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Personnel Selection Using Fuzzy VIKOR Methodology

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Abstract: Personnel selection is a fundamental business process for companies. Training, work experience and personal characteristics are the qualities that are considered for employee to be recruited. Selecting the best personnel for a job or a promotion can be handled as a Multi Criteria Decision Making (MCDM) problem. Solving a multi-criteria decision problem offers decision makers suggestions, regarding the best decision choices (alternatives). The aim of this paper is to determine the best performing personnel for promotion using one of a MCDM methodology, the fuzzy VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje in Serbian, means Multi criteria Optimisation and Compromise Solution) for a real personnel selection problem. For a case study in Turkey, personnel alternatives (A1, A2, A3, A4) waiting for promotion are ranked according to personnel selection criteria (22 sub-criteria are classified under 5 main criteria by 5 decision makers) using the fuzzy VIKOR with type 2 (trapezoidal) fuzzy numbers and the best-performing personnel is selected for promotion. According to the results, the best solution is found as Alternative A3. This study provides a more efficient approach to develop the best alternative under each of the selection criteria. Moreover, the Fuzzy VIKOR methodology helps managers/human resources department to easily predict how they can evaluate and promote employees. The main contribution of this study is to improve literature of fuzzy decision making for personnel selection problem.

Keywords: Personnel Selection, Personnel Selection Criteria, Trapezoidal Fuzzy Numbers, Multi Criteria Decision Making (MCDM), Fuzzy VIKOR Methodology

1. Introduction

One of the most critical stages for the success of the recruitment process is to reach qualified candidates. In order to reach these qualified candidates, all kinds of channels should be used to inform the candidates. These channels can be employment agencies, newspaper advertisements, colleague references, university visits and internet. After determining the qualified candidates, the most appropriate one for the job should be chosen. The selection of the most appropriate of these candidates is defined as personnel selection. The success and image of the company will be adversely affected as a result of hiring a poor and unqualified person. Choosing the wrong person will cost a lot of time and expense for the training and development of that person. For this reason, the selection of personnel will prevent this by choosing a suitable and qualified employee.

MCDM methods can be used to solve personnel selection problem. There have been many studies on the personnel selection using MCDM methods in the literature [1-12].

In personnel selection, GRA is studied extensively. Zhang and Liu [13] developed an intuitionistic fuzzy multi-criteria group decision making method with GRA to solve the personnel selection problem. Pramanik and Mukhopadhyaya [14] developed an intuitionistic fuzzy multi criteria group making method with GRA for teacher selection in higher education. Kundakci [15] proposed a scientific MCDM method using GRA for employee selection.

In the literature, many studies using FAHP on personnel selection can be found. Mikhailov [16] proposed a new fuzzy programming method to partnership selection problem in the basic framework of the AHP. Huang et al. [17] combined FAHP, Fuzzy Neural Networks, and Simple Additive Weighting (SAW) method to construct a new model for evaluation of managerial talent, and to develop a decision support system in human resource selection. Gungor et al. [18] proposed a personnel selection system based on FAHP to evaluate the best adequate personnel.

Celik et al. [19] proposed Fuzzy Integrated Multi-stages Evaluation Model (FIMEM) for academic personnel selection. The FIMEM consisted of FAHP and Fuzzy TOPSIS. Chen [20] constructed fuzzy multiple criteria model by FAHP for employee recruitment. Sun [21] developed an evaluation model by integrating FAHP and Fuzzy TOPSIS methods for the performance evaluation. Rouyendegh and Erkan [22] examined a FAHP using triangular fuzzy numbers for selecting the most suitable academic staff. They evaluated and prioritized five candidates under ten different subcriteria.

Fuzzy-VIKOR is also used for personnel selection in the literature as an application area. Alguliyev et al. [23] proposed a fuzzy hybrid multicriteria decision-making model for personnel evaluation. They used triangular fuzzy numbers and modified fuzzy VIKOR technique to select the best alternative. Liu et al. [24] combined the VIKOR method with interval 2-tuple linguistic variables to choose appropriate individuals among candidates for personnel selection. Ersoy [25] proposed an algorithm based on the Fuzzy VIKOR method for the personnel selection problem. But no study on personnel selection using Fuzzy VIKOR Methodology with type 2 fuzzy numbers could be found.

The aim of this paper is to determine the best-performing personnel using Fuzzy VIKOR Methodology and type 2 (trapezoidal) fuzzy numbers. 22 sub-criteria were determined for prioritization and these were classified under 5 main criteria by 5 experts from academia and industry. For a case study in Turkey, the ranking of the 4 (four) alternatives is calculated using the Fuzzy VIKOR Method and the best personnel is selected for promotion.

The rest of this paper is organized as follows: In Section 2, Fuzzy VIKOR Methodology is presented. In Section 3, an application of Fuzzy VIKOR Method in personnel selection is shown. Besides, calculated results are given in this section. Finally, obtained results are considered in Section 4.

2. Fuzzy VIKOR Methodology

The fuzzy VIKOR Methodology is an affective sourcing decision to find a preferable compromise with a best solution [26]. So this methodology will be very useful to find the best alternative.

The steps of fuzzy VIKOR are as shown below [26]:

Step 1: Generate feasible alternatives, determine the evaluation criteria, and form a group of decision makers. Assume that there are m alternatives, k evaluation criteria, and n decision makers.

Step 2: Define linguistic variables and their corresponding trapezodial fuzzy numbers. Linguistic variables were used to evaluate the importance of the criteria and the ratings of alternatives with respect to various criteria.

Step 3: Integrate decision-makers' preferences and opinions. The decision is derived by aggregating the fuzzy weight of criteria and fuzzy rating of alternatives from n decision-makers

$$\tilde{w}_j = \frac{1}{n}\left[\sum_{e=1}^{n} \tilde{w}_j^e\right],\ j = 1,2,\ldots,k \tag{1}$$

In addition, the preferences and opinions of n decision-makers with respect to j criteria for the important weight of each criteria and the rating of each alternative in the i^th^ alternative can be calculated by

$$\tilde{x}_{ij} = \frac{1}{n}\left[\sum_{e=1}^{n} \tilde{x}_{ij}^e\right],\ i = 1,2,\ldots,m \quad j = 1,2,\ldots,k \tag{2}$$

Step 4: Calculate fuzzy weighted average and construct the (normalized) fuzzy decision matrix

$$\tilde{D} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mk} \end{bmatrix}$$

$$\tilde{W} = \left[\tilde{w}_1, \tilde{w}_2, \ldots, \tilde{w}_k\right],\ j = 1,2,\ldots,k \tag{3}$$

where $\tilde{x}_{ij}$ is the rating of alternative A_i with respect to criterion C_j, and $\tilde{w}_j$ is the important weight of the j^{th} criterion. This study, therefore, denoted linguistic variables $\tilde{x}_{ij}$ and $\tilde{w}_j$ as trapezodial fuzzy numbers.

Step 5: Determine the Fuzzy Best Value (FBV) and fuzzy worst value (FWV):

$$\tilde{f}_j^* = \max_i \tilde{x}_{ij},\ \tilde{f}_j^- = \min_i \tilde{x}_{ij} \tag{4}$$

Step 6: Calculate the values $\tilde{w}_j(\tilde{f}_j^* - \tilde{x}_{ij}) / (\tilde{f}_j^* - \tilde{f}_j^-)$, $\tilde{S}_i$, $\tilde{R}_i$

$$\tilde{S}_i = \sum_{j=1}^{k} \tilde{w}_j(\tilde{f}_j^* - \tilde{x}_{ij}) / (\tilde{f}_j^* - \tilde{f}_j^-) \tag{5}$$

$$\tilde{R}_i = \max_j [\tilde{w}_j(\tilde{f}_j^* - \tilde{x}_{ij}) / (\tilde{f}_j^* - \tilde{f}_j^-)] \tag{6}$$

where $\tilde{S}_i$ is A_i with respect to all criteria calculated by the sum of the distance for the FBV, and $\tilde{R}_i$ is A_i with respect to the j^{th} criteria, calculated by the maximum distance of FBV.

Step 7: Calculate the values $\tilde{S}^*, \tilde{S}^-, \tilde{R}^*, \tilde{R}^-, \tilde{Q}_i$:

$$\tilde{S}^* = \min_i \tilde{S}_i,\ \tilde{S}^- = \max_i \tilde{S}_i$$

$$\tilde{R}^* = \min_i \tilde{R}_i,\ \tilde{R}^- = \max_i \tilde{R}_i \tag{7}$$

$$\tilde{Q}_i = v(\tilde{S}_i - \tilde{S}^*)/(\tilde{S}^- - \tilde{S}^*) + (1-v)(\tilde{R}_i - \tilde{R}^*)/(\tilde{R}^- - \tilde{R}^*) \quad (8)$$

Here, $\tilde{S}^*$ is the minimum value of $\tilde{S}_i$, which is the maximum majority rule or maximum group utility, and $\tilde{R}^*$ is the minimum value of $\tilde{R}_i$, which is the minimum individual regret of the opponent. Thus, the index $\tilde{Q}_i$ is obtained and is based on the consideration of both the group utility and individual regret of the opponent. In addition, v here means the weight of the strategy of the maximum group utility. When v>0.5, the decision tends toward the maximum majority rule; and if v=0.5, the decision tends toward the individual regret of the opponent.

Step 8: Defuzzify triangular fuzzy number $\tilde{Q}_i$ and rank the alternatives, sorting by the value Q_i. There are many defuzzification strategies for converting a fuzzy number into a crisp value. This study utilized the method of maximizing set and minimizing set to defuzzify triangular fuzzy number $\tilde{Q}_i$. The smaller the value Q_i, the better the alternative.

Step 9: Determine a compromise solution. Assume that the two conditions given below are acceptable. Then, by using the index Q_i, determine a compromise solution (a') as a single optimal solution.

1) Acceptable advantage:

$$Q(\mathrm{a}'') - \mathrm{Q}(\mathrm{a}') \geq \mathrm{DQ}$$

$$\mathrm{DQ} = \frac{1}{m-1} \; (\mathrm{DQ} = 0.25 \; if \; m \leq 4) \quad (9)$$

2) Acceptable stability in decision making: under this condition, $Q(\mathrm{a}')$ must be $S(\mathrm{a}')$ or/and $R(\mathrm{a}')$.

Step 10: Select the best alternative. Choose $Q(\mathrm{a}')$ as the best solution with the minimum of Q_i.

Linguistic variables were used to evaluate the importance of the criteria and the ratings of alternatives with respect to various criteria. A trapezoidal fuzzy number can be defined as $\tilde{\mathrm{A}} = (a, b, c, d)$ of crisp numbers with $a < b < c < d$ and membership function $\mathrm{f}_{\tilde{\mathrm{A}}}(\mathrm{x})$ of the fuzzy number $\tilde{\mathrm{A}}$ is given by (see Figure 1) [27]

$$\mathrm{f}_{\tilde{\mathrm{A}}}(\mathrm{x}) = \begin{cases} 0, & x < a \\ (x-a)/(b-a), & a < x < b \\ 1, & b < x < c \\ (x-c)/(d-c), & c < x < d \\ 0, & x < d \end{cases} \quad (10)$$

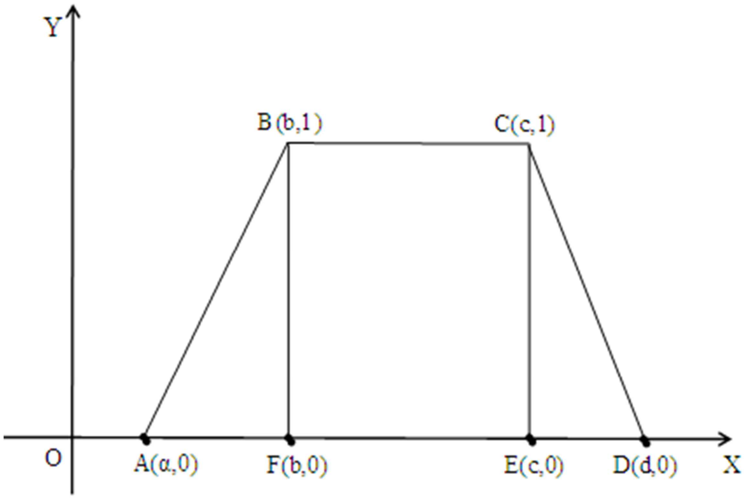

Figure 1. *Membership function of trapezoidal fuzzy number [28].*

If $\tilde{\mathrm{A}} = (a_1, b_1, c_1, d_1)$ and $\tilde{B} = (a_2, b_2, c_2, d_2)$ are two trapezoidal fuzzy numbers, then

$$\tilde{A} \oplus \tilde{B} = (\mathrm{a}_1 + \mathrm{a}_2, b_1 + b_2, c_1 + c_2, d_1 + d_2)$$

$$\tilde{A} \Theta \tilde{B} = (\mathrm{a}_1 - \mathrm{a}_2, b_1 - b_2, c_1 - c_2, d_1 - d_2)$$

$$k\,\tilde{A} = (\mathrm{k\,a}_1, \mathrm{k}\,b_1, \mathrm{k}\,c_1, \mathrm{k}\,d_1); \mathrm{k} > 0$$

$$k\,\tilde{A} = (\mathrm{k\,d}_1, \mathrm{k}\,c_1, \mathrm{k}\,b_1, \mathrm{k}\,a_1); \mathrm{k} < 0$$

are the fuzzy arithmetic operations [29].

3. Application: Determining the Best Alternative

In this paper, the best personnel is determined by using one of the MCDM techniques, the fuzzy VIKOR methodology and type 2 (trapezoidal) fuzzy numbers. The fuzzy VIKOR method provides a rational, systematic process to discover a best solution for a fuzzy multi-criteria decision making problem. The linguistic scales and corresponding trapezoidal fuzzy numbers can be seen in Table 1. Linguistic variables are used to evaluate the importance of the criteria and the ratings of alternatives.

Table 1. *Linguistic scale [27].*

Linguistic terms	Trapezoidal Fuzzy Numbers
Very low	[0, 0, 0.1, 0.2]
Less than half	[0.1, 0.2, 0.2, 0.3]
Low	[0.2, 0.3, 0.4, 0.5]
Medium	[0.4, 0.5, 0.5, 0.6]
Medium high/Medium Great	[0.5, 0.6, 0.7, 0.8]
High/Great	[0.7, 0.8, 0.8, 0.9]
Very high/Very Great	[0.8, 0.9, 1, 1]

22 sub-criteria are identified and classified under 5 main criteria by 5 decision makers from academia and industry as can be seen from Table 2. Based on our study's purpose, four candidate personnel (A_1, A_2, A_3, A_4) are proposed as suitable alternatives to be evaluated by 5 decision making experts (D_1, D_2, D_3, D_4, D_5) according to 22 decision criteria.

Table 2. *Personnel selection criteria.*

Main Criteria		Sub-criteria	
		SC11	Productive Activity
MC1	Activity	SC12	Auxiliary Activity
		SC13	Inefficient Activity
		SC21	Fee Paid
MC2	FEE	SC22	Payable Fee
		SC23	Requested Fee
		SC31	Education Status
		SC32	Foreign Languages
MC3	Education	SC33	Certificates
		SC34	Job Experience
		SC35	Technology Usage
		SC36	Lifelong Learning
		SC41	Self-Confidence
		SC42	Take Initiative
MC4	Internal Factors	SC43	Analytic Thinking
		SC44	Leadership
		SC45	Productivity
		SC46	Decision Making / Problem Solving
		SC51	Compatible with the Team/Communication
MC5	Business Factors	SC52	Teamwork Skills
		SC53	Finishing Work on Time
		SC54	Business Discipline

The decision makers' preferences and opinions are integrated by aggregating the important fuzzy weight of the criteria and the fuzzy ratings of alternatives from 5 decision makers, as shown in Tables 3 and 4.

Table 3. *The importance weight of each criteria.*

	D1	D2	D3	D4	D5
SC11	G	VG	VG	VG	MG
SC12	G	MG	VG	VG	G
SC13	G	MG	VG	VG	G
SC21	G	VG	G	G	G
SC22	G	G	VG	VG	G
SC23	G	G	G	G	MG
SC31	G	G	VG	VG	G
SC32	MG	MG	G	G	G
SC33	G	G	MG	MG	G
SC34	G	VG	MG	MG	MG
SC35	G	MG	MG	MG	MG
SC36	MG	G	G	MG	G
SC41	VG	VG	MG	G	MG
SC42	MG	MG	G	G	G
SC43	G	VG	VG	VG	VG
SC44	G	MG	G	G	G
SC45	VG	G	VG	G	VG
SC46	VG	G	G	VG	G
SC51	MG	G	MG	MG	MG
SC52	MG	MG	MG	G	MG
SC53	MG	MG	MG	MG	MG
SC54	G	MG	G	MG	G

Table 4. *The rating of each alternative under each criteria.*

	D1				D2				D3				D4				D5			
	A1	**A2**	**A3**	**A4**	**A1**	**A2**	**A3**	**A4**	**A1**	**A2**	**A3**	**A4**	**A1**	**A2**	**A3**	**A4**	**A1**	**A2**	**A3**	**A4**
SC11	MH	M	VH	H	MH	MH	H	H	MH	MH	VH	H	H	MH	H	H	MH	H	VH	H
SC12	H	MH	VH	H	H	MH	H	H	H	H	VH	H	VH	H	VH	H	H	MH	VH	H
SC13	MH	H	H	VH	H	M	H	H	H	H	VH	MH	H	H	H	VH	MH	H	H	MH
SC21	MH	H	H	H	VH	H	H	H	MH	MH	H	VH	H	H	H	MH	M	VH	H	H
SC22	H	H	H	VH	MH	MH	H	M	H	H	VH	VH	H	MH	H	M	H	H	VH	VH
SC23	MH	MH	VH	H	H	M	VH	H	MH	H	VH	VH	H	MH	H	H	H	MH	H	VH
SC31	MH	MH	H	H	M	M	H	VH	H	MH	H	H	VH	MH	H	MH	H	VH	H	H
SC32	H	MH	VH	H	MH	M	H	VH	MH	H	MH	H	H	MH	H	VH	MH	M	H	M
SC33	H	MH	H	VH	H	M	VH	H	H	MH	VH	VH	MH	MH	VH	H	H	MH	H	VH
SC34	H	H	H	VH	MH	H	M	MH	H	H	H	MH	VH	H	H	H	MH	MH	M	VH
SC35	MH	H	H	VH	MH	M	H	VH	H	MH	H	H	MH	M	VH	VH	MH	M	VH	H
SC36	M	M	H	H	H	MH	MH	M	MH	MH	M	M	H	H	VH	MH	MH	M	M	H
SC41	FH	H	H	H	MH	M	VH	H	H	H	H	H	MH	MH	VH	H	H	FH	H	H
SC42	H	H	H	VH	VH	MH	H	H	H	MH	M	H	H	H	VH	H	H	MH	H	H
SC43	VH	VH	H	H	VH	H	H	H	MH	MH	H	H	H	VH	H	H	H	MH	H	VH
SC44	H	H	VH	VH	H	H	H	MH	MH	MH	H	H	M	M	H	H	VH	M	MH	MH
SC45	MH	M	VH	H	MH	MH	H	VH	MH	H	H	H	H	M	H	VH	MH	H	VH	H
SC46	VH	VH	H	H	H	H	MH	MH	M	VH	VH	H	H	H	H	MH	MH	VH	H	H
SC51	MH	MH	MH	H	H	H	H	VH	M	H	H	H	H	MH	MH	MH	H	H	H	H
SC52	H	H	H	MH	MH	VH	VH	MH	H	H	H	MH	MH	H	H	H	MH	MH	M	M
SC53	H	H	H	VH	MH	MH	H	VH	MH	H	VH	H	MH	M	H	H	MH	H	VH	H
SC54	H	H	H	H	MH	MH	MH	H	H	H	VH	M	M	M	H	H	MH	MH	MH	H

According to (1-3), the fuzzy weighted average is calculated. Then, the results of the aggregate normalized fuzzy weight of criteria are defuzzified and shown in Table 5. Therefore, the weighted normalized fuzzy decision matrix is constructed and shown in Table 6. In addition, the fuzzy best value (FBV) and fuzzy worst value (FWV) are determined based on (4). Then, FBV and FWV are defuzzified and shown in Table 7.

Table 5. *The aggregate normalized weight of each criteria.*

	Weight
SC11	0.246
SC12	0.247
SC13	0.247
SC21	0.251
SC22	0.250
SC23	0.246
SC31	0.250
SC32	0.248
SC33	0.248
SC34	0.250
SC35	0.251
SC36	0.248
SC41	0.248
SC42	0.248
SC43	0.248
SC44	0.246
SC45	0.249
SC46	0.250
SC51	0.251
SC52	0.251
SC53	0.250
SC54	0.248

Table 6. *The weighted normalized fuzzy decision matrix.*

	A1				**A2**				**A3**				**A4**			
SC11	0.22	0.22	0.23	0.24	0.17	0.21	0.22	0.24	0.30	0.29	0.29	0.27	0.30	0.27	0.26	0.24
SC12	0.27	0.26	0.25	0.26	0.19	0.21	0.22	0.24	0.27	0.28	0.29	0.26	0.27	0.25	0.24	0.24
SC13	0.21	0.23	0.23	0.23	0.29	0.26	0.26	0.26	0.29	0.26	0.26	0.26	0.21	0.24	0.26	0.26
SC21	0.19	0.22	0.23	0.26	0.24	0.26	0.26	0.26	0.33	0.26	0.25	0.23	0.24	0.26	0.26	0.26
SC22	0.24	0.25	0.24	0.24	0.24	0.24	0.24	0.24	0.33	0.27	0.27	0.26	0.19	0.24	0.25	0.26
SC23	0.22	0.24	0.23	0.24	0.17	0.20	0.21	0.24	0.30	0.28	0.28	0.26	0.30	0.28	0.27	0.26
SC31	0.20	0.24	0.25	0.26	0.20	0.22	0.23	0.26	0.35	0.27	0.26	0.23	0.25	0.27	0.26	0.26
SC32	0.28	0.24	0.25	0.24	0.22	0.21	0.21	0.24	0.28	0.27	0.27	0.26	0.22	0.27	0.27	0.26

	A1				A2				A3				A4			
SC33	0.22	0.25	0.24	0.24	0.17	0.19	0.20	0.22	0.30	0.28	0.28	0.27	0.30	0.28	0.28	0.27
SC34	0.26	0.25	0.26	0.26	0.26	0.26	0.25	0.24	0.21	0.23	0.22	0.24	0.26	0.26	0.27	0.26
SC35	0.22	0.22	0.23	0.24	0.17	0.20	0.19	0.24	0.30	0.29	0.28	0.26	0.30	0.29	0.29	0.26
SC36	0.25	0.26	0.26	0.24	0.25	0.23	0.24	0.24	0.25	0.26	0.26	0.27	0.25	0.25	0.24	0.24
SC41	0.22	0.23	0.24	0.24	0.17	0.22	0.22	0.24	0.30	0.28	0.28	0.27	0.30	0.27	0.26	0.24
SC42	0.30	0.27	0.26	0.26	0.22	0.22	0.23	0.23	0.17	0.25	0.24	0.26	0.30	0.27	0.26	0.26
SC43	0.21	0.25	0.26	0.26	0.21	0.24	0.25	0.26	0.29	0.25	0.24	0.23	0.29	0.26	0.25	0.26
SC44	0.22	0.25	0.25	0.26	0.22	0.22	0.22	0.23	0.28	0.27	0.27	0.26	0.28	0.26	0.26	0.26
SC45	0.22	0.22	0.23	0.24	0.17	0.22	0.21	0.24	0.30	0.28	0.28	0.26	0.30	0.28	0.28	0.26
SC46	0.19	0.23	0.23	0.26	0.33	0.28	0.28	0.26	0.24	0.25	0.25	0.26	0.24	0.23	0.23	0.23
SC51	0.21	0.24	0.24	0.24	0.26	0.25	0.25	0.24	0.26	0.25	0.25	0.24	0.26	0.27	0.27	0.27
SC52	0.28	0.24	0.25	0.24	0.28	0.27	0.27	0.26	0.22	0.27	0.26	0.26	0.22	0.22	0.23	0.24
SC53	0.22	0.21	0.23	0.24	0.17	0.23	0.23	0.24	0.30	0.28	0.28	0.26	0.30	0.28	0.28	0.26
SC54	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.29	0.26	0.27	0.27	0.24	0.26	0.25	0.24

Table 7. *Defuzzified best value and defuzzified worst value.*

	f_i^*	f_i^-
SC11	0.290	0.211
SC12	0.284	0.216
SC13	0.268	0.224
SC21	0.273	0.225
SC22	0.290	0.233
SC23	0.284	0.206
SC31	0.281	0.227
SC32	0.271	0.223
SC33	0.285	0.195
SC34	0.264	0.224
SC35	0.287	0.202
SC36	0.260	0.245
SC41	0.286	0.214
SC42	0.275	0.225
SC43	0.267	0.238
SC44	0.268	0.228
SC45	0.283	0.208
SC46	0.290	0.227
SC51	0.267	0.230
SC52	0.271	0.226
SC53	0.281	0.212
SC54	0.280	0.238

By using (5)–(7), the values $\tilde{S}_i$, $\tilde{R}_i$, $\tilde{S}^*$, $\tilde{S}^-$, $\tilde{R}^*$ and $\tilde{R}^-$ are calculated. The value $\tilde{S}^*$ is the minimum value of $\tilde{S}_i$, which is the maximum majority rule and $\tilde{R}^*$ is the minimum value of $\tilde{R}_i$, which is the minimum individual regret of the opponent.

The value $\tilde{S}^-$ is the maximum value of $\tilde{S}_i$ and $\tilde{R}^-$ is the maximum value of $\tilde{R}_i$. Then, the values (S_i, R_i, S^*, S^-, R^*, R^-) are obtained after defuzzifying the values ($\tilde{S}_i$, $\tilde{R}_i$, $\tilde{S}^*$, $\tilde{S}^-$, $\tilde{R}^*$, $\tilde{R}^-$) as shown in Tables 8 and 9.

Table 8. *S_i and R_i.*

m	S_i	R_i
A1	0.174	0.25087
A2	0.193	0.25081
A3	0.046	0.25040
A4	0.082	0.25081

Table 9. *S^*, S^-, R^*, R^-.*

S^*	1.007
S^-	4.248
R^*	0.250
R^-	0.251

With (8), the value $\tilde{Q}_i$ is calculated. The index $\tilde{Q}_i$ is based on the consideration of both the group utility and individual regret of the opponent. Then, the index Q_i is obtained after defuzzifying $\tilde{Q}_i$ as shown in Table 10.

Table 10. *The rating of Q_i and each alternative.*

m	Q_i	Rank
A1	1.000	4
A2	0.973	3
A3	0.000	1
A4	0.369	2

Finally, the solution is determined by (9). The values (Q_i, S_i, R_i) are used to rank the alternatives in Table 11.

Consequently, the smaller the values, the better the alternative. According to the results in Table 11, the best solution is alternative A3. Therefore, the result suggests that A3 would be the best personnel for the firm.

Table 11. *The acceptable ratings.*

Q_i	A3>A4>A2>A1
S_i	A3>A4>A1>A2
R_i	A3>A4=A2>A1

4. Conclusion

The main contribution of this study is to contribute to the literature with a different application using Fuzzy VIKOR Methodology and trapezoidal fuzzy numbers. Trapezoidal fuzzy numbers are more useful and precise to deal with linguistic information in solving personnel selection problems. As a result of the evaluation process, the best alternative is A3. Specifically the results of this study enable firms and even decision-makers to identify a potentially effective alternative for personnel selection. For future researches, the problem could be solved by other MCDM techniques.

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