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Application of Fuzzy TOPSIS Technique for Evaluation of Project

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Abstract: The evaluation and selection of industrial projects before investment decision is often done by using marketing, technical and financial information. Financial assessment is commonly done using engineering economics techniques, but each technique has advantages and limitations in itself. On the other hand, in financial assessment, some of input data such as cash flow and interest rate may be uncertain and imprecise. For solving these problems, we propose a new method for the project selection problem. In this paper, four common methods of comparing alternative investments (Net Present Value, Rate of Return, Benefit Cost Analysis and Payback Period) are used as criteria in TOPSIS technique to obtain an aggregative assessment of criteria for projects. At first, by using a verbal variable, weight of each criterion in the form of a fuzzy number is defined and by using the optimistic, likely and pessimistic estimations, fuzzy desirability of projects based on any criterion is obtained. Then, by utilizing fuzzy theory based-TOPSIS, assessment of projects is done. A numerical example was used to illustrate how the proposed model works.

Key words: Fuzzy theory . financial assessment . net present value . payback period . rate of return . benefit-cost analysis

INTRODUCTION

The evaluation and selection of industrial projects is a very important task in investment companies. The project proposals may be intended for strategic R&D planning (selection of directions, topics, or projects); the development of new commercial products; the management and the implementation of organizational change; the management, the development and the implementation of information technology, etc. There is a comprehensive literature dedicated to the project selection problem that includes several approaches with taking into account various aspects of the given problem. Strategic purpose of the project, factors for the project selection and various qualitative and quantitative project selection models have been discussed by Meredith and Mantle [1]. A brief review of proposed models for project selection is presented.

Danila [2] and Shpak and Zaporojan [3] surveyed a number of the project selection methodologies and discussed several multi-criteria aspects of the problem. Khorramshahgole and Steiner [4] used goal programming associated to a Delphi process for finding the utility map. Chu *et al*. [5] used a heuristic method based on the fuzzy logic for ranking projects. Fasanghari and Habibipour [6] developed a fuzzy system that selects the best of ICT projects by using a fuzzy integer linear programming and the interaction with the user. Ahmadi [7] implemented an approach for optimal project selection with the interaction with the user. Ghasemzadeh *et al*. [8] and Ghasemzadeh and Archer [9] proposed a zero-one integer linear programming model for selecting and scheduling an optimal project portfolio, based on the organization's objectives and constraints. Wang and Hwang [10] formulated the R&D portfolio selection problem as a fuzzy zero-one integer programming model that could handle both uncertain and flexible parameters to determine the optimal project portfolio. Haroonabadi *et al*. [11] used fuzzy integer linear programming for strategic portfolio selection. A new transformation method based on qualitative possibility theory was developed to convert the fuzzy portfolio selection model into a crisp mathematical model from the risk-averse perspective. The transformed model could be solved by an optimization technique. Gabriel *et al*. [12] formulated a multi-objective, integer-constrained optimization model with competing objectives for the project selection by using probability distributions in order to describe costs. Analytical hierarchy process (AHP) has been used by many authors to resolve decision-making issues in the project selection [13-17]. Since AHP fails to address the issue of interdependencies among and between different levels of attributes, Probjot kaur and Mahanti [18] used Analytic Network Process (ANP) for selection of the

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best enterprise resource planning vendor alternative by using a dynamic multi-directional relationship among the decision attributes. They also equipped ANP with fuzzy logic for overcoming the impreciseness or vagueness in the preferences. Eddie *et al*. [19] applied the Analytic Network Process (ANP) to deal with interdependent relationships within a multi-criteria decision making (MCDM) model. Mohanty *et al*. [20] illustrated an application of the fuzzy ANP along with the fuzzy cost analysis in selecting R&D projects. The technique for order preference by similarity to ideal solution (TOPSIS) also is used by Jadidi *et al*. [21] Chen and Tzeng [22].

As it is understood from the literature, most of proposed models have considered the project evaluation and selection problem with uncertain and imprecise input data and as a multi-attribute decision making problem. In our proposed model we select the best project based on financial assessment. However, we use a fuzzy approach to represent uncertain and imprecise input data and also we use TOPSIS technique to obtain an aggregative assessment of criteria (Net Present Value (NPV), Rate of Return (ROR), Benefit Cost Analysis (B/C) and Payback Period (PB)) that represents a multi-attribute decision making problem. Financial assessment is commonly done by using engineering economics techniques. Engineering economics is the specialized study of financial and economic aspects of the industrial decision making. The role of engineering economics is to assess the desirability of a given project, estimate its value and justify it from an engineering point of view. There are four common methods of comparing alternative investments: (1) Net Present Value, (2) Rate of Return, (3) Benefit Cost Analysis and (4) Payback Period.

In our methodology, by using a verbal variable, weight of each criterion (economics engineering technique: NPV, ROR, B/C, PB) in the format of triangular fuzzy numbers is defined. Then, the optimistic, likely and pessimistic estimations of projects are obtained by each criterion. Using these estimations, we form the triangular fuzzy numb ers such that indicate fuzzy desirability of projects based on any criterion. Finally the accumulated fuzzy desirability is obtained by the fuzzy TOPSIS technique. The fuzzy TOPSIS is a fuzzy extension of TOPSIS to handle the fuzziness of the data involved in the decision making efficiently. The technique is easy to understand and it can handle both qualitative and quantitative data in the multi-attribute decision making (MADM) problems.

Other sections of the article are as follows: In section two, the fuzzy theory as well as defuzzing a fuzzy number are mentioned. In Section three, methodology is presented. We present an example for the model in section four. Finally, concluding remarks are provided in Section five.

FUZZY THEORY AND DEFUZZING A FUZZY NUMBER

Fuzzy sets theory was proposed formally by Lotfi Asgarzadeh at first. He discussed the theory in Control and Information Journal in 1969. The theory has been expanded and deepened a lot since its first appearance and has been applied in many areas.

In the fuzzy sets, the degree of membership is unclear, such as, the set of people who are tall or the set of high numbers. Asgarzadeh analyzed the fuzzy sets by allocating membership degree in range of [0, 1] to the members. If *U* is a reference set with some members (x), a fuzzy set in *U* is shown by using ordered pairs, such that

$$A = \{(x, \mu_A(x)) | x \in U\}$$

Where, $\mu_A(x)$ is a membership function or degree of membership which offers how much (x) belongs to fuzzy set of *A*. The function range includes none-negative real numbers having a maximum and normally it is considered as a closed range [0, 1]. It is an important note that there is no certain way to determine the membership function and it is mostly experimental and perceptual.

A convex and normal fuzzy set, such as *A* with the range of real numbers of *R* is a real fuzzy number if:

- There is only one $x_0 \in R$ for which we have $\mu_A(x)=1$
- Membership function of $\mu_A(x)$ is a continuous one.

Working with Fuzzy numbers due to their proper structure is time consuming and complicated. Proper fuzzy numbers are used to facilitate the calculations. They include bell form, triangular, trapezoid, triangular L-R and trapezoid L-R forms. We use triangular fuzzy numbers in this study because of their simple form in calculation. A triangular fuzzy number is shown as three ordered items (*l, m, u*) (Fig. 1) in which *l* and *u* are lower and upper bounds, *m* is the mean and (x) is between *l* and *u*.

Membership of fuzzy numbers is like Equation (1)

$$\mu_A(x) = \begin{cases} \dfrac{x-l}{m-l} & l < x < m \\ 1 & x = m \\ \dfrac{u-x}{u-m} & m < x < u \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

In the some of references, the triangular fuzzy number, *A* is shown as three ordered items (α, m, β) or (m, α, β) that *m* is mean, α and β are left wide side and right wide side of *A* respectively.

With the use of the profile concept, we can create a relation between normal and fuzzy set as follows. The members of *U* whose degree of membership in fuzzy set of *A* is at least a are called "profile-a" and are shown by A_α:

$$A_\alpha = \{x \in U | \mu_A(x) \geq \alpha\}$$

Robust profile of a or a robust set in a level is defined as follows:

$$A_\alpha = \{x \in U | \mu_A(x) > \alpha\}$$

To change a fuzzy number into a certain value, there are various methods, such as: gravity center, maximum membership function, giving score to left and right side of a fuzzy number, so on. Since in this study we use scoring to the left and right side of the fuzzy number, we explain its details.

In this method, the exact total score of a fuzzy number of *A* is obtained from adding left and right scores of A. The left and right scores, in turn, are obtained from two specific sets of min and max and membership degree of fuzzy number.

With this assumption that the range of fuzzy numbers is [0,1], Min and max sets are defined as follows:

$$\mu_{min}(x) = \begin{cases} 1-x; & 0 \leq x \leq 1 \\ 0; & \text{otherwise} \end{cases} \quad (2)$$

$$\mu_{max}(x) = \begin{cases} x; & 0 \leq x \leq 1 \\ 0; & \text{otherwise} \end{cases} \quad (3)$$

Where the left side score of *A* is obtained by Equation (4):

$$\mu_L(x) = \text{SUP}[\mu_{min}(x) \wedge \mu_x(x)] \quad (4)$$

And the right side score of *A* is obtained by Equation (5):

$$\mu_R(x) = \text{SUP}[\mu_{max}(x) \wedge \mu_x(x)] \quad (5)$$

After obtaining these scores, we can measure the total score by Equation (6) which is used as a determined and exact score.

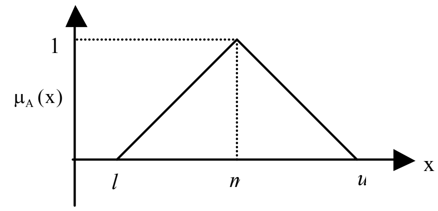

Fig. 1: Triangular fuzzy numbers

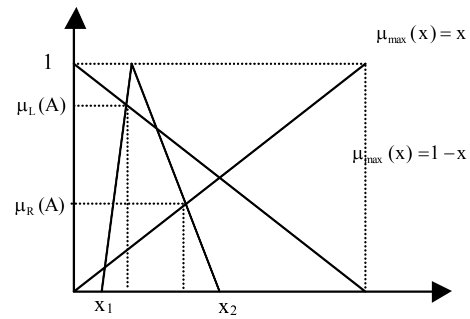

Fig. 2: The graphical form of the right and left side scores

$$\mu_T(x) = \frac{\mu_R(x) + 1 - \mu_L(x)}{2} \quad (6)$$

A triangular fuzzy number, such as A = (α, m, β) is given. Fig. 2 shows the right and left scores graphically. The membership function of fuzzy number of *A* is in the form of Equation (7):

$$\mu_A(x) = \begin{cases} \frac{x-(m-\alpha)}{\alpha}; & m-a < x < m \\ \frac{(m+\beta)-x}{\beta}; & m < x < m+\beta \end{cases} \quad (7)$$

The right and left side scores of a fuzzy number of *A* are given by Equation (8) [23]:

$$\begin{aligned} \frac{x_1-(m-\alpha)}{\alpha} &= 1-x_1 \Rightarrow x_1 = \frac{m}{1+\alpha} \Rightarrow \mu_L(A) \\ &= 1-x_1 = 1-\frac{m}{1+\alpha} \\ \frac{(m+\beta)-x_2}{\beta} &= x_2 \Rightarrow x_2 = \frac{m+\beta}{1+\beta} \Rightarrow \mu_R(A) \\ &= x_2 = \frac{m+\beta}{1+\beta} \end{aligned} \quad (8)$$

MATERIALS AND METHODS

The technique for order preference by similarity to ideal solution (TOPSIS) was first developed by Hwang and Yoon [24], based on the concept that the chosen alternative should have the shortest distance from the

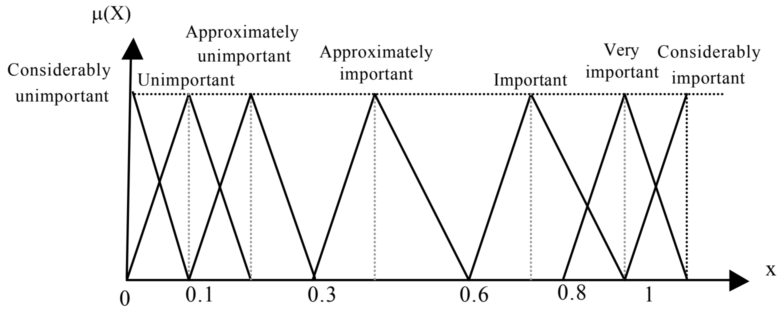

Fig. 3: The membership function of verbal variable for the criteria

Positive Ideal Solution (PIS) and the farthest from the Negative Ideal Solution (NIS) for solving a multiple criteria decision making problem. In short, the ideal solution is composed of all best values attainable of criteria, whereas the negative ideal solution is made up of all worst values attainable of criteria. In the proposed approach, four methods, NPV, ROR, B/C, PB, are considered as criteria to evaluate projects as alternatives. The proposed methodology includes three steps:

Step 1: By using a verbal variable, the weight of each criterion in the format of triangular fuzzy number can be defined (Fig. 3). For example if NPV is important for a project selection problem, its weight will be (0.6, 0.7, 0.9).

Step 2: The optimistic, likely and pessimistic estimations of projects are obtained by each criterion. The optimistic, likely and pessimistic estimations are applied as *l, m, u* in a triangular fuzzy number respectively. We must normalize the fuzzy numbers of the estimations before using them for fuzzy TOPSIS. For this purpose, at first we gain the fuzzy mean of each criterion for projects. Then, we divide the fuzzy numbers of the estimations of projects by the fuzzy mean of each criterion. By considering the criteria, we understand that if NPV, B/C or ROR increase for a project, the probability of choosing the project increase too, but if PB increase this probability decrease. Therefore we use the inverse of PB for evaluation of projects. After normalizing the fuzzy numbers of the estimations, we can consider Table 1.

Step 3: The obtained results are used as input data in a fuzzy TOPSIS technique. In this step, a TOPSIS-based model is presented. In this model, desirability of a project in the fuzzy form is obtained. For this purpose in different profiles, the right and left distance of any fuzzy number from ideal value (best) and non-ideal desirability (worst) are measured and this is the standard measuring of desirability of a project.

Table 1: Fuzzy based value of each criterion and optimistic, likely and pessimistic normalized estimations for projects using each criterion

Fuzzy weighted criterion	Project 1	Project 2	…….. Project *n*
(ρ_1, y_1, γ_1)	$(\alpha_{11}, r_{11}, \beta_{11})$	$(\alpha_{12}, r_{12}, \beta_{12})$	……. $(\alpha_{1n}, r_{1n}, \beta_{1n})$
(ρ_2, y_2, γ_2)	$(\alpha_{21}, r_{21}, \beta_{21})$	$(\alpha_{22}, r_{22}, \beta_{22})$	…..... $(\alpha_{2n}, r_{2n}, \beta_{2n})$
.	.	.	.
.	.	.	.
(ρ_m, y_m, γ_m)	$(\alpha_{m1}, r_{m1}, \beta_{m1})$	$(\alpha_{m2}, r_{m2}, \beta_{m2})$	……. $(\alpha_{mn}, r_{mn}, \beta_{mn})$

Table 2: The weight of each criterion in the form of a triangular fuzzy number

Criterion	Importance	Fuzzy number
ROR	Important	(0.6,0.8,0.9)
PB	Approximately unimportant	(0.1,0.2,0.3)
NPV	Very important	(0.8,0.9, 1)
B/C	Approximately important	(0.3,0.4,0.6)

Following steps are designed to obtain desirability of projects, using a fuzzy TOPSIS method:

- Fuzzy multiplying the weight of each criterion (w_i) by the value of criterion for each project (r_{ij}) according to Table 2:

$$N_{ij} = R_{ij} \otimes W_i$$

Where N_{ij} is a triangular fuzzy number as follows:

$$N_{ij} = (\alpha_{ij}, r_{ij}, \beta_{ij}) \otimes (\rho_i, y_i, \gamma_i)$$
$$= (\alpha_{ij}.y_i + r_{ij}.\rho_i, r_{ij}. y_i, \beta_{ij}.y_i + r_{ij}\gamma_i)$$

- Choosing the profile of α_0.
- Calculating following real numbers for each project and then producing matrix of L_α and R_α:

$$x_{ij}^- = \min\{x_{ij} \in R \,|\, \mu_{Nij}(x_{ij}) \geq \alpha_0\}$$
$$x_{ij}^+ = \max\{x_{ij} \in R \,|\, \mu_{Nij}(x_{ij}) \geq \alpha_0\}$$

The resulted matrix from x_{ij}^{-} is called L_{α_0} (i.e., meeting point of profile α_0 with left side equation of fuzzy number).

The resulted matrix from x_{ij}^{+} is called R_{α_0} (i.e., meeting point of profile α_0 with right side equation of fuzzy number).

The ideal and non-ideal solutions for matrixes of L_{α_0} and R_{α_0} due to *n* projects (j=1,2,……..*n*), *m* criteria (i=1,2,………*m*), are defined as follows:

Ideal solution for L_{α_0}:

$$A^{+}_{L_{\alpha_0}} = \{(\max_j x_{ij}^{-}) \big| j=1,2,...,n\} = \{x_1^{-+}, x_2^{-+}, x_1^{-+},...,x_m^{-+}\}$$

Non ideal solution for L_{α_0}:

$$A^{-}_{L_{\alpha_0}} = \{(\min_j x_{ij}^{-}) \big| j=1,2,...,n\} = \{x_1^{--}, x_2^{--}, x_1^{--},...,x_m^{--}\}$$

Ideal solution for R_{α_0}:

$$A^{+}_{R_{\alpha_0}} = \{(\max_j x_{ij}^{+}) \big| j=1,2,...,n\} = \{x_1^{++}, x_2^{++}, x_1^{++},...,x_m^{++}\}$$

Non ideal solution for R_{α_0}:

$$A^{-}_{R_{\alpha_0}} = \{(\min_j x_{ij}^{+}) \big| j=1,2,...,n\} = \{x_1^{+-}, x_2^{+-}, x_1^{+-},...,x_m^{+-}\}$$

- Calculating the distance of the projects of each matrix from its ideal or non-ideal solution by using the following equations:

The distance of project (j) of L_{α_0} from the ideal solution

$$dL_j^{+} = \left[\sum_{i=1}^{m}(x_{ij}^{-} - x_i^{-+})^2\right]^{\frac{1}{2}}, j=1,2,...,n$$

The distance of project (j) of L_{α_0} from the non ideal solution:

$$dL_j^{-} = \left[\sum_{i=1}^{m}(x_{ij}^{-} - x_i^{--})^2\right]^{\frac{1}{2}}, j=1,2,...,n$$

The distance of project (j) of R_{α_0} from the ideal solution:

$$dR_j^{+} = \left[\sum_{i=1}^{m}(x_{ij}^{+} - x_i^{++})^2\right]^{\frac{1}{2}}, j=1,2,...,n$$

The distance of project (j) of R_{α_0} from the non ideal solution:

$$dR_j^{-} = \left[\sum_{i=1}^{m}(x_{ij}^{+} - x_i^{+-})^2\right]^{\frac{1}{2}}, j=1,2,...,n$$

- Calculating proportional closeness to the ideal solution of L_{α_0} and R_{α_0} for project (j) by using the following equations:

$$C^*L_j = \frac{dL_j^{-}}{dL_j^{+} + dL_j^{-}} j=1,2,...,n$$

$$C^*R_j = \frac{dR_j^{-}}{dR_j^{+} + dR_j^{-}} j=1,2,...,n$$

- Fuzzy desirability U_j in α_0 profile is defined as follows:

$$U_j = \{(C^*L_j,\alpha_0),(C^*R_j,\alpha_0)\}, \text{if } C^*L_j < C^*R_j$$
$$U_j = \{(C^*R_j,\alpha_0),(C^*L_j,\alpha_0)\}, \text{if } C^*L_j > C^*R_j$$

In other words, the right and left side value of fuzzy desirability U_j is obtained using C^*L_j and C^*R_j.

In the TOPSIS model, the priority depends on proportional closeness of each alternative to the ideal solution. That is why the sixth step equation is used. Since in our proposed method, the left and right distances of any fuzzy number from the ideal and non-ideal solutions are used to measure desirability of projects, the above equations are used as the left and right sides of the fuzzy desirability. By creating various profiles and repeating Steps (2) to (6), the fuzzy desirability for all projects is produced.

In proposed approach, the fuzzy desirability for all of projects is produced. For exact and certain priority of projects, it is necessary to rank them. For this purpose, we apply the right and left sides scoring method of the fuzzy number.

With attending to problem structure and the fuzzy desirability of projects, if the fuzzy number of desirability of project be more slanted to right, it is worthier and better. Therefore, it is better to use a method that gives more score to projects that their fuzzy number of desirability is more slanted to right.

NUMERICAL EXAMPLE

In this section we use an example to illustrate how the proposed model works. Assume that a management wants to choose the best project amongst all proposed projects. Based on the proposed methodology, three

Table 3: The optimistic, likely and pessimistic estimations for each project based on each criterion

	Project 1	Project 2	Project 3	Project 4	Project 5
ROR	(21, 24, 25)	(24,25,26)	(18,20,24)	(19,21,24)	(18,20,23)
NPW	(8165,71340,85800)	(80815,84475,85480)	(85000,87275,89470)	(81500,82320,83000)	(90245,91548,94370)
B/C	(1.2,1.6,1.75)	(1.55,1.7,1.9)	(1.35,1.6,1.7)	(1.3,1.7,1.85)	(1.3,1.5,1.6)
PB	(3.5,4,5)	(4,5,6)	(2.5,3,4.5)	(2,4,4.5)	(1.5,3,4)

Table 4: Matrix *N*

	Project 1	Project 2	Project 3	Project 4	Project 5
ROR	(0.47, 0.87, 1.11)	(0.56,0.91,1.15)	(0.41,0.73,1.05)	(0.43,0.76,1.06)	(0.41,0.73,1.01)
NPW	(0.61,0.77,1.04)	(0.73,0.91,1.05)	(0.77,0.94,1.10)	(0.74,0.89,1.02)	(0.82,0.99,1.16)
B/C	(0.17,0.49,0.72)	(0.25,0.42,0.78)	(0.21,0.40,0.70)	(0.19,0.42,0.76)	(0.20,0.37,0.66)
PB	(0.10,0.18,0.37)	(0.09,0.15,0.30)	(0.14,0.25,0.48)	(0.24,0.35,0.58)	(0.32,0.44,0.48)

Table 5: Matrix R_α

Project	1	2	3	4	5
ROR	1.06	1.10	0.99	1.00	0.95
NPW	0.98	1.02	1.07	0.99	1.12
B/C	0.65	0.71	0.64	0.69	0.60
PB	0.33	0.27	0.43	0.34	0.43

Table 6: Matrix L_α

Project	1	2	3	4	5
ROR	0.55	0.63	0.47	0.50	0.47
NPW	0.65	0.77	0.80	0.77	0.85
B/C	0.22	0.28	0.25	0.24	0.24
PB	0.18	0.16	0.21	0.14	0.15

Table 7: $A^+_{L_{\alpha_0}}$, $A^-_{L_{\alpha_0}}$, $A^+_{R_{\alpha_0}}$, $A^-_{R_{\alpha_0}}$

	ROR	NPW	B/C	PB
$A^+_{L_{\alpha_0}}$	0.63	0.85	0.28	0.21
$A^-_{L_{\alpha_0}}$	0.47	0.65	0.22	0.15
$A^+_{R_{\alpha_0}}$	1.10	1.12	0.71	0.43
$A^-_{R_{\alpha_0}}$	0.95	0.98	0.60	0.27

steps are applied for evaluation and selection of projects.

In step 1, Table 2 presents the weight of each criterion in the form of a triangular fuzzy number by using a verbal variable.

In step 2, Table 3 shows the optimistic, likely and pessimistic estimations as fuzzy numbers for each project based on each criterion. Before using these fuzzy numbers, it is necessary to normalize them as it was discussed in the methodology section.

In step 3, by fuzzy multiplying the weight of each criterion by the normalized value of the criterion for each project, matrix *N* is gained (Table 4). Obtained results for L_α, R_α in Table 5 and 6 for $\alpha_0 = 0.2$; for $A^+_{L_{\alpha_0}}$, $A^-_{L_{\alpha_0}}$, $A^+_{R_{\alpha_0}}$ and $A^-_{R_{\alpha_0}}$ in Table 7 and for dR^-_j , dR^+_j , dL^-_j and dL^+_j in Table 8 have been mentioned respectively. Finally the fuzzy desirability for each project has shown in the Table 9.

Table 8: dR^-_j , dR^+_j , dL^-_j , dL^+_j

Project	1	2	3	4	5
dL^+_j	0.36	0.31	0.26	0.20	0.16
dL^-_j	0.08	0.21	0.19	0.22	0.36
dR^+_j	0.18	0.19	0.15	0.19	0.18
dR^-_j	0.14	0.19	0.19	0.12	0.22

Table 9: Desirability of projects in the form of fuzzy and exact numbers

	Fuzzy desirability	Certain desirability
Project 1	$U_1 = \{0.185,0.2),(0.734,0.2)\}$	0.362
Project 2	$U_2 = \{0.403,0.2),(0.489,0.2)\}$	0.467
Project 3	$U_3 = \{0.414,0.2),(0.560,0.2)\}$	0.532
Project 4	$U_4 = \{0.390,0.2),(0.528,0.2)\}$	0.493
Project 5	$U_5 = \{0.544,0.2),(0.587,0.2)\}$	0.652

For ranking the projects, we apply the right and left side scoring method of the fuzzy number. The result of ranking is shown in the Table 9. We can produce various profiles and consider that the ranking of projects don't change.

CONCLUSION

Selection of a project from a set of possible alternatives is a difficult task that the decision maker (DM) has to face. Financial assessment is one of the most important assessments for project selection problem that is commonly done by using the engineering economics techniques. In this paper, we proposed a new methodology to provide a simple approach to assess alternative projects financially and help the decision maker to select the best one. By using four common methods of comparing alternative investments as criteria in a TOPSIS technique, we supported project selection decisions to obtain an aggregative assessment of criteria. On the other hand by using fuzzy numbers for weight of each criterion and fuzzy desirability of projects based on any criterion and by utilizing fuzzy theory based-TOPSIS, assessment of projects was done. The model by using fuzzy theory supports the uncertain and imprecise data for project selection problem and by using TOPSIS technique supports project selection problem as multi-attribute decision making problem. We used the proposed model for a numerical example of project selection. For future research, we can change the criteria of project section as well as the fuzzy TOPSIS model can be applied for other problems in decision making.

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