDES	0.01	0.002	0.011	0.002	0.010	0.012	0.017
KFEIN	0.01	0.005	0.006	0.014	0.005	0.007	0.004
LINK	0.04	0.048	0.009	0.039	0.007	0.002	0.001
LOGO	0.01	0.004	0.004	0.022	0.006	0.003	0.005
SMART	0.01	0.002	0.004	0.001	0.005	0.003	0.006
Companies	SE	DL	NP	ROA	ROE	OPM	
ARENA	0.005	0.012	0.001	0.001	0.001	0.001	
ARMDA	0.003	0.015	0.001	-0.001	-0.001	0.010	
DGATE	0.006	0.011	-0.001	0.003	0.005	0.001	
DESPC	0.008	0.006	-0.001	0.010	0.009	0.001	
ESCOM	0.013	0.000	0.267	-0.006	-0.003	0.015	
FONET	0.010	0.005	-0.005	0.011	0.008	0.006	
INDES	0.003	0.014	-0.001	0.003	0.011	0.001	
KFEIN	0.008	0.004	-0.002	0.011	0.009	0.004	
LINK	0.012	0.002	-0.008	0.016	0.009	0.013	
LOGO	0.007	0.008	-0.003	0.008	0.008	0.012	
SMART	0.008	0.007	-0.003	0.009	0.008	0.011	

Step 4: Determining the Ideal (A+) and Negative Ideal (A–) Solution

In this step, we created ideal A+ and negative ideal A– solution sets. For the A+ set, the maximum value in each column of the V matrix and for the A– set the smallest value in each column of the V matrix and the clusters for 2018 are formed as follows:

A^+ = {0,0442; 0,0484; 0,0123; 0,0395; 0,0149; 0,0178; 0,0177; 0,0138; 0,0151; 0,2678; 0,0162; 0,0113; 0,0159}

A^- = {0,0024; 0,0024; 0,0015; 0,0009; 0,0004; 0,0001; 0,0006; 0,0033; 0,0005; -0,0079; -0,0060; -0,0034; 0,006}

Step 5: Calculating the Separation Distances of Each Alternative to the Ideal Solution and Negative Ideal Solution

We calculated the distance of each alternative from the positive ideal solution (S+) and negative ideal solution (S–) as follows for 2018:

S^+ = {0,03879; 0,03873; 0,03867; 0,03865; 0,00210; 0,03989; 0,03883; 0,03865; 0,03840; 0,03886; 0,03976}

S^- = {0,00042; 0,00037; 0,00045; 0,00059; 0,03828; 0,00042; 0,00062; 0,00045; 0,00319; 0,00057; 0,00034}

Step 6: Calculating the Distances of Each Alternative from the Ideal Solutions

We calculated the relative proximity of each decision point to the ideal solution (C) using Equation 4.

Table 6: Proximity Values According to the Ideal Solution for 2018

${C_1}^+$	ARENA	0.01073	${C_7}^+$	INDES	0.01565
${C_2}^+$	ARMDA	0.00956	${C_8}^+$	KFEIN	0.01161
${C_3}^+$	DGATE	0.01152	${C_9}^+$	LINK	0.07668
${C_4}^+$	DESPC	0.01502	${C_{10}}^+$	LOGO	0.01433
${C_5}^+$	ESCOM	0.94807	${C_{11}}^+$	SMART	0.00840
${C_6}^+$	FONET	0.01039			

In the ranking, the alternative with the highest "C" takes priority. Therefore, we arranged "C" values in order of magnitude and determined the performance order of alternatives. Table 7 shows the 2014–2018 period scores and performance rankings of the companies traded in the IT sector in the BIST.

Step 7: Rank the Preference Order

We have ranked the alternatives, sorted them by the value of the indicator ${C_i}^+$ in decreasing order.

Table 7: "C" Values and Ranking of Entities Included in the Study

Companies	C Values (2018)	R	C Values (2017)	R	C Values (2016)	R	C Values (2015)	R	C Values (2014)	R
ARENA	0.0107	9	0.0241	7	0.0574	9	0.1137	10	0.1690	6
ARMDA	0.0095	10	0.0233	8	0.0560	10	0.1141	9	0.1903	4
DGATE	0.0115	7	0.0553	5	0.1071	4	0.1853	4	0.1986	3
DESPC	0.0150	4	0.2879	9	0.0602	7	0.1527	7	0.2010	2
ESCOM	0.9480	1	0.2879	2	0.5260	1	0.3109	3	0.0821	8
FONET	0.0103	8	0.0133	11	0.0553	11	0.1722	6	0.0752	9
INDES	0.0156	3	0.0461	6	0.0869	5	0.1439	8	0.1864	5
KFEIN	0.0116	6	0.1193	4	0.1120	3	0.3838	2	NA	N/A
LINK	0.0766	2	0.1810	3	0.4756	2	0.6577	1	0.8598	1
LOGO	0.0143	5	0.0201	10	0.0700	6	0.1758	5	0.1162	7
SMART	0.0084	11	0.7846	1	0.0584	8	N/A	N/A	N/A	N/A

According to Table 7, ESCOM and LINK are generally in the top three and perform well in the IT sector. The company with the code SMART ranked first in 2017 and last in 2018. In the decision matrix for the criteria for 2017, we calculated SMART's stock turnover rate as 3261.47, well above the sector average (397.24). In the decision matrix for the criteria for 2018, we calculated SMART's stock turnover rate as 4.62, well below the sector average (45,26). Therefore, it is evident that the SMART company has problems in stock management that, according to TOPSIS, resulted in the company's poor financial performance. The yearly rankings obtained for the businesses other than the first two companies generally varied.

We also examined the relationship between financial performance and stock revenue for the 2014–2018 period. Determining the relationship between financial performance and stock revenue may be a practical contribution for the investors. Two different portfolios were formed by considering the performance rankings of the businesses included in the analysis for the 2014–2018 period, according to their "C" values. Because the stock returns data of KFEIN, FONET, and SMART could not be reached, their returns could not be calculated. Portfolio 1 consists of companies ranging from 1 to 4. Portfolio 2 consists of companies whose performance range, according to TOPSIS, varied between 5 and 8. Because Portfolio 1 includes businesses with high performance rankings (1–4), we expect higher returns from Portfolio 1. Similarly, because Portfolio 2 includes businesses with low performance rankings (between 5 and 8), we expect lower returns from Portfolio 2. Table 8 provides the average return for each of the two portfolios.

Table 8: The Average Return of the Portfolios

	Compa-nies	**Average Return for 2018 (%)**	**Compa-nies**	**Average Return for 2017 (%)**	**Compa-nies**	**Average Return for 2016 (%)**
Portfolio 1	ESCOM LINK INDES DESPC	0.13 1.33 0.46 0.27	ESCOM LINK DGATE INDES	0.21 0.35 -0.16 0.44	ESCOM LINK DGATE INDES	-0.3 0.04 0.78 0.18
Avr. %	**0.5475**		**0.2100**		**0.1750**	
Portfolio 2	LOGO DGATE ARENA ARMDA	0.08 1.61 0.01 0.08	ARENA ARMDA DESPC LOGO	0.21 -0.1 0.14 0.26	LOGO DESPC ARENA ARMDA	0.57 0.28 0.03 0.73
Avr. %	**0.4450**		**0.1275**		**0.4025**	
Portfolio 1	LINK ESCOM DGATE LOGO	1.09 0.66 4.03 5.08	LINK DESPC DGATE ARMDA	-0.37 -0.35 -0.28 -0.07	0.5475 % + 0.2100 % + 0,1750 % + 2,7150 % – 0,2675 % = 3,38 % 3,38 % / 5 = 0,676 %	
Avr. %	**2.7150**		**-0.2675**		**Portfolio 1 Average = 0.6760%**	
Portfolio 2	DESPC INDES ARMDA ARENA	1.03 0.45 1.62 0.86	INDES ARENA LOGO ESCOM	-0.03 -0.11 0.22 -0.59	0.4450 % + 0.1275 % + 0.4025 % + 0.9900 % - 0,1275 = 1,8375 % 1,8735% / 5 = 0,3675%	
Avr. %	**0.9900**		**-0.1275**		**Portfolio 2 Average = 0.3675%**	

According to Table 8, Portfolio 1 has a higher return than Portfolio 2 for the years 2018, 2017, and 2015 in the 5-year period. Accordingly, Portfolio 1 generated a return of 0.54% in 2018, 0.21% in 2017, and 2.71% in 2015. Portfolio 2 outperformed Portfolio 1 with returns of 0.40% and –0.12% in 2016 and 2014, respectively. The return of Portfolio 2, which is 0.40%, resulted mainly from the returns of ARMDA and LOGO. Therefore, these returns, which can be considered as exceptions, must be taken into consideration in the comparisons between the portfolios. Generally, we can say that the portfolio consisting of high performance rankings, as suggested by TOPSIS, produced better returns than the portfolio consisting of low rankings. This is supported by the portfolios' 5-year average return values. Accordingly, Portfolio 1 generated an average return of 0.68%, whereas Portfolio 2 yielded an average return of 0.37%.

In addition, we examined the relationship between the TOPSIS-proposed performance rankings for the 2014–2018 period using Spearman rank correlation as a statistical test and the SPSS 23.0 statistical package program for the analysis.

Table 9: Spearman Rank Correlation Coefficients of Rankings Based on "C" Values

Years	**2018**	**2017**	**2016**	**2015**	**2014**
2018	1.000	0.191	0.791(**)	0.527	0.183
2017	0.191	1.000	0.627(*)	0.588	0.317
2016	0.791(**)	0.627(*)	1.000	0.782(**)	0.267
2015	0.527	0.588	0.782(**)	1.000	0.117
2014	0.183	0.317	0.267	0.117	1.000

** and * show 1% and 5% significant correlational relationship respectively.

According to Table 9, there is a significant and positive relationship between performance values for the years 2016 and 2018, 2017, 2015.

CONCLUSIONS

In recent years, great progress has been made in the field of information technology. In parallel, IT is rapidly becoming the sine qua non of our lives. In other words, IT is becoming more and more effective in social life. It is necessary to monitor the developments in this field because IT is one of the most fundamental determinants of the global economy and a universal development tool. IT affects many field of the organizations. Companies want to benefit from the IT to improve their effectiveness and production or service quality. It is supposed that the demand for services and products related to IT will rise due to technological development, and, in turn, affects the firms' financial performance. Therefore, evaluating the performance of the companies operating in IT sector is an important issue for investors, shareholders, creditors and other practitioners.

Financial performance evaluation techniques are used to obtain information about companies' financial conditions, enabling them to determine, through financial performance measurements, which areas they operate well in and in which areas they could improve. In this study, we used financial ratios to measure financial performance, analyzing the financial performance of 11 BIST-traded IT sector companies in Turkey using financial statements for the 2014–2018 period. We used liquidity ratio, operating ratio, financial leverage ratio and profitability ratio. We used the TOPSIS method, because of its logicality, rationality, computational simplicity. In addition, this method is suitable for financial performance evaluation and comparison. We provided information about the financial ratios that we used to determine the business performance, then separately we calculated the financial ratios for each business to use as input data for the TOPSIS method. We then calculated performance rankings for all businesses. Finally, we created two different portfolios using TOPSIS for high-performing and low-performing businesses to determine the relationship between portfolio returns and business performance.

Our analysis showed that the performance scores of the companies operating in the IT sector fluctuated generally during the analysis period. However, we determined that the top two ranked companies tend to maintain their current positions. In addition, we determined that the portfolio consisting of high performance rankings suggested by TOPSIS had better returns than the portfolio consisting of low rankings. Finally, we determine whether the financial performance rankings proposed by the TOPSIS method are different from each other. It can be observed the performances of the companies operating in the information technology sector are generally similar over the years.

We weighted each criterion equally. It is possible to make an evaluation only for creditors, investors or shareholders. But, in such a case, the weights of the criteria may vary, so the rankings of the firms may change.

TOPSIS combines different assessment criteria that allow decision makers to make an objective assessment. Therefore, this study's results can provide information about the performance situations of the businesses in the IT sector and help current or potential investors make decisions. In future studies, TOPSIS can be used to compare changes over time in business financial performance. Furthermore, we can compare the financial performance results of different multicriteria decision-making methods with one another.

The results of the study are valid for the 2014–2018 period for BIST-traded IT companies but should not be generalized to other sectors. In addition, we cannot predict whether high- or low-performing businesses will continue to have the same success or failure in the coming years as a result of the analysis performed for the analysis period.

In future studies, other multi-criteria methods can be used to evaluate the performance of IT firms. In addition, the proposed method can be applied for evaluating the firms in other sectors.

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