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Study of risk management for National Highway Project

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Abstract - In today's world where intensive competition exists between enterprises, it is of great importance to work in cooperation with the right decision maker. Selection of the right weights is significant factor in the success of enterprises. In road construction the selection of right decision maker), the strengths and weaknesses of potential should be taken into consideration. Many qualitative and quantitative criteria are included in this selection process as well as the decision-maker. However, multi criteria decision making methods facilitate the process of finding a solution and enable decision makers to reach the right decisions.

Decision-making problems require systematic approach to evaluate alternatives using both quantitative and non-quantitative factors. Standard methods to solve problems lack considerations of non-quantitative factors, in which numeric value is difficult to assign. Different techniques like Fuzzy set theory, Analytic Hierarchy Process (AHP) and Multi Criteria Decision Making are presently being used in decision-making process. These techniques take multiple factors with vague values and /or concrete values. This research provides solution to a decision-making problem of budget allocation problem, to allocate funds to deserving and competing organizations by using integrated Fuzzy, AHP and MCDM techniques. Weights are calculated using Fuzzy set theory and AHP. Fuzzy set takes subjective values like preferred, strongly preferred etc. and AHP technique evaluates relative importance of factors by forming pair wise comparison matrix.

Experts in this domain were consulted to give their preferences. The technique of evaluating proposals helped in ranking after assigning weights to decision-making factors.

Key Words: Risk management,AHP,MCDM.

1. INTRODUCTION

Project risk management includes the processes concerned with identifying, analyzing, and responding to road project risk. It includes maximizing the results of positive events and minimizing the consequences of adverse events.

Consequences of uncertainty and its exposure in a project, is risk. In a project context, it is the chance of something happening that will have an impact upon objectives. It includes the possibility of loss or gain, or variation from a desired or planned outcome, as a consequence of the uncertainty associated with following a particular course of action. Risk thus has two elements: the likelihood or probability of something happening, and the consequences or impacts if it does. Managing risk is an integral part of good management, and fundamental to achieving good business and project outcomes and the effective procurement of goods and services. Risk management provides a structured way of assessing and dealing with future uncertainty.

As multi-criteria decision making approaches are mostly based on qualitative data and personal opinions, the fuzzy logic method is frequently used in the analysis of such data. In this regard, the Fuzzy AHP method, which is one of the fuzzy multi-criteria decision making methods, was used to give a ranking to risks associated with national highway project.

2. LITERATURE REVIEW

An extensive review of international project risk assessment and management was conducted during the initial phase of the research effort. Previous research suggests that construction activity is particularly subject to more risks than other business activities because of its complexity. Studies on risk management mainly focus on the effect of risk management on firm value (Hoyt & Liebenberg, 2011; Gordon, Loeb, & Tseng, 2009; Beasley, Pagach, & Warr, 2008), how to implement risk management (Pagach & Warr, 2011; Nocco & Stulz, 2006), factors that caused firm to implement risk management (Acharyya, 2009).

Vaidya and Kumar (2006) shows AHP can be used on six types of decisions; selecting one alternative from many, evaluation of alternatives, benefit-cost analysis, resource allocations, planning and development, and priority and ranking. Fuzzy logic has been applied for risk evaluation in other projects: Lee *et al.* (2003) for assessment of risks in application development, Liadis (2005) for evaluation of risk of fire, Ngai and Wat (2005) for assessment of risks in E-commerce development, Serguieve and Hunter (2004) for investment risk, and Sadiq and Husian (2005) for environmental risks.

Mustafa and Al-Bahar firstly applied AHP to evaluate risks in construction projects in uncertain environment in Bangladesh. Zayed *et al.* (2008), through identifying two major scopes affecting on highway projects (organization and project as the main level and lower level, respectively) and evaluating their effects on risks, provided a risk model facilitating the evaluation and ranking of the organization's projects. Zayed *et al.* (2008) designed the risk model using AHP. Azuma and Miyagi (2009) presented a new approach based on AHP for the risk evaluation. In their proposed approach, the traditional AHP evaluation was considered as the utility. Then, degree of importance related to each risk was replaced with the value of utility.

Wang *et al.* (2008) used an integrated AHP and data envelopment analysis (DEA) to evaluate risks in the bridge construction projects. Wang and Elhag (2007) applied the fuzzy group decision making approach to assess the risks in constructing the bridge. They showed that the fuzzy group decision making approach is flexible, operational, and effective in modeling the risks in bridge construction.

3. METHODOLOGY

3.1 FUZZY-AHP Method

AHP provides a way to rank the alternatives of a problem by deriving priorities. AHP gives effective means to deal with complex decision making and can assist with identifying and weighting selection criteria, analyzing the data collected for the criteria and expediting the decision making process. AHP has been shown to be a robust method of eliciting and using multi criteria preference relationships in a range of applications. It is designed for situations in which ideas, feelings, and emotions are quantified based on subjective judgment to provide a numeric scale for prioritizing decision alternatives. The AHP is based on a matrix of pair wise comparisons between criteria, and it can be used to evaluate the relative performance of decision alternatives (for example products and services) with respect to the relevant criteria.

To solve a decision problem with AHP, there are some steps which are defined below.
Step 1: Determination of the geometric mean of the data collected.
Step 2: Comparison Matrix between Factors Is Formed.
Comparison matrix between factors is a nxn dimensional square matrix. The matrix components on the diagonal of this matrix take 1 value.
Step 3: Determine the Weight of Each Factor.
After collecting the expert views & compiling collected data, next step was to determine the weight of each factor. Weights are determined by applying AHP technique. First revise comparison matrix, square matrix, compare the importance of one alternative than other.
Step 4: Percentage Importance Distribution of the Criteria Are Determined
Comparison matrix shows importance levels of factors to each other within a certain logic framework. However, the weights of these factors in total, in other words to determine the percentage importance distribution

Step 5: Calculation of most probable value

3.2 CASE STUDY

The National Highway Authority of India was constituted by an act parliament, the The National Highway Authority of India Act 1988.it is responsible for the development, maintenance & management of The National Highway entrusted to it and for matter connected.The Authority was operationalized in Feb, 1995.

The (NHAI) is the authority responsible for the development, maintenance& management of The National Highway entrusted to it. The NHAI is undertaking the development activities under in 5 phases. The NHAI is also responsible for implementing other project on National Highway, primarily road to major ports in India.

As of January 2012, under phase I,II,III & V of India's national efforts has already finished & put in use about 1700 km of 4/6 lane highways. The country is in process of building an additional 33441km of 4 to 6 lanes, international quality highway throughout India. Of this target about 11800 km of modern highway were under implementation in January 2012, & 20000 km of highway have been identified of contract award India road building rate has accelerated in recent year & averaged about 11 km /day in second half of 2011. The country target to build 600 km of modern roads every month through 2014.

NHAI has granted and authorized the PSPEL to investigate, study, design, engineer procure, finance, construct, operate and maintain the stretches From Km 40.000 to Km 144.400 on NH-9 and has been made a concession agreement (CA) with PSEPL on 19th May 2009 in which the concession period is 21 years including construction period.

3.3 Details of case study

Name of project	Four laning of Pune Solapur Section of NH-9 from km 40000 to km 144.44. in the state of Maharashtra under NHDP PHASE III on DBFOT Basis.
Employer	NHAI
Concessionaire	Pune Solapur Expressways Private Limited
Funding Agency	BOT
Letter of acceptance date	17 Feb 2009
Contract Sign Date	19 May 2009
Financial closure Date	14 November 2009
Notice to Commence Date	28 November 2009
Contract Duration	810 Days
Independent consultant	Mr. Renardt S.A
Project Management Consultant	Egis India Consulting Engineers Private Limited
Design Consultant	Consulting Engg Group
Civil Contractor	Oriental Structural Engineers Pvt Limited
Contact value	442.47 crore
Contact Agreement No.	
Contractual Completion Date (original / extended)	15th Feb 2012
Details of Extension of time	-----------------
End of defects liability period (original / extended)	24 months from COD
Contact value (IRS/other currency)	442,46,72,556.00
Performance security Details (% BG Details)	7.5% of contact value as performance security which will be released with the completion certificate

Table no.3.1.1Determination of the geometric mean of the data collected:

Factor Id.(A)	Factor Description (B)	Geometric mean (C)
1	Environmental Permission (C1)	8.511
2	Emotional Issue (C2)	6.079
3	Land Acquisition (C3)	6.617
4	Political (C4)	6.435
5	Quality (C5)	6.198
6	Time (C6)	4.022
7	Money (C7)	5.318
8	Machinery (C8)	5.856
9	Rebound development around road analysis (C9)	6.522
10	Labor (C10)	7.13
11	Natural Obstruction (C11)	5.486
12	Knowledge level of lead group (C12)	4.678

After collecting the expert view and compiling collected data, next step was N determine the weight of each factor. Weights are determined by applying AHP technique. First a pair wise comparison matrix is design. A pair wise comparison matrix, square matrix, compares the important of one alternative over that. The pair wise comparison matrix is shown in Table no 3.1.2

Sample calculation

$$\frac{C1}{C2} = \frac{8.511}{8.511}$$

=1

$$\frac{C1}{C2} = \frac{8.511}{6.079} = 1.440$$

To explain, below matrix, let us take the case of factor C11. Factor C11 is preferred over factor C12 with value 1.400066. Factor C12 has priority over C11 with numeric value as 0.714252. It is on the assumption that when factor i has some value assigned to it compared with factor j, then j has reciprocal value when compared with i. Diagonal elements have value one

Table 3.1.2: Determination of weightage:

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
C1	1	1.4400	1.2860	1.3226	1.3731	2.1161	1.5816	1.4533	1.3613	1.1936	1.5514	1.8193
C2	0.7142	1	0.9186	0.9446	0.9808	1.5114	1.1297	1.0380	0.9723	0.8525	1.1080	1.2994
C3	0.7746	1.0085	1	1.0282	1.0676	1.6452	1.2296	1.1295	1.0583	0.9280	1.2061	1.4144
C4	0.7560	1.0585	0.9729	1	1.0382	1.5995	1.1958	1.0988	1.0292	0.9025	1.7298	1.3755
C5	0.7282	1.0195	0.9366	0.9631	1	1.5410	1.1518	1.0584	0.9913	0.8692	1.1297	1.3249
C6	0.4725	0.6616	0.6078	0.6250	0.6489	1	0.7474	0.6868	0.6433	0.5640	0.7331	0.8590
C7	0.6322	0.8851	0.8132	0.8362	0.8681	1.3378	1	0.9188	0.8606	0.7546	0.9808	1.1502
C8	0.6880	0.9633	0.8849	0.9100	0.9448	1.4559	1.0880	1	0.9366	0.8213	1.0674	1.2518
C9	0.7345	1.0284	0.9448	0.9715	1.0081	1.5544	1.1618	1.0676	1	0.8768	1.1396	1.3364
C10	0.8377	1.1728	1.0775	1.1080	1.1503	1.7727	1.3250	1.2175	1.1404	1	1.2996	1.5241
C11	0.6445	0.9024	0.8290	0.8525	0.8851	1.3639	1.1019	0.9368	0.8774	0.7694	1	1.1727
C12	0.5492	0.7695	0.7069	0.7269	0.7547	1.1631	0.8693	0.7988	0.7482	0.6561	0.8527	1
TOTAL	8.5316	11.9096	10.9782	11.2886	11.7197	18.061	13.5819	12.4043	11.6189	10.188	13.7982	15.5277

Dividing corresponding by sum to each factor:

Sample calculation

$$C = \frac{\text{each factor}}{\sum \text{vertical column}}$$

$$C2 = \frac{0.7142}{8.5316} = 0.0837$$

Table 3.1.3:Final score of risk factor

Suming of elements of row and dividing the sum of column

No.	Final score of risk factor	Rank
C1	0.1170	2
C2	0.0833	8
C3	0.0907	6
C4	0.0915	5
C5	0.0850	7
C6	0.0546	11
C7	0.1415	1
C8	0.0802	9
C9	0.1002	3
C10	0.0975	4
C11	0.0757	10
C12	0.0539	12

Table 3.1.4: Ranking of factor

Sr.No	Factor	Value	Ranking
1	Rebound development around road analysis	0.1415	1
2	Political	0.1170	2
3	Land acquisition	0.1002	3
4	Environmental Permission	0.0975	4
5	Money	0.0915	5
6	Time	0.0907	6
7	Quality	0.085	7
8	Machinery	0.0833	8
9	Natural Obstruction	0.0802	9
10	Labor	0.0757	10
11	Knowledge level of lead group	0.0546	11
12	Emotional Issue	0.0539	12

4. CONCLUSION

AHP is one of the most convenient methodologies in order to evaluate risk issues. It can be said that using linguistic variables makes the evaluation process more realistic. Because risk evaluation is not an exact process and has fuzziness in its body. Here, the usage of fuzzy AHP weights makes the application more realistic and reliable.

- First time 12 factors where identify and finalized through literature and expert opinion for risk analysis for construction of road project.
- First time FAHP has been applied to rank this 12 factor Fuzzy Set theory is used to face the problem of subjectively in expert judgment.

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