

**Research Article**

**Fuzzy Based Approaches For Multi Period Financial Performance Evaluation of Turkish Retail Sector**

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**Abstract**

This study presents a hybrid fuzzy multi criteria decision making approach to evaluate multi period financial performance of Turkish retail sector. Financial performance criteria of companies have basically been used to evaluate the company's financial situation and performance. This study evaluates financial performance of Turkish retail companies with respect to seven years by using multi criteria decision making approaches. Fuzzy analytic hierarchy process (FAHP) is utilized for determining the importance weights of the financial performance criteria. Then rankings of the retail companies are evaluated by three different multi-criteria decision making methods; Vise Kriteriajumska Optimizacija I Kompromisno Resenje (VIKOR), Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) and Elimination Et Choix Traduisant la Realité (ELECTRE) approaches.

**Keywords:** Financial performance evaluation, Multi criteria decision-making (MCDM), Fuzzy AHP, Turkish retail sector.

**1. Introduction**

Retail sector is one of the leading sectors in Turkey which is dynamic trade area as an energy, education and health sector. Especially, Istanbul, Izmir, Ankara and Bursa are growing rapidly so then big retail companies are widespread in these cities in Turkey. Turkish retail sector has a positive development to attract domestic and foreign investment. In our country, the weight of retailing has seemed to increase paralleling to the trend in developed countries for the last 20 years (The Competition Authority 2012).

The financial performance and the financial ratios are used by organizations to evaluate their performance (Kızılkaya 2011). Performance evaluation is regarded as a multi-criteria decision making (MCDM) problem, which selects an option from a set of alternatives characterized in terms of their criteria (Baležentis *et al.* 2012; Zavadskas *et al.* 2014). MCDM aims to obtain the optimum choice that has the highest degree of satisfaction for all of the relevant criteria (Yang *et al.* 2007; Yalcin *et al.* 2012). The methodological framework of MCDM is well suited to the complex nature of financial decision making problems (Zavadskas, Turskis 2011). The MCDM paradigm provides in financial decision making, the possibility of structuring complex evaluation problems, the introduction of both quantitative (i.e. financial ratios) and qualitative criteria in the evaluation process, the transparency in the evaluation, allowing good argumentation in financial decisions, and the introduction of sophisticated, flexible and realistic scientific methods in the financial decision-making process. However, most important of all, MCDM enables the decision makers (DM) to participate actively in the financial decision-making process and supports him in understanding the peculiarities and the special features of the real-world problem that he faces (Zopounidis 1999; Zopounidi, Doumpos 2002).

Feng and Wang (2000) presented a performance evaluation process for airlines with financial ratios taken into consideration. While grey relation analysis is used to select the representative criteria, TOPSIS method is used for the outranking of airlines. Mercan *et al.* (2003) presented a financial performance index for commercial banks

using Data Envelopment Analysis (DEA) to select fundamental financial ratios using 1989–99 data from commercial banks in Turkey. Yurdakul and Ic (2004) proposed the TOPSIS method for the financial performance evaluation of the Turkish automotive companies. Wang (2008) applied fuzzy TOPSIS to evaluate financial performance of domestic airlines in Taiwan. Kung and Wen (2007) proposed grey relational analysis to evaluate the relationship between company attributes and its financial performance. They used six financial criteria to classify twenty items of financial ratios. Lee *et al.* (2008) proposed FAHP and balanced scorecard (BSC) hybrid approach for evaluating an information technology department in the manufacturing industry. Chen and Hung (2009) presented ELECTRE method in a stock portfolio selection problem. They aimed how to allocate the capital to a large number of stocks in order to bring a most profitable return for investors. Ertugrul and Karakasoglu (2009) presented FAHP and TOPSIS methods to evaluate the financial performance of Turkish cement companies. In their study, cement companies are evaluated by taking into considering only some of the traditional AFP measures. Yalcin *et al.* (2009) proposed a fuzzy performance evaluation model with both financial and non-financial performance criteria for Turkish commercial banks. They applied FAHP and TOPSIS for this evaluation. Wang (2009) presented combining grey relation analysis with fuzzy multi criteria group decision-making in order to evaluate financial performance of Taiwan container lines. Xidonasa *et al.* (2009) proposed the ELECTRE Tri outranking classification method for selecting the attractive equities, through the evaluation of the overall corporate performance of the corresponding companies. Halkos and Nickolaos (2012) presented an application of bootstrapped DEA to evaluate the performance of twenty three Greek manufacturing sectors with the use of financial data. Yalcin *et al.* (2012) evaluated financial performance of Turkish manufacturing companies by integrated FAHP, VIKOR and TOPSIS.

Kilic *et al.* (2015) proposed principal component analysis for corporate performance based on three main factors as financial performance, market performance and production performance. Return on assets (profit/total assets), general profitability of the firm, return on sales (profit/total sales) and cash flow excluding investments are determined as important financial performance variables. Cruz-González *et al.* (2015) evaluated financial measures, technological environmental dynamism, innovation strategy and technological diversification as critical variables in decision-making process. Farrokh *et al.* (2016) evaluated the financial performance of Iranian eight basic metals companies by using FAHP, VIKOR and TOPSIS depending on liquidity, financial leverage, profitability and growth ratios. Erdogan *et al.* (2016) compared the performance of twenty one food firms using BIST database for four years with respect to FAHP, TOPSIS, VIKOR and ELECTRE methods.

This study aims to present an approach for evaluating the financial performance of retail companies. Firstly, FAHP is utilized for determining the weights of the criteria and then ranking of the companies is determined by PROMETHEE, ELECTRE and VIKOR approaches. Financial measures of companies have basically been used to evaluate the company's financial situation and performance. Financial ratios of companies are computed between 2006 and 2012 from Borsa Istanbul (BIST) database.

The reminder of paper is organized as follows: In Section 2, financial performance criteria that are used in the performance evaluation of the retail companies are briefly explained. Section 3 presents the applied approaches. In Section 4, applications for financial performance evaluation of the retail companies are given. Finally, results of the applications and suggestions for further research are presented in conclusion section.

## 2. Financial Performance Criteria

In this study, decision makers determined ten different financial ratios in six separate groups representing liquidity, operation activity, capital intensity, leverage, solvency, profitability and equity productivity that are beneficial criteria for retail sector companies selected from BIST database. These performance measures are important for evaluation in the retail sector.

In the following, the criteria measures are explained briefly;

**Liquidity:** Liquidity ratios indicate a company's ability to meet its short-term obligation. To evaluate liquidity of retail companies, this study used *current ratio*, which is current asset to current liabilities, *currency ratio*, and a strict ratio to demonstrate power of paying short terms liabilities, *quick ratio*, and a ratio of quick assets to current liabilities (Youn and Gu 2010).

*Current ratio:* Current assets financial measure is divided by current liabilities (Baležentis *et al.* 2012).

*Currency ratio:* Cash and cash equivalents are divided by current liabilities and this ratio is calculated.

*Quick ratio:* Low liquid values as stocks, letters of credit are subtracted from current assets, and then this value is divided by current liabilities.

**Operation activity:** The ratios of this group are very crucial for the retail company's performance (Youn and Gu 2010).

*Accounts receivable turnover:* This is a ratio of credit sales to average accounts receivable, measuring the efficiency in the use of accounts receivable. Sales value is divided by average short term receivables. Short term

receivables are derived from average of beginning of the period and end of period value. (Beginning of the period value + end of period value) / 2 is the denominator value.

*Inventory turnover:* Inventory turnover, which is net sales income divided by average inventory, shows the efficiency in using inventory to generate sales. (Beginning of the stock value + end of stock value) / 2 is the denominator value. This ratio performs the rate of inventory transformation into cash. Greater value of this ratio is beneficial for retail companies like the other ratios except debt ratio.

**Capital intensity:** This ratio is an indicator of a company’s capital intensity or usage performance of assets. Lower value of this ratio signalizes high risk level in the sector (Bodie *et al.* 2004).

*Assets turnover ratio:* Ratio is calculated with the aid of dividing by net sales value to current liabilities value. This ratio measures the efficiency of a company's use of its assets in generating sales revenue or sales income to the company.

**Financial leverage:** Leverage ratio measure the extent to which a company is relying upon debt (Baležentis *et al.* 2012). Highly leveraged companies are more vulnerable to failure, especially when a financial shock occurs. The leverage ratio is a measure of the percentage of debt in total capitalization (Bodie *et al.* 2004).

*Debt ratio:* Debt ratio, which is total liabilities to equity capital, was used in this study to assess indebtedness of the retail companies. Short-term and long-term liabilities are taken into account in this ratio.

**Profitability:** In the performance evaluation, profitability is the other important criteria for the financial performance (Yalcin *et al.* 2012).

*Earnings per share:* A good way to determine whether a company is growing is to look at their earnings per share compared to previous years. This ratio is period net income/loss to paid capital. Earnings per share serve as an indicator of a company's profitability.

*Return on equity capital:* It performs the percentage of profit earned on common stockholders’ investment in the companies. This ratio is useful for comparing the profitability of a company to that of other companies in the same industry. Profit before tax (accounting profit) is divided by equity capital, and then the ratio value acquired.

**Equity productivity:** It analyzes efficiency of equity capital usage of the companies in the same sector (Turkish Capital Markets Association 2012).

*Equity capital turnover:* A measure indicating how effectively investment capital is used to produce revenues. Capital turnover is expressed as a ratio of annual sales to equity capital.

### 3. The mathematical approaches

The main objective of this paper is to evaluate the best company of the Turkish retail sector. For this purpose, we use FAHP to determine the weights of all criteria, and then choose the best company in Turkish retail sector by VIKOR, PROMETHEE, and ELECTRE approaches with respect seven years. In this section, the basic definitions and steps of the applied approaches are presented.

#### 3.1. Fuzzy analytic hierarchy process

In this study, the weights of the financial performance criteria are obtained by using Buckley’s (Buckley 1985) extension FAHP approach since it is easy to extend to the fuzzy case and guarantees a unique solution to the reciprocal comparison matrix and the steps of this approach are relatively easier than the other FAHP approaches. The steps used for the Buckley’s FAHP algorithm can be summarized as follows (Buckley 1985; Demirel *et al.* 2008; Kaya and Kahraman 2011; Gumus *et al.* 2013).

Calculation of the triangular fuzzy numbers; fuzzy addition, multiplication, subtraction, division and reciprocal of a fuzzy number is calculated by the rules (Hsieh *et al.* 2004);

**Step 1** Construct pairwise comparison matrices among all the criteria in the hierarchical structure (equation 1) using linguistic term shown in Table 1.

Table 1. Memberships function of linguistic scale

Linguistic variables	Triangular fuzzy number	Triangular fuzzy reciprocal number
Equally important (Eq)	(1, 1, 3)	(1/3, 1, 1)
Weakly important (Wk)	(1, 3, 5)	(1/5, 1/3, 1)
Essentially important (Es)	(3, 5, 7)	(1/7, 1/5, 1/3)
Very strongly important (Vs)	(5, 7, 9)	(1/9, 1/7, 1/5)

<b>Absolutely important (Ab)</b>	(7, 9, 9)	(1/9, 1/9, 1/7)
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Assign linguistic terms shown in equation (2), to the pair wise comparisons by asking which is the more important of each two criteria, such as

$$M = \begin{pmatrix} 1 & a_{12} & a_{1n} \\ a_{21} & 1 & a_{2n} \\ a_{n1} & a_{n2} & 1 \end{pmatrix} = \begin{pmatrix} 1 & a_{12} & a_{1n} \\ 1/a_{21} & 1 & a_{2n} \\ 1/a_{n1} & a_{n2} & 1 \end{pmatrix} \quad (1)$$

Where

$$a_{ij} = \begin{cases} 1, 3, 5, 7, 9 & \text{criterion } i \text{ has relative} \\ & \text{importance to criterion } j \\ 1 & i = j \\ 1^{-1}, 3^{-1}, 5^{-1}, 7^{-1}, 9^{-1} & \text{criterion } i \text{ has less} \\ & \text{importance to criterion } j \end{cases} \quad (2)$$

**Step 2** Use geometric mean technique to define the fuzzy geometric mean as follows:

$$r_i = (a_{i1} \otimes a_{i2} \otimes \dots \otimes a_{in})^{1/n} \quad (3)$$

where  $a_{in}$  is fuzzy comparison value of criterion  $i$  to criterion  $n$ , thus, is geometric mean of fuzzy comparison value of criterion  $i$  to each criterion.

**Step 3** Calculate the fuzzy weights of each criterion using

$$w_i = r_i \otimes (r_1 \oplus r_2 \oplus \dots \oplus r_n)^{-1} \quad (4)$$

where  $w_i$  is the fuzzy weight of the  $i$ th criterion, can be indicated by  $w_i = (lw_i, mw_i, uw_i)$ . Here  $lw_i, mw_i, uw_i$  and stand for the lower, middle and upper values of the fuzzy weight of the  $i$ th criterion.

**Step 4** Utilize center of area (COA) method to find out the best nonfuzzy performance (BNP) value (crisp weights) of each criterion by the following equation:

$$BNPw_i = [(uw_i - lw_i) + (mw_i - lw_i)] / 3 + lw_i \quad (5)$$

According to the value of the derived BNP for each of the alternatives, the ranking of the each alternative can then proceed.

### 3.2. VIKOR approach

The VIKOR approach is introduced by Yu (1973) and Zeleny (1982). This approach is based on an aggregating function representing closeness to the reference point(s). The VIKOR approach is introduced an aggregating function, representing the distance from the ideal solution by Yalcin *et al.* (2012). A comprehensive review of VIKOR is proposed by Gul *et al.* (2016). The main steps of the VIKOR approach are described as follows:

**Step 1** Determine the best  $f_i^*$  and the worst  $f_i^-$  value of all criterion functions assuming that  $i$ th function represents a benefit:

$$f_i^* = \max_j f_{ij} \quad f_i^- = \min_j f_{ij} \quad (6)$$

**Step 2** Compute the values  $S_j$  and  $R_j$ ;  $j = 1, \dots, J$ , by the relations

$$S_j = \sum_{i=1}^n w_i (f_i^* - f_{ij}) / (f_i^* - f_i^-) \quad (7)$$

$$R_j = \max [w_i (f_i^* - f_{ij}) / (f_i^* - f_i^-)] \quad (8)$$

where  $w_i$  are the weights of criteria, expressing their relative importance.

**Step 3** Compute the values,  $Q_j$   $j = 1, \dots, J$ , by the relation

$$Q_j = \nu(S_j - S^*) / (S^- - S^*) + (1 - \nu)(R_j - R^*) / (R^- - R^*) \quad (9)$$

where  $S^* = \min_j S_j$ ;  $S^- = \max_j S_j$  and  $R^* = \min_j R_j$ ;  $R^- = \max_j R_j$

$\nu$  is introduced as weight of the strategy of “the majority of criteria” (or “the maximum group utility”) and usually  $\nu = 0.5$ .

**Step 4** Rank the alternatives, sorting by the values  $S$ ,  $R$  and  $Q$ , in decreasing order. The results are three ranking lists.

**Step 5** Propose as a compromise solution, for given criteria weights, the alternative ( $a'$ ), which is the best ranked by the measure  $Q$  if the following two conditions are satisfied:

C1. “Acceptable advantage”:  $Q(a'') - Q(a') \geq DQ$ , where  $a''$  is the alternative with second position in the ranking list by  $Q$ ;  $DQ = 1/(J-1)$ ;  $J$  is the number of alternatives.

C2. “Acceptable stability in decision making”: Alternative  $a'$  must also be the best ranked by  $S$  or/and  $R$ . This compromise solution is stable within a decision making process, which could be: “voting by majority rule” (when  $\nu > 0,5$  is needed), or “by consensus”  $\nu \approx 0,5$ , or “with veto” ( $\nu < 0,5$ ). Here,  $\nu$  is the weight of the decision making strategy “the majority of criteria” (or “the maximum group utility”). If one of the conditions is not satisfied, then the set of compromise solutions is proposed, which consists of:

Alternatives  $a'$  and  $a''$  if only the conditions C2 are not satisfied.

Alternatives  $a'$ ;  $a''$ ; ... ;  $a^{(k)}$  if the conditions C1 are not satisfied,

$a^{(k)}$  is determined by the relation  $Q(a^{(k)}) - Q(a') \approx DQ$ , the positions of these alternatives are “in closeness”.

### 3.3. PROMETHEE approach

PROMETHEE is an outranking approach which initial references are prepared by Brans *et al.* (1984), Brans and Vincke (1985), and Brans *et al.* (1986). The evaluation of alternatives with PROMETHEE is required two additional types of information (Tuzkaya *et al.* 2010).

- Information on the relative importance (i.e. the weights) of the criteria considered.
- Information on the decision-makers’ preference function, which he/she uses when comparing the contribution of the alternatives in terms of each separate criterion.

The basic steps of the PROMETHEE algorithm can be outlined as follows (Dagdeviren 2008; Tuzkaya *et al.* 2010; Bölükbaş *et al.*, 2012).

**Step 1** Specify a generalized preference function  $p_j(d)$  for each criterion  $j$ .

**Step 2** Define a vector containing the weights, which are a measure for the relative importance of each criterion,  $w^T = [1, \dots, w_k]$  If all the criteria are of the same importance in the opinion of the decision maker, all weights can be taken as being equal.

**Step 3** Define for all the alternatives  $a_i, b_i \in A$  the outranking relation  $\pi$  :

$$\pi : \begin{cases} A \times A \rightarrow [0,1] \\ \pi(a_i, b_i) = \sum_{k=1}^K w_k (p_k(f_k(a_i) - f_k(b_i))) \end{cases} \quad (10)$$

The preference index  $\pi(a_i, b_i)$  is a measure for the intensity of preference of the decision maker for an alternative  $a_i$  in comparison with an alternative  $b_i$  for the simultaneous consideration of all criteria. It is basically a weighted average of the preference functions  $p_k(d)$  and can be represented as a valued outranking graph.

**Step 4** As a measure for the strength of alternatives  $a_i \in A$ , the leaving flow is calculated:

$$\Phi^+(a_i) = \frac{1}{T-1} \sum_{\substack{t=1 \\ t \neq i}}^n \pi(a_i, b_t) \quad (11)$$

The leaving flow is the sum of the values of the arcs which leave node  $a_i$  and therefore yields a measure of the “outranking character” of  $a_i$ .

**Step 5** As a measure for the weakness of the alternatives  $a_i \in A$ , the entering flow is calculated, measuring the “outranked character” of  $a_i$  (analogously to the leaving flow):

$$\Phi^-(a_i) = \frac{1}{T-1} \sum_{\substack{t=1 \\ t \neq i}}^n \pi(b_t, a_i) \quad (12)$$

**Step 6** A graphical evaluation of the outranking relation is derived: Basically, the higher the leaving flow and the lower the entering flow, the better the action. This result is graphically represented by a partial preorder (PROMETHEE I) or a complete preorder (PROMETHEE II).

In PROMETHEE I, alternative  $a_i$  is preferred to alternative  $b_i$  ( $a_i P b_i$ ) at least one of the elements of equation (13) is satisfied (Dagdeviren 2008):

$$\begin{aligned}
 a_i P b_i \text{ if: } & \Phi^+(a_i) > \Phi^+(b_i) \text{ and } \Phi^-(b_i) < \Phi^-(a_i) \text{ or} \\
 & \Phi^+(a_i) > \Phi^+(b_i) \text{ and } \Phi^-(b_i) = \Phi^-(a_i) \text{ or} \\
 & \Phi^+(a_i) = \Phi^+(b_i) \text{ and } \Phi^-(b_i) < \Phi^-(a_i).
 \end{aligned}
 \tag{13}$$

PROMETHEE I evaluation allows indifference and incomparability situations. Therefore sometimes partial rankings can be obtained. In the indifference situation ( $a_i I b_i$ ), two alternatives  $a_i$  and  $b_i$  have the same leaving and entering flows:

$$a_i I b_i \text{ if: } \Phi^+(a_i) = \Phi^+(b_i) \text{ and } \Phi^-(b_i) = \Phi^-(a_i)
 \tag{14}$$

Two alternatives are considered incomparable,  $a_i R a_i$ , if alternative  $a_i$  is better than alternative  $a_i$  in terms of leaving flow, while the entering flows indicate the reverse:

$$\begin{aligned}
 a_i R b_i \text{ if: } & \Phi^+(a_i) > \Phi^+(b_i) \text{ and } \Phi^-(b_i) < \Phi^-(a_i) \text{ or} \\
 & \Phi^+(a_i) < \Phi^+(b_i) \text{ and } \Phi^-(b_i) < \Phi^-(a_i)
 \end{aligned}
 \tag{15}$$

Via PROMETHEE II, the complete ranking can be obtained. For the complete ranking calculations, net flow values of alternatives can be calculated as equation (16). Here, if alternative  $a_i$ 's net flow is bigger than alternative  $b_i$ 's net flow, this indicates that, alternative  $a_i$  outranks alternative  $b_i$

$$\Phi^{net}(a_i) = \Phi^+(a_i) - \Phi^-(a_i)
 \tag{16}$$

Type 6: Gaussian criteria:

$$p(x) = \begin{cases} 0, & x \leq 0 \\ 1 - e^{-x^2/2\sigma^2} & x \geq 0 \end{cases}
 \tag{17}$$

If a particular criterion is of the Gaussian type, the preference of the decision-maker still grows with the deviation  $x$ . The value of  $\sigma$  may be easily fixed according to the experience obtained with the normal distribution in statistics (Kalogeras *et al.* 2005).

### 3.4. ELECTRE approach

The ELECTRE approach was first introduced by Benayoun *et al.* (1966). The basic concept of the ELECTRE approach is to deal with "outranking relations" by using pair wise comparisons among alternatives under each one of the criteria separately (Figueira *et al.* 2005; Sevkli 2010; Kaya, Kahraman 2011).

**Step 1** Define a decision matrix ( $A_{ij}$ ) containing the alternatives and criteria.

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}
 \tag{18}$$

**Step 2** Normalized decision matrix is calculated which equation (19) is used and normalized X matrix is obtained.

$$x_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^m a_{kj}^2}} \quad X_{ij} = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix}
 \tag{19}$$

**Step 3** Weighted decision matrix  $Y_{ij}$  is calculated which weighted of criteria is defined.

**Step 4** Set of Concordance and discordance index is defined which based on comparing the alternatives.  $k$  and  $l$  index must not be equal  $k \neq l$ .

$$C_{kl} = \{j, y_{kj} \geq y_{lj}\} \tag{20}$$

$$D_{kl} = \{j, y_{kj} < y_{lj}\} \tag{21}$$

**Step 5** Concordance and discordance index is calculated.

$$C_{kl} = \sum_j w_j \tag{22}$$

$$D_{kl} = \frac{\sum_{j=0} |v_{kj^0} - v_{lj^0}|}{\sum_j |v_{kj} - v_{lj}|} \tag{23}$$

$C_{kl}$  is sum of weighted which is contained concordance matrix. Average value of  $\bar{C}$  and  $\bar{D}$  is calculated. If  $C_{kl} \geq \bar{C}$  and  $D_{kl} \leq \bar{D}$  the alternative k ( $A_l$ ) is superior than alternative l ( $A_l$ ) ( $A_l$ )  $\rightarrow$  ( $A_l$ ).

**Step 6** Rank the alternatives which the net concordance ( $C_p$ ) and discordance ( $D_p$ ) index is calculated.

$$C_p = \sum_{k=1}^m C_{pk} - \sum_{k=1}^m C_{kp} \quad D_p = \sum_{k=1}^m D_{pk} - \sum_{k=1}^m D_{kp} \tag{24}$$

#### 4. A real case application of Turkish retail sector

This study aims to evaluate financial performance of Turkish retail companies with respect to seven years by using MCDM approaches. The weight of the criteria is obtained by using FAHP, firstly. PROMETHEE, ELECTRE and VIKOR approaches determined the ranking of the companies.

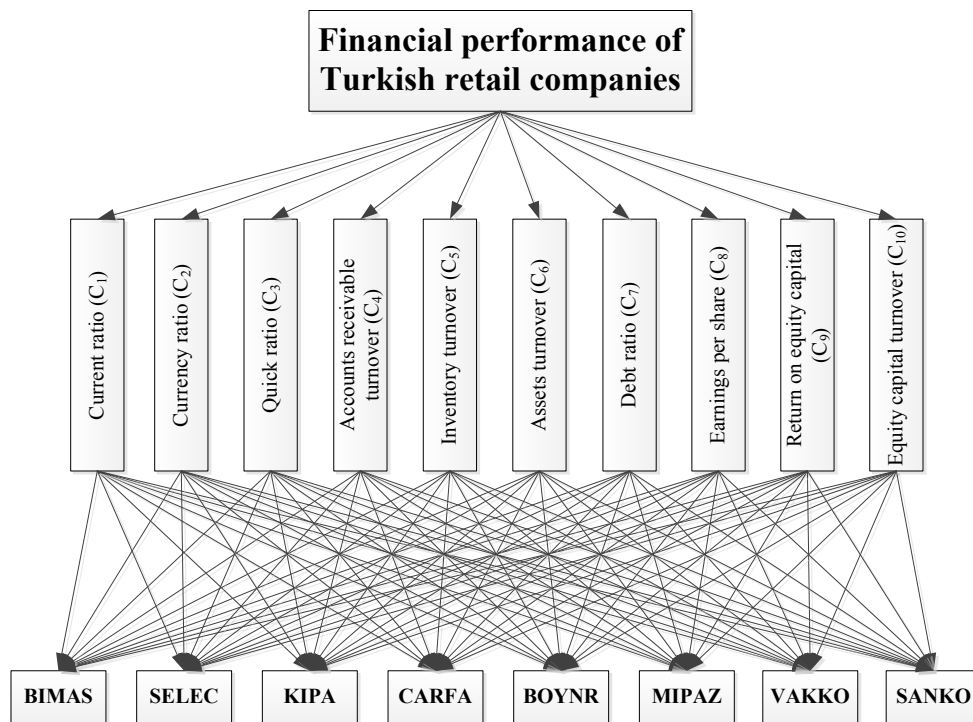


Fig. 1. The hierarchical structure

The hierarchical structure of financial performance evaluation criteria for Turkish retail companies is presented in Figure 1.

##### 4.1. The importance weights of the evaluation criteria

FAHP approach is used to determine the weightings for evaluation criteria among three different decision makers. In this study, Buckley’s extension is applied to hierarchical analysis by allowing fuzzy numbers for the pairwise comparisons. In this part, we shortly review concepts and calculation for fuzzy hierarchical evaluation. Buckley extended Saaty’s AHP to the case where the evaluators are allowed to employ fuzzy ratios in place of exact ratios to handle the difficulty for people to assign exact ratios when comparing two criteria and derive the fuzzy weights of criteria by geometric mean approach (Buckley 1985). Table 2 presents the pair wise comparison matrix according to the three experts’ group decisions.

Table 2. Pairwise comparisons of financial performance evaluation criteria

Criteria	Current ratio	Currency ratio	Quick ratio	Accounts receivable turnover	Inventory turnover	Assets turnover	Debt ratio	Earnings per share	Return on equity capital	Equity capital turnover
Current ratio (C <sub>1</sub> )	Eq	Wk	1/Wk	1/Ab	1/Ab	1/Wk	1/Es	1/Vs	1/Es	1/Wk
Currency ratio (C <sub>2</sub> )	1/Wk	Eq	1/Wk	1/Ab	1/Ab	1/Wk	1/Wk	1/Es	1/Es	1/Wk
Quick ratio (C <sub>3</sub> )	Wk	Wk	Eq	1/Es	1/Es	1/Eq	1/Wk	1/Es	1/Es	1/Wk
Accounts receivable turnover (C <sub>4</sub> )	Ab	Ab	Es	Eq	1/Eq	Es	Wk	Wk	Wk	Es
Inventory turnover (C <sub>5</sub> )	Ab	Ab	Es	Eq	Eq	Es	Es	Wk	Wk	Wk
Assets turnover (C <sub>6</sub> )	Wk	Wk	Eq	1/Es	1/Es	Eq	1/Wk	1/Wk	1/Wk	1/Wk
Debt ratio (C <sub>7</sub> )	Es	Wk	Wk	1/Wk	1/Es	Wk	Eq	1/Wk	1/Wk	1/Eq
Earnings per share (C <sub>8</sub> )	Vs	Es	Es	1/Wk	1/Wk	Wk	Wk	Eq	Wk	Wk
Return on equity capital (C <sub>9</sub> )	Es	Es	Es	1/Wk	1/Wk	Wk	Wk	1/Wk	Eq	Wk
Equity capital turnover (C <sub>10</sub> )	Wk	Wk	Wk	1/Es	1/Wk	Wk	Eq	1/Wk	1/Wk	Eq

Then, the fuzzy evaluation matrix for determining the importance weights of the financial performance criteria is obtained using Table 1 and Table 2 and the results are presented in Table 3.

Table 3. Fuzzy evaluation of financial performance criteria

	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>
C <sub>1</sub>	(1, 1, 1)	(1, 3, 5)	(0.2, 0.33, 1)	(0.11, 0.11, 0.14)	(0.11, 0.11, 0.14)
C <sub>2</sub>	(0.2, 0.33, 1)	(1, 1, 1)	(0.2, 0.33, 1)	(0.11, 0.11, 0.14)	(0.11, 0.11, 0.14)
C <sub>3</sub>	(1, 3, 5)	(1, 3, 5)	(1, 1, 1)	(0.14, 0.2, 0.3)	(0.14, 0.2, 0.33)
C <sub>4</sub>	(7, 9, 9)	(7, 9, 9)	(3, 5, 7)	(1, 1, 1)	(0.33, 1, 1)
C <sub>5</sub>	(7, 9, 9)	(7, 9, 9)	(3, 5, 7)	(1, 1, 3)	(1, 1, 1)
C <sub>6</sub>	(1, 3, 5)	(1, 3, 5)	(1, 1, 3)	(0.14, 0.2, 0.33)	(0.14, 0.2, 0.33)
C <sub>7</sub>	(3, 5, 7)	(1, 3, 5)	(1, 3, 5)	(0.2, 0.33, 1)	(0.14, 0.2, 0.33)
C <sub>8</sub>	(5, 7, 9)	(3, 5, 7)	(3, 5, 7)	(0.2, 0.33, 1)	(0.2, 0.33, 1)
C <sub>9</sub>	(3, 5, 7)	(3, 5, 7)	(3, 5, 7)	(0.2, 0.33, 1)	(0.2, 0.33, 1)
C <sub>10</sub>	(1, 3, 5)	(1, 3, 5)	(1, 3, 5)	(0.14, 0.2, 0.33)	(0.2, 0.33, 1)
	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>	C <sub>9</sub>	C <sub>10</sub>
C <sub>1</sub>	(0.2, 0.33, 1)	(0.14, 0.2, 0.33)	(0.11, 0.14, 0.2)	(0.14, 0.2, 0.33)	(0.2, 0.33, 1)
C <sub>2</sub>	(0.2, 0.33, 1)	(0.2, 0.33, 1)	(0.14, 0.2, 0.33)	(0.14, 0.2, 0.33)	(0.2, 0.33, 1)
C <sub>3</sub>	(0.33, 1, 1)	(0.2, 0.33, 1)	(0.14, 0.2, 0.33)	(0.14, 0.2, 0.33)	(0.2, 0.33, 1)
C <sub>4</sub>	(3, 5, 7)	(1, 3, 5)	(1, 3, 5)	(1, 3, 5)	(3, 5, 7)
C <sub>5</sub>	(3, 5, 7)	(3, 5, 7)	(1, 3, 5)	(1, 3, 5)	(1, 3, 5)
C <sub>6</sub>	(1, 1, 1)	(0.2, 0.33, 1)	(0.2, 0.33, 1)	(0.2, 0.33, 1)	(0.2, 0.33, 1)
C <sub>7</sub>	(1, 3, 5)	(1, 1, 1)	(0.2, 0.33, 1)	(0.2, 0.33, 1)	(0.33, 1, 1)
C <sub>8</sub>	(1, 3, 5)	(1, 3, 5)	(1, 1, 1)	(1, 3, 5)	(1, 3, 5)
C <sub>9</sub>	(1, 3, 5)	(1, 3, 5)	(0.2, 0.33, 1)	(1, 1, 1)	(1, 3, 5)
C <sub>10</sub>	(1, 3, 5)	(1, 1, 3)	(0.2, 0.33, 1)	(0.2, 0.33, 1)	(1, 1, 1)

Then, the fuzzy geometric mean is calculated using equation (3). For example, in order to use equation (4),  $r_1 = (a_{11} \cdot x_{a_{12}} \cdot x_{a_{13}} \cdot x_{a_{14}} \cdot x_{a_{15}} \cdot x_{a_{16}} \cdot x_{a_{17}} \cdot x_{a_{18}} \cdot x_{a_{19}} \cdot a_{110})^{1/10}$ , to obtain the fuzzy weights of criteria and it is shown in Table 4. Likewise, we can obtain the remaining,  $r_i (r_1, r_2 \dots r_{10})$ , line value of the final comparison matrix. For the weight of each criterion, they can be done as follows:  $W_i$  is the fuzzy weight of the  $i$ th criterion, can be demonstrated by a TFN,  $W_i = (Lw_i, Mw_i, Uw_i)$ . Here  $Lw_i$ ,  $Mw_i$  and  $Uw_i$  stand for the lower, middle and upper values of the fuzzy weight of the  $i$ th criterion. Inverse matrix used in the formula above  $r^{-1} = (0.044, 0.07, 0.13)$  is built up.

Table 4. Aggregate and inverse matrix

Criteria	Geometric Mean
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C <sub>1</sub>	(0.216, 0.309, 0.540)
C <sub>2</sub>	(0.195, 0.270, 0.540)
C <sub>3</sub>	(0.298, 0.525, 0.890)
C <sub>4</sub>	(1.838, 3.497, 4.510)
C <sub>5</sub>	(2.052, 3.497, 5.030)
C <sub>6</sub>	(0.356, 0.582, 1.240)
C <sub>7</sub>	(0.508, 1.000, 1.760)
C <sub>8</sub>	(1.061, 2.088, 3.500)
C <sub>9</sub>	(0.858, 1.621, 2.910)
C <sub>10</sub>	(0.508, 0.950, 1.900)
Sum Matrix	(7.890, 14.338, 22.830)
Inverse Matrix	(0.044, 0.070, 0.130)

Likewise, we can obtain the remaining,  $w_i = (w_1, w_2, w_3, w_4, w_5, w_6, w_7, w_8, w_9, w_{10})$ , criteria weights in the application. For the consistency of the fuzzy pair-wise comparison matrices, we used defuzzification technique to convert the fuzzy numbers into crisp numbers. The most common used approaches for the defuzzification are Mean-of-Maximum, Center-of-Area, and Alpha-cut Method (Zhao, Govind 1991). Best Nonfuzzy Performance (BNP) values are used to determine the criteria weightings. In this study, we utilized the Center-of-Area method owing to its calculation easiness.

Table 5. Determining the weights of criteria in FAHP approach

Criteria	Geometric Mean	Fuzzy Rating	Criteria weight	Normalized weights %
C <sub>1</sub>	(0.216, 0.309, 0.54)	(0.009, 0.022, 0.07)	0.0333	% 2.36 (9)
C <sub>2</sub>	(0.195, 0.27, 0.54)	(0.009, 0.019, 0.07)	0.0321	% 2.27 (10)
C <sub>3</sub>	(0.298, 0.525, 0.89)	(0.013, 0.037, 0.11)	0.0541	% 3.83 (8)
C <sub>4</sub>	(1.838, 3.497, 4.51)	(0.081, 0.244, 0.57)	0.2986	% 21.14 (2)
C <sub>5</sub>	(2.052, 3.497, 5.03)	(0.09, 0.244, 0.64)	0.3239	% 22.92 (1)
C <sub>6</sub>	(0.356, 0.582, 1.24)	(0.016, 0.041, 0.16)	0.0709	% 5.02 (7)
C <sub>7</sub>	(0.508, 1, 1.76)	(0.022, 0.07, 0.22)	0.1052	% 7.44 (6)
C <sub>8</sub>	(1.061, 2.088, 3.5)	(0.046, 0.146, 0.44)	0.2119	% 15 (3)
C <sub>9</sub>	(0.858, 1.621, 2.91)	(0.038, 0.113, 0.37)	0.173	% 12.24 (4)
C <sub>10</sub>	(0.508, 0.95, 1.9)	(0.022, 0.066, 0.24)	0.1099	% 7.78 (5)

Fuzzy weights of criteria used in the approaches for sorting companies are presented in Table 5. According to FAHP, accounts receivable turnover and inventory turnover are determined as the highest importance weight for financial performance evaluation of retail companies based on expert decision. The other important criteria are earnings per share and return on equity capital. Besides the financial ratios, the decision makers' priorities are also affected the ranking of the companies. If there will be a difference in the priority of the decision makers, the ranking may change. For this reason decision maker should know his priority properly and then determine the weights of the criteria.

#### 4.2. Ranking the companies by the approaches

Eight retail companies called BIMAS, SELEC, KIPA, CARFA, BOYNR, MIPAZ, VAKKO and SANKO from BIST are evaluated in this application. *BIMAS* first opened the doors in 1995 with 21 stores. Its main principle is to offer consumers basic food items and consumer goods at the best prices and highest quality. BIM, pioneer of the hard-discount model in Turkey, limits its product portfolio to approximately 600 items and aims at having diverse private label products. By the end of 2013 BIM reached 4000 stores in Turkey with the opening of four new regional offices and 345 new stores during the year.

SELEC started its operations 50 years ago, 35-year-old Turkey was a young Republic readily willing to develop and progress. In Turkey, in 1958, there were a lot of shortcomings in the healthcare industry such as doctors, pharmacies, drugs, and drug distribution. In a very short time, it became the first pharmaceutical distributor with a multi branch operation by opening offices first in Istanbul, then in Adana. SELEC started a future-focused organization in the early 2000s, and closely monitored, adopted, and even went beyond the developments experienced in pharmaceutical distributors in modern countries.

KIPA is a retail company which is founded with 100 businessmen's initiative in Izmir, a historic commercial center, in 1992. It is one of the largest employers in the retail sector in Turkey employs a total of 9,600 people.

CARFA has formed the basis of modern retailing in the world since 1963. CARFA established by Sabancı cooperation in 1996, in Istanbul. The company has Europe's best retail chains. The company employs 8000 people with 243 stores which is operating in the hypermarket and supermarket format in Turkey.

BOYNR is a member of one of the leading non-food retail groups in Turkey, it commenced commercial operations in the year 1981. The company employs 5200 people with 139 stores through 28 cities of Turkey. There are different products in BOYNR Stores; world-renowned brands, ranging from home textiles to bathroom fittings, kitchen appliances to table accessories, decorative items and gift products and functional electrical goods are available.

MIPAZ was founded in 1980 as a member of the Dogan group of companies. MIPAZ has a leading position within the media marketing companies. The Company delivered various products from the computer to the mobile phone and electronics to white goods to the costumers.

VAKKO is a Turkish fashion company, one of the leading fashion houses in the country. It mostly produces luxury textile and leather goods and accessories. The first Vakko fashion store opened in 1962 in İstanbul. The company has more than one hundred stores, today all over Turkey.

SANKO diversified its operations from textile to other industries and thanks to sound management decisions, became the giant Holding company that it is today. It is home to over 14,000 employees with internationally renowned companies in textiles, energy production, construction and construction machinery, packaging, finance, information technology, shopping-mall investment and management, health, and education.

Values of ten ratios explained briefly above are derived from the balance sheets and detailed income statements of the companies from consecutive seven years between 2006 and 2012. Multi period financial evaluation procedure utilizes FAHP approach in combination with multi criteria making approaches as VIKOR, PROMETHEE and ELECTRE. The results of three approaches are presented in Table 6, Table 7 and Table 8, respectively.

According to the result of the VIKOR approach, BIMAS has the highest financial performance. SANKO is also at the second position for seven years. On the other hand MIPAZ has the lowest financial performance except for 2006. The results are presented in Table 6 and graphically in Figure 2.

Table 6. Results of the performance evaluation via VIKOR approach.

	2006	2007	2008	2009	2010	2011	2012
<b>BIMAS</b>	0.000	0.000	0.000	0.030	0.000	0.000	0.238
<b>SELEC</b>	0.663	0.589	0.626	0.548	0.566	0.654	0.780
<b>KIPA</b>	0.396	0.495	0.492	0.506	0.519	0.621	0.782
<b>CARFA</b>	0.553	0.437	0.289	0.603	0.595	0.604	0.656
<b>BOYNR</b>	0.848	0.638	0.702	0.699	0.720	0.695	0.360
<b>MIPAZ</b>	0.790	1.000	1.000	1.000	1.000	1.000	1.000
<b>VAKKO</b>	0.759	0.579	0.802	0.800	0.801	0.814	0.811
<b>SANKO</b>	0.291	0.265	0.229	0.117	0.376	0.343	0.248

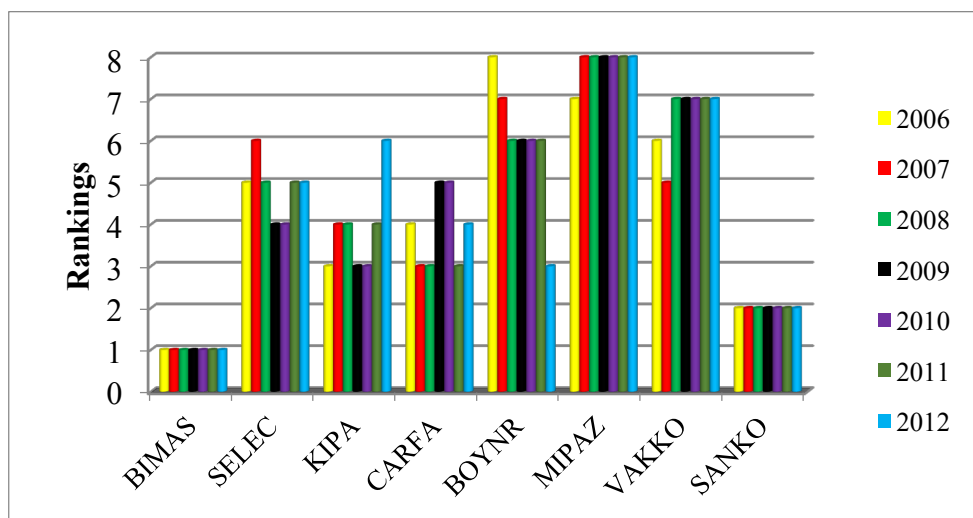


Fig. 2. Comparison of the retail companies by the VIKOR.

BIMAS has the highest financial performance with respect to PROMETHEE approach. SANKO is the second company for six years by evaluation of PROMETHEE. SANKO is the third position in retail sector due to the economic crisis in 2008. Besides, MIPAZ has the lowest financial performance except for 2006. The results are presented in Table 7 and graphically in Figure 3. The same results for BIMAS and MIPAZ are obtained by PROMETHEE approach.

Table 7. Results of the performance evaluation via PROMETHEE approach.

FIRMS	2006	2007	2008	2009	2010	2011	2012
BIMAS	0.349	0.305	0.349	0.362	0.395	0.444	0.453
SELEC	-0.060	-0.094	-0.124	-0.028	-0.015	-0.076	-0.081
KIPA	0.077	-0.072	0.018	0.088	0.073	-0.065	-0.180
CARFA	-0.218	-0.127	0.165	-0.168	-0.159	-0.125	-0.028
BOYNR	-0.034	0.016	-0.067	-0.015	-0.026	0.013	0.052
MIPAZ	-0.190	-0.239	-0.283	-0.269	-0.283	-0.244	-0.297
VAKKO	-0.131	0.051	-0.207	-0.142	-0.152	-0.141	-0.090
SANKO	0.207	0.160	0.150	0.172	0.166	0.194	0.170

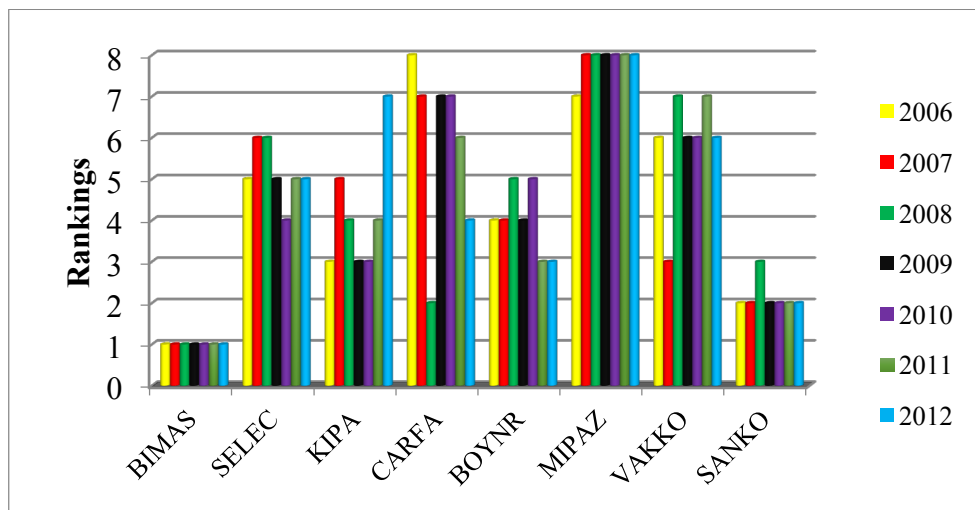


Fig. 3. Comparison of the retail companies by the PROMETHEE.

According to the result of the ELECTRE approach, BIMAS has the best position with respect to financial performance for seven years as obtained by VIKOR and PROMETHEE. SANKO is also second position for six years except 2008. MIPAZ has the last position in financial performance according to ELECTRE approach (Table 8).

Table 8. Results of the performance evaluation via ELECTRE approach

FIRMS	2006	2007	2008	2009	2010	2011	2012
BIMAS	9.563	9.332	8.870	9.553	9.801	10.257	10.060
SELEC	-0.908	-2.800	-2.328	1.696	1.128	0.157	-0.905
KIPA	5.370	-0.519	1.848	3.306	3.023	-0.298	-4.249
CARFA	-6.154	-0.492	5.835	-4.119	-3.045	-2.412	-0.887
BOYNR	-0.780	0.383	-0.798	0.755	0.090	2.140	4.803
MIPAZ	-7.394	-11.698	-12.261	-11.274	-11.762	-10.667	-10.632
VAKKO	-5.254	1.734	-6.398	-4.702	-3.579	-4.813	-3.242
SANKO	5.558	4.061	5.231	4.784	4.344	5.636	5.053

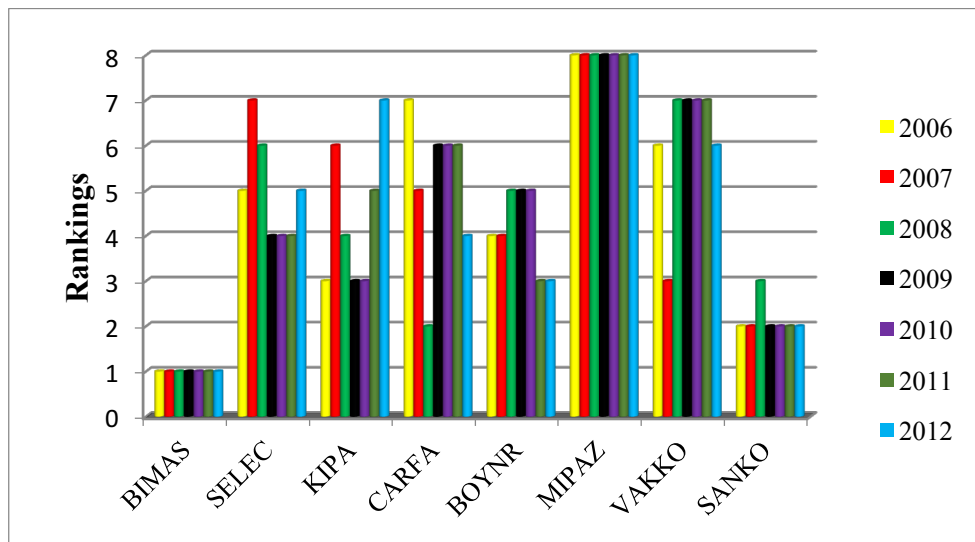


Fig. 4. Comparison of the retail companies by the ELECTRE.

If we make an overall assessment for companies' financial performance on the basis of seven years, BIMAS has the best level for overall performance evaluation by the three different approaches. SANKO is the second successful company according to three different approaches according to the seven years. Greater value of this ratio is beneficial for the companies. High inventory turnover rate has a critical importance for obtaining better financial performance in this sector. BIMAS shows the efficiency in using inventory to generate sales and has very good inventory turnover rate for each year. Generally a high value of accounts receivable turnover is favorable and lower figure may indicate inefficiency in collecting outstanding sales. Hence Retailer Company has to improve this ratio. BIMAS and SANKO has also high rate with respect to this financial performance criteria. Earnings per share ratio is another important financial performance criterion for indicating company strength. It is also considered as the one of the most important financial performance criterion to determine company's profitability. According to the data between 2006 and 2012, BIMAS and SANKO have respectable performance. MIPAZ is determined as the lowest financial performance evaluation. It has to improve financial performance criteria. VAKKO has the second worst financial performance after the last company for overall results of the approaches.

Other four retail companies, BOYNER, CARFA, KIPA and SELEC, have different rankings for financial performance. Some of beneficial criteria are composed of major part of total weight. It means importance of these criteria is nearly %70 of the total weight in the evaluation of retail sector and affects the results more than the other criteria. Especially, higher rates of accounts receivable turnover, inventory turnover, earnings per share and return on equity capital are main factors to achieve successful results about companies' financial performance.

### 5. Conclusion

An approach by integrated FAHP and the three different MCDM methods are proposed for financial performance evaluation of Turkish retail companies take into consideration seven years. FAHP approach is utilized to determine the weights of the criteria of the performance evaluation. Accounts receivable turnover and inventory turnover are determined as the best two criteria for financial performance evaluation of retail companies based on expert decision via FAHP. In the third part of the study, proposed approaches are used in determining the ranking of the retail companies by comparing the companies according to the predetermined criteria. The financial performance evaluation of Turkish retail companies is ranked by using VIKOR, PROMETHEE and ELECTRE approaches. According to the ranking results, the best company with respect to financial performance evaluation is the same with regard to three different approaches for seven years.

To the best of our knowledge, it is one of the important studies on Turkish retail companies in this area. The proposed approaches can be used as benchmarking for other retail companies as well as other industries. In future studies other MCDM approaches such as DEMATEL, MOORA and ORESTE can be used to evaluate the financial performance of retail companies. Also various different kinds of MCDM approaches under fuzzy environment can be used regarding performance evaluation which can consider other financial criteria.

### Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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