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# Risk Management in Infrastructure Projects in India

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**Abstract**— Managing risks in infrastructure construction projects has been recognized as a very important management process in order to achieve the project objectives in terms of time, cost, quality and scope. This paper aims to identify and analysis of risks associated with the infrastructure projects. Based on a comprehensive assessment of conditions of contracts, this paper identifies risks and classifies them into eight types. It is observed by qualitative risk analysis, opposition from social bodies, changes in design and suspension of work are recognized to influence the project objectives maximally. This study has been found that few suggestions to mitigate construction project risks. The contract documents are used as a tool to manage risk and client, contractors and investors need to establish risk management policy throughout the project life. It is concluded that clients, designers, contractor and government bodies must work cooperatively from the feasibility phase onward to address potential risks in time.

**Keywords**— Construction projects, Contract, Qualitative risk analysis, Risks, Risk management

## I. INTRODUCTION

Infrastructure Construction projects are unique in character and do not lend themselves to standardization [1]. The construction project of dynamic nature, with many seasonal and cyclical ups and downs. Hence, each construction project requires a lot of care in handling [2]. Also, construction activity consists a number of agencies i.e. the client, consultant and the contractor. In order to establish the duties, obligations, rights, responsibilities among the various agencies, a contract is required to be made between them which will establish a mutual relationship to do a work.

The most of civil engineering work is performed under contract. A contract provides a “self-contained statement of obligations as between its own parties”. In any successful construction project the contracts are vital as it is important, difficult, costly and lengthy proceedings. The contract documents can be used as a tool to manage risk by allocating risks to the various agencies through the various contracts between them [4]. It is very important for all the agencies that they are aware at all times of the extent of risk exposure or the risks that they have to manage otherwise it may lead to a number of disputes, disagreements and disruptions. One of the major reasons of disagreement and conflict is inadequate and defective contract documentation and also inappropriate contract arrangements [4].

This paper deals with study of the risk management in construction contract and aims to identify the key problems in critical areas of construction project, which have the potential to become major roadblocks in the progress of the project. In present work, a case study Flyover in Pune city of Maharashtra state, India, has been referred. The study identify, classify of various risks in a given set of contract documents of construction project, and on basis of qualitative risk analysis, suggests methods to mitigate risks in construction projects.

## II. METHODOLOGY

The purpose of this study, the research methodologies are used in order to collect data, analysis data and report on findings and results. The research methodology selected for this risk management project comprised comprehensive literature review, followed by open interviews and distributing questionnaire surveys to the various agencies i.e. client, contractors, consultants of the projects. For data analysis purposes in this study, methods used qualitative risk analysis. Fig. 1 shows the research methodology flow chart as used for this study.

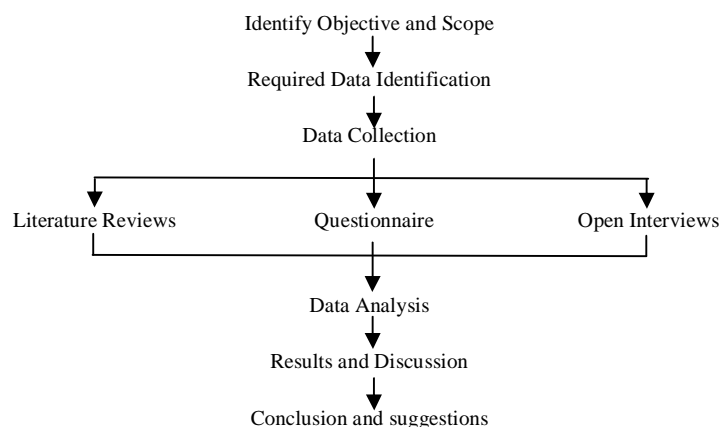


Fig. 1 Research Methodology Flow Chart

### III. RISK MANAGEMENT IN CONSTRUCTION

The risk is the likelihood of variation in the occurrence of an event, which may have either positive or negative consequences [6]. Risk can also be defined as an event that may or may not occur and can lead to higher costs, extension of the project, failure to quality requirements/ norms, failure to satisfy information requirements/ norms and failure to satisfy specified organizational Risk Management [8]. The nature of risk is such that the risk for one person may be an opportunity for another. This entirely depends on, from whose point of view the project is being judged i.e. a range of possible outcomes, individual consequences and probability [9].

D. W. Stam [8], and L. Y. Shen [9], proposed a risk management is explained as “a system which aims to identify and quantify all risks to which the business or project is exposed so that a conscious decision can be taken on how to manage the risks.”

Risk management provides support for attempts to gain better control over a project when it comes to time, cost, quality, scope and organization. Risk management can help to promote progress of the activities within a project, instils confidence in the project, promote communication within the project and support the decision-making process within a project. Company does not have time or capacity to engage in risk management, mostly company not familiar or thinking cost involving process, so that risk management is generally not applied to every construction project [8].

The steps in the process of risk management are:

- Risk Identification
- Risk Classification
- Risk Analysis
- Risk Response

Contracting and Risk

Construction projects have an abundance of risks, contractors cope with, and owners pay for. When developing a contract strategy it is important for the client to communicate his objectives to the contractor to ensure that the most appropriate risk-sharing strategy is chosen [7]. The risk is best placed with that party involved in the management of the project who is best able to manage the factor which gives rise to it [4].

In addition to the legislative and policy requirements, the following Common issues in contracting that are relevant throughout the project life are Managing risks, Managing relationships, Managing resources, Specifying responsibilities, Keeping records, Behaving ethically[12].

### IV. DATA COLLECTION

For the purpose of this study, a set of contract documents of the infrastructure project in Pune city of India has been referred. To alleviate the congestion at junctions, government has planned project which includes three flyovers. While the initial cost was Rs. 50 cr, it has now escalated to Rs 68 cr. Table I shows the referred contract documents between client and contractor.

TABLE I - REFERRED CONTRACT DOCUMENTS

Sr. No.	Contain
1	Tenderer Notice
2	Detailed tender notice
3	Instructions to Tenderers
4	Declaration of the contractor
5	General Conditions of contract
6	Special Conditions of contract
7	Technical Specifications
8	Tender of works
9	Letter of Acceptance
10	Material Brought By Contractor
11	Schedule A, Schedule B
12	Suggestive:- Format for Cement, Steel & Asfalt
13	Price Variation Clause
14	Bill of Quantity

From questionnaire survey and open interviews of case study of project of flyovers in Pune, there is suspension of project which result cost overruns and time overruns. The existing heritage structure has a problem with one of the flyover project. Some part of heritage structure will be on the road and the main entrance of the heritage structure would be closed forever. The traffic will move very close to the heritage buildings. Existing structure and social- non government agencies oppose the project. So there is suspension of project work. To preserve a heritage structures client changed the design.

## V. RISK ANALYSIS

Here the various risk related to the contract document of project are identified, studied, classified and analyzed. From the study of PMC contract document, it found that there are various clauses mentioned, as General conditions, Technical specifications and special conditions. With the help of the checklist given by L.Y. Shen risks are identified and grouped in eight different categories which are physical risk, financial risk, legal risk, construction risk, political risk, design risk, environmental risk & contractual risk. Table II shows the matrix of risks and types of risks for condition of contract.

TABLE II - RISK MATRIX OF CONDITIONS/ TYPE OF RISKS CONTRACT DOCUMENTS

Conditions Of Contract	Risks Classification							
	Physical	Financial	Legal	Construction	Political	Design	Environmental	Contractual
<b>General conditions</b>								
Suspension of work		*			*			
Changes in design		*		*		*		
Extension of time		*						*
Penalty for delay		*						*
Insurance and Indemnity		*						*
Labour regulations	*				*		*	
Extra works		*		*				
Accidents	*							
Quality assurance plan		*		*		*	*	
<b>Technical Specification</b>								
General tech. spec.				*		*		
Supplementary tech. spec				*		*		
Prevention of property				*		*		
Tests List with frequency				*		*		
<b>Special conditions</b>								
Advance		*						
Dispute and Arbitration			*					*
Arrangement of traffic during construction	*			*				
Completion certificate				*				*
Environmental safeguard	*						*	
Price variation clause		*						*
Opposition from social Bodies					*	*		

### Qualitative risk analysis (QRA):

Qualitative risk analysis determines the importance of addressing specific risks and guides risk responses. It helps to determine the likelihood and potential effect of the risks on the project objectives. It provides a quick and clear picture of risks and is easy to understand.

To do this analysis QRA Sheet was used which consists of identified risks classified into various types requiring a subjective response on the probability of its occurrence on a 5 point scale of: very low, low, medium, high, very high and on the impact of these risks again on a 5 point scale of, very low, low, medium, high, very high. Table III shows format of QRA sheet which consists of the probabilities and impact assessment responses of contractors and owners.

TABLE III - FORMAT OF THE QRA SHEET

Risks	Probability					Impact				
	Very low	Low	Medium	High	Very high	Very low	Low	Medium	High	Very high
<b>A. Physical</b>										
Risk 1										
Risk 2										
<b>B. Financial</b>										
Risk 1										
Risk 2										

The responses on QRA sheet were analysed using median as a measurement of central tendency. Table IV shows sample calculation of the probabilities and impact assessment responses of contractors and owners for each risk.

TABLE IV- QRA SHEET WITH SAMPLE CALCULATION

	Contractors											Owners												
	Probabilities					P	Impact					I	Probabilities					P	Impact					I
Risks	P 1	P 2	P 3	P 4	P 5		I 1	I 2	I 3	I 4	I 5		P 1	P 2	P 3	P 4	P 5		I 1	I 2	I 3	I 4	I 5	
Risk 1	2	1	0	0	0		1	1	1				2	2					1		2		1	
Cum. Freq.	2	3	3	3	3	P 1	1	2	3	3	3	I 2	2	4	4	4	4	P 1	1	1	3	3	4	I 3
Risk 2	1	1	1	0	0		1	1	1	1			2	1	1				1	2	2			
Cum. Freq.	1	2	3	3	3	P 2	0	1	2	3	3	I 3	2	3	4	4	4	P 1	0	2	4	4	4	I 2

For performing qualitative analysis, the responses of owner and contractor on their assessment of probabilities and impact of risks were analysed to arrive at a single rating for each risk. This rating is plotted in Table V which shows the opinions about probability & impact related to owners & contractors point of view.

TABLE V - RATING FOR RISKS IDENTIFIED IN CONTRACT

PMC conditions	Owner		Contractor	
Risks	Probability	Impact	Probability	Impact
Change in Design	High	High	high	High
Opposition from Social Bodies	medium	High	high	very high
Suspension of Work	High	High	high	High
Extra Works	medium	High	medium	Medium
Accidents and safety	Low	Low	medium	High
Penalty for delay	medium	medium	medium	Medium
Disputes	Low	Low	Low	Medium
Extension of time	medium	medium	medium	High
Insurance and Indemnity	Low	Low	Low	Medium
Prevention of property	medium	medium	Low	Medium
Price variation	medium	High	medium	High
Quality assurance	Low	medium	medium	Medium
Labour regulations	Low	medium	medium	Medium
Excessive approval by government	medium	medium	medium	High
Material management	Low	medium	medium	Medium
Traffic diversion	Low	medium	medium	medium
Dispute and Arbitration	Low	medium	medium	medium

## VI. RESULTS AND DISCUSSIONS

While making the contract agreement, there are various clauses can make conflicts between client & contractor, so for avoiding any disputes the risk identification was performed on the conditions of contract and specifications.

For that infrastructure projects in Pune are studied. From the study of various contract clauses from contract document it knows that there various risks can be generate. Those risks identified in the contract documents were classified under the categories of physical, financial, legal, construction, political, design, environmental and contractual risks; depending on the nature of its impact. The risks identified in the contract documents are placed against each condition of contract.

The risk assessment matrix is formed according to the impact of risks on client & contractor. Because every clause of contract is may be converted into the risk & it may effects on different perspectives of the project i.e. time, cost, scope, quality. The probability & impact is combined to determine whether the activity is very high risk, high, medium, low, or very low risk for each objective or clause. While studying the qualitative risk analysis there is contract document it is observed that the client of project have made the contract agreement like that they have minimized the majority of risk which can affect them. In between that some risks are kept same which have low probability & low impact on them. The risks are transferred to the contractor.

The major risks factors were found to be the agreement of the contract, change in design, opposition from social bodies, suspension, price escalation and renegotiations. Finally, some suggestions are find out to reduce or mitigate construction project risks are identified which are the stable cash flow of project funding, more precise geotechnical data, consulting constructability reviews from experts, set a realistic contract performance times, work and rework cost estimates, introducing phased pricing, pre-plan for permits & approvals, information regarding utilities and zoning, pre-define rates, equations and procedures, use of experienced project personnel, proper material management, minimise communication gap by periodic meeting ,inspection & reviews and last but not least use the contracting process as a risk avoidance measure.

## VII. CONCLUSIONS

On the basis of survey, this study has systematically examined major risks affecting the infrastructure project. In this paper qualitative risk analysis technique provides an effective insight and clear picture of the risks involved in infrastructure construction in Pune city. The contract documents are used as a tool to manage risk by allocating risks to various agencies through various contracts. To minimize the chances of failure or under-performance, risk management policy must be implements and evaluate regularly into the construction project. This study provides useful references to any infrastructure construction projects in India.

It is concluded that clients, designers, contractor and government bodies must work cooperatively from the feasibility phase onward to address potential risks in time. The analysis and findings in this paper also present valuable data for the Indian government and local construction agencies to have an in-depth understanding of the risk environment in construction in Pune city of India. Such understanding is very important for implementing further effective measures to ensure the right direction of future development to construction professionals.

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