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Application of Fuzzy Linguistic SAW and TOPSIS Multiple Criteria Group Decision Making Method using Pentagonal Fuzzy Number for Supplier Selection Problem

Research Article*

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Abstract: In this paper, a Multiple Criteria Group Decision Making (MCGDM) technique based on Pentagonal Fuzzy Number and Fuzzy Linguistic SAW-TOPSIS method is used to solve the medical supplier selection problem. The aim of this paper is to develop a methodology which can be take into consideration by some important criteria which affect the process of supplier selection and calculating the weights for each criterion based on SAW and TOPSIS method. The entire methodology is illustrated with the help of a numerical example.

Keywords: Supplier Selection, MCGDM, Linguistic SAW, TOPSIS, Pentagonal Fuzzy Number.

1. Introduction and Preliminaries

There are many multi criteria problems in decision making which have been solved by multi criteria decision making methods. The main goal of MCDM is to find the best alternative decision by quantitative and qualitative criteria. SAW and TOPSIS (The technique for order performance by similarity to ideal solution) are the major techniques in dealing with multiple criteria group decision making problems. It simultaneously considers both the shortest distance from the positive ideal solution (PIS) and the farthest distance from the negative ideal solution (NIS) and preference order is ranked according to their relative closeness combining two distance measures. The result of this study indicates that the supplier selection and evaluation is a multiple criteria group decision making process that is, typically more than one criteria need is to be considered and evaluated in the best supplier.

Definition 1.1 (Pentagonal Fuzzy Number)**.** *A Pentagonal fuzzy number $\tilde{A}_p = (a, b, c, d, e)$. Where a, b, c, d and e are real numbers and its membership function is given below,*

$$\mu_{\tilde{A}_P}(x) = \begin{cases} 0, & for\ x < a, \\ \frac{(x-a)}{(b-a)}, & for\ a \le x \le b \\ \frac{(x-b)}{(c-b)}, & for\ b \le x \le c \\ 1, & for\ x = c \\ \frac{(d-x)}{(d-c)}, & for\ c \le x \le d \\ \frac{(e-x)}{(e-d)}, & for\ d \le x \le e. \end{cases} \quad (1)$$

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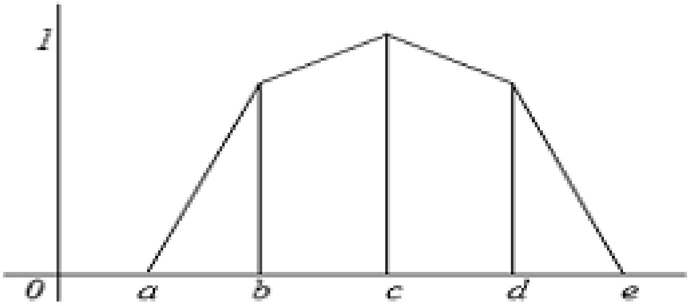
Definition 1.2 (Graphical Representation (The Graph of pentagonal fuzzy number))**.**



Definition 1.3 (Arithmetic operation on pentagonal fuzzy number)**.** *Let $\tilde{A}$ and $\tilde{B}$ be two positive pentagonal fuzzy numbers $\tilde{A} = (a_1, a_2, a_3, a_4, a_5)$ and $\tilde{B} = (b_1, b_2, b_3, b_4, b_5)$ some algebraic operations can be expressed as follows [9],*

Scalar Summation:

$$A \oplus B = [a_1 + b_1, a_2 + b_2, a_3 + b_3, a_4 + b_4, a_5 + b_5] \quad (2)$$

Scalar Subtraction:

$$A \ominus B = [a_1 - b_1, a_2 - b_2, a_3 - b_3, a_4 - b_4, a_5 - b_5] \quad (3)$$

Scalar Multiplication:

$$A \otimes B = [a_1 b_1, a_2 b_2, a_3 b_3, a_4 b_4, a_5 b_5] \quad (4)$$

Scalar Division:

$$A(\div)B = [a_1/b_1, a_2/b_2, a_3/b_3, a_4/b_4, a_5/b_5] \quad (5)$$

Operator Max :

$$A \vee B = [a_1 \vee b_1, a_2 \vee b_2, a_3 \vee b_3, a_4 \vee b_4, a_5 \vee b_5] \quad (6)$$

Operator Min:

$$A \wedge B = [a_1 \wedge b_1, a_2 \wedge b_2, a_3 \wedge b_3, a_4 \wedge b_4, a_5 \wedge b_5] \quad (7)$$

Definition 1.4 (Distance between the fuzzy pentagonal numbers)**.** *Let $\tilde{a} = (a_1, a_2, a_3, a_4, a_5)$ and $\tilde{b} = (b_1, b_2, b_3, b_4, b_5)$ be two pentagonal fuzzy numbers then the distance between them is computed as*

$$d(\tilde{a}, \tilde{b}) = \sqrt{\frac{1}{5}((a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2 + (a_4 - b_4)^2 + (a_5 - b_5)^2)}$$

2. SAW Method

Simple Additive weighting (SAW) is a simple and most often used multi attribute decision technique. This method is based on the weighted average. An evaluation score is calculated for each alternative by multiplying fuzzy number value given to the alternative of that attribute with the weights of relative importance directly assigned by decision maker followed by summing of the products for all criteria. Let D_N, $N = (1, 2, 3, \ldots, t)$ be the committee of various decision makers. The C_j $(j = 1, 2, 3, \ldots, n)$ and A_i $(i = 1, 2, 3, \ldots, m)$ are criteria and alternatives respectively. The f_{ij} is a value of j^{th} criteria for the i^{th} alternatives. The basic principle of SAW is to obtain a weighted sum of the performance ratings of each alternative under all attributes. Process of SAW consist of these steps.

Step 1: Arranging the committee of decision making group and defined a finite set of criteria and alternatives.

Step 2: Describing the Linguistic variables. These Linguistic variable are expressed by pentagonal fuzzy numbers. Here the suitable linguistic variables for evaluating the weights of criteria and the fuzzy ratings of alternatives.

Step 3: Calculate the fuzzy weight of each criteria with following equation

$$w_j = \frac{1}{N}[w_j^{(1)} + w_j^{(2)} + \ldots + w_j^{(t)}]. \tag{8}$$

Also calculate the fuzzy ratings of each alternative with following equation

$$x_{ij} = \frac{1}{N}[x_j^{(1)} + x_j^{(2)} + \ldots + x_j^{(t)}] \tag{9}$$

Step 4: Compute the fuzzy decision matrix. The fuzzy decision matrix for the alternative ($\tilde{D}$) and the criteria ($\tilde{W}$) is constructed as follows

$$\tilde{D} = \begin{array}{c} \\ A_1 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{ccc} C_1 & \ldots & C_n \end{array} \\ \begin{pmatrix} \tilde{x}_{11} & \ldots & \tilde{x}_{1n} \\ \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \ldots & \tilde{x}_{mn} \end{pmatrix} \end{array}$$

$$\tilde{w} = (\widetilde{w_1}, \widetilde{w_2}, \ldots, \widetilde{w_n})$$

Step 5: Normalize the fuzzy decision matrix. The normalized fuzzy decision matrix $\tilde{R}$ is given by $\tilde{R} = [\tilde{r}_{ij}]_{m\times n}$, $i = 1, 2, \ldots, n$, $j = 1, 2, \ldots, m$, where

$$\tilde{r}_{ij} = x_{ij}/(\max x_{ij}) \tag{10}$$

and x_{ij} is the element of the decision matrix $\tilde{D}$ which represents the original value of the j^{th} criteria of the i^{th} alternative.

Step 6: Compute the weight normalized matrix. The weight normalized matrix $\tilde{V}$ for criteria is computed by multiplying the weights ($\tilde{W}_j$) of evaluation criteria with the normalized fuzzy decision matrix $\tilde{r}_{ij}$. $\tilde{V} = [\tilde{V}_{ij}]_{m\times n}$, $i = 1, 2, 3, \ldots, n$, $j = 1, 2, 3, \ldots, m$, where

$$\tilde{V}_{ij} = \sum \tilde{r}_{ij}(\cdot) w_j \quad \text{for } i = 1, 2, 3, \ldots, n, \quad j = 1, 2, 3, \ldots, m \tag{11}$$

Step 7: Rank the alternatives. Finally then the alternative with the highest value is selected as the preferred (best) one.

3. Numerical Example

A case study conducted in a medical field for demonstrating the application of the proposed decision making method. In this problem the five supplies: Viki (A_1), Bellman (A_2), Sanchez (A_3), Mani (A_4), Krishna (A_5) and five benefit criteria: relationship with customers (C_1), reliability (C_2), experience (C_3), delivery (C_4), management (C_5). A committee of five decision makers D_1, D_2, D_3, D_4, D_5 is constructed for the selection of best or suitable supplier.The proposed fuzzy linguistic SAW method is utilized to solve the MCDGM problem with the following steps:

Step 1: Form a committee of decision makers and then describing a finite set of criteria and alternative. In this problem, the five criteria C_1, C_2,. . . , C_5 and five alternatives A_1, A_2,. . . ,A_5 and five decision makers D_1, D_2,. . . ,D_5.

Step 2: Five decision makers use the linguistic variables such as very low, low, medium low, medium, medium high, high and very high are given in Table 1 and 2 to assess the weight of five criteria is given in Table 3. The fuzzy decision matrices are given in Table 4.

	D_1	D_2	D_3	D_4	D_5
C_1	ML	M	MH	H	ML
C_2	H	VH	M	MH	VH
C_3	VH	H	VH	MH	H
C_4	L	ML	M	VL	L
C_5	M	H	ML	MH	ML

Table 1: Linguistic variables for weight of each criteria

Very poor (VP)	(0.00,0.00,0.00,0.00,0.10)
Poor (P)	(0.00,0.00,0.10,0.20,0.30)
Medium Poor (MP)	(0.10,0.20,0.30,0.40,0.50)
Fair (F)	(0.30,0.40,0.50,0.60,0.70)
Medium Good (MG)	(0.50,0.60,0.70,0.80,0.90)
Good (G)	(0.70,0.80,0.90,1.00,1.00)
Very Good (VG)	(0.90,1.00,1.00,1.00,1.00)

Table 2: Linguistic variables for the ratings

Very Low (VL)	(0.00,0.00,0.00,0.00,0.10)
Low (L)	(0.00,0.00,0.10,0.20,0.30)
Medium Low (ML)	(0.10,0.20,0.30,0.40,0.50)
Medium (M)	(0.30,0.40,0.50,0.60,0.70)
Medium High (MH)	(0.50,0.60,0.70,0.80,0.90)
High (H)	(0.70,0.80,0.90,1.00,1.00)
Very High(VH)	(0.90,1.00,1.00,1.00,1.00)

Table 3: The weight of the criteria

C_1	C_2	C_3	C_4	C_5
(0.34,0.44,0.54,0.64,0.72)	(0.66,0.72,0.82,0.88,0.92)	0.7,0.76,0.86,0.92,0.94)	(0.08,0.12,0.2,0.28,0.38)	(0.38,0.48,0.58,0.68,0.76)

Table 4: The ratings of the 5 candidates by decision makers under all criteria

Step 3: The linguistic variables are converted into pentagonal fuzzy number. The fuzzy weights of C_1, C_2,..., C_5 are computed by using the equation (8).

Step 4: Construct decision matrix by using the equation (9).

	C_1	C_2	C_3	C_4	C_5
A_1	(0.38,0.48,0.58,0.68,0.76)	(0.46,0.56,0.66,0.76,0.82)	(0.54,0.64,0.72,0.8,0.84)	(0.58,0.68,0.76,0.84,0.9)	(0.56,0.64,0.72,0.8,0.84)
A_2	(0.32,0.4,0.5,0.6,0.68)	(0.5,0.6,0.68,0.76,0.82)	(0.5,0.6,0.68,0.76,0.82)	(0.34,0.44,0.54,0.64,0.72)	(0.36,0.52,0.6,0.68,0.76)
A_3	(0.62,0.72,0.8,0.88,0.92)	(0.66,0.76,0.82,0.88,0.92)	(0.58,0.68,0.76,0.84,0.9)	(0.42,0.52,0.62,0.72,0.8)	(0.34,0.52,0.54,0.64,0.74)
A_4	(0.38,0.48,0.58,0.68,0.76)	(0.5,0.6,0.7,0.8,0.86)	(0.42,0.52,0.6,0.68,0.74)	(0.48,0.56,0.64,0.72,0.76)	(0.36,0.44,0.54,0.64,0.7)
A_5	(0.5,0.6,0.68,0.76,0.82)	(0.46,0.56,0.64,0.72,0.8)	(0.38,0.44,0.5,0.56,0.64)	(0.44,0.52,0.6,0.68,0.74)	(0.78,0.88,0.94,1.00,1.00)

Table 5: Fuzzy decision matrix

Step 5: Compute normalized decision matrix by using the equation (10)

	C_1	C_2	C_3	C_4	C_5
A_1	(0.61,0.66,0.72,0.77,0.82)	(0.69,0.73,0.80,0.86,0.89)	(0.93,0.94,0.94,0.95,0.98)	(1.00,1.00,1.00,1.00,1.00)	(0.71,0.72,0.76,0.8,0.84)
A_2	(0.51,0.55,0.56,0.68,0.73)	(0.75,0.78,0.82,0.86,0.89)	(0.86,0.88,0.89,0.90,0.91)	(0.58,0.64,0.76,0.76,0.8)	(0.46,0.59,0.63,0.68,0.76)
A_3	(1.00,1.00,1.00,1.00,1.00)	(1.00,1.00,1.00,1.00,1.00)	(1.00,1.00,1.00,1.00,1.00)	(0.72,0.76,0.81,0.85,0.88)	(0.43,0.59,0.57,0.64,0.74)
A_4	(0.62,0.66,0.72,0.77,0.82)	(0.75,0.88,0.85,0.90,0.93)	(0.72,0.76,0.78,0.80,0.82)	(0.82,0.82,0.84,0.85,0.87)	(0.46,0.5,0.57,0.64,0.7)
A_5	(0.80, 0.83,0.84,0.86,0.89)	(0.69,0.73,0.78,0.81,0.86)	(0.65,0.69,0.65,0.66,0.71)	(0.75,0.76,0.78,0.80,0.82)	(1.00,1.00,1.00,1.00,1.84)

Table 6: The Fuzzy normalized decision matrix

Step 6: Compute weighted normalized decision matrix by using the equation (11)

	C_1	C_2	C_3	C_4	C_5
A_1	1.981	3.227	3.981	1.06	2.247
A_2	1.694	3.323	3.730	0.793	1.868
A_3	2.68	4	4.2	0.83	1.779
A_4	1.981	3.539	3.28	0.894	1.714
A_5	2.290	3.201	2.78	0.849	2.88

Table 7: Weighted normalized decision matrix

Step 7: Rank the alternatives.

S_1	S_2	S_3	S_4	S_5
12.49	11.408	13.549	11.407	12.016

Table 8: Raked personnel

Finally in SAW method, the best supplier is S_3 and then S_2, S_5, S_4 and S_1 will be follow.

4. TOPSIS Method

TOPSIS method was introduced for the first time by Yoon and Hwang and was appraised by surveyors and different operations. TOPSIS is a decision making technique and it is a goal based approach for finding the alternative that is closed to the ideal solution. The TOPSIS approach choose the alternative that is closest to the positive ideal solution and farthest from the negative ideal solution. Fuzzy TOPSIS has been applied to supplier selection problems. The various steps of fuzzy TOPSIS are presented as follows. Let D_N, $N = (1, 2, 3, \ldots, t)$ be the committee of various decision makers. The C_j $(j = 1, 2, 3, \ldots, n)$ and $A_i = (i = 1, 2, 3, \ldots, m)$ represent the different criteria and alternatives respectively. The f_{ij} is a value of j_{th} criteria for the i_{th} alternatives.

Step 1: Assuming the ratings to the criteria and the alternative. Let us assume there are A_i candidates $A = (A_1, A_2, A_3, \ldots, A_i)$, which are to be evaluated against m criteria $C = (C_1, C_2, C_3, \ldots, C_m)$. The weights are denoted by W_j $(j = 1, 2, 3, \ldots, m)$. The performance ratings of each decision maker O_N $(N = 1, 2, 3, \ldots, t)$ for each alternative A_i $(i = 1, 2, 3, \ldots, n)$ with respect to criteria C_j $(j = 1, 2, 3, \ldots, m)$ are denoted by $\tilde{R}_k = \tilde{X}_{ijk}$ $(i = 1, 2, 3, \ldots, n, \quad j = 1, 2, 3, \ldots, m, \quad k = 1, 2, 3, \ldots, t)$

Step 2: The Linguistic variables expressed by pentagonal fuzzy numbers. Here the suitable linguistic variables are used for evaluating the weight of criteria and the fuzzy rating of alternatives

Step 3: Calculate the fuzzy weight of each criteria with following equation.

$$W_j = \frac{1}{N}[W_j^{(1)} + W_j^{(2)} + \ldots + W_j^{(t)}]. \tag{12}$$

Also calculate the fuzzy ratings of each alternative with following equation

$$X_{ij} = \frac{1}{N}[X_j^{(1)} + X_j^{(2)} + \ldots + X_j^{(t)}] \tag{13}$$

Step 4: Compute the fuzzy decision matrix. The fuzzy decision matrix for the alternative $(\tilde{D})$ and the criteria $(\tilde{W})$ is constructed as follows

$$\tilde{D} = \begin{matrix} & C_1 & \ldots & C_n \\ A_1 & \tilde{x}_{11} & \ldots & \tilde{x}_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ A_m & \tilde{x}_{m1} & \ldots & \tilde{x}_{mn} \end{matrix}$$

$$\tilde{w} = (\widetilde{w_1}, \widetilde{w_2}, \ldots, \widetilde{w_n})$$

Step 5: Normalized the fuzzy decision matrix. The normalized fuzzy decision matrix $\tilde{R}$ is given by

$$\tilde{R} = [\tilde{r}_{ij}]_{m \times n},\ i = 1, 2, \ldots, n,\ j = 1, 2, \ldots, m,\ \text{where } \tilde{r}_{ij} = \left(\frac{a_{ij}}{e_j^*}, \frac{b_{ij}}{e_j^*}, \frac{c_{ij}}{e_j^*}, \frac{d_{ij}}{e_j^*} \frac{e_{ij}}{e_j^*}\right) \tag{14}$$

and $e_j^* = \max e_{ij}$ (benefit criteria) $\tilde{r}_{ij} = \left(\frac{a_j^-}{e_{ij}}, \frac{a_j^-}{d_{ij}}, \frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right)$, where $a_j^- = \min a_{ij}$ (cost criteria).

Step 6: Compute the weighted normalized matrix. The weighted normalized matrix $\tilde{V}$ for criteria is computed by multiplying the weights $(\tilde{W}_j)$ of evaluation criteria with the normalized fuzzy decision matrix $\tilde{r}_{ij}$.

$$\tilde{V} = [\tilde{V}_{ij}]_{m\times n},\ i = 1,2,3,\ldots,n,\ j = 1,2,3,\ldots,m \text{ where } \tilde{V}_{ij} = \tilde{V}_{ij}(\cdot)\tilde{w}_j \tag{15}$$

Step 7: Compute the fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solution (FNIS) it follow that,

$$A^+ = (\tilde{P}_1^+,\ \tilde{P}_2^+,\ \ldots,\ \tilde{P}_n^+),\ \text{where } \tilde{P}_i^+ = \max\{V_{ij}\} \tag{16}$$

$$A^+ = (\tilde{P}_1^-,\ \tilde{P}_2^-,\ \ldots,\ \tilde{P}_n^-),\ \text{where } \tilde{P}_i^- = \min\{V_{ij}\} \tag{17}$$

Where $\tilde{V}_{ij} = \tilde{r}_{ij}(\cdot)\tilde{w}_j$ is the normalized weighted matrix $V = [\tilde{V}_{ij}]_{m\times n}$.

Step 8: Compute distance from each alternative let d_{ij}^+ and d_{ij}^- be distance from alternative to the ideal solution (or) (negative ideal solution). Distance of V_{ij} to P_j^+ and P_j^- respectively, therefore

$$d_{ij}^+ = d(\tilde{V}_{ij},\ P_j^+) \text{ and } d_{ij}^- = d(\tilde{V}_{ij}, P_j^-) \tag{18}$$

Step 9: compute the closeness coefficient (CC_i) of each alternative: The closeness coefficients (CC_i) represents the distances to the FPIS and FNIS simultaneously and hence closeness coefficient of each alternative is calculated as:

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-},\quad i = 1,2,\ldots,n$$

Step 10: Rank the alternatives. Finally, rank all the alternatives A_i according to the closeness coefficient in decreasing order.

5. Numerical Example

A case study conducted in a medical field for demonstrating the application of the proposed decision making method. In this problem the five supplies are Rame (A_1), Tamizh (A_2), Selvan (A_3), Kumaran (A_4), Dhivan (A_5) and five benefit criteria are relationship with customers (C_1), reliability (C_1), experience (C_3), delivery (C_4) management (C_5). A committee of five decision makers D_1, D_2, D_3, D_4, D_5 is constructed for the selection of best or suitable supplier. The proposed fuzzy linguistic TOPSIS method is utilized to solve the MCDGM problem with the following steps Compute normalized decision matrix Using Table 5

Step 5: Compute normalized decision matrix by using the equation (14)

	C_1	C_2	C_3	C_4	C_5
A_1	(0.41,0.52,0.63,0.73,0.82)	(0.5,0.60,0.71,0.82,0.89)	(0.6,0.71,0.78,0.88,0.93)	(0.64,0.75,0.84,0.93,1)	(0.56,0.64,0.72,0.8,0.84)
A_2	(0.34,0.43,0.54,0.65,0.73)	(0.54,0.65,0.73,0.82,0.89)	(0.55,0.66,0.75,0.84,0.91)	(0.37,0.48,0.6,0.71,0.8)	(0.36,0.52,0.6,0.68,0.76)
A_3	(0.67,0.78,0.86,0.95,1)	(0.71,0.82,0.89,0.95,1)	(0.64,0.75,0.84,0.93,1)	(0.46,0.57,0.68,0.8,0.88)	(0.34,0.52,0.54,0.64,0.74)
A_4	(0.41,0.52,0.63,0.73,0.82)	(0.54,0.65,0.76,0.86,0.93)	(0.46,0.57,0.66,0.75,0.82)	(0.53,0.62,0.71,0.8,0.84)	(0.36,0.44,0.54,0.64,0.7)
A_5	(O.54,0.65,0.73,0.82,0.89)	(0.5,0.60,0.69,0.78,0.86)	(0.42,0.48,0.55,0.62,0.71)	(0.48,0.57,0.66,0.75,0.82)	(0.78,0.88,0.94,1,1)

Table 9: The Fuzzy normalized decision matrix

Step 6: Compute the weighted normalized matrix by using equation (15)

	C_1	C_2	C_3	C_4	C_5
A_1	(0.13,0.22,0.34,0.46,0.59)	(0.33,0.43,0.58,0.72,0.81)	(0.42,0.53,0.67,0.80,0.87)	(0.05,0.09,0.16,0.26,0.38)	(0.21,0.30,0.41,0.54,0.63)
A_2	(0.11,0.18,0.29,0.41,0.52)	(0.35,0.46,0.59,0.72,0.81)	(0.38,0.50,0.64,0.77,0.85)	(0.02,0.05,0.12,0.19,0.30)	(0.13,0.24,0.34,0.46,0.57)
A_3	(0.22,0.38,0.46,0.60,0.72)	(0.46,0.59,0.72,0.83,0.92)	(0.44,0.57,0.72,0.85,0.94)	(0.03,0.06,0.13,0.22,0.33)	(0.12,0.24,0.31,0.43,0.56)
A_4	(0.13,0.22,0.34,0.46,0.59)	(0.35,0.46,0.62,0.75,0.85)	(0.32,0.43,0.56,0.69,0.77)	(0.04,0.07,0.14,0.22,0.31)	(0.13,0.21,0.31,0.43,0.53)
A_5	(0.18,0.28,0.32,0.52,0.64)	(0.33,0.43,0.56,0.68,0.79)	(0.29,0.36,0.47,0.57,0.66)	(0.03,0.06,0.13,0.21,0.31)	(0.29,0.42,0.54,0.68,0.76)

Table 10:

Step 7: Calculate FPIS and FNIS by using formula (16) and (17)

$P_1^+ =$	(0.22,0.38,0.46,0.60,0.72)	$P_1^- =$	(0.11,0.18,0.29,0.41,0.52)
$P_2^+ =$	(0.46,0.59,0.72,0.83,0.92)	$P_2^- =$	(0.33,0.43,0.56,0.68,0.79)
$P_3^+ =$	(0.44,0.57,0.72,0.85,0.94)	$P_3^- =$	(0.29,0.36,0.47,0.57,0.66)
$P_4^+ =$	(0.05,0.09,0.16,0.26,0.38)	$P_4^- =$	(0.02,0.05,0.12,0.19,0.30)
$P_5^+ =$	(0.29,0.42,0.54,0.68,0.76)	$P_5^- =$	(0.12,0.21,0.31,0.43,0.53)

Step 8: The distance measurement

$d_1^+ =$	0.4206	$d_1^- =$	0.4121
$d_2^+ =$	0.5965	$d_2^- =$	0.2214
$d_3^+ =$	0.2434	$d_3^- =$	0.6024
$d_4^+ =$	0.6565	$d_4^- =$	0.2156
$d_5^+ =$	0.52332	$d_5^- =$	0.3242

Step 9: Calculate the $CC_i = \frac{d_i^-}{d_i^+ + d_i^-}$

$CC_1 =$	0.4948
$CC_2 =$	0.2709
$CC_3 =$	0.7122
$CC_4 =$	0.2472
$CC_5 =$	0.3825

The candidate A_3 is best supplier rather than the candidate A_1, A_2, A_3, A_4 and A_5.

6. Conclusion

In this paper, we study the integration of fuzzy linguistic SAW and TOPSIS with the support of pentagonal fuzzy number. The proposed SAW and TOPSIS method is a ground decision makers to rank the candidate alternative more efficiently and easily. The verified example concerning the supplier selection shows that the SAW and TOPSIS method is very useful for the selection of best alternatives.

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