Application of integrated fuzzy MCDM approach for financial performance evaluation of Turkish technology sector

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Abstract: Information and communications technology (ICT) sector of Turkey encountered a massive increase since 1970s as a result of the rapid international development in the communications and information technologies. Compliance with such a huge investment and the market integration of ICT sector, the analysis and evaluation of its financial performance is very important. In this regard, an integrated fuzzy Shannon's entropy and fuzzy ELECTRE I approach is proposed. To avoid subjectivity in the decision process, FSE method is used to assign weights for the evaluation criteria, then FELECTRE I method is applied to evaluate and rank alternatives. The proposed approach is used to identify and evaluate the financial performance of companies listed at BIST Technology Index of Turkey, in which DESPEC Company is financially evaluated to be the best company within the sector. Sensitivity analysis and comparison of the results with other MCDM models are also provided.

Keywords: financial performance evaluation; fuzzy Shannon's entropy; FSE; FELECTRE I; Turkish technology sector.

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1 Introduction

Financial performance evaluation is used extensively to understand a company's performance and to compare its performance with industry peers. Financial evaluation is also very useful in making economic decisions and predicting a company's future cash flows (Berk et al., 2012). Due to increased complexity of socio-economic environment, the liberalisation and internationalisation of financial markets and competition conditions in these markets, the efficient usage of resources has become a necessity. Besides that, the activities aimed at appreciating the company values have also gained importance (Tooranloo and Iranpour, 2017; Yalcin et al., 2012). In consequence of this diversification of activities and changes, there is a requiring need for using more efficient financial analysis methods and more exclusive techniques.

Financial ratio analysis is one of the financial assessment methods that is very crucial measurement tool for evaluating financial performance of an entity from different aspects such as liquidity, return, activity and level of growth. In which, a great number of studies have been approved its usefulness and reliability (Shaverdi et al., 2014; Vimrova, 2015). Still, financial ratios are accurate predictors of corporate success or failure when used with advanced statistical techniques (Drury, 1981). Such techniques include: regression and correlation techniques, artificial intelligence algorithms, multi-criteria decision-making (MCDM) techniques and data envelopment analysis. Nevertheless, MCDM techniques are considered to be the most effective techniques for performance evaluation, due to its ability to follow multiple objectives that often have distinct decision variables described by evaluation scales with different measures and determine the weight of each criterion and the performance score of alternatives (Silva and Figueiredo, 2018; Beheshtinia and Omidi, 2017). MCDM techniques can be categorised into compromise, outranking and hierarchical ranking techniques. Because of the shortcomings of the hierarchical techniques, many researchers highlighted the potential of compromise and outranking MCDM techniques (Girubha et al., 2016).

In outranking techniques, comparisons of all objects relations are build-up on the basis of all relevant information; in order to determine if there is existed preference, indifference or incomparability relation among each pair of objects [Huylenbroeck, (1995), p.491). From the literature, elimination and choice expressing reality (ELECTRE) and PROMETHEE were found to be the most widely used outranking techniques. However, ELECTRE technique is widely known to be successfully used to solve different concrete problems and has the provision to handle imprecision data (Brans and Vincke, 1985; Girubha et al., 2016). Additionally, ELECTRE technique has a long history of successful real-world applications with considerable impact on human decisions (Figueira et al., 2010). On the other hand, TOPSIS and VIKOR are the most commonly used compromise ranking techniques. In which TOPSIS method helps selecting the best alternative that is very close to the ideal solution. While VIKOR method helps selecting the best alternative that provides a maximum group utility and a minimum of an individual regret (Opricovic and Tzeng, 2004).

The investment of information and communications technology (ICT) sector of Turkey is assessed to be about $30.3 billion in 2011, with a massive increase since 1970s as a result of the rapid international development in the communications and information technologies. Not only ICT sector has a direct impact on the industrial structures and geographical locations of the regions (Madudova, 2016), but also it has been noticed that with each single unit of growth of ICT rises, 1.8 unites of growth rise will be in the whole economy (YASED, 2012). Compliance with such a huge investment and the market integration of ICT sector, the analysis and evaluation of its financial performance is very important.

In this regard, a fuzzy MCDM financial performance evaluation framework is proposed and applied to publicly traded companies listed at Istanbul Stock Exchange (BIST) ICT sector. To avoid subjectivity of decision makers, fuzzy Shannon's entropy (FSE) method is used to assign weights of the criteria, then fuzzy elimination and choice expressing reality I (FELECTRE I) method is used to rank the alternatives. Besides, sensitivity analysis and comparative analysis with fuzzy TOPSIS and fuzzy VIKOR are also provided.

This study contributes to the literature by the proposal of ratio analysis framework, the use of objective method of FSE to assign the weights to the evaluation criteria and the application of FELECTRE I method to evaluate and rank companies listed at BIST Technology Index of Turkey. The rest of the study is prepared as follows: Section 2 describes the background and review of financial performance evaluation studies. Section 3 describes the proposed approach. The application of the proposed approach, sensitivity analysis and comparison with other FMCDM methods are presented in Section 4. Section 5 finally states conclusions and final comment.

2 Literature review

In recent years, the financial performance evaluation has been applied in many areas using different models. In Table 1, a review of financial performance evaluation studies is presented. Hierarchical MCDM methods such as AHP and FAHP are commonly used to assign criteria weights. Unfortunately, hierarchical methods have subjectivity problems as they depend on the preference evaluation of decision makers. Meanwhile, using objective methods which depends on crisp value might not produce the proper weights due to uncertainty of financial data. To overcome the subjectivity problem and the uncertainty of financial data, FSE method is used to assign the weights of criteria depending on interval fuzzy values. Furthermore, sensitivity analysis based on different criteria weights is applied to approve the usefulness of the proposed approach.

Ratio selection is an important and contentious matter as information overlaps individual ratios. If all ratios were included, the decision model would contain repetitive redundant data as to using the debt to equity ratio and equity to debt ratio. Also, if only fully independent ratios were used, the information content of the semi-independent ratios would be lost (Barne, 1987). Some papers used different financial ratios which still can produce the same outcome, for example, Tayyar et al. (2014) used the current liability to assets ratio, while Shaverdi et al. (2014) used long-term liabilities to assets ratio. In this paper, the literature review presented the gap of financial evaluation, which directed the study to develop a general ratio analysis approach. The financial ratios used in previous studies and in the proposed approach are shown in Table 2.

Table 1 Review of financial performance evaluation

Paper	*Method*	*Field of application*
Tan et al. (1997)	Descriptive statistics, factor and variance analysis	Public companies in Singapore
Feng and Wang (2000)	Grey relation analysis and TOPSIS	Airline companies in Taiwan
Ho (2004)	Grey relation analysis	Australia's major banks
Chang (2006)	Grey relation analysis and grey situation decision	Commercial banks in Taiwan
Wu et al. (2009)	FAHP with SAW, TOPSIS and VIKOR	Banks performance
Bulgurcu (2012)	TOPSIS	Technology companies at Istanbul Stock Exchange
Joshi et al. (2013)	VAIC and ROA	The Australian financial sector
Alenjagh (2013)	ANP and PROMETHEE	Insurance companies at Tehran Stock Exchange (TSE)
Akotey et al. (2013)	Panel regression	Life insurance companies in Ghana
Katchova and Enlow (2013)	Financial ratios and Du Pont analysis	Publicly-traded agribusinesses, USA
Ying Lai et al. (2014)	Distress analysis and Altman's Z-index	Public construction companies in Malaysia
Ghadikolaei et al. (2014)	FAHP, FVIKOR, ARAS-F and fuzzy COPRAS	Automotive companies at TSE
Rezaie et al. (2014)	Fuzzy AHP and VIKOR	Iranian cement firms
Shah and Jan (2014)	Regression analysis and correlation technique	Private banks in Pakistan
Costea (2014)	Fuzzy C-means clustering and artificial intelligence algorithms	Non-banking financial institutions in Romania
Mandic et al. (2014)	Fuzzy AHP and TOPSIS	Serbian banks
Fenyves et al. (2015)	Data envelopment analysis	Agricultural enterprises
İslamoğlu et al. (2015)	Entropy and TOPSIS	Real estate investment trusts
Thobejane et al. (2017)	Cross-sectional regression and rank correlation test	Equity unit trusts in South Africa
Beheshtinia and Omidi (2017)	AHP, MDL, FTOPSIS, FVIKOR and Copeland method	Banking industry

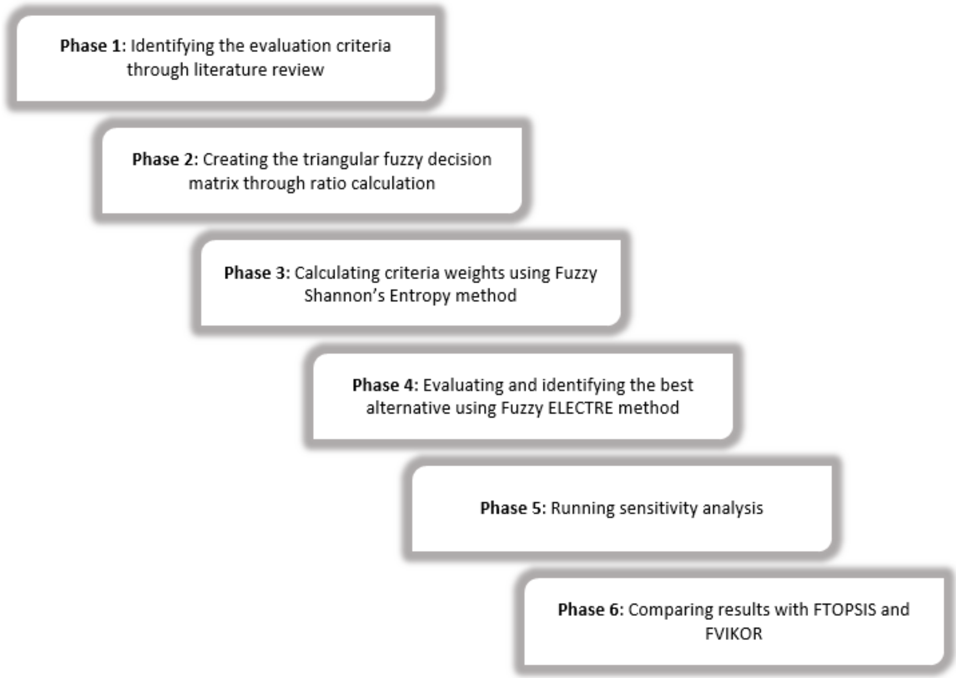
3 The proposed approach

In this study, integration of FSE with FELECTRE I methods is used to assess the financial performance of Turkish ICT firms. Phases of the proposed approach can be expressed as in Figure 1.

Table 2 Applied financial ratios

Paper/criteria	*Current ratio*	*Acid test ratio*	*Networking capital*	*Stock turnover*	*Receivables turnover*	*Total assets turnover*	*Equity turnover*	*NWC turnover*	*Total debt ratio*	*Debt to equity ratio*	*Long-term debt to assets*	*Interest coverage ratio*	*Gross profit margin*	*Operating profit margin*	*Net profit margin*	*Return on assets*	*Return on equity*	*Assets growth ratio*	*Sales growth ratio*	*Equity growth ratio*
Drury (1981)		√	√	√						√		√			√	√				
Tan et al. (1997)	√	√	√	√	√	√		√	√	√	√	√			√	√	√			
Hsieh and Wang (2001)	√	√		√	√	√			√			√			√	√	√		√	√
Ho and Wu (2006)						√			√	√	√			√		√	√	√	√	√
Tahoori et al. (2011)	√	√	√	√	√	√		√	√	√		√	√		√	√	√			
Ahrendsen and Katchova (2012)	√		√			√			√	√		√		√	√	√	√			
Reddy et al. (2013)	√	√		√		√				√		√		√	√	√	√			
Liu et al. (2013)	√	√		√	√	√					√	√			√	√	√			
Katchova and Enlow (2013)	√	√				√			√		√		√			√	√			
Kazan and Ozdemir (2014)	√	√		√	√	√	√	√	√		√		√	√	√	√	√			
Shaverdi et al. (2014)	√	√		√	√	√			√		√	√			√	√	√	√	√	√
Tayyar et al. (2014)	√	√			√		√	√	√	√	√				√	√	√			
Ying Lai et al. (2014)	√	√							√	√					√	√	√			
Fenyves et al. (2015)	√	√	√	√	√				√										√	√
Apan et al. (2015)	√	√				√	√	√	√	√	√					√	√			
Eyüboğlu and Çelik (2016)	√	√			√	√	√		√	√					√	√	√	√	√	√
Perçin and Aldalou (2018)	√	√	√	√	√	√		√	√		√				√	√				

Figure 1 Flowchart of the proposed approach



3.1 Evaluation criteria

The role of criteria in the decision-making process is to measure how the alternatives fulfil the goals of financial performance (Hajek et al., 2017). In this approach, financial ratios are considered as the evaluation criteria. Table 3 shows financial ratios and their calculations:

- Liquidity ratios: Represent a general measure that evaluates the ability of an entity to meet its financial obligations when it come due, in an effective manner, holding a margin of safety to account for unexpected loss in value of assets or emergent payments.
- Activity ratios: Measure how effectively and efficiently an entity is utilising its available assets to generate return.
- Financial leverage ratios: Measure the entity's reliability on debt financing in compare to equity, and the cost of financing.
- Profitability ratios: Measure the entity's ability to meet the overall goal of achieving profit. Measuring the utilisation of available resources for the generation of adequate returns.
- Growth ratios: Measure the growth in companies' size, investments and operations.

Table 3 Evaluation criteria

Liquidity ratios		
Current ratio	L1	Current assets / current liabilities
Acid test ratio	L2	(Current assets – inventory) / current liabilities
Networking capital to asset ratio	L3	Net working capital / total assets
Activity ratios		
Stock turnover	A1	Cost of goods sold / average stock
Account receivable turnover	A2	Net sales / average accounts receivables
Total assets turnover	A3	Net sales / total assets
Equity turnover	A4	Net sales / equity
Networking capital turnover	A5	Net sales / networking capital
Financial leverage ratios		
Total debt ratio	F1	Total debt / total assets
Debt to equity ratio	F2	Total debt / equity
Long-term debt to assets ratio	F3	Long-term debt / total assets
Interest coverage ratio	F4	Income before interests and tax / interest expenses
Profitability ratios		
Gross profit margin	P1	Gross profit / net sales
Operating profit margin	P2	Income before interests and tax / net sales
Net profit margin	P3	Net income / net sales
Return on assets	P4	Net income / total assets
Return on equity	P5	Net income / equity
Growth ratios		
Total assets growth ratio	G1	(Total assets$_1$ / total assets$_0$) – 1 $*$ 100%
Sales growth ratio	G2	(Net sales$_1$ / net sales$_0$) – 1 $*$ 100%
Equity growth ratio	G3	(Equity$_1$ / equity$_0$) – 1 $*$ 100%

3.2 Fuzzy entropy method

There are several methods used for assessing criteria weights in a decision-making process, however, entropy method offers faster and objective evaluation compared with other weighting methods (Abidin et al., 2016). The notion of Shannon's entropy has an important function in information theory and is used to refer to a general measure of uncertainty (Mohamadi et al., 2017). According to the idea of information entropy, the number or quality of information acquired from decision-making setting is one of the determinants of accuracy and reliability of decision-making problem (Wu et al., 2011). Therefore, the entropy method is very useful for determining the weights of the criteria in a MCDM problem.

In this study, the FSE method proposed by Lotfi and Fallahnejad (2010) has been applied to assign weights of criteria. Steps of FSE decision-making process used to assign criteria weights can be explained as follow (Lotfi and Fallahnejad, 2010):

Step 1 Construct the fuzzy decision matrix.

For a problem of m alternatives ($A_1, A_2, \ldots, A_m$) and n criteria ($C_1, C_2, \ldots, C_n$), the fuzzy performance/decision matrix D can be constructed as:

$$D = \begin{bmatrix} \breve{x}_{11} & \cdots & \breve{x}_{1j} & \cdots & \breve{x}_{1n} \\ \vdots & & \vdots & & \vdots \\ \breve{x}_{i1} & \cdots & \breve{x}_{ij} & \cdots & \breve{x}_{in} \\ \vdots & & \vdots & & \vdots \\ \breve{x}_{m1} & \cdots & \breve{x}_{mj} & \cdots & \breve{x}_{mn} \end{bmatrix} \text{ where } \breve{x}_{ij} = \left(a_{ij}, b_{ij}, c_{ij}\right) \tag{1}$$

$i = 1, 2, \ldots, m, \quad j = 1, 2, \ldots, n$

$\breve{x}_{ij}$ represent the performance value of alternative i from the view point of criterion j.

For the purpose of defining triangular fuzzy numbers (TFNs), financial ratios are calculated for five years, then the lowest, average and the highest ratios are to represent (l, m, u) elements of a TFN, respectively.

Step 2 Construct the fuzzy interval data decision matrix using the α-level sets.

The α-level set of a fuzzy variable $\breve{x}_{ij}$ is defined by a set of elements that belong to the fuzzy variable $\breve{x}_{ij}$ with membership of at least α.

That is:

$$\left(\tilde{x}_{ij}\right)_{\alpha} = \left\{x \in R \mid \mu_{\tilde{x}_{ij}}(x) \geq \alpha\right\} \tag{2}$$

The following interval form is also used to express the α-level set:

$$\begin{aligned} &\left[\left(\tilde{x}_{ij}\right)_{\alpha}^{l}, \left(\tilde{x}_{ij}\right)_{\alpha}^{u}\right] = \\ &\left[\min_{x_{ij}}\left\{x_{ij} \in R \mid \mu_{\tilde{x}_{ij}}\left(x_{ij}\right) \geq \alpha\right\}, \max_{x_{ij}}\left\{x_{ij} \in R \mid \mu_{\tilde{x}_{ij}}\left(x_{ij}\right) \geq \alpha\right\}\right] \end{aligned} \tag{3}$$

where ($0 < \alpha \leq 1$). Fuzzy data (TFNs) can be transformed into fuzzy interval data using levels of confidence $1 - \alpha$, explained as follow:

$$\tilde{x}_{ij} = \left[\alpha x_{ij}^{m} + (1-\alpha)x_{ij}^{l}, \alpha x_{ij}^{m} + (1-\alpha)x_{ij}^{u}\right] \tag{4}$$

The fuzzy interval decision matrix would be as in the following equation:

$$ID = \begin{bmatrix} \breve{x}_{11} & \cdots & \breve{x}_{1j} & \cdots & \breve{x}_{1n} \\ \vdots & & \vdots & & \vdots \\ \breve{x}_{i1} & \cdots & \breve{x}_{ij} & \cdots & \breve{x}_{in} \\ \vdots & & \vdots & & \vdots \\ \breve{x}_{m1} & \cdots & \breve{x}_{mj} & \cdots & \breve{x}_{mn} \end{bmatrix} \text{ where } \breve{x}_{ij} = \left(x'_{ij}, x''_{ij}\right) \tag{5}$$

$i = 1, 2, \ldots, m, \quad j = 1, 2, \ldots, n$

Step 3 Normalise the fuzzy interval decision matrix.

The normalised fuzzy interval decision matrix can be calculated using the following equations:

$$p_{ij}^{l} = \frac{x_{ij}'}{\sum_{j=1}^{m} x_{ij}^{u}}, \; p_{ij}^{u} = \frac{x_{ij}''}{\sum_{j=1}^{m} x_{ij}^{u}} \tag{6}$$

Step 4 Calculate the interval entropy's lower bound e_j^l and upper bound e_j^u.

$$\begin{aligned} e_j^l &= \min\left\{-k\sum_{j=1}^{m} p_{ij}^{l}.\ln p_{ij}^{l}, -k\sum_{j=1}^{m} p_{ij}^{u}.\ln p_{ij}^{u}\right\} \\ e_j^u &= \max\left\{-k\sum_{j=1}^{m} p_{ij}^{l}.\ln p_{ij}^{l}, -k\sum_{j=1}^{m} p_{ij}^{u}.\ln p_{ij}^{u}\right\} \end{aligned} \tag{7}$$

where k is the entropy constant and $k = (\ln m)^{-1}$. If $p_{ij} = 0$, and/or $\ln p_{ij} = 0$, then $p_{ij}.\ln p_{ij}$ is equal to 0.

Step 5 Calculate the lower and upper bounds of the interval of diversification, d_j^l, d_j^u.

$$d_j^l = 1 - e_j^u, \; d_j^u = 1 - e_j^l \tag{8}$$

Step 6 Calculate the interval weights of criteria $\tilde{w}_j = [w_j^l, w_j^u]$:

$$w_j^l = \frac{d_j^l}{\sum_{j=1}^{n} d_j^u}, \; w_j^u = \frac{d_j^u}{\sum_{j=1}^{n} d_j^l} \tag{9}$$

Theorem, the inequality $w_j^l \le w_j^u, \; j = 1, \ldots, n$ is held.

Step 7 Defuzzify the interval fuzzy numbers into a crisp value using the following equation:

$$w_j = \left(w_j^l + w_j^u\right)/2 \tag{10}$$

Then, criteria weights should be normalised as $\sum_{j}^{n} w_j = 1$.

3.3 FELECTRE I method

ELECTRE is a widely recognised evaluation method with a strong performance track record that can be employed to facilitate decision-making activities which incorporate both qualitative and quantitative criteria (Genc, 2015). The major purpose of ELECTRE I method is to select a desirable alternative that meets both the demands of concordance preference above many evaluation benchmarks, and of discordance preference under any optional benchmark (Rouyendegh and Erol, 2012). Three different outranking relations are defined in ELECTRE I method listed as: preference (*S*), means 'at least as good as'; indifference (≈), means 'not significantly different'; and incomparable (?), means 'not comparable' (Belbag et al., 2016). In contrast to other benchmarking analysis, the non-usage of the aggregation of many criteria into a single performance indicator in ELECTRE I assure achieving distinguished results (Iazzolino et al., 2012).

Evaluating and ranking of alternatives using FELECTRE I method can be summarised as follows (Asghari et al., 2010; Azadnia et al., 2011; Aytaç et al., 2011):

Step 1 Normalise the triangular fuzzy-decision matrix.

Normalising the fuzzy decision matrix [explained in equation (1)] as:

$$\breve{R} = [\breve{r}_{ij}]_{m \times n}, i = 1, 2, \ldots, m, \quad j = 1, 2, \ldots, n \tag{11}$$

The normalisation process can be performed by the following equation:

$$\begin{aligned} \breve{r}_{ij} &= \left(\frac{a_{ij}}{c_j^+}, \frac{b_{ij}}{c_j^+}, \frac{c_{ij}}{c_j^+} \right), c_j^+ = \max c_{ij} \left\{ c_{ij} \mid j = 1, 2, \ldots, n \right\} j \in B \\ \breve{r}_{ij} &= \left(\frac{c_j^-}{c_{ij}}, \frac{c_j^-}{b_{ij}}, \frac{c_j^-}{a_{ij}} \right), c_j^- = \min a_{ij} \left\{ c_{ij} \mid j = 1, 2, \ldots, n \right\} j \in C \end{aligned} \tag{12}$$

where B is the set of benefit attributes and C is the set of cost attributes.

Step 2 Structure the weighted normalised matrix.

Using the relative weights of criteria W_j as calculated by FSE, the weighted fuzzy normalised decision matrix is shown as $\breve{V}$:

$$\breve{V} = [\breve{v}_{ij}]_{m \times n} = \begin{bmatrix} \tilde{v}_{11} & \tilde{v}_{12} & \cdots & \tilde{v}_{1n} \\ \tilde{v}_{21} & \tilde{v}_{22} & \cdots & \tilde{v}_{2n} \\ \vdots & \vdots & \ddots & \\ \tilde{v}_{m1} & \tilde{v}_{m2} & \cdots & \tilde{v}_{mn} \end{bmatrix}, \tag{13}$$

$$i = 1, 2, \ldots, m, \quad j = 1, 2, \ldots, n$$

where $\breve{v}_{ij} = \breve{r}_{ij} \times W_j$

Step 3 Compute the distance between any two alternatives.

The concordance and discordance matrices are constructed by utilising the weighted normalised fuzzy decision matrix and paired comparison among the alternatives. Considering two alternatives, the concordance set is formed as:

$$J_c = \left\{ j \mid \tilde{v}_{gj} > \tilde{v}_{fj} \right\} \tag{14}$$

where J_c is the concordance coalition of the attributes in which A_gSA_f, and the discordance set is defined as:

$$J_d = \left\{ j \mid \tilde{v}_{gj} < \tilde{v}_{fj} \right\} \tag{15}$$

where J_d is the discordance coalition and it is against the assertion A_gSA_f, S is the outranking relation and A_gSA_f means that "A_g is at least as good as A_f."

Hamming distance is used while finding distance between two fuzzy numbers. For any fuzzy numbers $\tilde{A}$ and $\tilde{B}$, the Hamming distance $(\tilde{A}, \tilde{B})$ can be found as:

$$d\left(\tilde{A}, \tilde{B}\right) = \int_R \left|\mu_{\tilde{A}}(x) - \mu_{\tilde{B}}(x)\right| dx \tag{16}$$

where R is the set of real numbers.

So, to compare any two alternatives A_g and A_f with respect to each attribute, and to define the concordance and discordance sets, specify the least upper bound of the alternatives, $\max(\tilde{v}_{gj}, \tilde{v}_{fj})$ and then, the Hamming distance method is used which assumes that:

$$\begin{aligned} \tilde{v}_{gj} \geq \tilde{v}_{fj} &\leftrightarrow d\left(\max\left(\tilde{v}_{gj}, \tilde{v}_{fj}\right), \tilde{v}_{fj}\right) \geq d\left(\max\left(\tilde{v}_{gj}, \tilde{v}_{fj}\right), \tilde{v}_{gj}\right) \\ \tilde{v}_{gj} \leq \tilde{v}_{fj} &\leftrightarrow d\left(\max\left(\tilde{v}_{gj}, \tilde{v}_{fj}\right), \tilde{v}_{fj}\right) \leq d\left(\max\left(\tilde{v}_{gj}, \tilde{v}_{fj}\right), \tilde{v}_{gj}\right) \end{aligned} \tag{17}$$

Step 4 Structure the concordance matrix.

The concordance matrix for each pairwise comparison of the alternatives can be defined as:

$$\tilde{C} = \begin{bmatrix} - & \cdots & \tilde{c}_{1f} & \cdots & \tilde{c}_{1m} \\ \vdots & & & & \\ \tilde{c}_{g1} & \cdots & \tilde{c}_{gf} & \cdots & \tilde{c}_{gm} \\ \vdots & & \vdots & \ddots & \vdots \\ \tilde{c}_{m1} & \cdots & \tilde{c}_{mf} & \cdots & - \end{bmatrix}$$

where

$$\tilde{c}_{gf} = \left(c_{gf}^l, c_{gf}^m, c_{gf}^u\right) = \sum\nolimits_{j \in J_c} \tilde{W}_j = \left(\sum\nolimits_{j \in J} W_j^l, \sum\nolimits_{j \in J} W_j^m, \sum\nolimits_{j \in J} W_j^u\right) \tag{18}$$

Then, specify the concordance level as $\tilde{c} = (c^l, c^m, c^u)$ where

$$c^l = \frac{\sum\nolimits_{f=1}^m \sum\nolimits_{g=1}^m c_{gf}^l}{m(n-1)}, \; c^m = \frac{\sum\nolimits_{f=1}^m \sum\nolimits_{g=1}^m c_{gf}^m}{m(n-1)} \text{ and } c^u = \frac{\sum\nolimits_{f=1}^m \sum\nolimits_{g=1}^m c_{gf}^u}{m(n-1)} \tag{19}$$

Step 5 Structure the discordance matrix.

The discordance matrix alternatives can be defined as:

$$D = \begin{bmatrix} - & \cdots & d_{1f} & \cdots & d_{1m} \\ \vdots & & & & \\ d_{g1} & \cdots & d_{gf} & \cdots & d_{gm} \\ \vdots & & \vdots & \ddots & \vdots \\ d_{m1} & \cdots & d_{mf} & \cdots & - \end{bmatrix},$$

$$d_{gf} = \frac{\max_{j \in J_D} \left|\tilde{v}_{gj} - \tilde{v}_{fj}\right|}{\max_j \left|\tilde{v}_{gj} - \tilde{v}_{fj}\right|} = \frac{\max_{j \in J_D} \left|d\left(\max\left(\tilde{v}_{gj}, \tilde{v}_{fj}\right), \tilde{v}_{fj}\right)\right|}{\max_j \left|d\left(\max\left(\tilde{v}_{gj}, \tilde{v}_{fj}\right), \tilde{v}_{fj}\right)\right|} \tag{20}$$

And the discordance level is described as:

$$\bar{D} = \frac{\sum_{f=1}^{m} \sum_{g=1}^{m} d_{gf}}{m(m-1)} \tag{21}$$

Step 6 Construct the Boolean matrices B and H:

The Boolean matrix B is determined by the minimum concordance level, $\tilde{\tilde{C}}$ as follows:

$$B = \begin{bmatrix} - & \cdots & b_{1f} & \cdots & b_{1m} \\ \vdots & & & & \\ b_{g1} & \cdots & b_{gf} & \cdots & b_{gm} \\ \vdots & & \vdots & \ddots & \vdots \\ b_{m1} & \cdots & b_{mf} & \cdots & - \end{bmatrix}, \begin{Bmatrix} \tilde{c}_{gf} \geq \tilde{\tilde{C}} \leftrightarrow b_{gf} = 1 \\ \tilde{c}_{gf} < \tilde{\tilde{C}} \leftrightarrow b_{gf} = 0 \end{Bmatrix} \tag{22}$$

Boolean matrix H is measured by a minimum discordance level

$$H = \begin{bmatrix} - & \cdots & h_{1f} & \cdots & h_{1m} \\ \vdots & & & & \\ h_{g1} & \cdots & h_{gf} & \cdots & h_{gm} \\ \vdots & & \vdots & \ddots & \vdots \\ h_{m1} & \cdots & h_{mf} & \cdots & - \end{bmatrix}, \begin{Bmatrix} d_{gf} < \bar{D} \leftrightarrow h_{gf} = 1 \\ d_{gf} \geq \bar{D} \leftrightarrow b_{gf} = 0 \end{Bmatrix} \tag{23}$$

The elements in matrices B and H with the value of 1 indicate the dominance relation between alternatives.

Step 7 Construct the global matrix Z.

The global matrix Z is calculated by peer to peer multiplication of the elements of the matrices B and H as follows:

$$Z = B \times H$$

where each element z_{gf} of matrix Z is obtained as:

$$z_{gf} = b_{gf} \cdot h_{gf}. \tag{24}$$

Step 8 Construct a decision graph and rank the alternatives.

Using the general matrix Z, a decision graph is drawn to determine the ranking order of the alternatives. For the two alternatives A_g and A_f, there is an arc between the two alternatives from A_g to A_f if alternative A_g outranks A_f, there is no arc between the two alternatives if alternatives A_g and A_f are incomparable, and there are two arcs between the two alternatives in both directions if these alternatives are indifferent.

4 Application of the proposed approach

4.1 Case study

The proposed approach is applied to publicly traded companies listed at BIST ICT Index of Turkey, which are: ALKATEL, ANEL, ARENA, ARMADA, ASELS, DATAGATE, DESPEC, ESCOM, FONET, INDEKS, KAREL, KRON, LINK, LOGO, NETAS and PLASTIKKART, and they are denoted as A1 to A16, respectively. Financial ratios are calculated for five years from 2012 to 2016, data instructed from companies' annual reports. The constructed fuzzy decision matrix is shown in Table A1.

In the next phase, FSE method is applied to the decision matrix and the final criteria weights are calculated. The results of applying FSE to the decision matrix are shown in Table 4.

Table 4 Weights of criteria

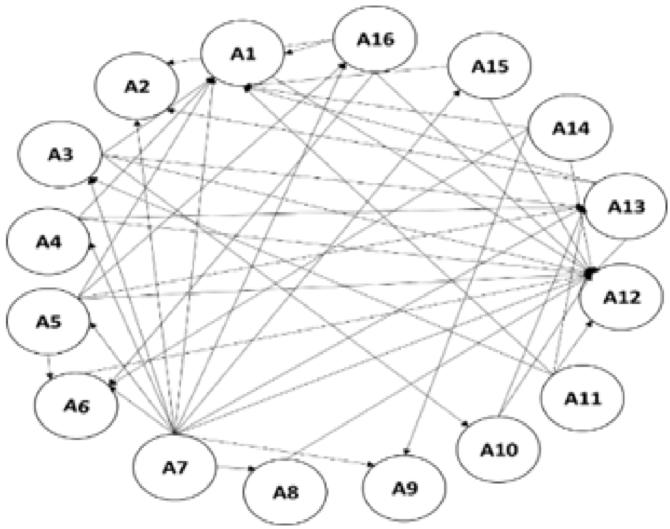
Criterion	*L1*	*L2*	*L3*	*A1*	*A2*	*A3*	*A4*	*A5*	*F1*	*F2*
Weight	0.035	0.037	0.028	0.07	0.022	0.024	0.037	0.038	0.019	0.037
Criterion	*F3*	*F4*	*P1*	*P2*	*P3*	*P4*	*P5*	*G1*	*G2*	*G3*
Weight	0.054	0.064	0.017	0.11	0.116	0.056	0.052	0.066	0.076	0.04

Following, alternatives are evaluated using FELECTRE I method. Table 5 shows the global matrix *Z*. The first and second domination relationships have been considered from Table 5 and Figure 2, in which, DESPEC (A7) has the highest domination followed by A5 then A11. The final order of alternatives using FELECTRE I is also shown in Table 5.

Table 5 The global matrix *Z* and FELECTRE I ranking

A	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*Rank*
A1		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	10
A2	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
A3	1	0		0	0	0	0	0	0	1	0	1	1	0	0	0	4
A4	1	0	0		0	0	0	0	0	0	0	1	1	0	0	0	6
A5	1	0	0	0		1	0	0	0	0	0	1	1	0	0	1	2
A6	0	0	0	0	0		0	0	0	0	0	1	0	0	0	0	10
A7	1	1	1	1	1	1		1	1	1	0	1	1	0	1	1	1
A8	0	0	0	0	0	0	0		0	0	0	1	0	0	0	0	10
A9	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	16
A10	0	0	0	0	0	0	0	0	0		0	1	1	0	0	0	8
A11	1	0	1	0	0	0	0	0	0	0		1	1	0	0	0	3
A12	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	16
A13	1	1	0	0	0	0	0	0	0	0	0	1		0	0	0	7
A14	1	0	0	0	0	1	0	0	1	0	0	1	0		0	0	5
A15	1	0	0	0	0	0	0	0	0	0	0	1	0	0		0	9
A16	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0		5

Figure 2 The decision graph



4.2 Results and discussion

The application of FSE method showed that profitability is the most important dimension with total weight of 35.5%. And the most important financial ratios are net profit margin 11.6% and operating profit margin 11.4% then sales growth 7.6%, stock turnover 7%, assets growth 6.6% and interest coverage ratio 6.4% (Table 4). Reflecting that the net profit margin a company achieves is the most important factor of maintaining a strong financial performance followed by operating profit margin and the growth percentage of sales, which is supported by the fact that the ultimate investment goal is the wealth maximising.

There are different studies conducted to evaluate the financial performance as shown in Section 2. Despite using different method for assigning criteria weights, there is a general consistency in results (Chang, 2006; Rezaie et al., 2014; Kazan and Ozdemir, 2014). As to Rezaie et al. (2014), profitability is the most important dimension, net profit margin followed by cash ratio and return on equity are the most important ratios and the remaining criteria have close weight vectors to each other.

A few number of studies have been conducted to evaluate the financial performance of Turkish companies listed at BIST ICT Index (Dumanoğlu and Ergül, 2010; Turkmen and Cağıl, 2012; Örs et al., 2015). Despite of considering more than one year of financial data in the evaluation process of these studies, the evaluation is applied for every single year separately. To overcome the gap of applying the financial analysis for every year separately, this study evaluated the financial performance of the companies during the period of 2012–2016 in a single general evaluation process. Additionally, repetitive redundant ratios have been used in some studies as: Örs et al. (2015) employed the accounts receivable turnover ratio and the average collection period, although, Apan et al. (2015) employed the debt to assets ratio along with equity to assets ratio. Moreover, the growth ratios were not a part of the pervious evaluation models. Considering these drawbacks, in this study, financial ratios are selected carefully to avoid the repetitiveness of data which included the liquidity, activity, financial leverage, growth and profitability of the companies in the evaluation process.

Previous studies applied compromise programming, grey relation analysis and TOPSIS methods to rank the alternatives of the ICT sector of Turkey, while, neither the ELECTRE I method nor the fuzzy logic were considered in previous studies. Besides, the usage of FELECTRE I method in this study, it conducted sensitivity analysis and comparison of results with FTOPSIS and FVIKOR methods.

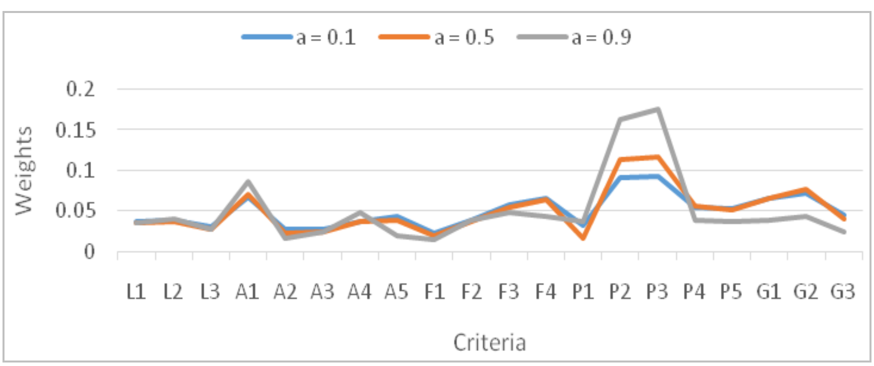
4.3 Sensitivity analysis

The parameter has been used in the construction of fuzzy interval decision matrix. Normally, the value of is taken as 0.5. A sensitivity analysis on taking in the values of (0.1, 0.9) is conducted for validating the results obtained. Table 6 and the corresponding Figure 3 show the new criteria weights results in accordance with values.

Table 6 Sensitivity analysis results of criteria weights

α	*L1*	*L2*	*L3*	*A1*	*A2*	*A3*	*A4*	*A5*	*F1*	*F2*
0.1	0.037	0.038	0.031	0.068	0.027	0.027	0.037	0.043	0.022	0.039
0.5	0.035	0.037	0.028	0.07	0.022	0.024	0.037	0.038	0.019	0.037
0.9	0.036	0.04	0.028	0.087	0.016	0.024	0.048	0.019	0.015	0.039
α	*F3*	*F4*	*P1*	*P2*	*P3*	*P4*	*P5*	*G1*	*G2*	*G3*
0.1	0.058	0.066	0.033	0.091	0.092	0.054	0.053	0.066	0.072	0.045
0.5	0.054	0.064	0.017	0.114	0.116	0.056	0.052	0.066	0.076	0.04
0.9	0.048	0.043	0.037	0.163	0.176	0.038	0.037	0.039	0.043	0.024

Figure 3 Sensitivity analysis of criteria weights (see online version for colours)

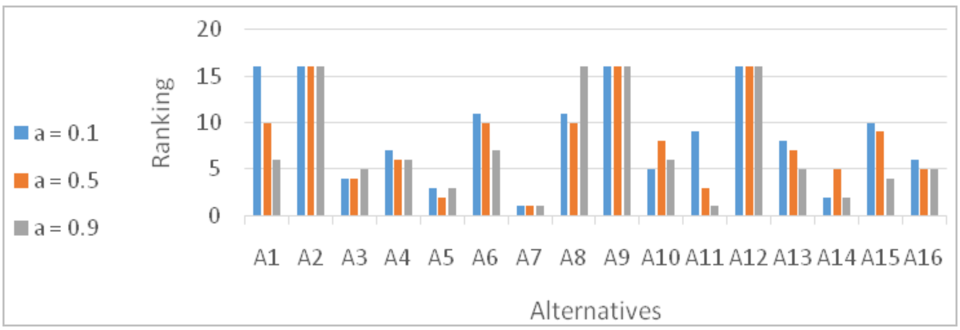


Using $\alpha = 0.1$ provides that the average evaluation value of an alternative is just 10% important and the minimum or maximum value is 90%, which is the pessimistic case that gives more credit to the terminal values 'extreme cases'. On the other hand, for $\alpha = 0.9$ gives more credit to the average values providing that it is the 'most likely' to happen. With regard to Figure 3, the criteria weights did not show a considerable change in the three cases. The new ranking results are shown in Table 7 and the corresponding Figure 4. In general, alternatives would act nearly the same in the three situations. A7 is still the best alternative, A2, A9 and A12 are the worst ranked firms for all values of α. However, when α is equal to 0.9, A11 and A7 are both would be considered the best alternatives.

Table 7 Sensitivity analysis ranking results

α	*A1*	*A2*	*A3*	*A4*	*A5*	*A6*	*A7*	*A8*	*A9*	*A10*	*A11*	*A12*	*A13*	*A14*	*A15*	*A16*
0.1	16	16	4	7	3	11	1	11	16	5	9	16	8	2	10	6
0.5	10	16	4	6	2	10	1	10	16	8	3	16	7	5	9	5
0.9	6	16	5	6	3	7	1	16	16	6	1	16	5	2	4	5

Figure 4 Sensitivity analysis of ranking results (see online version for colours)



Sensitivity analysis results provide that the ranking among the alternatives is not very sensitive to different α level, and the obtained results of the proposed approach are reliable.

4.4 *Comparison with other methods*

Comparison of the proposed approach with FSE and FTOPSIS and FSE and FVIKOR is provided in this section. The results of applying FTOPSIS (Koulinas et al., 2019) and FVIKOR (Opricovic, 2011) methods are shown in Table 8 and Figure 5 along with FELECTRE I results.

Figure 5 Comparison with other methods (see online version for colours)

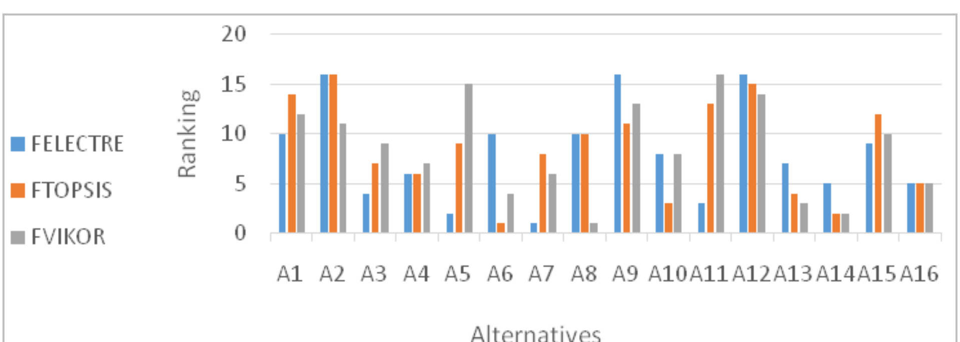


Table 8 Results comparison with other methods

FELECTRE I		*FTOPSIS*				*FVIKOR*			
A	*Rank*	*D+*	*D–*	*CC*	*Rank*	*S*	*R*	*Q*	*Rank*
A1	10	0.52	0.48	0.481	14	0.62	0.09	0.711	12
A2	16	0.64	0.37	0.363	16	0.64	0.08	0.698	11
A3	4	0.48	0.55	0.533	7	0.58	0.09	0.669	9
A4	6	0.47	0.54	0.538	6	0.56	0.09	0.648	7
A5	2	0.47	0.54	0.531	9	0.61	0.1	0.735	15
A6	10	0.41	0.59	0.587	1	0.49	0.09	0.595	4
A7	1	0.48	0.54	0.532	8	0.53	0.09	0.632	6
A8	10	0.47	0.5	0.519	10	0.5	0.07	0.514	1
A9	16	0.5	0.49	0.495	11	0.57	0.1	0.725	13
A10	8	0.46	0.55	0.545	3	0.57	0.09	0.661	8
A11	3	0.53	0.5	0.486	13	0.64	0.1	0.768	16
A12	16	0.55	0.47	0.462	15	0.59	0.1	0.726	14
A13	7	0.46	0.54	0.543	4	0.48	0.09	0.58	3
A14	5	0.43	0.57	0.569	2	0.48	0.09	0.572	2
A15	9	0.52	0.5	0.489	12	0.61	0.09	0.689	10
A16	5	0.47	0.55	0.541	5	0.51	0.09	0.617	5

Results show that A6, which is the best alternative by FTOPSIS, is the best alternative that would provide the highest return and lowest risk. A8, the best alternative by FVIKOR, would provide the highest income regardless of the risk taken. While, A7, the best alternative by FELECTRE I, would be better than the largest number of other alternatives in most financial aspect. Despite not being the best alternative by any of the three method, A14 seems to have a competing position among other alternatives. In FTOPSIS and FVIKOR methods, if a company has a high financial leverage and low growth as an example, the effect of high leverage could show the company with a better financial performance than it really is. Controversy, FELECTRE I method evaluates alternatives based on every aspect apart, providing the strongest alternative by majority support of criteria.

Where DATAGATE is the best alternative that would provide the highest return and lowest risk, ESCOM would provide the highest income regardless of the risk taken. However, the evaluation process shall consider every financial aspect of a company as a separated indicator not to be aggregated into a single performance indicator. Which is accomplished by comparing how every two alternative act in every financial performance aspect that is achieved by the FELECTRE I method. In this regard, DESPEC is financially the best alternative of Turkish companies listed at BIST ICT Index.

5 Conclusions

ICT sector is a horizontal sector that affects all other industries, and a simple growth in the sector would result in a larger growth in the whole economy. With rapid increase of investments and the market integration, the analysis and evaluation of companies in ICT sector has gained importance. This study suggested a ratio analysis framework to evaluate the financial performance of companies relaying on a FMCDM approach. To avoid subjectivity, FSE method is used to assign the criteria weights. FELECTRE I method is applied then to evaluate and rank alternatives. The proposed approach is used to analyse and evaluate the financial performance of Turkish companies listed at BIST ICT Index.

The results of the present study showed that profitability is the most important dimension. Net profit margin, operating profit margin, sales growth and stock turnover are the most important ratios in assessing company's financial performance. In most financial aspect, DESPEC is better than the largest number and worse than the least number of alternatives; thus, it is the best company in BIST ICT Index for the period of 2012–2016 using the proposed approach. Sensitivity analysis provided that the ranking among the alternatives is not very sensitive to the changes in the weights of financial performance evaluation criteria.

FTOPSIS and FVIKOR methods evaluate the alternatives considering all aspects in a single general evaluation process. Controversy, FELECTRE I method evaluates all alternatives based on each aspect separately, determining the best alternative which is supported by the majority of criteria. In this regard, the proposed approach is assessed to provide better results than FTOPSIS and FVIKOR.

Findings of this study primarily emphasis the significance of the proposed approach in assessing the financial performance of entities based on financial ratios. Also, it assures identifying the best alternative that is compared by one to one comparison with each alternative, and is not very sensitive to changes in the criteria weights. Future studies may consider rough, hesitant, stochastic and intuitionistic fuzzy sets.

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Appendix

Table A1 Fuzzy decision matrix

		L1			*L2*			*L3*			*A1*			*A2*	
A1	1.17	1.45	1.78	1.07	1.29	1.60	0.12	0.27	0.41	9.7	11.9	16.1	2.13	2.65	3.07
A2	0.48	1.82	5.80	0.43	1.59	4.98	–0.05	0.02	0.18	1.1	15.3	58.1	0.12	2.04	6.03
A3	1.37	1.48	1.58	0.96	1.05	1.13	0.26	0.32	0.36	8.2	9.0	10.3	3.84	5.05	5.76
A4	1.28	1.46	1.58	1.07	1.22	1.39	0.22	0.31	0.36	11.1	14.4	16.2	3.06	3.67	4.21
A5	1.87	2.13	2.50	1.21	1.50	1.75	0.22	0.28	0.35	2.17	2.52	2.74	2.42	3.05	4.08
A6	1.17	1.37	1.65	1.02	1.15	1.30	0.12	0.24	0.39	9.7	20.7	30.5	3.65	4.86	6.03
A7	2.80	3.31	4.02	1.94	2.39	2.71	0.64	0.69	0.74	6.7	7.7	8.4	4.30	4.51	5.04
A8	0.26	0.90	2.20	0.26	0.82	2.20	–0.09	0.00	0.15	0.00	2.6	8.4	0.04	1.90	4.90
A9	0.04	0.59	0.96	0.04	0.58	0.95	–0.26	–0.13	–0.02	0.00	183	550	3.03	5.18	7.53
A10	1.13	1.16	1.22	0.93	0.95	0.99	0.11	0.13	0.17	10.9	14.2	18.8	3.37	4.01	4.46
A11	1.65	1.83	2.09	1.11	1.24	1.43	0.29	0.33	0.38	2.3	2.4	2.6	2.56	2.72	2.83
A12	1.55	2.49	3.32	1.50	2.41	3.23	0.18	0.38	0.55	5.0	13.1	19.8	0.89	1.24	1.44
A13	7.3	10.4	16.2	7.2	10.4	16.2	0.70	0.72	0.74	16	52	87	1.55	2.09	3.18
A14	0.94	1.66	2.22	0.94	1.66	2.21	–0.03	0.20	0.28	7.9	15.1	30.2	1.93	2.21	2.79
A15	1.26	1.48	1.95	1.14	1.36	1.81	0.17	0.26	0.43	8.9	11.3	13.0	1.50	1.76	2.19
A16	3.5	6.1	10.5	2.6	4.3	7.3	0.56	0.61	0.66	6.7	7.5	8.2	5.96	8.00	9.58

		A3			*A4*			*A5*			*F1*			*F2*	
A1	1.00	1.26	1.57	3.24	5.40	7.22	3.76	5.21	8.1	0.64	0.75	0.84	1.78	3.29	5.23
A2	0.00	0.38	1.48	0.00	0.57	1.55	–4.4	1.49	8.4	0.04	0.31	0.71	0.04	0.89	2.48
A3	2.19	2.51	2.71	6.12	7.62	9.37	6.18	8.08	10.2	0.63	0.76	1.10	1.68	2.28	3.09
A4	1.90	2.33	2.93	7.48	8.88	10.36	5.32	7.89	9.9	0.70	0.74	0.77	2.35	2.85	3.43
A5	0.44	0.48	0.55	0.98	1.09	1.29	1.33	1.80	2.30	0.50	0.55	0.62	1.00	1.25	1.63
A6	1.99	2.56	3.95	5.07	11.4	17.5	5.1	13	20.2	0.61	0.74	0.86	1.54	3.48	6.11
A7	2.00	2.20	2.39	2.91	3.18	3.45	2.91	3.21	3.50	0.25	0.31	0.36	0.34	0.45	0.55
A8	0.01	0.36	1.71	0.01	0.67	3.29	–0.36	2.13	11.3	0.07	0.18	0.48	0.07	0.28	0.92
A9	0.58	0.92	1.56	1.08	2.05	4.3	–67.3	–20	–2.4	0.45	0.52	0.64	0.82	1.12	1.76
A10	2.07	2.28	2.67	9.58	13.4	17.0	12.2	18.3	23.1	0.78	0.82	0.85	3.62	4.80	5.67
A11	0.64	0.68	0.72	1.20	1.42	1.81	1.81	2.10	2.31	0.44	0.51	0.60	0.78	1.09	1.52
A12	0.54	0.57	0.64	0.73	0.85	0.98	1.01	1.87	3.24	0.24	0.32	0.43	0.31	0.48	0.74
A13	0.25	0.39	0.45	0.27	0.44	0.53	0.36	0.55	0.63	0.06	0.10	0.14	0.07	0.12	0.16
A14	0.57	0.63	0.73	1.09	1.16	1.20	–20.5	–2.1	3.14	0.32	0.46	0.53	0.48	0.86	1.11
A15	0.71	0.80	0.92	1.76	2.07	2.31	2.13	3.31	4.43	0.49	0.61	0.68	0.95	1.60	2.09
A16	1.45	1.70	1.94	1.79	2.06	2.21	2.46	2.81	3.00	0.11	0.17	0.24	0.12	0.21	0.32

Table A1 Fuzzy decision matrix (continued)

	F3			*F4*			*P1*			*P2*			*P3*		
A1	0.04	0.13	0.21	–1.8	5.20	17.1	0.08	0.12	0.20	–0.03	0.04	0.12	–0.05	0.03	0.08
A2	0.00	0.18	0.47	–5.6	5.48	28.9	–8.0	–2.8	0.18	–26.9	6.7	59.1	–32	4.7	55.3
A3	0.00	0.10	0.47	2.44	3.19	3.74	0.06	0.07	0.07	0.03	0.03	0.03	0.01	0.01	0.02
A4	0.00	0.06	0.12	2.36	3.01	3.50	0.05	0.06	0.06	0.03	0.03	0.03	0.01	0.01	0.02
A5	0.25	0.30	0.39	1.51	8.89	27.4	0.23	0.24	0.26	0.08	0.15	0.23	0.08	0.15	0.21
A6	0.00	0.07	0.18	0.58	10.1	23.7	0.03	0.04	0.04	0.02	0.03	0.04	–0.02	0.01	0.02
A7	0.00	0.00	0.01	3.08	4.48	8.45	0.08	0.10	0.11	0.08	0.10	0.12	0.05	0.06	0.06
A8	0.00	0.01	0.01	1.60	13.9	45.1	0.10	0.80	1.00	0.08	5.44	18.7	0.02	5.09	18.2
A9	0.04	0.11	0.20	2.52	3.21	3.82	0.22	0.37	0.49	0.12	0.21	0.31	0.08	0.15	0.23
A10	0.00	0.02	0.05	1.22	2.49	4.08	0.04	0.05	0.06	0.03	0.03	0.04	0.00	0.01	0.02
A11	0.05	0.11	0.19	1.05	1.60	2.72	0.20	0.23	0.26	0.12	0.14	0.17	0.03	0.05	0.08
A12	0.01	0.03	0.06	–11.3	3.03	9.6	0.48	0.63	0.83	–0.7	0.15	0.50	–0.7	0.11	0.46
A13	0.02	0.02	0.03	–2.3	10.3	38.5	0.66	0.73	0.80	–0.3	0.15	0.37	–0.3	0.07	0.25
A14	0.04	0.10	0.21	6.57	10.7	15.0	0.88	0.95	0.98	0.28	0.30	0.33	0.24	0.27	0.31
A15	0.03	0.03	0.04	1.28	2.60	6.33	0.10	0.12	0.14	0.02	0.05	0.08	0.00	0.02	0.04
A16	0.01	0.02	0.04	1.44	18.7	52.8	0.05	0.08	0.10	0.01	0.04	0.05	0.00	0.03	0.04
	P4			*P5*			*G1*			*G2*			*G3*		
A1	–0.07	0.03	0.09	–0.34	0.10	0.30	–0.04	0.10	0.27	–0.12	0.10	0.33	–0.10	0.15	0.39
A2	–0.08	0.05	0.24	–0.27	0.02	0.26	–0.80	–0.15	0.42	–1.00	–0.41	0.56	–0.51	–0.14	0.27
A3	0.02	0.03	0.05	0.06	0.10	0.16	0.09	0.25	0.41	0.07	0.13	0.22	0.17	0.22	0.26
A4	0.01	0.03	0.05	0.06	0.13	0.19	–0.19	0.24	0.59	0.06	0.19	0.36	0.16	0.23	0.28
A5	0.03	0.07	0.09	0.08	0.16	0.24	0.19	0.29	0.39	0.09	0.21	0.36	0.11	0.23	0.33
A6	–0.04	0.03	0.06	–0.10	0.16	0.36	–0.30	0.44	1.87	–0.37	0.56	1.89	0.07	0.20	0.36
A7	0.12	0.12	0.14	0.16	0.18	0.19	–0.03	0.08	0.21	–0.15	0.05	0.17	0.03	0.07	0.14
A8	0.03	0.08	0.22	0.04	0.09	0.25	–0.39	–0.05	0.08	–1.00	0.02	1.42	0.02	0.04	0.05
A9	0.07	0.12	0.14	0.15	0.25	0.34	–0.01	0.17	0.28	–0.41	–0.04	0.25	0.19	0.30	0.34
A10	0.01	0.03	0.04	0.03	0.17	0.27	0.02	0.19	0.41	–0.12	0.22	0.53	0.04	0.11	0.17
A11	0.02	0.04	0.05	0.04	0.07	0.09	0.14	0.17	0.20	0.07	0.17	0.26	0.04	0.06	0.09
A12	–0.39	0.07	0.29	–0.55	0.09	0.39	–0.27	0.21	0.57	–0.32	0.25	0.87	0.12	0.25	0.39
A13	–0.09	0.04	0.11	–0.09	0.05	0.13	0.05	0.11	0.20	–0.06	0.27	0.80	0.04	0.08	0.13
A14	0.14	0.17	0.20	0.26	0.31	0.36	0.22	0.48	0.98	0.24	0.44	0.53	0.21	0.29	0.33
A15	0.00	0.02	0.04	0.01	0.05	0.08	0.02	0.21	0.50	–0.04	0.26	0.63	–0.07	0.13	0.26
A16	0.00	0.05	0.07	0.00	0.06	0.10	0.03	0.09	0.14	–0.08	0.08	0.26	0.00	0.05	0.09