Personnel selection through Fuzzy ELECTRE I method

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Abstract* – *In today's conditions, where competition is becoming more severe, selection of personnel suitable for the posts offered by organizations is gaining greater importance. The current study deals with the issue of personnel selection for a sales engineer post of an international firm. Personnel selection criteria were determined through the analyses conducted by the human resources department and a literature review. The most suitable candidate was selected by evaluation of five criteria by three decision makers through Fuzzy ELECTRE method.

Key words – ELECTRE method, fuzzy ELECTRE method, human resources, multi criteria decision making, personnel selection.

I. Introduction

Personnel of a firm make up the most vital resource of it. Regardless of the type of the firm, each firm needs personnel. In this regard, the most important objective is to find the employee having the best qualifications for each position. Selection of suitable personnel has a strategic importance for organizations. Therefore, selection of personnel cannot be performed haphazardly.

Personnel selection means finding the best employee from either inside the organization or outside of it for a position. Methods or techniques to be used in the selection process are expected to have a capacity of predicting the future performance of the candidate [1].

In the current study, Fuzzy ELECTRE I method was administered to the problem of selecting the best candidate for a sales engineer position. After the presentation of general information and a literature review about Fuzzy ELECTRE method, the stages of the method to be implemented for the solution of the problem are explained in the third section. After the discussion of the personnel selection operation, evaluation of the application and suggestions for future research are presented in the fifth section of the study.

II. Literature Review About Fuzzy ELECTRE Method

Multi-criteria decision making methods are used for risk evaluation and selection of alternatives competing with each other in terms of more than one criterion. In the present study, Fuzzy ELECTRE method was employed. ELECTRE method is a technique developed to order a series of alternatives. It is based on binary superiority comparisons between alternative decisions points for each evaluation factor. Following the first method known as ELECTRE I, different versions of this approach have been developed. In literature, there are ELECTRE I, ELECTRE II, ELECTRE III and ELECTRE IV methods[2].

When compared to the other methods, Fuzzy ELECTRE requires fewer inputs for the problems having high number of alternatives and criteria. Moreover, performances of alternatives can easily be analyzed and there is no obligation to make binary comparisons [3]. Requirement of certain performance value measurement and criterion weight is one disadvantage of ELECTRE technique. In real world problems, these cannot always be evaluated. Fuzzy set theories are ideal for the elimination of this disadvantage. As fuzzy logic can express uncertainties in linguistics variables and in the nature of the problem, it is frequently used for the improvement of ambiguous information and procedures. The method has the capacity to consider the scale of order by including a random interval without adapting the original scale. Unlike classical ELECTRE methods, clear data are not used while evaluating alternatives and criteria. Instead, fuzzy structures are constructed. Instead of clear data, fuzzy values are capitalized on. Fuzzy ELECTRE has been used for the solution of many real life problems.

Sevkli developed a Fuzzy ELECTRE technique for the selection of the supplier to contribute to organizations' attempts to establish strategies and supply chains [4]. Montazer et al. developed an expert decision system by using ELECTRE III method for the selection of a supplier [5]. Asghari et al. designed a Fuzzy ELECTRE application for the evaluation of 5 different mobile payment models in terms of 7 different criteria [6]. Kaya and Kahraman proposed an environmental effect evaluation methodology through Fuzzy ELECTRE approach. In their study, they evaluated the effect of six different industrial zones on environment to design the industrial structuring of the city of Istanbul and defined environmentally risky alternatives [7]. Aytac et al. compared five different catering services in the city of Denizli by using Fuzzy ELECTRE technique [8]. Hatami and Tavana developed an extension of ELECTRE I method in order to make decisions in fuzzy media and they presented the details of their method on a numerical sample. Moreover, Hamming developed a different technique based on distance [9]. Kabak et al. generated a combination of Fuzzy ANP, Fuzzy TOPSİS and Fuzzy ELECTRE methods and thus developed a multi-criteria decision making technique including both qualitative and quantitative factors for personnel selection [11]. Rouyendegh and Erkan investigated the role of potential boundary conditions and intellectual values in the selection of academicians [12]. Vahdani et al. compare the existing Fuzzy ELECTRE method with intuitional methods by analyzing the effect of a comprehensive sensitivity analysis and its corresponding threshold values. [13]. Hatami at al. employed Fuzzy ELECTRE method to evaluate the hazardous waste recycling plants in terms of human health, environmental protection and safety [14]. Zandi and Roghanian developed an alternative Fuzzy ELECTRE technique based on VİKOR method [15]. Kheirkhah and Dehghani evaluate the quality of public transportation by using Fuzzy ELECTRE technique. [16]. Xu and Shen developed a technique for multi-criteria decision making problems by

using ELECTRE I method for Atanassov's intuitionistic fuzzy sets model [17]. Wu and Chen developed a method that can yield ideal solutions to multi-criteria decision making problems even with erroneous or incomplete data for Atanassov's intuitionistic fuzzy sets model Moreover, they analyzed their method on two samples 18]. Anojkumar et al. analyzed Fuzzy TOPSİS, Fuzzy VİKOR, Fuzzy ELECTRE and Fuzzy PROMETHEE methods for the selection of materials for pipe production in sugar industry. They developed a systematic approach to the selection of best alternative material based on seven evaluation criteria [19]. Chen and Xu combined ELECTRE II method with indecisive fuzzy logic to develop an alternative Fuzzy ELECTRE technique [20]. Lupo conducted a study based on Fuzzy ELECTRE method to evaluate the service quality of three international airports in Sicilia region and to make detailed suggestions [21].

III. Stages OF Fuzzy ELECTRE Method

In many studies in literature, ELECTRE method and fuzzy logic have been synthesized. Hatami and Tavana developed a different technique based on Hamming distance. They then compared the developed technique with TOPSİS technique, which is one of the accepted techniques in literature. Their analyses revealed that this new technique yields more effective results [10]. In the current study, the technique developed by Hatami and Tavana was also used.

The stages of the technique are presented below:

Stage 1: First, a group of decision makers is constituted to determine the performances of alternatives and significance levels of criteria. Significance levels of criteria to be used to evaluate alternatives are classified. These restricted significant levels are evaluated through fuzzy values.

Stage 2: Levels of achievement to be used in the evaluation of alternatives based on the criteria are classified and then evaluated through fuzzy values.

Stage 3: Decision makers evaluate each criterion according to significance levels determined in Stage 1.

Stage 4: Each of the decision makers evaluates each alternative according to each criterion based on achievement levels classified in Stage 2.

Stage 5: Means of importance weights of the criteria evaluated by the decision makers are taken.

$$\hat{R} = (a, b, c),\ k = 1, 2, 3 \ldots K$$

$$a = \frac{1}{K}\sum_{k=1}^{K} a_k,\ b = \frac{1}{K}\sum_{k=1}^{K} b_k,\ c = \frac{1}{K}\sum_{k=1}^{K} c_k \quad (1)$$

Stage 6: Means of the achievement levels of the alternatives evaluated by the decision makers according to the criteria are taken.

$$(x_{ij}) = (a_{ij}, b_{ij}, c_{ij})$$

$$a_{ij} = \frac{1}{K}\sum_{k=1}^{K} a_{ijk},\ b_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ijk},\ c_{ij} = \frac{1}{K}\sum_{k=1}^{K} c_{ijk} \quad (2)$$

With these values, fuzzy decision matrix is constructed.

$$\hat{D} = \begin{bmatrix} \hat{x}_{11} & \cdots & \hat{x}_{1n} \\ \vdots & \ddots & \vdots \\ \hat{x}_{m1} & \cdots & \hat{x}_{mn} \end{bmatrix} \quad (3)$$

Stage 7: At this stage, the constructed decision matrix is normalized. In the normalization operation, the highest fuzzy numerical data for one criterion in the decision matrix is determined and all the numerical data in this criterion are divided by this number. This operation is repeated for all the criteria. In this way, normalized decision matrix is formed.

$$\hat{R} = [\hat{r}_{ij}]_{mxn} \qquad i = 1, 2, 3, \ldots m;\ j = 1, 2, 3, \ldots n$$

$$\hat{r}_{ij} = \left(\frac{a_{ij}}{\hat{c}_j}, \frac{b_{ij}}{\hat{c}_j}, \frac{c_{ij}}{\hat{c}_j}\right),\ \hat{c}_j = \max c_{ij} \quad (4)$$

Stage 8: Fuzzy values in the obtained fuzzy decision matrix are multiplied with the importance weights of the criteria found in Stage 5 according to each criterion. In this way, weighted normalized decision matrix is obtained. This matrix is shown with "v".

$$\hat{V} = \begin{bmatrix} \hat{v}_{11} & \cdots & \hat{v}_{1n} \\ \vdots & \ddots & \vdots \\ \hat{v}_{m1} & \cdots & \hat{v}_{mn} \end{bmatrix} \quad (5)$$

Stage 9: At this stage, by administering "Hamming Distance" method, the table showing the distances of binary alternatives between the criteria that will help us to construct inconsistency matrices is formed. Each alternative is compared with all the other alternatives. The purpose for the use of this method is to find the number of two values. That is, we can find out how different the alternatives are from each other.

Stage 10: At this stage, by capitalizing on the weighted normalized decision matrix, conformity matrix is constructed. One alternative is compared with each of the other alternatives. Importance weights of the criteria in which the alternative is superior or equal to another with which it is compared are summed up. The conformity matrix obtained in this way is shown with $\hat{C}$.

$$\hat{C} = \begin{bmatrix} \hat{c}_{11} & \cdots & \hat{c}_{1n} \\ \vdots & \ddots & \vdots \\ \hat{c}_{m1} & \cdots & \hat{c}_{mn} \end{bmatrix} \quad (6)$$

Stage 11: At this stage, by capitalizing on the table showing the distances of binary alternatives between the criteria, inconsistency matrix is obtained. Each alternative is compared with each of the other alternatives. The criteria in which an alternative is inferior to another are determined. This value is divided by the highest value in this column. This operation is repeated for all the alternatives. The inconsistency matrix obtained in this way is shown with $\hat{D}$.

$$\widehat{D} = \begin{bmatrix} \hat{d}_{11} & \cdots & \hat{d}_{1n} \\ \vdots & \ddots & \vdots \\ \hat{d}_{m1} & \cdots & \hat{d}_{mn} \end{bmatrix} \quad (7)$$

Stage 12: Each value in the conformity matrix is compared with the mean of all the values in this matrix. Values bigger than the mean are evaluated as 1 and those smaller than it is evaluated as 0. In this way, Boolean conformity matrix is obtained and shown with B vector.

$$\mathrm{B} = \begin{bmatrix} b_{11} & \cdots & b_{1n} \\ \vdots & \ddots & \vdots \\ b_{m1} & \cdots & b_{mn} \end{bmatrix} \quad (8)$$

$$\hat{c}_{mn} \geq \bar{C} \Rightarrow b_{mn} = 1 \quad (9)$$

$$\hat{c}_{mn} < \bar{C} \Rightarrow b_{mn} = 0 \quad (10)$$

Stage 13: Each value in the inconsistency matrix is compared with the mean of all the values in the matrix. Values bigger than the mean are evaluated as 1 and those smaller than it or equal to it are evaluated as 0. In this way, Boolean inconsistency matrix is obtained and shown with H vector.

$$\mathrm{H} = \begin{bmatrix} h_{11} & \cdots & h_{1n} \\ \vdots & \ddots & \vdots \\ h_{m1} & \cdots & h_{mn} \end{bmatrix} \quad (11)$$

$$\hat{d}_{mn} < \bar{D} \Rightarrow h_{mn} = 1 \quad (12)$$

$$\hat{d}_{mn} \geq \bar{D} \Rightarrow h_{mn} = 0 \quad (13)$$

Stage 14: Boolean conformity matrices are multiplied with each other and thus, spherical matrix is obtained. This matrix is represented with Z.

$$\mathrm{Z} = \mathrm{B} \times \mathrm{H} \quad (14)$$

Each element in these matrices (z_{mn}) is obtained by multiplying each value in Boolean conformity and inconsistency matrices with each other.

$$z_{mn} = b_{mn} \times h_{mn} \quad (15)$$

Stage 15: By analyzing the spherical matrix, superiorities of the alternatives to each other are determined. An alternative having the value of 1 in the matrix is superior to the other. However, this does not mean that an alternative having the value of 0 is inferior to the other. Under the conditions of the spherical matrix, a superiority scheme is drawn. By interpreting this scheme, selection order of the alternatives is determined.

Conclusion

Personnel of a firm make up the most vital resource of it. Regardless of the type of the firm, each firm needs personnel. In this regard, the most important objective is to find the employee having the best qualifications for each position. Selection of suitable personnel has a strategic importance for organizations. Therefore, selection of personnel cannot be performed haphazardly. In the current study, Fuzzy ELECTRE I method was administered to the problem of selecting the best candidate for a sales engineer position. After the presentation of general information and a literature review about Fuzzy ELECTRE method, the stages of the method to be implemented for the solution of the problem are explained in the third section. Method steps are given for use to personnel selection application. Method will be tested in a real-life problems in future studies. Future research may try multi-criteria decision making methods such as VİKOR, TOPSİS, DEMATEL and their fuzzy versions. In addition, the same method can be used for other positions after the reevaluation of the criteria.

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