Evaluation of Risks in Construction Project

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***Abstract*—Construction projects are the most important sector in countries because of the essentiality of nation security, public safety, socioeconomic security, and way of life. According to the importance of construction project, it is a necessity to analyse the potential risks to do not allow these risks convert into events. The primary objective of this paper is to identify and rank the risks in construction project. A case study of dam construction is presented to demonstrate the applicability and performance of the proposed model. We have proposed a hierarchical structure for ranking risk in dam construction projects. The proposed structure can consider dependence among the different criteria. According to the complexity of problem and the inherent uncertainty, this research adopts the fuzzy TOPSIS as a fuzzy multi criteria decision making technique to determine the weights of each criterion and the importance of alternatives with respect to criteria. The proposed method is a suitable approach when performance ratings and weights are vague and imprecise.**

Keywords—Risk, Fuzzy TOPSIS method, Dam construction, Risk Ranking.

I. INTODUCTION

Risk is defined as an uncertain event or condition that has a potential effect on project objective. To avoid such problems, managers are obliged to carry out a risk management program. It involves approaches, including the identification, evaluation and control of risk.

Dam construction projects are of especial importance regarding in-time completion and assigned funds because of their importance in operation size and large investment. It is exposed to various risks and uncertainties like underground conditions, natural disasters, high cost of construction, labour problems, social and political problems. The critical success for a dam construction project is the efficient and effective allocation of project risks. So, identification, evaluation of these risk and representations of solutions for obviating them have great benefits for timely completion of project.

The risks involved in a project cannot be directly quantified or given a monetary value in decision-making process. Decision making in construction projects is a complicated process, and in most cases the value for each criterion is determined carelessly by decision makers. Moreover, in many cases criteria are examined by linguistic variables such as; Very low, Low, Medium, High and Very high. Quantifications of these linguistic variables using fuzzy logic will provide a more realistic approach for evaluation of a construction project. These ambiguities necessitate the use of fuzzy logic in the risk evaluation.

"Technique for Order Preference by Similarity to Ideal Solution" (TOPSIS) method is widely used to solve multi criteria decision making problems. This method assigns the best alternative among a pool of feasible alternatives. On the other hand, fuzzy logic is a helpful tool in the presence of uncertainty and complexity. Many times, dam construction projects find themselves involved in the situation where unexpected conditions threaten the continuation of project. To overcome these limitations management always looks for a reliable technique. Therefore the use of TOPSIS method under fuzzy environment in order to evaluate the existing risk in dam construction project can be useful.

In [1] the author has mentioned the Overview of the Application of fuzzy techniques in construction management research in the recent years. In [2] the author use the fuzzy multiple attribute decision making for evaluating aggregate risk in green manufacturing. In [3] the author has given the definitions of linguistic variables as author said that it will useful for all the construction projects. The author Adel Hatami-Marbini and Saber Saati [2] apply the fuzzy TOPSIS method performed in order to obtain the alternative priorities so that organizations are able to make strategically appropriate decisions an example is given to highlight the procedure of the proposed method. Sadoullah Ebrahimnejad et al. in [8] use the fuzzy TOPSIS method for ranking the risks in Build-Operate –Transfer project and compared this method with Fuzzy Linear Programming Technique for Multidimensional Analysis of Preference (FLINMAP) method.

II. FUZZY TOPSIS METHOD

A. Fuzzy set theory

Fuzzy set theory is suitable for uncertain or vague information that involves human intuitive thinking.

Definition 1: A fuzzy set $\tilde{a}$ in a universe of discourse X is characterized by a membership function $\mu\tilde{a}(x)$ that maps each element x in X to a real number in the interval [0, 1]. The function value $\mu_{\tilde{a}}(x)$ is termed the grade of membership of x in $\tilde{a}$. The nearer the value of $\mu_{\tilde{a}}(x)$ to unity indicate the higher the grade of membership of x in $\tilde{a}$.

B. Fuzzy numbers

Triangular fuzzy numbers are likely to be the most adoptive ones because of their simplicity in modeling and ease of interpretation.

Definition 2: A triangular fuzzy number is represented as a triplet $\tilde{a} = (a_1, a_2, a_3)$ .The membership function $\mu_{\tilde{a}}(x)$ of triangular fuzzy number $\tilde{a}$ is given as:

$$\mu_{\tilde{a}}(x) = \begin{cases} \frac{x-a_1}{a_2-a_1} & \text{if } a_1 < x < a_2 \\ \frac{a_3-x}{a_3-a_2} & \text{if } a_2 < x < a_3 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

where a_1, a_2, a_3 are the real numbers.

Definition 3: Let $\tilde{a} = (a_1, a_2, a_3)$ and $\tilde{b} = (b_1, b_2, b_3)$ be two triangular fuzzy numbers. The distance between them is given using the vertex method by:

$$d(\tilde{a}, \tilde{b}) = \sqrt{\frac{1}{3}[(a_1 - b_2)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2]} \quad (2)$$

C.Linguistic variables

The fuzzy linguistic variables are a variable whose values are words or sentence in a natural language. It helps experts to evaluate the importance of the criteria and to rate the alternatives with respect to various criteria. In fuzzy set theory conversion scales are applied to transform the linguistic terms in to fuzzy numbers. For the proposed work, we have applied a scale of 1 to 9 for rating the criteria and the alternatives (risks). The values of the triangular fuzzy number that we have chosen for the linguistic variables are taking in to account the fuzziness and the distance among the variables. TABLE I shows linguistic variables used for importance weight of each criterion and preference rating of each alternative in decision process.

TABLE I. LINGUISTIC VARIABLES AND TRIANGULAR NUMBERS

Linguistic variable	Fuzzy number
Very low (VL)	(1,1,3)
Low (L)	(1,3,5)
Medium(M)	(3,5,7)
High (H)	(5,7,9)
Very High (VH)	(7,9,9)

D. Fuzzy TOPSIS method

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was one of the classical methods, first developed by Hwang and Yoon for solving a MCDM problem where in the process of TOPSIS the performance ratings and the weights of the criteria were given as crisp values. C.T.Chen extended the concept of TOPSIS to develop a methodology for solving multi person multi criteria decision making problems in fuzzy environment. In fuzzy TOPSIS, the fuzziness in the decision data and group decision-making process is considered. In addition, linguistic variables are used to assess the weights of all criteria and the performance ratings of each alternative strategy with respect to each criterion.

The detailed description of fuzzy TOPSIS method is as follows;

Let's say the decision group has K members. If the fuzzy rating and importance weight of the kth decision maker, about the ith alternative on jth criterion, are:

$\tilde{x}_{ij}^k = (a_{ij}^k, b_{ij}^k, c_{ij}^k)$ and $\tilde{w}_j^k = (w_{j1}^k, w_{j2}^k, w_{j3}^k)$ respectively, where i=1, 2,…,m and j=1,2,…,n then, the aggregated fuzzy weights $(\tilde{w}_{ij})$ of each criterion are calculated as

$\tilde{w}_j^k = (w_{j1}, w_{j2}, w_{j3})$ where:

$$w_{j1} = \min_k\{w_{jk1}\}, w_{j2} = \frac{1}{k}\sum_{k=1}^{k} w_{jk2}, \quad w_{j3} = \max_k\{w_{jk3}\} \quad (3)$$

The aggregated fuzzy ratings $\tilde{x}_{ij}$ of alternatives (i) with respect to each criterion (j) are given by $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ such that:

$$a_{ij} = \min_k\{a_{ij}^k\}, b_{ij} = \frac{1}{k}\sum_{k=1}^{k} b_{ij}^k, c_{ij} = \max_k\{c_{ij}^k\} \quad (4)$$

A fuzzy multicriteria group decision making (GDM) problem can be expressed in matrix format as:

$$\tilde{D} = \begin{matrix} & \begin{matrix} C_1 & C_2 & & C_n \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ \\ A_m \end{matrix} & \begin{pmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \dots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \dots & \tilde{x}_{2n} \\ \dots & \dots & \tilde{x}_{ij} & \dots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \dots & \tilde{x}_{mn} \end{pmatrix} \end{matrix}$$

(5)

$$\tilde{W} = (\tilde{w}_1, \tilde{w}_2, \dots, \tilde{w}_n) \quad (6)$$

where $\tilde{x}_{ij}$,i=1,2,…,m; j=1,2,…,n and $\tilde{w}_j$, j=1,2,…,n are linguistic triangular fuzzy numbers, $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ and $\tilde{w}_j = (w_{j1}, w_{j2}, w_{j3})$. $\tilde{x}_{ij}$ is the performance rating of the ith alternative A_i with respect to the jth criterion C_j and $\tilde{w}_j$ represent the weight of the jth criterion C_j.

The linear scale transformation is used to transform various criteria scales in to comparable scale. The normalization method preserves the property that the ranges of normalized triangular fuzzy numbers belong to [0, 1].The normalized fuzzy decision matrix denoted by $\tilde{R}$ as,

$$\widetilde{R} = [\tilde{r}_{ij}]_{m\times n} \quad (7)$$

where,

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \quad \text{and}$$
$$c_j^* = \max_i c_{ij} \quad \text{(for benefit criteria)} \quad (8)$$

$$\tilde{r}_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right) \quad \text{and}$$
$$a_j^- = \min_i a_{ij} \quad \text{(for cost criteria)} \quad (9)$$

The cost type criteria mean the lower; the better and benefit type criteria mean the higher, the better.

The weighted normalized fuzzy decision matrix $\widetilde{V}$ is computed by multiplying the weights ($\widetilde{w}_j$) of evaluation criteria with the normalized fuzzy decision matrix $\tilde{r}_{ij}$ as:

$$\widetilde{V} = [\tilde{v}_{ij}]_{m\times n}, i = 1,2,\ldots,m; \quad j = 1,2,\ldots,n$$
(10)

where, $\tilde{v}_{ij} = \tilde{r}_{ij} (.) \widetilde{w}_j$

The basic concept of TOPSIS is that the chosen alternative should have the shortest distance from the positive-ideal solution and the farthest distance from the negative-ideal solution. The FPIS and FNIS of the alternatives are defined as follows,

$$A^* = (\tilde{v}_1^*, \tilde{v}_2^*, \ldots, \tilde{v}_n^*) \quad (11)$$

where,

$$\tilde{v}_j^* = \max_i\{v_{ij3}\}, \quad i = 1,2,\ldots,m; \quad j = 1,2,\ldots,n$$

$$A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \ldots, \tilde{v}_n^-) \quad (12)$$

where,

$$\tilde{v}_j^- = \min_i\{v_{ij1}\}, \quad i = 1,2,\ldots,m; \quad j = 1,2,\ldots,n$$

The distance (d_i^* and d_i^-) of each weighted alternative i = 1, 2, . . . , m from the FPIS and the FNIS is computed as follows,

$$d_i^* = \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^*), \quad i = 1,2,\ldots,m \quad (13)$$

$$d_i^- = \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^-), \quad i = 1,2,\ldots,m \quad (14)$$

where $d_v(\tilde{a}, \tilde{b})$ is the distance measurement between two fuzzy number $\tilde{a}$ and $\tilde{b}$.

The closeness coefficient CC_i represents the distances to fuzzy positive ideal solution, A^* and the fuzzy negative ideal solution, $A-$ simultaneously. The closeness coefficient of each alternative is calculated as:

$$CC_i = \frac{d_i^-}{d_i^- + d_i^*}, \quad i = 1,2,\ldots,m \quad (15)$$

The alternative with highest closeness coefficient represents the best alternative and is closest to the FPIS and farthest from the FNIS.

III. EVALUATION OF RISKS

Evaluation of risk is a part of risk management which can help decision makers to rank the existing risks. In this part we have evaluate the risks in dam construction project.. The evaluation of risks in dam construction project using fuzzy TOPSIS method has following stages:

1. Identify the existing risks associated with dam construction project.
2. Select the evaluation criteria.
3. Develop hierarchical structure of problem.
4. Evaluate the identified risks using fuzzy TOPSIS method

A. Identification of risks

In this research, risks are identified with help of data collection through on-field observation and consultation with dam construction project experts and respective officers. For this purpose a questionnaire is prepared and distributed to the number of officers working in the irrigation department of Maharashtra government. From the collected risks we have selected the important risks for further evaluation.

B.Selection of criteria

In this study, I have selected the appropriate criteria and sub-criteria. These criteria and sub-criteria are determined using review of literature. Obviously, based on real world condition, the proposed model is capable of considering the different criteria. The selected criteria are;

1. Risk probability of occurrence (C_1): the likelihood that each specific risk will occur.
2. Risk impact: the potential effect on a project objective. It is divided to three sub-criteria cost impact (C_2), time impact (C_3) and quality impact (C_4). As Figure shows, these sub-criteria are dependent. The arrows represent the inner-dependence among the sub-criteria.
3. Risk detection (C_5): the ease of detecting a given risk.

The Risk probability of occurrence (C_1), cost impact (C_2), time impact (C_3), quality impact (C_4) all are cost criteria (lesser the better) and Risk detection (C_5) is benefit criteria (larger the better).

C. Hierarchical structure of problem

The hierarchical structure of the problem presents the objective of the problem with the criteria and alternatives.

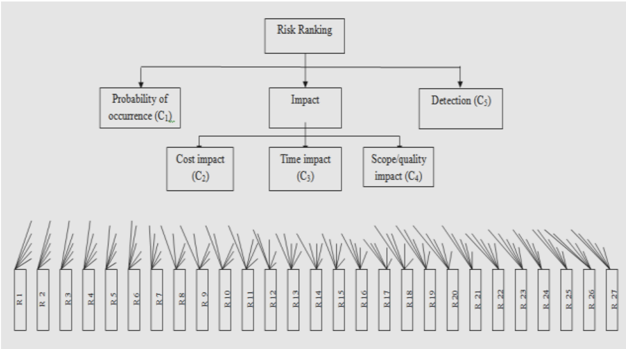

Fig.1. Hierarchical structure of problem

D. Evaluation of risks using fuzzy TOPSIS method

A team five decision makers i.e. experts working on the proposed dam site was formed. The five DMs express their opinions on the importance weights of the five criteria and the ratings of each alternative strategy with respect to the all criteria independently in terms of linguistic variables for this purpose we were used the questionnaire forms.

TABLE II IMPORTANCE WEIGHTS OF THE CRITERIA BY FIVE DMS

Criteria	DM_1	DM_2	DM_3	DM_4	DM_5
Probability of occurrence(C_1)	VL	L	VL	L	VL
Cost impact(C_2)	VH	VH	VH	VH	VH
Time impact(C_3)	VH	VH	VH	VH	VH
Scope/quality impact(C_4)	H	VH	H	VH	H
Detection(C_5)	M	M	M	H	M

TABLE III RATINGS OF ALTERNATIVE (RISKS) WITH RESPECT TO CRITERIA BY THE FIVE DMS

Risks	Probability of occurrence(C1)					Cost impact(C2)					Time Impact(C3)					Scope/quality impact(C4)					Detection(C5)				
	D1	D2	D3	D4	D5	D1	D2	D3	D4	D5	D1	D2	D3	D4	D5	D1	D2	D3	D4	D5	D1	D2	D3	D4	D5
R1	VL	VL	VL	VL	VL	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	H	VH	VH	VH	VH	M	L	L	L	VL
R2	L	L	L	L	VL	H	H	VH	H	VH	H	H	H	H	H	M	H	VH	H	VH	M	M	M	M	M
R3	L	L	L	L	L	H	H	H	H	H	H	H	VH	H	VH	H	H	H	H	H	H	H	H	H	H
R4	VH	VH	VH	VH	VH	VH	VH	H	H	VH	VH	VH	VH	VH	VH	VL	VL	VL	VL	VL	VH	VH	VH	VH	VH
R5	VH	VH	VH	VH	VH	VH	VH	VH	H	H	VH	VH	VH	VH	VH	VL	VL	VL	VL	VL	VH	VH	VH	VH	VH
R6	M	M	M	M	M	H	H	H	H	H	VH	VH	VH	VH	VH	VL	VL	VL	VL	VL	M	M	M	M	M
R7	H	H	H	H	H	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VL	VL	VL	VL	VL	M	M	M	M	M
R8	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VL	VL	VL	VL	VL	M	M	M	M	M
R9	M	M	M	M	M	L	L	L	L	L	M	M	M	M	M	VL	VL	VL	VL	VL	VH	VH	VH	VH	VH
R10	VL	VL	VL	VL	VL	M	M	M	M	M	H	H	H	H	H	M	M	M	M	M	H	H	H	H	H
R11	VL	VL	VL	VL	VL	H	H	H	H	H	H	H	H	H	H	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH
R12	H	L	L	M	M	M	M	M	M	H	H	H	H	H	H	L	L	L	M	L	M	M	M	M	M
R13	M	M	M	M	M	H	H	H	H	H	M	M	M	M	M	L	L	L	L	L	M	M	M	M	M
R14	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	M	M	M	M	M	M	M	H	H	M
R15	H	H	H	H	H	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	M	M	M	M	M	L	L	L	L	L
R16	H	M	H	H	M	H	H	H	H	H	M	H	M	H	H	L	L	M	L	H	L	L	VL	VL	L
R17	M	M	L	M	L	M	M	L	M	L	L	VL	VL	L	VL	VH	VH	VH	VH	VH	M	M	M	M	M
R18	M	M	M	M	M	M	M	M	M	M	H	H	H	H	H	M	M	M	M	M	M	M	M	M	M
R19	H	H	H	H	H	M	M	M	M	M	M	M	M	M	M	L	L	L	L	L	M	M	M	M	M
R20	H	H	H	H	H	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	M	M	M	M	M	L	M	M	M	L
R21	H	H	H	H	H	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	M	M	M	M	M	M	M	M	M	M
R22	H	H	H	H	H	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	M	M	M	M	M	L	M	L	L	M
R23	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	M	M	M	H	M	H	H	H	H	H
R24	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
R25	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VH	VL	M	M	L	L
R26	H	H	H	H	H	L	L	L	L	L	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M

From the TABLE II and using "3" calculate the aggregated fuzzy weights $(\tilde{w}_{ij})$of each criterion. Construct the fuzzy decision matrix from table 3 and using "4" as shown in TABLE IV.

TABLE IV FUZZY DECISION MATRIX

	C1	C2	C3	C4	C5
R1	(1, 1, 3)	(7, 9, 9)	(7, 9, 9)	(5, 8.6, 9)	(1, 3, 7)
R2	(1, 2.6, 5)	(5, 7.8, 9)	(5, 7, 9)	(3, 7.4, 9)	(3, 5, 7)
R3	(1, 3, 5)	(5, 7, 9)	(5, 7.8, 9)	(5, 7, 9)	(5, 7, 9)
R4	(7, 9, 9)	(5, 8.2, 9)	(7, 9, 9)	(1, 1, 3)	(7, 9, 9)
R5	(7, 9, 9)	(5, 8.2, 9)	(7, 9, 9)	(1, 1, 3)	(7, 9, 9)
R6	(3, 5, 7)	(5, 7, 9)	(7, 9, 9)	(1, 1, 3)	(3, 5, 7)
R7	(5, 7, 9)	(7, 9, 9)	(7, 9, 9)	(1, 1, 3)	(3, 5, 7)
R8	(7, 9, 9)	(7, 9, 9)	(7, 9, 9)	(1, 1, 3)	(3, 5, 7)
R9	(3, 5, 7)	(1, 3, 5)	(3, 5, 7)	(1, 1, 3)	(7, 9, 9)
R10	(1, 1, 3)	(3, 5, 7)	(5, 7, 9)	(3, 5, 7)	(5, 7, 9)
R11	(1, 1, 3)	(5, 7, 9)	(5, 7, 9)	(7, 9, 9)	(7, 9, 9)
R12	(1, 5, 9)	(3, 5, 7)	(5, 7, 9)	(1, 3.4, 7)	(3, 5, 7)
R13	(3, 5, 7)	(5, 7, 9)	(3, 5, 7)	(1, 3, 5)	(3, 5, 7)
R14	(7, 9, 9)	(7, 9, 9)	(7, 9, 9)	(3, 5, 7)	(3, 5.8, 9)
R15	(5, 7, 9)	(7, 9, 9)	(7, 9, 9)	(3, 5, 7)	(1, 3, 5)
R16	(3, 6.2, 9)	(5, 7, 9)	(3, 5.8, 9)	(1, 4.2, 9)	(1, 2.2, 5)
R17	(1, 4.2, 7)	(1, 4.2, 7)	(1, 1.8, 5)	(7, 9, 9)	(3, 5, 7)
R18	(3, 5, 7)	(3, 5, 7)	(5, 7, 9)	(3, 5, 7)	(3, 5, 7)
R19	(5, 7, 9)	(3, 5, 7)	(3, 5, 7)	(1, 3, 5)	(3, 5, 7)
R20	(5, 7, 9)	(7, 9, 9)	(7, 9, 9)	(3, 5, 7)	(1, 4.2, 7)
R21	(5, 7, 9)	(7, 9, 9)	(7, 9, 9)	(3, 5, 7)	(3, 5, 7)
R22	(5, 7, 9)	(7, 9, 9)	(7, 9, 9)	(3, 5, 7)	(1, 3.8, 7)
R23	(5, 7, 9)	(5, 7, 9)	(5, 7, 9)	(3, 5.4, 9)	(5, 7, 9)
R24	(5, 7, 9)	(5, 7, 9)	(5, 7, 9)	(5, 7, 9)	(5, 7, 9)
R25	(7, 9, 9)	(7, 9, 9)	(7, 9, 9)	(7, 9, 9)	(1, 3.4, 7)
R26	(5, 7, 9)	(1, 3, 5)	(3, 5, 7)	(3, 5, 7)	(3, 5, 7)
R27	(3, 6.6, 9)	(7, 9, 9)	(7, 9, 9)	(3, 5.4, 9)	(1, 1.4, 5)

Normalize the fuzzy decision matrix using "7", "8", "9",such that all triangular fuzzy numbers belong to [0, 1].

TABLE V NORMALIZED FUZZY DECISION MATRIX

	C1	C2	C3	C4	C5
R1	(0.333, 1.000, 1.000)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.111, 0.116, 0.200)	(0.111, 0.333, 0.778)
R2	(0.200, 0.385, 1.000)	(0.111, 0.128, 0.200)	(0.111, 0.143, 0.200)	(0.111, 0.135, 0.333)	(0.333, 0.556, 0.778)
R3	(0.200, 0.333, 1.000)	(0.111, 0.143, 0.200)	(0.111, 0.128, 0.200)	(0.111, 0.143, 0.200)	(0.556, 0.778, 1.000)
R4	(0.111, 0.111, 0.143)	(0.111, 0.122, 0.200)	(0.111, 0.111, 0.143)	(0.333, 1.000, 1.000)	(0.778, 1.000, 1.000)
R5	(0.111, 0.111, 0.143)	(0.111, 0.122, 0.200)	(0.111, 0.111, 0.143)	(0.333, 1.000, 1.000)	(0.778, 1.000, 1.000)
R6	(0.142, 0.200, 0.333)	(0.111, 0.143, 0.200)	(0.111, 0.111, 0.143)	(0.333, 1.000, 1.000)	(0.333, 0.556, 0.778)
R7	(0.111, 0.143, 0.200)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.333, 1.000, 1.000)	(0.333, 0.556, 0.778)
R8	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.333, 1.000, 1.000)	(0.333, 0.556, 0.778)
R9	(0.143, 0.200, 0.333)	(0.200, 0.333, 1.000)	(0.143, 0.200, 0.333)	(0.333, 1.000, 1.000)	(0.778, 1.000) 1.000)
R10	(0.333, 1.000, 1.000)	(0.143, 0.200, 0.333)	(0.111, 0.143, 0.200)	(0.143, 0.200, 0.333)	(0.556, 0.778, 1.000)
R11	(0.333, 1.000, 1.000)	(0.111, 0.143, 0.200)	(0.111, 0.143, 0.200)	(0.111, 0.111, 0.143)	(0.778, 1.000, 1.000)
R12	(0.111, 0.200, 1.000)	(0.143, 0.200, 0.333)	(0.111, 0.143, 0.200)	(0.143, 0.294, 1.000)	(0.333, 0.556, 0.778)
R13	(0.142, 0.200, 0.333)	(0.111, 0.143, 0.200)	(0.143, 0.200, 0.333)	(0.200, 0.333, 1.000)	(0.333, 0.556, 0.778)
R14	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.143, 0.200, 0.333)	(0.333, 0.644, 1.000)
R15	(0.111, 0.143, 0.200)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.143, 0.200, 0.333)	(0.111, 0.333, 0.556)
R16	(0.111, 0.161, 0.333)	(0.111, 0.143, 0.200)	(0.111, 0.172, 0.333)	(0.111, 0.238, 1.000)	(0.111, 0.244, 0.556)
R17	(0.142, 0.238, 1.000)	(0.143, 0.238, 1.000)	(0.200, 0.556, 1.000)	(0.111, 0.111, 0.143)	(0.333, 0.556, 0.778)
R18	(0.142, 0.200, 0.333)	(0.143, 0.200, 0.333)	(0.111, 0.143, 0.200)	(0.143, 0.200, 0.333)	(0.333, 0.556, 0.778)
R19	(0.111, 0.143, 0.200)	(0.143, 0.200, 0.333)	(0.143, 0.200, 0.333)	(0.200 0.333, 1.000)	(0.333, 0.556, 0.778)
R20	(0.111, 0.143, 0.200)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.143, 0.200, 0.333)	(0.111, 0.467, 0.778)
R21	(0.111, 0.143, 0.200)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.143, 0.200, 0.333)	(0.333, 0.556, 0.778)
R22	(0.111, 0.143, 0.200)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.143, 0.200, 0.333)	(0.111, 0.422, 0.778)
R23	(0.111, 0.143, 0.200)	(0.111, 0.143, 0.200)	(0.111, 0.143, 0.200)	(0.111, 0.185, 0.333)	(0.556, 0.778, 1.000)
R24	(0.111, 0.143, 0.200)	(0.111, 0.143, 0.200)	(0.111, 0.143, 0.200)	(0.111, 0.143, 0.200)	(0.556, 0.778, 1.000)
R25	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.111, 0.378, 0.778)
R26	(0.111, 0.143, 0.200)	(0.200, 0.333, 1.000)	(0.143, 0.200, 0.333)	(0.143, 0.200, 0.333)	(0.333, 0.556, 0.778)
R27	(0.111, 0.152, 0.333)	(0.111, 0.111, 0.143)	(0.111, 0.111, 0.143)	(0.111, 0.185, 0.333)	(0.111, 0.156, 0.556)

From the TABLE V and using "10"calculate the weighted normalized Fuzzy decision matrix as shown in TABLE VI

TABLE VI WEIGHTED NORMALIZED FUZZY DECISION MATRIX

	C1	C2	C3	C4	C5
R1	(0.333, 1.800, 5.000)	(0.778, 1.000, 1.286)	(0.778, 1.000, 1.286)	(0.556, 0.907, 1.800)	(0.333, 1.800, 7.000)
R2	(0.200, 0.692, 5.000)	(0.778, 1.154, 1.800)	(0.778, 1.286, 1.800)	(0.556, 1.054, 3.000)	(1.000, 3.000, 7.000)
R3	(0.200, 0.600, 5.000)	(0.778, 1.286, 1.800)	(0.778, 1.154, 1.800)	(0.556, 1.114, 1.800)	(1.667, 4.200, 9.000)
R4	(0.111, 0.200, 0.714)	(0.778, 1.097, 1.800)	(0.778, 1.000, 1.286)	(1.667, 7.800, 9.000)	(2.333, 5.400, 9.000)
R5	(0.111, 0.200, 0.714)	(0.778, 1.097, 1.800)	(0.778, 1.000, 1.286)	(1.667, 7.800, 9.000)	(2.333, 5.400, 9.000)
R6	(0.143, 0.360, 1.667)	(0.778, 1.286, 1.800)	(0.778, 1.000, 1.286)	(1.667, 7.800, 9.000)	(1.000, 3.000, 7.000)
R7	(0.111, 0.257, 1.000)	(0.778, 1.000, 1.286)	(0.778, 1.000, 1.286)	(1.667, 7.800, 9.000)	(1.000, 3.000, 7.000)
R8	(0.111, 0.200, 0.714)	(0.778, 1.000, 1.286)	(0.778, 1.000, 1.286)	(1.667, 7.800, 9.000)	(1.000, 3.000, 7.000)
R9	(0.143, 0.360, 1.667)	(1.400, 3.000, 9.000)	(1.000, 1.800, 3.000)	(1.667, 7.800, 9.000)	(2.333, 5.400, 9.000)
R10	(0.333, 1.800, 5.000)	(1.000, 1.800, 3.000)	(0.778, 1.286, 1.800)	(0.714, 1.560, 3.000)	(1.667, 4.200, 9.000)
R11	(0.333, 1.800, 5.000)	(0.778, 1.286, 1.800)	(0.778, 1.286, 1.800)	(0.556, 0.867, 1.286)	(2.333, 5.400, 9.000)
R12	(0.111, 0.360, 5.000)	(1.000, 1.800, 3.000)	(0.778, 1.286, 1.800)	(0.714, 2.294, 9.000)	(1.000, 3.000, 7.000)
R13	(0.143, 0.360, 1.667)	(0.778, 1.286, 1.800)	(1.000, 1.800, 3.000)	(1.000 2.600, 9.000)	(1.000, 3.000, 7.000)
R14	(0.111, 0.200, 0.714)	(0.778, 1.000, 1.286)	(0.778, 1.000, 1.286)	(0.714, 1.560, 3.000)	(1.000, 3.480, 9.000)
R15	(0.111, 0.257, 1.000)	(0.778, 1.000, 1.286)	(0.778, 1.000, 1.286)	(0.714, 1.560, 3.000)	(0.333, 1.800, 5.000)
R16	(0.111, 0.290, 1.667)	(0.778, 1.286, 1.800)	(0.778, 1.552, 3.000)	(0.556, 1.857, 9.000)	(0.333, 1.320, 5.000)
R17	(0.143, 0.428, 5.000)	(1.000, 2.143, 9.000)	(1.400, 5.000, 9.000)	(0.556, 0.867, 1.286)	(1.000, 3.000, 7.000)
R18	(0.143, 0.360, 1.667)	(1.000, 1.800, 3.000)	(0.778, 1.286, 1.800)	(0.714, 1.560, 3.000)	(1.000, 3.000, 7.000)
R19	(0.111, 0.257, 1.000)	(1.000, 1.800, 3.000)	(1.000, 1.800, 3.000)	(1.000, 2.600, 9.000)	(1.000, 3.000, 7.000)
R20	(0.111, 0.257, 1.000)	(0.778, 1.000, 1.286)	(0.778, 1.000, 1.286)	(0.714, 1.560, 3.000)	(0.333, 2.520, 7.000)
R21	(0.111, 0.257, 1.000)	(0.778, 1.000, 1.286)	(0.778, 1.000, 1.286)	(0.714, 1.560, 3.000)	(1.000, 3.000, 7.000)
R22	(0.111, 0.257, 1.000)	(0.778, 1.000, 1.286)	(0.778, 1.000, 1.286)	(0.714, 1.560, 3.000)	(0.333, 2.280, 7.000)
R23	(0.111, 0.257, 1.000)	(0.778, 1.286, 1.800)	(0.778, 1.286, 1.800)	(0.556, 1.444, 3.000)	(1.667, 4.200, 9.000)
R24	(0.111, 0.257, 1.000)	(0.778, 1.286, 1.800)	(0.778, 1.286, 1.800)	(0.556, 1.444, 1.800)	(1.667, 4.200, 9.000)
R25	(0.111, 0.200, 0.714)	(0.778, 1.000, 1.286)	(0.778, 1.000, 1.286)	(0.556, 0.867, 1.286)	(0.333, 2.04, 7.000)
R26	(0.111, 0.257, 1.000)	(1.400, 3.000, 9.000)	(1.000, 1.800, 3.000)	(0.714, 1.560, 3.000)	(1.000, 3.000, 7.000)
R27	(0.111, 0.273, 1.667)	(0.778, 1.000, 1.286)	(0.778, 1.000, 1.286)	(0.556, 1.444, 3.000)	(0.333, 0.840, 5.000)

Calculate the distance (d_i^* and d_i^-) of each risk from the FPIS and the FNIS using "13", "14" and finally find the CCi value of all risks using "15"as shown in TABLE VII.

TABLE VII CCi VALUE OF ALL RISKS

Risks	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R26	R27
d_i^*	33.767	32.640	32.171	29.098	29.098	30.213	30.702	30.807	25.699	30.468	31.191	30.771	30.970	33.544	34.730	32.831	28.884	32.358	30.592	34.180	33.715	34.263	32.470	32.928	35.252	30.456	34.989
d_i^-	8.317	9.734	10.446	13.656	13.656	12.508	11.779	11.611	19.624	12.128	10.675	14.045	12.173	7.858	5.513	10.608	17.612	8.679	12.542	6.740	6.852	6.699	8.873	8.159	5.424	12.561	5.755
CC_i	0.1976	0.2297	0.2451	0.3194	0.3194	0.2928	0.2773	0.2737	0.4330	0.2847	0.2550	0.3134	0.2822	0.1898	0.1370	0.2442	0.3788	0.2115	0.2908	0.1647	0.1689	0.1635	0.2146	0.1986	0.1333	0.2920	0.1412

Compare the risks according to their CCi value. Rank all the risks in the descending order of CCi for getting the riskiest risk as shown in TABLE VIII.

TABLE VIII RANK OF RISKS

Risks	R9	R17	R4	R5	R12	R6	R26	R19	R10	R13	R7	R8	R11	R3	R16	R2	R23	R18	R24	R1	R14	R21	R20	R22	R27	R15	R25
CCi	0.4330	0.3788	0.3194	0.3194	0.3134	0.2928	0.2920	0.2908	0.2847	0.2822	0.2773	0.2737	0.2550	0.2451	0.2442	0.2297	0.2146	0.2115	0.1986	0.1976	0.1898	0.1689	0.1647	0.1635	0.1412	0.1370	0.1333
Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27

IV. RESULT AND DISCUSSION

The closeness coefficient CC_i represents the distances to fuzzy positive ideal solution, A^* and the fuzzy negative ideal solution, A− simultaneously. As the closeness coefficient CC_i is the satisfaction degree, the risk (alternative) with highest closeness coefficient represent the shortest distance from FPIS therefore it is best or safe risk (alternative)and the risk (alternative)with lowest closeness coefficient represent the more distance from FPIS therefore it is riskiest risk (alternative). In table 8 risk R9 is having highest CC_i value and risk R25 is having lowest CC_i value. Therefore risk R25 is the riskiest risk in this dam construction project.

V. CONCLUSION

The main purpose of this paper is to propose a risk evaluation approach of the problems that might be encountered during construction project. In this paper we have use detectability as criteria than traditional risk evaluation methods Based on inherent complexity and problems connected with assigning a precise performance rating to alternatives due to less information or even lack of information and lack of clarity, a multi criteria decision making methodology based on the fuzzy logic theory is also employed in such a way as to guarantee evaluation coherence.

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