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FINANCIAL PERFORMANCE EVALUATION OF FIRMS IN BIST CHEMICAL PETROLEUM PLASTIC SECTOR BY USING AN INTEGRATED MULTI-CRITERIA DECISION MAKING METHOD

BIST KİMYA, PETROL, PLASTİK SEKTÖRÜNDE YER ALAN FİRMALARIN FİNANSAL PERFORMANSININ TÜMLEŞİK BİRÇOK KRİTERLİ KARAR VERME YÖNTEMİ İLE DEĞERLENDİRİLMESİ

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Abstract:

As financial performance indicators reflect the competitiveness of companies, financial performance evaluation has a vital importance in a competitive environment. This study aims to evaluate financial performances of the companies listed on Borsa Istanbul chemical, petroleum, plastic indices. In this context, financial ratio analysis of these companies is done for the years between 2010 and 2012, and the obtained data were evaluated by using Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The AHP approach is used to determine relative importance weights of the main criteria and sub-criteria. The weights and financial ratios are combined by using the TOPSIS approach. As a result of the analysis, the most important ratios are profitability ratios, and Tüpraş has the best financial performance.

Key Words: *Financial Performance, AHP, TOPSIS.*
Jel Classification: *M10, M41, C61*

Özet:

Finansal performans göstergeleri firmaların rekabet gücünü gösterdiğinden, rekabetçi bir çevrede finansal performansın değerlendirilmesi hayati öneme sahiptir. Bu çalışmada Borsa İstanbul'da kimya, petrol ve plastik sektöründe faaliyet gösteren firmaların, finansal performanslarının değerlendirilmesi amaçlanmıştır. Bu bağlamda, söz konusu firmaların 2010-2012 yılları için finansal rasyoları hesaplanmış ve elde edilen veriler analitik hiyerarşi süreci (AHS) ve ideal çözüme yakınlığa göre sıralama tekniği olan TOPSIS ile değerlendirilmiştir. AHS yöntemi kriter ve alt kriterlerin göreli önem ağırlıklarını belirlemede kullanılmıştır. Ağırlıklar ve finansal rasyolar TOPSIS yaklaşımı kullanılarak birleştirilmiştir. Yapılan analiz sonucunda, karar vericilerin yaptıkları değerlendirmelere göre en önemli kriterlerin karlılık oranları ve en iyi performansa sahip firmanın Tüpraş olduğu belirlenmiştir.

Anahtar Kelimeler: *Finansal Performans, AHS, TOPSIS.*
Jel Kodları: *M10, M41, C61*

1. INTRODUCTION

In today's highly competitive environment performance measurement and evaluation have become more important not only for organizations but also for investors and creditors. The existence and growth of an organization depend on its competitive strength. Growing in a healthy way and being competitive require measuring and evaluating firm performance. Generally, performance evaluation of firms is realized within the context of financial analysis. In the evaluation of the financial performance of companies, past period data and the firm's financial statements are used. For the financial performance analysis of companies, traditional methods -ratio analysis, vertical percentage analysis, trend percent analysis, profit analysis, funds flow analysis- and mathematical methods -TOPSIS, fuzzy TOPSIS, ELECTRE, Analytical Hierarchy Process (AHP), fuzzy AHP, Fuzzy Logic, data envelopment analysis (DEA), etc.- can be used. Investors, analysts and managers can evaluate the operation of a firm and analyze the firm's position within a sector over time by using financial ratios.

Financial ratio analysis provides a snapshot of a firm's financial position at any particular moment in time and a comprehensive idea about the financial performance of the company over a particular period of time. It is a useful tool for judging the financial health or performance of a particular firm over time and comparing a firm's financial position and performance with respect to others in the same or different industry to pinpoint problem areas or to identify areas of further improvements (De et al., 2011: 13). Because performance is an indicator of a firm's success, measurement method must include various quantitive and qualitative measurable decision criteria and alternatives. For this reason, evaluation of firm performance can be defined as a multi-criteria decision making (MCDM) problem. MCDM methods take into consideration numerous independent criteria or goals and

help the decion maker to determine the most appropriate option. AHP and TOPSIS are the most popular methods among MCDM methods (Perçin and Karakaya, 2012: 243).

The purpose of this study is to measure and evaluate financial performances of the firms that are traded on Borsa Istanbul (BIST) and operating in chemical, petroleum and plastic indices between the years 2010-2012 by using MCDM methods (AHP and TOPSIS). There are various studies related with performance evaluation of the companies that are traded on BIST in different sectors, but no study was encountered related with performance evaluation of firms operating in chemical, petroleum and plastic sector. This sector mostly depends on imports, but it is a growing sector and foreseen to be a locomotive sector of Turkey within a few years. Almost every product's raw materials are provided by the chemical industry. For these reasons, this sector is chosen, and the performance of the companies in it were evaluated. In this study, financial ratio analysis is used to measure the level of liquidity, operational activity, leverage, profitability, and market value of the firms. Because performance evaluation is considered as a MCDM problem, firm's performances in terms of financial ratios are analyzed by using MCDM techniques - AHP and TOPSIS. The AHP approach is used to weight (relative importances of) the main criteria and their sub-criteria. The weights and performance scores are combined by using the TOPSIS approach.

The structure of the paper is as follows: First financial ratios used in this paper and their formulas are explained. Secondly, a brief literature review based on Turkey studies on performance evaluation and MCDM methods is given. In the third section, AHP and TOPSIS are explained. In the fourth section, application and its results are given.

2. LITERATURE REVIEW

TOPSIS method has been used to measure and evaulate the financial performance of companies since 1980s. Recent studies in Turkey that used TOPSIS to evaulate the financial performance of the firms: Yurdakul and İç (2003), Dumanoğlu (2010), Dumanoğlu and Ergül (2010), Ergül and Akel (2010), Bülbül and Köse (2011), Uygurtürk and Korkmaz (2012), Yılmaz Türkmen and Çağıl (2012) analyzed financial performances of companies in different sectors in Istanbul Stock Exchange (ISE) with TOPSIS method.

Studies that use integrated methods of MCDM to evaluate the performances of Turkish firms: Ertuğrul and Karakaşoğlu (2009) developed a fuzzy model to evaulate the performance of the Turkish cement firms in ISE by using financial ratios, Fuzzy Analytic Hierarchy Process (FAHP) and TOPSIS methods. Yalçın et al. (2009) has proposed a fuzzy multi-criteria decision model (FAHP and TOPSIS) to evaluate the performances of banks. Their results show that not only financial performance but also non-financial performance should be taken into account in a competitive environment. Karğın (2010) has measured and compared the financial performance of 26 textile firms by using some financial ratios and FAHP and TOPSIS methods. They found that profitability and liquidity ratios are the first two determinants of financial performance of textile firms. Perçin and Karakaya (2012) have evaluated the performance of information technology (IT) firms by using FAHP and TOPSIS methods and have compared the performance results with the companies' values. They observed that there is a strong and meaningful relationship between the performance scores and the firms' values. Yalçın et al. (2012) has used FAHP, TOPSIS and VIKOR methods for the performance evaluation of Turkish manufacturing industries. They indicated that the obtained ranks of the companies by these methods are almost the same with the ranks respect to their own sectors. Önder et al. (2013)

has evaluated the financial performances of Turkish banks between 2002-2011 by using both AHP and TOPSIS methodolologies for the ranking of banks. Akkoç and Vatansever (2013) have assessed financial performances of 12 commercial banks by employing FAHP and Fuzzy TOPSIS methods. Their findings show that these two methods rank banks in a similar manner. Aytekin and Sakarya (2013) have analyzed the financial performance of food enterprises that are traded on BIST by using financial ratios and TOPSIS method. They concluded that after the 2008 global financial crisis, between the years of 2009-2012, no enterprise has showed the best financial performance successively in all years. Tayyar et al. (2014) has evaluated the financial performance of the companies operating in IT sector in BIST by using AHP and Grey Relational Analysis. They have indicated that profitability ratios were the most important criteria and determined the firm which has the highest financial performance among the other companies operating in the same sector.

3. PERFORMANCE MEASUREMENT WITH FINANCIAL RATIOS

Performance measurement is the use of quantitative tools to gauge an organization's performance in relation to a specific goal or an expected outcome (Crosson and Needles, 2008: 352). Measuring financial performance is important for economic units. Financial performance measures are used as indicators for assesment of economic units' success. With the help of financial performance, financial positions of the businesses, profitabilities of the investments and the businesses' degrees of riskiness can be determined. In addition, financial performance provides managers with important information for evaluation of the past performance, investment and financing (source of financing) decisions for the future, and utilization of resources. Financial ratios are useful tools in understanding and monitoring a company's financial situation and performance.

Financial ratios provide information about the firm's liquidity, growth, and profitability. Financial ratios enable the comparison of the firm with itself over time and with other firms in the sector. Financial ratios are used to assess the current and past performances of firms. When comparing the performance of a firm with itself over time, firm's past ratios are used, and the changes in these ratios over years are taken into account. In addition, whether the budget targets are met is also considered. When comparing a firm with another firm, related ratios are calculated for both of the firms for the same interval. Financial ratios have a broad user base such as creditors, business executives, current or potential partners, financial analysts, and academic researchers (Uygurtürk and Korkmaz, 2012: 100).

Financial ratios are generally broken down into categories according to the information they provide. Liquidity ratios are used to evaluate a firm's ability to satisfy its short-term financial obligations. Financial leverage ratios are used to evaluate the degree of a company's fixed financing obligations and ability to serve the source of financing. Financial leverage influences the rate of return owners expect to realize on their investment and the degree of risk involved. Profitability ratios measure how effectively a firm's management is generating profits on sales, total assets and stockholders' investments. Activity ratios indicate how efficiently a firm is using its assets to generate sales. Market-based ratios measure the financial market evaluation of a company's stock (Moyer et al., 1990: 68).

In this study, ratios in Table 1 have been used. The ratios used in evaluating the performances of firms prevent subjective decisions, but they may not be sufficient alone. Because different firms can be superior to others according to different ratios, so comparison of financial results may cause problems for decision makers (DMs). For this reason MCDM methods like AHP and TOPSIS provide DMs with more objective evaluation opportunities by combining different evaluation options under a common denominator (Yükçü and Atağan, 2010: 35).

Table 1: Financial Ratios

Liquidity Ratios	**Formulas**
Current Ratio	Current Assets/Current Liabilities
Acid-test Ratio (Quick ratio)	Current Assets-Inventories/Current Liabilities
Financial Leverage Ratios	
Debt Ratio	Total Debt / Total Assets
Debt to Equity	Total Debt / Equity
Profitability Ratios	
Net Profit Margin Ratio	Net Profit/NetSales
Return on Assets	Net Profit/ Total Assets
Return on Equity	Net Profit/ Equity
Activity Ratios	
Account Receivable Turnover	Net Sales/Average accounts receivable
Inventory Turnover	Cost of goods sold/Average inventory
Total Asset Turnover	Net Sales/Total Assets
Market-based Ratios	
Earning per Share (EPS)	Net Income/Number of Common Stock

4. MULTI-CRITERIA DECISION MAKING

Decision making is a process of selecting the most appropriate alternative among the alternatives in a decision set. In real life situations, DMs should evaluate various criteria and a large number of alternatives. In such cases DMs' problems are called MCDM problems (Akkoç and Vatansever, 2013: 56).

The structure of the typical MCDM problem consists of m alternatives and n decision criteria. Each alternative can be evaluated with respect to each decision criterion, and the relative importance weight of each criterion can be estimated as well (Triantaphyllou and Mann, 1995: 36).

MCDM porblems can be solved by MCDM techniques which provide DMs with some benefits in terms of evaluating various alternatives in different units and an

advantage by using quantitative and qualitative variables simultaneously (Akkoç and Vatansever, 2013: 57).

4.1. Analytic Hierarchy Process (AHP)

AHP which was developed by Saaty (1980) is a powerful and flexible MCDM technique to support priority-setting and decision making with both quantitative and qualitative aspects of a decision must be considered (Cheng and Wang, 2004: 79). The main strength of the method is that it reduces the number of decision variables that must be considered simultaneously from many to two (Taylor III, et al., 1998: 680). In this study, AHP is used to calculate relative importance weights of criteria and sub-criteria.

If n criteria are considered in order to provide and quantify judgements on the relative importance of each criterion with respect to other criteria, AHP is an appropriate technique for determining the relative importance of the criteria. AHP method can be used to construct the hierarchical structure of the MCDM problem and calculate the importance weights of the main criteria and sub-criteria. The top element of the hierarchy is the main objective of the MCDM problem, while the other elements at lower levels are associated with the criteria to reach the main objective (Cheng and Wang, 2004). Main criteria can be divided into sub or sub-sub-criteria for additional information, and they can be subjective or objective depending on the means used in evaluating the contribution of criteria below them in the hierarchy. Criteria don't depend on the elements below them in the hierarchy (Qureshi and Harrison, 2003: 443).

AHP technique is described by Saaty (2008) as in the following steps (Saaty, 2008: 85; Hamzaçebi and Pekkaya, 2011: 9188):

1. Defining the MCDM problem and knowledge seeking

2. Constructing the hierarchical structure of the MCDM problem

3. Prepearing the pairwise comparison matrices

4. Obtaining the relative importance weights from the pairwise comparison matrices and control the consistency ratios of matrices

AHP is composed of several techniques, such as hierarchical structuring, pairwise comparisons and the eigenvector method for deriving weights, priorities and consistency of decision matrices (Büyükyazıcı and Sucu, 2003: 66-67).

Let {C1, C2, ….., Cn} denote the criteria (n is the number of compared criteria) and w = (w1, w2, ….., wn) represents criteria's priority vector. Pairwise comparison matrix A = represents the intensities of the DM's preferences between individual pairs of criteria (Ci versus Cj, for all i, j = 1,2,…..,n). To obtain a pairwise comparison matrix A, a DM compares pairs of criteria for all possible pairs, where aij shows the preference weight of Ci which is obtained by comparison with Cj (Alonso and Lamata, 2006: 446).

$$A = \left[a_{ij}\right] = \begin{pmatrix} 1 & a_{12} & \dots & a_{1j} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2j} & \dots & a_{2n} \\ . & . & . & . & . & . \\ 1/a_{1j} & 1/a_{2j} & \dots & a_{ij} & \dots & a_{in} \\ . & . & . & . & . & . \\ 1/a_{1n} & 1/a_{2n} & \dots & 1/a_{in} & \dots & 1 \end{pmatrix} \quad (1)$$

$$W = \left[w_i / w_j\right] = \begin{pmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ . & . & . & . \\ . & . & . & . \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{pmatrix} \quad (2)$$

Each criterion is compared with all other criteria on a numerical scale given in Table 2 according to the intensity of importance. If the comparison is consistent, the elements of pairwise comparison matrix will satisfy the following conditions (Solnes, 2003: 295):

$$aij = wi/wj = 1/aji \text{ , } aii = 1, aik \text{ . } akj = aij \quad (i, j, k = 1, 2, \ldots, n) \qquad (3)$$

Table 2: The Definition and Explanation of Every Comparative Importance

Comparative Importance	**Definition**	**Explanation**
1	Equally important	Two decision factors (criteria) equally influence the parent decision factor.
3	Moderately more important	One decision factor is moderately more influential than the other.
5	Strongly more important	One decision factor has stronger influence than the other.
7	Very strongly more important	One decision factor has significantly more influence over the other.
9	Extremely more important	The difference between influences of the two decision factors is extremely significant.
2, 4, 6, 8	Intermediate judgement values	Judgement values between equally, moderately, strongly, very strongly, and extremely.
Reciprocals		If a_{ij} is the judgement value when i is compared to j, then $a_{ji} = 1/a_{ij}$ is the judgement value when j is compared to i.

Source: (Cheng and Wang, 2004: 81)

If pairwise comparison matrix A is totally consistent, then it is noticed that A = W, and the principal eigenvalue (λmax) is equal to n. Let aij give the relative importance of the elements i and j. The goal of AHP is to compute a vector of weights {w1, w2,…..wn} associated with A. If A is an nxn non-negative, primitive (if Ak > 0 for some power k) matrix, then one of it's eigenvalues λmax, is positive and greater

than or equal to all other eigenvalues. Also, there is a positive eigenvalue w corresponding to that eigenvalue and that eigenvalue is a simple root of the following equation where w is the weight vector of the decision problem's goal (Alonso and Lamata, 2006: 447):

$$Aw = \lambda max\ w \quad (4)$$

Because of the inconsistency of human judgements when assessing weights, the aggregation weight vector might be invalid. The consistency index (CI) and consistency ratio (CR) are used to check the consistency of pairwise comparison matrices. They are calculated by the following equations (Chang et al., 2012: 370-371):

(5)

(6)

RI is a random index which is obtained from Table 3 by different orders of pairwise comparison matrices. If the CR value is below 0.1, it means pairwise comparison matrix and also the judgements of DMs are consistent (Chang et al., 2012: 371).

Table 3: Random Indexes (RI)

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.58

Source: (Dalalah et al., 2010: 570)

4.2. The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

The TOPSIS algorithm was first introduced by Yoon and Hwang (1981). TOPSIS helps finding the best alternative which is the nearest to the positive ideal solution (PIS) and the farthest from the negative ideal solution (NIS). The PIS maximizes the benefit criteria and minimizes the cost criteria whereas NIS maximizes the cost

criteria and minimizes the benefit criteria (Dağdeviren et al., 2009: 8145). In TOPSIS method, alternatives are graded based on ideal solution similarity. If an alternative is closer to the PIS, it has a higher grade (Bhutia and Phipon, 2012: 44). TOPSIS algorithm consists of the following steps:

1. Establish a decision matrix for the ranking. Let xij (i = 1, 2, ….., m and j = 1, 2, ….., n) denote the performance value of ith (Ai) alternative with respect to jth criterion (Cj) (Triantaphyllou and Mann, 1995: 36). The structure of the decision matrix denoted by D = (xij)mxn can be expressed as follows (Önder and Dağ, 2013: 63-64):

$$\mathbf{D} = \begin{array}{c|ccccc} & C_1 & C_2 & C_3 & \dots & C_n \\ A_1 & x_{11} & x_{12} & x_{13} & \dots & x_{1n} \\ A_2 & x_{21} & x_{22} & x_{23} & \dots & x_{2n} \\ A_3 & x_{31} & x_{32} & x_{33} & \dots & x_{3n} \\ . & . & . & . & \dots & . \\ . & . & . & . & \dots & . \\ . & . & . & . & \dots & . \\ A_m & x_{m1} & x_{m2} & x_{m3} & \dots & x_{mn} \end{array} \qquad (7)$$

2. Calculate a normalized decision matrix R = (rij). The normalized value rij is calculated as follows (Dağdeviren et al., 2009:8145):

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{m} x_{kj}^{2}}} \qquad i = 1,2,\dots..,m \qquad j = 1,2,\dots\dots,n$$

(8)

3. Determine the weighted decision matrix V = (vij)mxn. The weighted decision matrix is constructed by multiplying each element of each column of the normalized decision matrix by the weights of the criteria (Maliki et al., 2012: 5).

$$v_{ij} = w_j \cdot r_{ij} \qquad i = 1,2,\dots..,m \qquad j = 1,2,\dots\dots,n$$

(9)

. Identify the PIS (A+) and NIS (A–) respectively as follows (Önder and Dağ, 2013: 64):

$$A^{+} = \left\{ v_1^{+}, v_2^{+}, ..., v_n^{+} \right\} = \left\{ \left(\underset{i}{\text{Max}} \;\; v_{ij} \middle| \, j \in K \right), \left(\underset{i}{\text{Min}} \;\; v_{ij} \middle| \, j \in K' \right) \right\}$$

(10)

$$A^{-} = \left\{ v_1^{-}, v_2^{-}, ..., v_n^{-} \right\} = \left\{ \left(\underset{i}{\text{Min}} \;\; v_{ij} \middle| \, j \in K \right), \left(\underset{i}{\text{Max}} \;\; v_{ij} \middle| \, j \in K' \right) \right\}$$

(11)

K is associated with benefit criteria and is associated with cost criteria.

5. Calculate the distances denoted by d+ (the distances of each alternative from PIS) and d– (the distances of each alternative from NIS). The distances of each alternative from the PIS and NIS are calculated by the Euclidean distance (Tavana and Hatami-Marbini, 2011: 13590):

$$d_i^{+} = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^{+} \right)^2} \qquad i = 1,2,.....,m \qquad j = 1,2,.....,n$$

(12)

$$d_i^{-} = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^{-} \right)^2} \qquad i = 1,2,.....,m \qquad j = 1,2,.....,n$$

(13)

6. Calculate the relative closeness coefficients (CCi) of each alternative and rank the performance order. The larger CCi value means the better performance of the alternatives (Dağdeviren et al., 2009: 8145).

$$CC_i = \frac{d_i^{-}}{d_i^{+} + d_i^{-}} \qquad i = 1,2,.....,m \qquad 0 \le CC_i \le 1$$

(14)

5. APPLICATION

The sample consists of firms listed on BIST which is operating in chemical, petroleum, plastic indices. This study is based on the secondary data obtained from the balance sheets and profit-loss statements for the 3 years between 2010 and 2012. The companies of which financial performances were analyzed are listed in Table 4. Four companies excluded from the study due to lack of data.

Table 4: Firms Traded on BIST Chemical, Petroleum, Plastic Indices

Firms			
1	Aksa (AKSA)	11	Good-Year (GOODY)
2	Alkim Kimya (ALKIM)	12	Gübre Fabrikaları (GUBRF)
3	Aygaz (AYGAZ)	13	Hektaş (HEKTS)
4	Bagfaş (BAGFS)	14	Marshall (MRSHL)
5	Brisa (BRISA)	15	Petkim (PETKM)
6	Berkosan Yalıtım (BRKSN)	16	Pimaş (PIMAS)
7	Deva Holding (DEVA)	17	OMV Petrol Ofisi (PTOFS)
8	DYO Boya (DYOBY)	18	Sasa Polyester (SASA)
9	Ege Gübre (EGGUB)	19	Soda Sanayii (SODA)
10	Ege Profil (EGPRO)	20	Tüpraş (TUPRS)

5.1. An Integrated AHP and TOPSIS Method for The Evaluation of Financial Performances of Firms Traded on BIST Chemical, Petroleum, Plastic Indices

Like all decision making methods, AHP and TOPSIS have some strengths and weaknesses. AHP is an effective technique for making comparisons among main criteria, sub-criteria or alternatives and identifying the relative importance or priority weights of them. However, if there are lots of alternatives, DMs may lose consistency in their judgements while comparing the alternatives. Although the consistency ratio for each pairwise comparison matrix can be calculated, analysts often face

inconsistent decision matrices if the number of alternatives is very high. AHP allows both qualitative assessment and quantitative values in decision making process. The priority weights of alternatives are determined according to their share in the total value. But if there are negative values among quantitative values, AHP can't be used. Because pairwise comparison matrix must be same with the mathematical form-known as a positive reciprocal matrix (Coyle, 2004: 8). TOPSIS is effectively used in group decision making and when there are various alternatives. Also, as the method sorts the alternatives by their distances from the ideal solution, negative values can be considered in decision process, but TOPSIS is insufficient for the hierarchical planning of main criteria and sub-criteria and their comparisons.

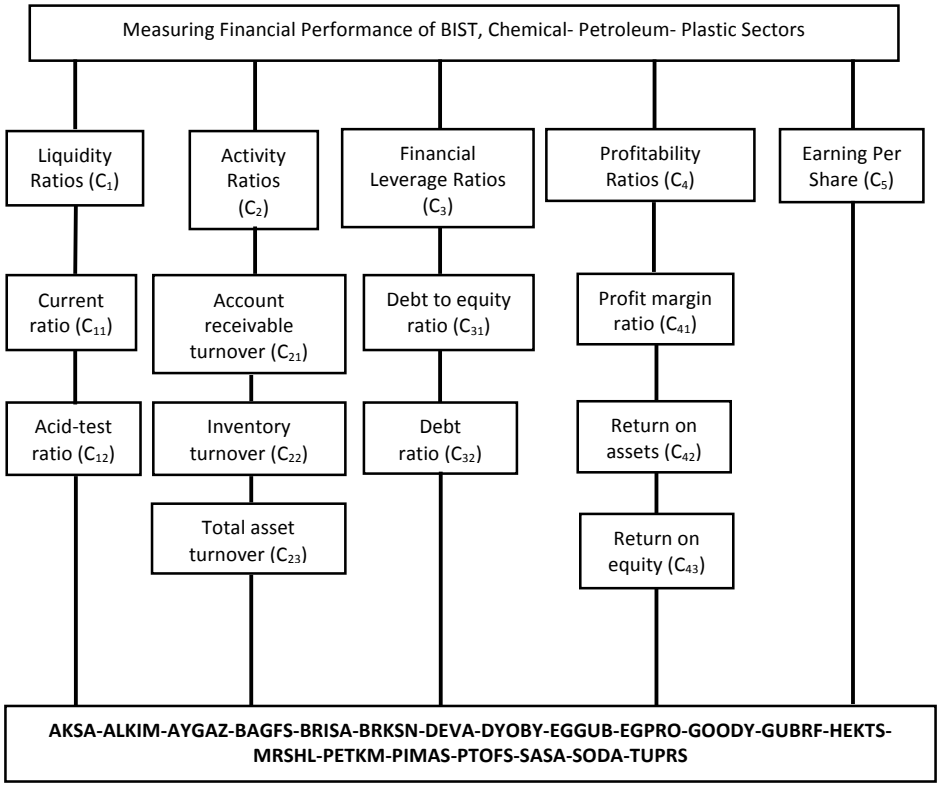
For these reasons, in this study, AHP method is used to construct the hierarchical structure of the financial performance evaluation problem and calculate the importance weights of the main criteria and sub-criteria. Then TOPSIS method is used to evaluate the alternatives with respect to their financial ratios. With this integrated usage, the elimination of the disadvantages of those two methods can be provided for.

The analysis of the research consists of the following steps:

1. The hierarchical structure of the MCDM problem which shows the objective, main criteria, sub-criteria and alternatives is constructed and shown in Figure 1.

2. Two experts (an investor and a manager) were asked to evaluate main criteria and sub-criteria with the help of a survey to determine the relative importance weights of criteria by doing pairwise comparisons. Also Saaty's intensity of importance scale in Table 2 was sent to the experts to enable their evaluation to be according to this scale.

Figure 1 : Hierarchical Structure of The MCDM Problem



The pairwise comparison matrices which are obtained from DMs' assessments for main criteria and sub-criteria, the relative importance weights that are calculated by AHP and consistency ratios of the pairwise comparison matrices are given in Table 5 and Table 6. The relative importance weights which are determined seperately for two DMs are aggregated by calculating their arithmetic averages.

Table 5: Pairwise Comparison Matrices of the Main Criteria and Average Importance Weights

Investor							**Manager**							Average Importance Weights
	C_1	C_2	C_3	C_4	C_5	Weights		C_1	C_2	C_3	C_4	C_5	Weights	
C_1	1	2	1	1/3	1/3	0.125	C_1	1	1	1/2	1/2	2	0.157	0.141
C_2	1/2	1	1/2	1/3	1/4	0.077	C_2	1	1	1/2	1/2	2	0.157	0.117

C_3	1	2	1	1/3	1/3	0.125	C_3	2	2	1	1/3	2	0.225	0.175
C_4	3	3	3	1	1/2	0.283	C_4	2	2	3	1	3	0.367	0.325
C_5	3	4	3	2	1	0.390	C_5	1/2	1/2	1/2	1/3	1	0.094	0.242
CR = 0.022							CR = 0.037							

Table 6: Pairwise Comparison Matrices of the Sub-Criteria and Average Importance Weights

Investor					**Manager**					Average Importance Weights
Liquidity Ratios (C_1)					Liquidity Ratios (C_1)					
	C_{11}	C_{12}		Importance Weights		C_{11}	C_{12}		ImportanceWeights	
C_{11}	1	1/2		0.333	C_{11}	1	1/2		0.333	0.333
C_{12}	2	1		0.667	C_{12}	2	1		0.667	0.667
Activity Ratios (C_2)					Activity Ratios (C_2)					
	C_{21}	C_{22}	C_{23}	Importance Weights		C_{21}	C_{22}	C_{23}	Importance Weights	
C_{21}	1	4	6	0.685	C_{21}	1	2	3	0.539	0.612
C_{22}	1/4	1	3	0.221	C_{22}	1/2	1	2	0.297	0.259
C_{23}	1/6	1/3	1	0.094	C_{23}	1/3	1/2	1	0.164	0.129
CR = 0.047					CR = 0.008					
Financial Leverage Ratios (C_3)					Financial Leverage Ratios (C_3)					
	C_{31}	C_{32}		Importance Weights		C_{31}	C_{32}		Importance Weights	
C_{31}	1	1/2		0.333	C_{31}	1	1		0.5	0.417
C_{32}	2	1		0.667	C_{32}	1	1		0.5	0.583
Profitability Ratios (C_4)					Profitability Ratios (C_4)					
	C_{41}	C_{42}	C_{43}	Importance Weights		C_{41}	C_{42}	C_{43}	Importance Weights	
C_{41}	1	4	4	0.655	C_{41}	1	2	2	0.500	0.577
C_{42}	1/4	1	1/2	0.134	C_{42}	1/2	1	1	0.250	0.192
C_{43}	1/4	2	1	0.211	C_{43}	1/2	1	1	0.250	0.231
CR = 0.047					CR = 0.000					

When the importance weights of main criteria are ranked, it is seen that the most important criteria are profitability ratios with 32.5% importance weight. Earning per share is ranked second with 24.2% importance weight,; financial leverage ratios are ranked third with 17.5% importance weight,; liquidity ratios are

ranked fourth with 14.1% importance weight, and activity ratios are ranked the last with 11.7% importance weight.

3. After determining the importance weights of criteria, financial ratios of the firms are calculated by using their financial statements between the years of 2010 and 2012. Decision matrices for each sub-criterion are obtained by determining the arithmetic averages of financial ratios calculated seperately for 3 years. Average values of the financial ratios which are used for the analysis are shown in Table 7.

4. After the financial ratios are calculated, the values in Table 7 are normalized by using the equation (8). Then, importance weights of sub-criteria belonging to each main criterion are multiplied by the normalized values, and weighted normalized values belonging to sub-criteria are aggregated and shown in Table 8. During this process, by calculating the reciprocals of financial ratios that are preferred to take low values, so those ratios are transformed into values which are preferred to be high.

Table 7: Average Values of Financial Ratios of the Firms

Firm	C_1		C_2			C_3		C_4			C_5
	C_{11}	C_{12}	C_{21}	C_{22}	C_{23}	C_{31}	C_{32}	C_{41}	C_{42}	C_{43}	
AKSA	1.684	1.275	0.603	8.133	0.136	0.766	0.430	0.513	0.071	0.123	0.577
ALKIM	2.506	1.694	1.324	4.569	0.179	0.459	0.313	0.389	0.070	0.103	0.646
AYGAZ	1.750	1.356	1.695	29.677	0.177	0.298	0.227	0.618	0.109	0.141	1.025
BAGFS	2.678	1.810	3.133	5.262	0.260	0.412	0.291	0.580	0.157	0.222	0.016
BRISA	1.351	0.799	0.961	4.455	0.253	1.185	0.532	0.282	0.071	0.156	2.543
BRKSN	1.784	1.118	1.076	2.567	0.140	0.907	0.444	0.041	0.007	0.006	0.005
DEVA	1.363	0.875	0.940	2.208	0.222	0.892	0.471	0.026	0.007	0.013	0.0002
DYOBY	0.903	0.753	0.579	7.044	0.208	7.889	0.881	-0.160	-0.025	-0.316	-0.138
EGGUB	0.441	0.152	16.736	5.066	0.161	1.105	0.519	0.265	0.042	0.086	0.042
EGPRO	1.592	1.411	0.482	8.574	0.238	1.199	0.545	0.223	0.053	0.117	0.258
GOODY	1.865	1.290	0.788	7.745	0.231	0.803	0.440	0.286	0.069	0.123	0.175
GUBRF	1.046	0.729	1.489	3.596	0.245	1.573	0.611	0.590	0.146	0.376	0.491
HEKTS	3.507	2.478	1.381	2.695	0.285	0.398	0.278	0.409	0.117	0.161	0.207
MRSHL	2.106	1.578	2.112	6.954	0.491	0.580	0.363	0.034	0.017	0.022	0.261
PETKM	1.541	0.994	0.365	8.229	0.063	0.578	0.365	0.461	0.033	0.051	0.083
PIMAS	1.327	0.983	0.383	4.895	0.153	1.548	0.603	-0.037	-0.003	-0.015	-0.0003
PTOFS	1.485	0.923	0.704	19.228	0.126	2.289	0.695	-0.090	-0.011	-0.037	-0.133

SASA	1.144	0.621	0.738	5.155	0.142	1.387	0.575	0.030	0.029	0.053	0.647
SODA	1.916	1.544	1.499	7.971	0.179	0.500	0.333	0.571	0.104	0.157	0.407
TUPRS	1.090	0.738	1.442	13.474	0.142	2.473	0.712	0.540	0.074	0.258	4.577

Table 8: Aggregated Normalized Decision Matrix for the Main Criteria

Firms	**C_1**	**C_2**	**C_3**	**C_4**	**C_5**
AKSA	0.22118	0.08546	0.20091	0.25663	0.10477
ALKIM	0.30501	0.09564	0.29911	0.20662	0.11744
AYGAZ	0.23351	0.25223	0.43380	0.31987	0.18625
BAGFS	0.32599	0.17276	0.32733	0.35998	0.00292
BRISA	0.15091	0.09208	0.14977	0.18750	0.46207
BRKSN	0.20679	0.07042	0.18481	0.02018	0.00085
DEVA	0.16044	0.07439	0.17909	0.01722	0.00004
DYOBY	0.12677	0.08785	0.06734	-0.17047	-0.02514
EGGUB	0.03635	0.62893	0.15581	0.14269	0.00763
EGPRO	0.23338	0.09720	0.14672	0.14455	0.04693
GOODY	0.23046	0.10215	0.19450	0.17703	0.03175
GUBRF	0.12998	0.10434	0.12436	0.40620	0.08928
HEKTS	0.43960	0.10072	0.34037	0.25871	0.03755
MRSHL	0.27467	0.17759	0.24867	0.02831	0.04742
PETKM	0.18190	0.06813	0.24830	0.19376	0.01514
PIMAS	0.17168	0.06146	0.12606	-0.01908	-0.00006
PTOFS	0.17125	0.15126	0.10199	-0.04941	-0.02422
SASA	0.12119	0.07386	0.13495	0.04322	0.11755
SODA	0.26267	0.12116	0.27850	0.30600	0.07400
TUPRS	0.13287	0.14582	0.09823	0.31063	0.83149

5. At this step, by multiplying importance weight of each main criterion by the values given in Table 8, weighted normalized decision matrix is obtained and demonstrated in Table 9. Later, by selecting maximum and minimum values for each main criterion, PIS (A+) and NIS (A–) are determined respectively.

PIS = A+ = {0.062, 0.074, 0.076, 0.132, 0.201}

NIS = A– = {0.005, 0.007, 0.012, –0.055, –0.006}

Table 9: Weighted Normalized Decision Matrix

Firms	C_1	C_2	C_3	C_4	C_5
AKSA	0.03119	0.01000	0.03516	0.08340	0.02535
ALKIM	0.04301	0.01119	0.05234	0.06715	0.02842
AYGAZ	0.03292	0.02951	0.07592	0.10396	0.04507
BAGFS	0.04596	0.02021	0.05728	0.11699	0.00071
BRISA	0.02128	0.01077	0.02621	0.06094	0.11182
BRKSN	0.02916	0.00824	0.03234	0.00656	0.00021
DEVA	0.02262	0.00870	0.03134	0.00560	0.00001
DYOBY	0.01787	0.01028	0.01178	-0.05540	-0.00608
EGGUB	0.00513	0.07358	0.02727	0.04637	0.00185
EGPRO	0.03291	0.01137	0.02568	0.04698	0.01136
GOODY	0.03249	0.01195	0.03404	0.05754	0.00768
GUBRF	0.01833	0.01221	0.02176	0.13201	0.02161
HEKTS	0.06198	0.01178	0.05957	0.08408	0.00909
MRSHL	0.03873	0.02078	0.04352	0.00920	0.01148
PETKM	0.02565	0.00797	0.04345	0.06297	0.00366
PIMAS	0.02421	0.00719	0.02206	-0.00620	-0.00001
PTOFS	0.02415	0.01770	0.01785	-0.01606	-0.00586
SASA	0.01709	0.00864	0.02362	0.01405	0.02845
SODA	0.03704	0.01418	0.04874	0.09945	0.01791
TUPRS	0.01873	0.01706	0.01719	0.10095	0.20122

6. Distances from PIS and NIS are calculated with the help of equations (12) and (13) and shown in Table 10.

Table 10: Distances from PIS (d^+) and Distances from NIS (d^-)

Firms	d^+	d^-	Firms	d^+	d^-
AKSA	0.200	0.147	**GOODY**	0.222	0.119
ALKIM	0.197	0.139	**GUBRF**	0.202	0.190
AYGAZ	0.167	0.183	**HEKTS**	0.208	0.159
BAGFS	0.209	0.184	**MRSHL**	0.236	0.082
BRISA	0.145	0.167	**PETKM**	0.225	0.125
BRKSN	0.252	0.070	**PIMAS**	0.261	0.054
DEVA	0.253	0.067	**PTOFS**	0.270	0.045
DYOBY	0.297	0.013	**SASA**	0.230	0.079
EGGUB	0.230	0.123	**SODA**	0.199	0.164
EGPRO	0.225	0.108	**TUPRS**	0.097	0.260

7. Closeness coefficients (CC_i) of each alternative are calculated by the equation (14) and the alternatives are ranked according to their CC_i values.

Table 11: CC_i Values and Ranking Order of the Alternatives

	Firm	**CC_i**		**Firm**	**CC_i**
1	**TUPRS**	0.728	11	**GOODY**	0.349
2	**BRISA**	0.535	12	**EGGUB**	0.348
3	**AYGAZ**	0.522	13	**EGPRO**	0.326
4	**GUBRF**	0.485	14	**MRSHL**	0.259
5	**BAGFS**	0.467	15	**SASA**	0.257
6	**SODA**	0.452	16	**BRKSN**	0.217
7	**HEKTS**	0.433	17	**DEVA**	0.208
8	**AKSA**	0.423	18	**PIMAS**	0.171
9	**ALKIM**	0.413	19	**PTOFS**	0.144
10	**PETKM**	0.357	20	**DYOBY**	0.042

6. CONCLUSION

Investors, analysts and managers can evaluate the operations of a firm and analyze the firm's position within a sector over time by using financial ratios, but most of the time, ratio analysis is not sufficient by itself. Because firms' financial performance comparison results change according to the ratios taken. A firm may have superior performance for one ratio, but when the other ratio taken it may not show good performance. Because MCDM methods like AHP and TOPSIS provide DMs with more objective evaluation opportunities by combining different evaluation options in a common denominator; these integrated methods are used in this study and firms' performances are evaluated with these methods.

First the importance weights of main criteria are ranked with AHP and it is seen that the most important criteria are profitability ratios with 32.5% importance weight,; earning per share is ranked second with 24.2% importance weight; financial leverage ratios are ranked third with 17.5% importance weight; liquidity ratios are

ranked fourth with 14.1% importance weight, and activity ratios are ranked the last with 11.7% importance weight. As a result, ratios related with profitability are seen most important by DMs. By using financial ratios, TOPSIS method is used to rank the alternatives. The firms which have the best financial performances according to our analysis are TUPRS (0.728), BRISA (0.535), AYGAZ (0.522) respectively. DYOBY (0.042) has the worst performance. The firm which shows the best performance has high profitability, high earning per share and high inventory turnover ratios. But the firm's other ratios are at acceptable levels. The firms which have negative profitability ratios and earning per share are ranked at the last.

Performance ranking of the firms is affected by the researchers and DMs preferences. Because of this, evaluation of financial performance with these methods requires determination of DMs goals and priorities and main criteria and sub-criteria appropriate to the analysis.

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