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Risk Assessment in Construction of Highway Project

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***Abstract*—Risk assessment is necessary prior to planning and management of risks to minimize the adverse impacts of risks involved in highway construction. Risk factors are involved at every stage from designing and planning stages to completion of project. To enhance successful performance on highway construction projects, risk factors of the projects have to be identified, assessed and minimized for scheduled, safe and cost-effective completion of the projects. This study involves identification, classification and assessment of various risks in construction of highway projects using Relative Importance Index (RII). Further, risk factors are ranked according to their impacts.**

Keywords*— *Risk Assessment; Planning; Management; Risk; Identification of Risk.

I. INTRODUCTION

Risk is involved in every aspect, and the construction of highway projects are no exception. Risk is defined as the possibility of loss, injury, disadvantage or destruction also as a combination of the probability of frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence. Risk assessment is a stepwise procedure consisting of risk identification, risk classification and risk analysis or evaluation. Risk assessment is determination of quantitative or qualitative estimate of risk.

Highway projects consist of many risks and this is due to involvement of many contracting parties including designers, contractors, sub-contractor and suppliers. Risks are the major cause of poor performance on highway construction projects. Construction of highways involves various risk factors from designing and planning stages to completion of project. Due to these factors, there are delays in completion of project which involve large funds. So risk assessment consisting of risk identification, risk classification and risk analysis or evaluation is necessary for maintaining cost and quality of the project and for scheduled completion of the project. [1]

The solution to a decision making problem of budget allocation problem, to allocate funds to deserving and competing organizations can be done by using integrated Fuzzy, AHP and MCDM techniques [2]. The major risk factors affecting highway construction project cause delay in making decision and land acquisition. Hence it needs to deploy the use of proper risk management [3]. The most significant risks include inefficient planning, unexpected ground utilities, quality and integrity of design, and delays in approvals [4].

Risk assessment for highway construction project is done to prevent adverse impact at the design or planning stage, prioritize hazards and control measures, to maintain cost and quality of the project and for scheduled completion of the project. This study involves risk identification, risk classification, risk analysis or evaluation and ranking of risks using Relative Importance Index (RII).

II. OBJECTIVES AND IMPORTANCE

The objectives of this study are listed below:

- To define the various major risks involved in highway construction project.
- To identify and classify the various risks involved in construction of highway.
- To analyze or evaluate the risks involved in highway construction.

This study mainly focusses on assessment of various risk factors involved in construction of highway from designing and planning stages to completion of project. The risks are analyzed by using quantitative tool, i.e. RII. Risks are ranked according to their adverse impact on the highway construction project. Risk having Rank 1 has greater adverse impact than the risk having Rank 2. The assessment of risk factors will help in risk planning and risk management of any project. Further, this will help in improving the performance of highway construction projects - to maintain cost and quality of the project and for scheduled completion of the project.

III. METHODOLOGY

The various risks were identified and classified and based on that a questionnaire was prepared on “5-point Likert scale”, where point 1 to point 5 varies from very low risk to very high risk respectively. The data collection was done for the sample size of 52, through questionnaire survey. Further, this data was compiled and analyzed using Relative Importance Index (RII) method. The analyzed risks were ranked according to their importance of adverse impacts on highway construction project.

The methodology of this study is explained through the flow diagram of work as shown in Fig. 1.

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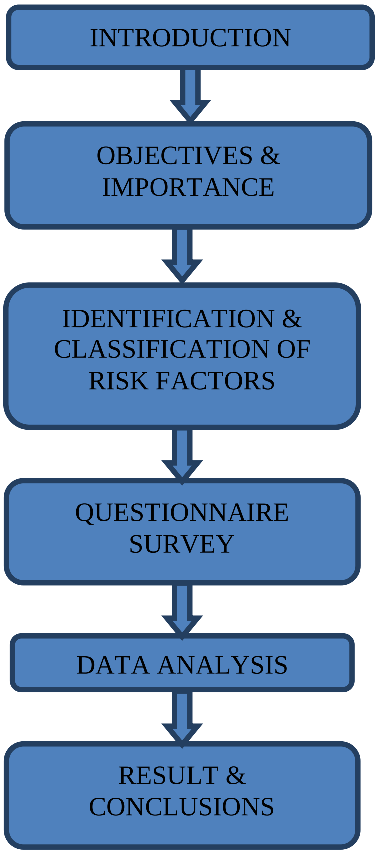

Fig. 1: Flow diagram of work.

IV. IDENTIFICATION AND CLASSIFICATION OF RISKS

(1) Construction Risk:

Most risks associated with the construction are more likely to root in contractors and subcontractors. To keep the construction work on track, experienced contractors need to be involved in the project as early as possible to make sound preparations for developing valid construction programs. Machineries, delay due to rain and other causes, uncertain market conditions, contractor productivity issues, time etc. are the risks which construction phase constitutes.

(2) Design Risk:

This may result from issues such as variations in design and defective designs. The design risks arise due to uncertainty in horizontal alignment, uncertain indirect costs and consideration of improper basic parameters while designing. To avoid defective design, the design team needs not only to fully understand what the clients want as defined in the project brief, but also to establish an efficient communication scheme among the designers.

(3) Political Risk:

"Excessive approval procedures in administrative government departments" and "bureaucracy of government" are not seldom complained by clients and contractors. These risks are normally out of the control of the project stakeholders. To attract investment within their administrative territory, the government agencies should always make great efforts to create a friendly environment in which the approval procedures are reduced or at least the approval time is shortened, and the bureaucracy is minimized.

(4) Organizational Risks:

Lack of skilled labour, lack in knowledge level of lead group, etc. are the example of organizational risks. Lack of skilled labour can lead to project delays, poor workmanship, safety and liability issues.

(5) Accidental Risks:

Unanticipated damage during construction is a accidental risk. Any type of accidents on construction sites like machineries accidents, overexertion, accidental falls etc. can be disastrous for the project.

(6) Uncertain market conditions:

Uncertain market conditions usually called as "price inflation of construction materials" is identified to be related to external environment. The price of construction materials is always changing in response to the inflation and the relation between supply and demand in the construction material market. As this risk is usually unavoidable, clients should choose an appropriate type of contract; while contractor should always avoid using fixed price contracts to bear the risk.

(7) Time/Funds:

As time and cost are always closely correlated, a lengthy schedule will undoubtedly wreck the project cost benefit. Correlation between time and cost is a quantitative risk. In extreme cases the risk of time and cost overruns can compromise the economic viability of the project, making a potentially profitable investment untenable.

(8) Utilities:

Utilities include: electricity, gas, water, fuel, etc. which plays a huge role in construction projects completion; shortage of these utilities would create problems on site. For example, use of ground water is prohibited by government agencies for highway construction projects in India.

V. ANALYSIS OF RISKS

The data collected through questionnaire survey was analyzed by using quantitative method of relative importance index (RII) on a excel sheet. The RII is computed using the equation:

$$RII = \frac{\sum W}{A * N} \qquad (0 \le RII \le 1)$$

Where:

W – is the weight given to each risk by the respondents and ranges from 1 to 5, (where "1" is "very low risk" and "5" is "very high risk")

A – is the highest weight (i.e. 5 in this case) and;

N – is the total number of respondents. [7]

The various risks categorized under different categories were calculated and ranked. The higher value of RII represent significant risks affecting construction of highway project. The Table I below shows the risks with RII value and their ranks:

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TABLE I: Risk Analysis Using RII.

Risk Category	Risk No.	Risks	RII	Rank
Construction	R1	Machineries	0.692307	16
	R2	Delay due to rain or other causes	0.665384	23
	R3	Uncertain construction market conditions	0.642307	28
	R4	Contractor productivity issues	0.723076	11
	R5	Time	0.765384	2
Design	R6	Development around road analysis	0.615384	30
	R7	Uncertainty in horizontal alignment	0.615384	30
	R8	Uncertainty in access requirements	0.680769	17
	R9	Uncertain indirect costs: design, construction, project management	0.696153	15
	R10	Design errors and omissions	0.711538	12
	R11	Consideration of improper basic parameters	0.653846	24
Topography	R12	Construction in hilly region	0.742307	6
	R13	Uncertainty in landscaping activities	0.673076	21
Political	R14	Issues related to obtaining Railway Permits	0.765384	2
	R15	Issues related to obtaining Govt. Permits	0.734615	9
	R16	Other Political or external issues	0.700000	14
	R17	Change in policies	0.669230	22
Land acquisition	R18	Uncertain land acquisition cost	0.753846	5
	R19	Uncertain land acquisition schedule	0.711538	12
	R20	Change in policies	0.642307	28
Environmental	R21	Natural obstruction: hills, rivers, trees	0.653846	24
	R22	EIA Required	0.607692	33
Organizational	R23	Skilled Labour	0.603846	34
	R24	Knowledge level of lead group	0.592307	35
Accidental	R25	Unanticipated damage during construction	0.742307	6
Utilities	R26	Utilities not relocated on time	0.726923	10
	R27	Fuel: availability, price	0.615384	30
	R28	Electricity	0.646153	27
Minerals	R29	Mineral mining issues	0.676923	18
	R30	Cost of minerals	0.676923	18
Law and order	R31	Local disturbances	0.757692	4
Climatic condition	R32	Unforeseen climatic conditions	0.653846	24
Others	R33	Quality: construction, product	0.676923	18
	R34	Funds/Money	0.769230	1
	R35	Emotional issues	0.588461	36
	R36	Heritage issues	0.742307	6

VI. RESULT

The relative importance index (RII) for the risk priority is calculated based on all responses for each risk. The priority of each risk is given by the relative importance index (RII) value which is according to the adverse impact of each risk. The risks are prioritizing according their ranks. The priority helps to identify the most significant risks.

In this analysis, the overall top ten most significant risks were shown in Fig. 2 with their RII values and ranks. Hence, the overall top ten identified risks were R5, R12, R14, R15, R18, R25, R26, R31, R34 and R36. Also, the most significant risks from each category were short listed out and shown in Fig. 3. The most significant risks from each risk category were R5, R10, R12, R14, R18, R21, R23, R25, R26, R29, R30, R31, R32 and R34.

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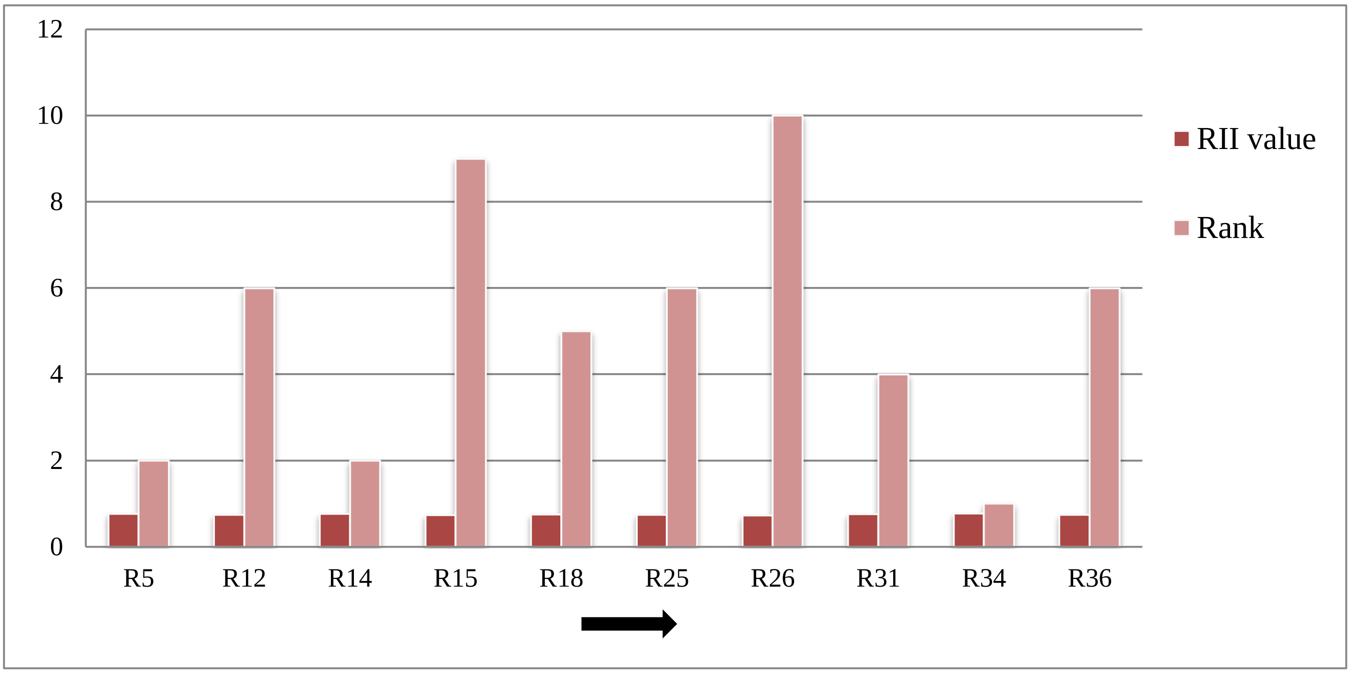

Fig. 2: Bar chart analysis of overall top ten risks.

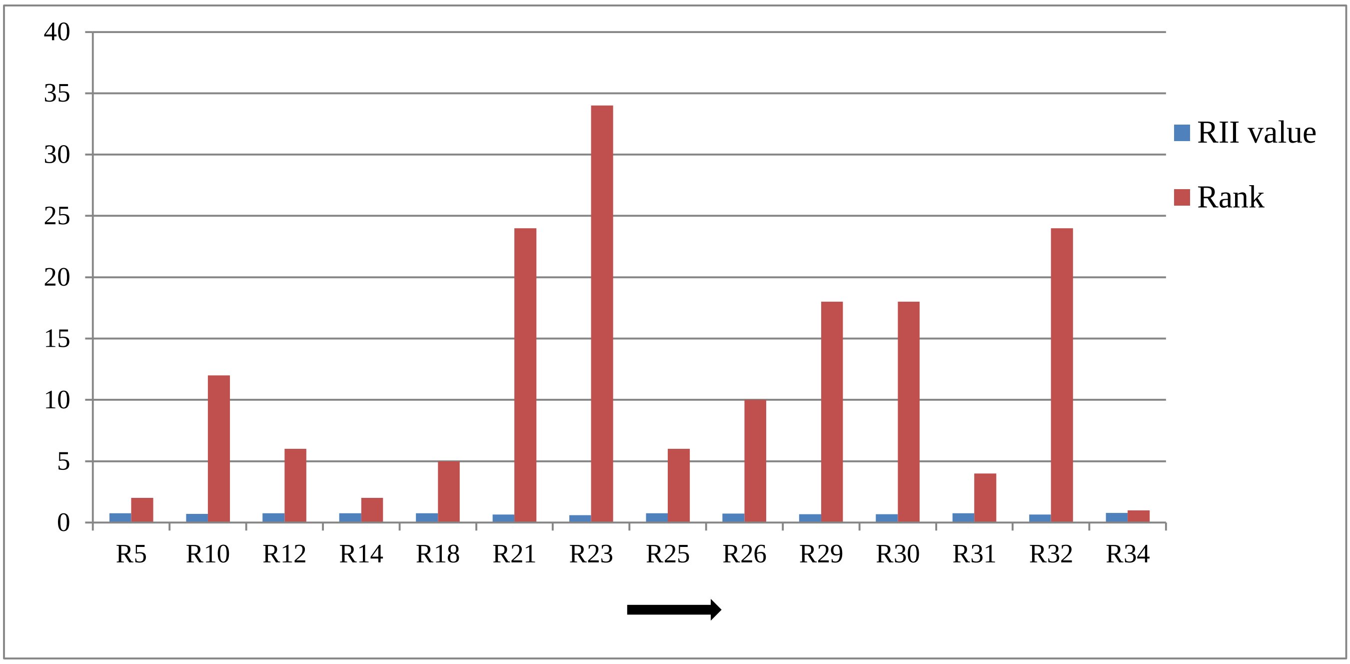

Fig. 3: Bar chart analysis of most significant from each risk category risks.

VII. CONCLUSION

This study concluded that an effective risk assessment is determination of quantitative estimate of risks as risks are involved at every stage of highway construction project. This study provides a good understanding of the risk assessment procedure to assist in assessing the risks involved during construction. Risk assessment is an effective tool for supporting decision-making and corrective actions in construction. This assessment of risk factors will help in risk planning and risk management of any highway construction project. Further, this will help in improving the performance of highway construction projects, i.e., to maintain cost and quality of the project and for scheduled completion of the project.

From analysis and results, for overall risks mainly utilities relocation on time, obtaining government agencies approvals, construction in hilly terrain and land acquisition impose high risk on any highway construction project. In construction risk category delay in project impose the high risk. Similarly, in design category errors in designing due to consideration of improper basic parameters and in environmental category natural obstructions have the greater impact on highway construction project. These were the

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significant risks which mainly cause the delay of the project. As time and cost of the project are related, hence as the time of the project overruns the cost also overruns and impose high risk on highway construction project.

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