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Risk Analysis for Short Term Projects (STP's) using Fuzzy AHP Method

Charu Saini, Amrita Jyoti
CSE, ABES Engg. College
India

Abstract— Short Term Projects (STP's) are key revenue generators for medium scale industries but these short term projects are equally risky as these were developed in short time under low expertise and scare resources so it is always a chance that these STP's can fail. Hence there is a need of preassessment of risk for such projects. Today there are many algorithms that access the failure risk for such projects. A few are fuzzy association rule mining, fuzzy analytic network process (FANP), fuzzy analytic hierarchy process (FAHP) etc. FAHP is both simple and robust at the same time. Dependence of this method on opinions of experts in the form of saaty's pair-wise comparison matrix makes it powerful over other methods. Integration with fuzzy theory incorporates the case of vagueness in expert's mind. In this study we are employing FAHP on risk assessment of STP's executed by a company, although not all of them were executed. Data is being prepared by the some experts who executed the projects.

Keywords—Risk analysis; STP's risk analysis model; Expert's preassessment matrices(saaty's matrices); Evaluation of projects risk; Fuzzy analytic hierarchy process; FMADM

I. Introduction

The object of this paper is to introduced a new approach for STP's risk analysis through the fuzzy AHP. The fuzzy AHP provides the flexible and easily understood way to analyse project risks. It is a multi criteria decision making methodology that allows subjective as well as objective factors to be considered in the process which is precisely what is needed. The FAHP gives developers a more rational basis on which to make decisions. Thus FAHP will be used to provide a methodology for risk analysis and assessment. Hence the use of FAHP allows the management team to document and communicate an explicit, common, and shared understanding of the degree of a project's riskiness. In this way it becomes a living picture of management's understanding of the project's risks. The FAHP based decision making method is effective for constructing an evaluation method which can assist software project developers, users and procurers in evaluating the risk analysis for software projects. Fuzzy multiple attribute decision- making (FMADM) methods have been developed to address the imprecision in assessing the relative importance of attributes and the performance ratings of alternatives with respect to attributes. Conventional MADM cannot effectively handle problems with such imprecise information. To resolve this difficulty, Fuzzy set theory, first introduced by Zadeh has been used and is adopted herein. Fuzzy set theory attempts to select, prioritize or rank a finite number of courses of action by evaluating a group of predetermined criteria. FAHP has been applied in different fields (eg. [1] -[5]) In the field of project/construction management, evaluation of software quality, Risk assessment of vicarious management corporation, Risk evaluation of solar photovoltaic power generation industry and prediction model of wind speed based on improved FAHP etc.

II. RISK ANALYSIS

A Risk is an event or condition that, if it occurs, has a positive or negative effect on project objectives. Risk Analysis is an iterative process. It is a tool to enhance the scientific basis of regularity decisions. Risk Analysis is a proactive approach for minimizing the uncertainty and potential loss associated with a project.

Characteristics of Risk Analysis

The three common characteristics of Risk are:

- It represents a future event,
- It has the probability of occurring of greater than 0%, but less than 100%, and
- The consequence of the Risk must be unexpected or unplanned

III. PROPOSED MODEL

Many Short Term Projects construction process is characterized by a number of uncertainties, uncertainty about environment conditions, subcontractor failure, and different site conditions are typical risk variables that exist in mostly construction project. As s result, many software projects fails to achieve their time cost and quality goals. Hence a hierarchical model is used for analysing the risk of STP's, This Hierarchical structure includes four levels such as:

Level 1: Goal as Risk
Level 2: This level includes six risk dimensions as:

- D1 – Team Risk
- D2 - Requirements Risk
- D3 - Customers and Users Risk
- D4 - Projects Managements Risk
- D5 - Projects Complexity Risk
- D6 - Environment Risk of Organization

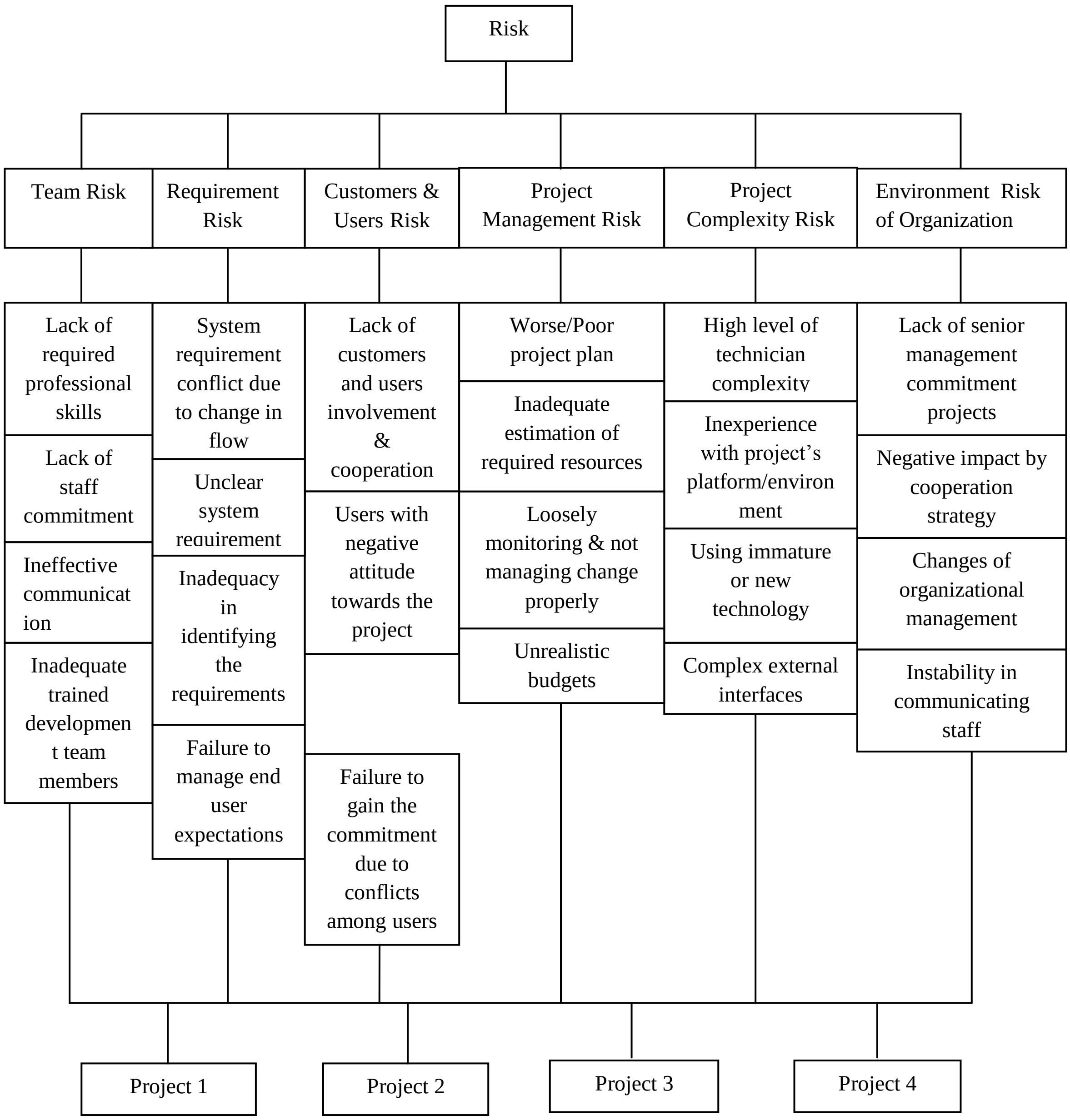

Fig. 1 STP's Risk Analysis Model

Level 3: This level contains four factors in each dimension as shown in fig 1.
Level 4: This level contains four projects that will be processed for analyzing the risk.

IV. FAHP USED IN PROPOSED MODEL

Analytic Hierarchy Process (AHP) is a decision method that decomposes a complex multi-criteria decision problem into the hierarchy. The AHP incorporates the evaluations of all decision makers into a final decision, without having to elicit their utility functions. The AHP perception to exact numbers, Since real world is highly ambiguous. Therefore, some scholars have combined fuzzy theory with AHP to analyzed the ambiguous real world problems.

Fuzzy multiple attribute decision- making (FMADM) methods have been developed to address the imprecision in assessing the relative importance of attributes and the performance ratings of alternatives with respect to attributes.Conventional MADM cannot effectively handle problems with such imprecise information. To resolve this difficulty,

Fuzzy set theory, first introduced by Zadeh has been used and is adopted herein.

In this approach we will analyze the risk of four short term projects (Project 1, Project 2, Project 3 & Project 4) as shown in fig. 1. For the Saaty's matrices three expert is taken. So three pair-wise comparison matrices are made for each level and every sub-criteria in each level. After that from these matrices TFN's (Triangular Fuzzy Numbers) are generated i.e. denoted by the L, M and U. G is obtain to perform the defuzzification or to remove the fuzziness then some eigen vectors are generated i.e. called the weight age. At last consistency test is performed if the matrix is consistent then the estimate will be accepted otherwise a new comparison matrix is solicited. The values of eigen vectors justifies which one is risky out of the four projects.

The FAHP process comprises of four major steps as discussed below:

1. Establish model and problem:

The problem should be stated clearly and decomposed into a rational system like a hierarchy (e.g. fig. 1). The structure can be determined by the opinion of decision makers through brainstorming or other appropriate methods.

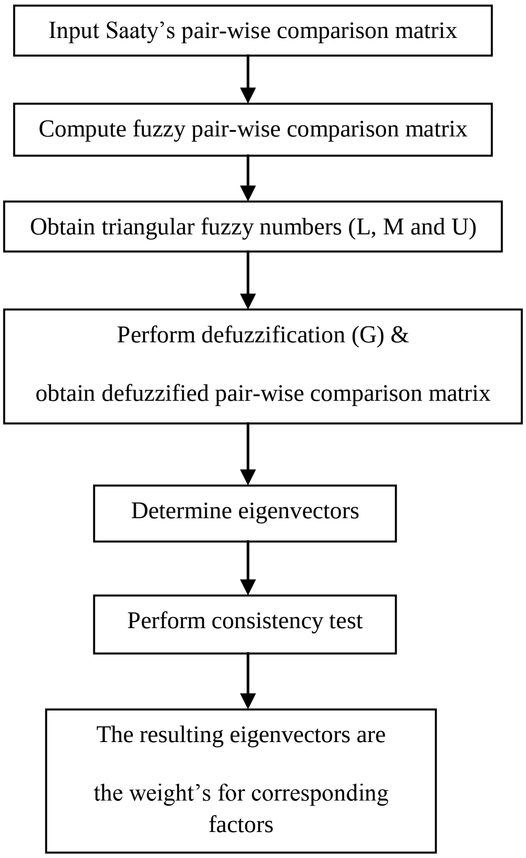

Fig. 2 Steps of applying FAHP

2. Input saaty's pair-wise comparison matrix:

The AHP process as initially proposed by Saaty (1980) only uses the pair-wise comparison matrix to evaluate ambiguity in multi-criteria decision marking problems. The relative importance of two elements is rated using a scale with the values 1, 3, 5, 7 and 9, where 1 denotes equally important, 3 for slightly more important, 5 for strongly more important, for demonstrably more important, and 9 for absolutely more important, respectively.Hence the pair-wise comparison matrices (also known as saaty's matrices), either made by the experts or the project developer.

3. Obtaining triangular fuzzy numbers:

fuzzy set is a class of objects with a graded continuum of membership. Such a set is characterized by a membership function, which assigns to each object a membership grade between zero and one. Figure 3 depicts a triangular fuzzy number. A TFN is denoted simply as (L, M, U). As formulas (2)–(5) demonstrate, the parameters L, M and U denote the smallest possible value, the most promising value (Geomean) and the largest possible value, respectively, that describes a fuzzy event [1]. The triangular fuzzy numbers uij are established as follows:

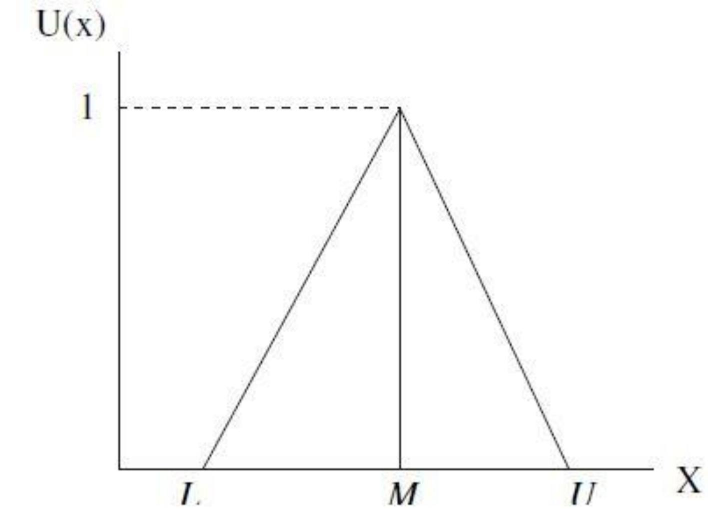

Fig 3 Triangular fuzzy numbers

$$\tilde{u}_{ij} = (L_{ij}, M_{ij}, U_{ij}),\quad L_{ij} \le M_{ij} \le U_{ij} \quad \text{and} \quad L_{ij}, M_{ij}, U_{ij} \in [1/9, 9], \tag{2}$$

$$L_{ij} = \min(B_{ijk}), \tag{3}$$

$$M_{ij} = \sqrt[n]{\prod_{k=1}^{n} B_{ijk}}, \tag{4}$$

$$U_{ij} = \max(B_{ijk}), \tag{5}$$

Where B_{ijk} represents a judgment of expert k for the relative importance of two criteria C_i–C_j.

4. Establishing fuzzy pair-wise comparison matrix and defuzzification:

$$\tilde{A} = [\tilde{a}_{ij}] = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \frac{1}{\tilde{a}_{12}} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{1}{\tilde{a}_{1n}} & \frac{1}{\tilde{a}_{2n}} & \cdots & 1 \end{bmatrix} \end{array} \tag{6}$$

where $\sim a_{12}$ denotes a triangular fuzzy number for the relative importance of two criteria C1and C2. Additionally $[a_{ij}]$ represents the triangular fuzzy numbers by the formulae (2)–(5).Various defuzzification methods are available, and the method adopted herein was derived from Liou and Wang. As shown in formulae (7) and (8), this method can clearly express fuzzy perception [1].

$$g_{\alpha,\beta}(a_{ij}) = [\ \beta.\ f_\alpha(L_{ij}) + (1-\beta).\ f_\alpha(U_{ij})\ ],\quad 0 \le \beta \le 1,\ 0 \le \alpha \le 1 \tag{7}$$

where $f_\alpha(L_{ij}) = (M_{ij} - L_{ij}).\alpha + L_{ij}$ represents the left-end value of α-cut for a_{ij} and $f_\alpha(U_{ij}) = U_{ij} - (U_{ij} - M_{ij}).\alpha$ represents the right-end value of α-cut for $a_{ij.}$

$$g_{\alpha,\beta}(a_{ij}) = 1/\ g_{\alpha,\beta}(a_{ij}),\ 0 \le \beta \le 1,\ 0 \le \alpha \le 1,\ i>j \tag{8}$$

α can be viewed as a stable or fluctuating condition. β can be viewed as the degree of pessimism in a decision maker.

5. Determine eigenvectors:

Notably, $\lambda_{max}$is defined as the eigenvalue of the single pair-wise comparison matrix $g_{\alpha,\beta}(A)$.

$$g_{\alpha,\beta}(A).W = \lambda_{max} W \tag{10}$$

and

$$[g_{\alpha,\beta}(A) - \lambda_{max} I]\ W = 0, \tag{11}$$

Where W denotes the eigenvector of $g_{\alpha,\beta}(A)$, $0 \le \beta \le 1$, $0 \le \alpha \le 1$

6. Consistency test:

Saaty (1980) proposed a consistency index (C.I.) and consistency ratio (C.R.) to verify the consistency of the comparison matrix. The C.I. and R.I. are defined as follow:

$$C.I = \lambda_{max} - \frac{n}{n-1} \quad (12)$$

$$C.R = \frac{C.I}{R.I} \quad (13)$$

where R.I. represents the average consistency index over numerous random entries of the same order reciprocal matrices. The values of R.I. has taken from the general library of world scientific publishing company.

V. Result

A Hierarchical Input data for this evaluation model will be the pair-wise comparison matrix made by experts in the fields of short term project development. The scale used is from 1/9 to 9. Each element represents a row by column weight age between alternatives. consistency index (C.I.) and consistency ratio (C.R.) to verify the consistency of the comparison matrix. If C.R < 0.5, the estimate is accepted or matrix is consistent; otherwise, matrix is inconsistent and a new comparison matrix is solicited until C.R < 0.5.

VI. Conclusion

FAHP is a good approach for risk assessment of Short Term Projects as again it is highly simple in execution and powerful in results. The Parent-Child hierarchy gives a direct dependence of dimensions on sub factors and hence the impact of performance of a project on a particular domain gets directly reflected in the overall risk of project failure.

Secondly the dependence of result on expert's opinion makes the process highly vulnerable. Limitations- There is no dependence of projects on sub factors. The Parent-Child should be treated as nodes i.e. there should be a back dependence also which will further improve the solution.

Acknowledgment

We reference and absorb many experts and scholar's research results and research viewpoints in this paper, we express our heartfelt gratitude and respect to them here.

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