

# Risk Management in Infrastructure Projects

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**ABSTRACT-** Management of risks in the infrastructure projects has been categorized of utmost importance to the process of management so that the project objectives and motives in terms of time, cost, quality may be accomplished. The identification and analysis of risks which are bracketed with infrastructure projects is the main aim of this paper. Risks have been identified and classified in this paper based on comprehensive assessment of conditions of contracts. It has been seen that the project objectives are impacted heavily due to the opposition of social bodies, the qualitative risk analysis, any design change and of course the suspension of work due to various reasons. The main tool to manage risks has been attributed to contracts. The risk management policy has to be implied throughout the life of the project. In nutshell, from the initial phase, the contractor and the government bodies should work harmoniously, in coordination so that the potential risks can be addressed well in time.

**KEYWORDS-** Infrastructure, Risk management, Policy, Government bodies, work

## I. INTRODUCTION

Distinctive in nature, the infrastructure construction projects do not impart themselves rather are not obliged to standardization [1]. The construction project of dynamic nature, with many seasonal and cyclical ups and downs. All the construction projects are thus in need of careful handling and supervision owing to the vigorous character of the infrastructure construction projects[2]. The client, consultant and the contractor are the number of agencies involved to name a few when it comes to construction activity. A contract is required to be made allying various duties, obligations and responsibilities amid copious agencies which will help establishing a mutual relationship to do a particular work or chore. A contract if seen forms the basis of a construction project and if observed, it is under a contract that various civil engineering works and projects are carried out [3]. A contract, to be brief, is something which amongst the parties dispenses a self-sufficient statement of obligations and responsibilities.[4] The various risks associated with a project or work can be well managed by administering them to the respective agencies via the contracts. A conscious approach round the clock is hence required or needed to comprehend the stretch, exposure and the vulnerabilities. When the details, the stretch of exposure, the vulnerabilities of the project are not well understood by the parties involved, it results

in chaos. Such a chaotic situation gives rise to disputes, disruptions and disagreements between the working parties associated with the project

When the documentation is insufficient scanty and faulty, it forms the basis of rationale of the dissent and conflict. The contract agreement hence forth if of un professional type may lead to conflicts.

This paper aims in identifying the main hurdles and obstacles of the construction projects by diving into the details of risks and there by relating various risks with the projects of construction and how those can be managed. For the same purpose, a case study of Rambag Jahangir chowk flyover in Srinagar city of Jammu and Kashmir has been considered an various risks which have the potential to cause hindrance in the project have been studied. On the basis of qualitative risk analysis, the documents of contract paper, various risks have been identified which are associated with the projects and also the methods to mitigate the risks have been suggested.

## II. METHODOLOGY

Methodology forms an important part of this project as it helps to identify the risks, the collection of data and also provides an idea about what steps should be taken to mitigate the risks well in time so that the construction projects may not suffer. The methodology for the risks management in infra structure project consists of collecting data through questionnaires and literature reviews. Open interviews could not be carried out owing to the Covid-19 Pandemic. The questionnaires have been allocated to various agencies i.e client, contractors, consultants of the projects, Engineers in order to collect data and withdraw relevant results from the same.

Research Methodology chart used has been shown in Fig. 1 below:

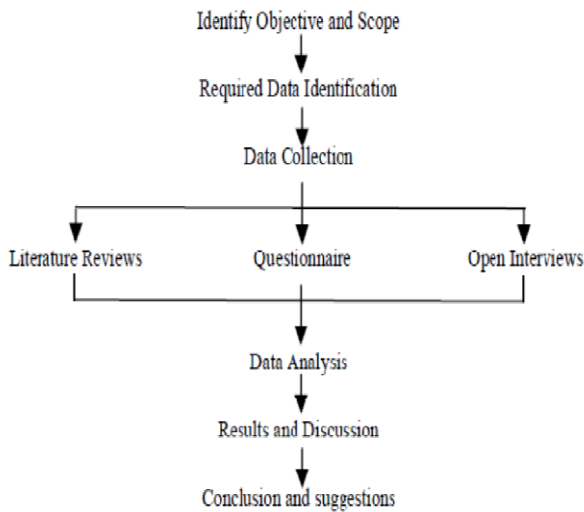


Fig. 1 Research Methodology Flow Chart

Figure 1: Research Methodology chart

### III. MANAGEMENT OF RISK IN INFRASTRUCTURE CONSTRUCTION PROJECTS

A risk may be defined as the probability of discrepancy in the occurrence of an event which may either have a constructive outcome or a negative result[10]. An event which may or may not take place resulting in escalated cost, extension and addendum of the project life non fulfilment and conformity to quality requirements/standards, failure in satisfying norms is another way of defining a risk[6]. No amount of planning can defeat risk. The character of risk is such that the risk for one person or agency may be an opportunity or right set of circumstances for another. All this altogether pivots on, from whose opinion or sentiment, the project is being judged i.e. an array of practical outcomes and consequences, discrete consequences and probability[7].

Risk Management is a structure that targets and designs in order to recognize and calibrate all the array of risks for which the project is exhibited so that a reasonable and deliberate attempt on the management of risks can be made. This definition has been proposed by D.W. Stam and L.Y. Shen[8]. As regards the time, cost, quality, scope

and organization, risk management is something which helps provide support to these areas. The advancement and progression of the activities within a project can be boosted with the help of the process of risk management. The risk management can also contribute to the credence and confidence of the team members, build communication and support massively the decisive power and the decision making process within the project.[9]

The various steps in the process of risk management can be broadly categorized into the following steps:

- Identification of Risks.
- Analysis of risks.
- Risk response development.

#### A. Risk Response

There are ample risks involved with construction projects with which the contractors do subsist and the owners do make a choice for making payments. A project without risks is not possible[10]. The risks may be huge to small. So, whenever a strategy for the risk management is framed, it is vital for the client company to clearly convey the objectives, goals and targets to the contractor in order to certify choosing the most pertinent risk- sharing plan. Risk is best managed by the party or team who knows how to manage the factors giving rise to a risk [11]. Moreover, when considering the scheme and judicial requirements, the subsequent usual issues in contracting that are relevant and pertinent all throughout the project life are risk management, resource management, relationship management, record keeping, behaving ethically and of course taking and specifying responsibilities[12].

### IV. COLLECTION OF DATA

A Set of contract documents of the infrastructure project in srinagar of j&k has been studied carefully for the purpose and accomplishment of this study. The government had planned certain projects for the alleviation of congestion of traffic at the junctions [13]. This included single flyovers with two segregate bridges over the river Jhelum. Rs 219.26 crore was the initial cost. However, the cost finally ended up at Rs 379.67 crore. M/S Valecha Engineering limited Mumbai and M/S Simplex Infrastructure Private Limited Mumbai were the contractors to whom the project work was allotted [14]. The respective contract documents between the client and contractor have been shown in the Table 1 below.

Table 1: Referred Contract Documents

S. No.	REFERRED CONTRACT DOCUMENTS
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, & Asphalt
13	Price Variation Clause
14	Bill of Quantity

The open interviews and the questionnaires carried out for the case study of the infrastructure project of Rambagh flyover in J&K has shown and signified that due to the risks, the work gets suspended due to which the project is delayed and hence there is an overrun in cost and time [15]. The main problem encountered in the execution of this very project ( that is the Jehangir Chowk- Rambagh flyover for alleviating congestion of traffic ) was that the traffic would move very close to the heritage buildings and other important structures. For the same reason, the project had to be redesigned and the flyover which earlier was expected to run till Natipora was stopped at Rambagh only [16]. There was suspension of work due to some political reasons as well which included the abrogation of article 370 on Aug5,2019.

The valley saw a lot of unrest and indefinite curfews during this period due to which the project missed deadlines and was unable to be completed in the stipulated time [17]. In this study, various risks in context to the contract documents have been initially identified, then studied, further classified and finally analysed. If seen from the contract documents of ERA(Economic Reconstruction Agency), the various clauses mentioned are General Conditions, Technical Specifications and that of Special conditions [18]. The various risks have been categorized into physical, legal, financial, political, constructional, environmental, design and contractual risk. The types of risks as per the condition of contract has been represented in Table 2 below.

Table 2: Risk Matrix of Conditions/Type Of Risks Contract Documents

Conditions of Contract	Risk Classification							
	P h y s i c a l	F i n a n c i a l	L e g a l	C o n s t r u c t i o n a l	P o l i t i c a l	D e s i g n	E n v i r o n m e n t a l	Contr actual
General Conditions								
Suspension of Work		*			*			
Changes in Design		*		*		*		
Extension of Time		*						*
Penalty for Delay		*						*
Insurance & Indemnity		*						*
Labour Regulations	*				*		*	
Extra works		*		*				
Accidents	*							
Quality Assurance Plans		*		*		*	*	
Technical Specifications								
General Tech. Specification				*		*		
Supplementary Tech. Specification				*		*		
Prevention of Property				*		*		
Test List with Frequency				*		*		
Special Conditions								
Advance		*						
Dispute and Arbitration			*					*
Arrangement of Traffic during Construction	*			*				
Completion Certificate				*				*
Environmental Safe Guard	*						*	
Price Variation Clause		*						*
Opposition from Social Bodies					*	*		

**A. Qualitative Risk Analysis (QRA)**

The importance and essence of addressing peculiar risks and then guiding the risk reverences and responses is what Qualitative Risk Analysis does. The likelihood and the potential outcomes of the risks on the project objectives are aided by Qualitative Risk Analysis[19]. This analysis provides a vivid and a comprehensible picture of risks. In order to carry out qualitative risk analysis, a QRA sheet has been used. The QRA sheet consists of risks which have been recognized. These risks are categorized into

copious types and requires a subjective feedback which is based on the probability of its occurrence on a five-point scale of very high, high, medium, low, very low. The format of QRA sheet has been shown in tableIII given below. This QRA sheet does consist of the probabilities and the effect evaluation and assessment responses of the contractors and clients[20]. The median method which is a measure of central tendency has been used for the analysis of the responses on QRA sheet.Format for QRA sheet is given in form of Table-3

Table 3: Format of The Qra Sheet

Risks	Probability					Impact				
	Very High	High	Medium	Low	Very Low	Very High	High	Medium	Low	Very Low
A. Physical										
B. Risk 1	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.
M. Risk 2	N.	O.	P.	Q.	R.	S.	T.	U.	V.	W.
X. Financial	Very High	High	Medium	Low	Very Low	Very High	High	Medium	Low	Very Low
Y. Risk 1	Z.	AA.	BB.	CC.	DD.	EE.	FF.	GG.	HH.	II.
JJ. Risk 2	KK.	LL.	MM.	NN.	OO.	PP.	QQ.	RR.	SS.	TT.

The sample calculation of the probabilities and the impact assessment For each risk, Table IV shows sample calculation of the probabilities and impact assessment of

the responses of contractors, clients, owners for each risk has been shown in Table 4 below.

Table 4: Qra Sheet with Sample Calculation

	Contractors										Owners													
	P	P	P	P	P	P	I	I	I	I	I	I	P	P	P	P	P	P	I	I	I	I	I	I
Risks																								
Risks 1	2	1	0	0	0		1	1	1			2	2					2		2			1	
Cum-Freq.	2	3	3	3	3	P	1	2	3	3	3	I	2	4	4	4	4	P	1	1	3	3	4	I
Risks 2	1	1	1	0	0		1	1	1	1			2	1	1				1	2	2			
Cum-Freq.	1	2	3	3	3	P	0	1	2	3	3	I	2	3	4	4	4	P	0	2	4	4	4	I

The responses of owners, clients and contractors were assessed and analysed on the probablities and impact of the risks in order to perform the qualitative risk analysis. This was done to reach at a single point/rating for each risk. The

plot of this very rating has been represented in Table 5 below which enumerates the various opinions about the occurrence of risks, their impact as per the point of view of owner and contractor.

Table 5: Rating for Risks Identified In The Contract

PMC Conditions  Risks	Owner		Contractor	
	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 Work	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

## V. RESULTS AND DISCUSSIONS

There can be disputes and conflicts between a client and a contractor owing to certain clauses mentioned in the contract. Now in order to work harmoniously and to avoid any conflict/dispute, the risk identification has been performed on the specifications and conditions of contract of the project. In order to accomplish the above mentioned objectives, the infrastructure project (Jehangir Chowk-Rambagh flyover) in Srinagar has been studied. If we go through the various contract documents, a number of risks can be identified which on studying can be classified into physical, legal, financial, political, constructional, environmental, contractual and design risks. Against each condition of the contract, the risks recognized are marked or laid down. In accordance to the impact of risks on the contractor and client the risk assessment matrix is set up. The study shows that each clause of the contract may have risks which need to be identified and mitigated in the stipulated time. These risks will have an impact on the project in terms of quality, scope, cost and time. It is thus quintessential, to see the occurrence, probability and impact of the risks as a whole in order to conclude the risks as very low intensity risks, low intensity risks, medium intensity risks, high or very high intensity risks. It can henceforth be concluded from the study that while certain risks may be avoided, certain may not. While some can be mitigated, some can be transferred. Usually, low

probability and low impact risks are transferred. Price escalation, change in design, suspension of work, frequent shutdowns, pandemic are a few major risks in the infrastructure construction projects.

In this study, it has been found that the mitigation strategies may include very precise geotechnical data, stable cash flow funding, cost estimates, reviews and suggestions from experts, work and rework cost estimates, planning for permits and approvals, realistic approach to finishing time, contingency plans, recovery activities etc.

## VI. CONCLUSION

The major risks affecting the infrastructure projects have been systematically analysed in this study through various surveys. A vivid insight of the copious risks involved in the infrastructure construction projects in Srinagar (Jehangir Chowk-Rambagh flyover) has been provided by QRA technique through this paper. In this study, the contract documents have served as a tool for administering copious risks to different agencies via contracts. The Risk Management policy is supposed to be implemented and evaluated regularly into the construction projects to cut back the chances of dereliction and underperformance. Useful references to various construction projects of india has been provided in this study.

It is hence concluded that the clients, designers, contractors and government bodies must work in coordination from

the feasibility phase so that the potential risks can be addressed well in time. The analysis and findings in this paper also present valuable data for local construction agencies to have an in-depth comprehension of the risk environmental construction in Srinagar city of India. Such understanding is very important for implementing further effective measures to assure the proper direction of future development to construction professionals.

### CONFLICT OF INTREST

We have no conflict of interest to share

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### REFERENCES

- [1] Richardh Clough, Wilae- Inter-science, New Mexico.
- [2] Project Management Body Knowledge, Project Management Institute, Edition-2004.
- [3] M.H.McCaloum, Construction Risks and Contracting Practices, American Co-orporate Counsil Ass.Annual Meeting –Oct-2000.
- [4] R. Flanagan and G.Normaan, Risk Management and Constructions, Black will Scientific Publication, London-93.
- [5] G Smit and C. M Bohm, “Small-Medium Contractor Contingency and Assumption of Risk. Journal of Construction Engineering.and Management,”
- [6] N.J Smith, Managing Risk in Constructions Project, Oxford- 99.
- [7] D.W Staam, Project risk Management, An essential tool of managing and Controlling project, Kugan Page Limited-Dutch-2005.
- [8] L.Y Shen, Risk management, Inter-national Journal of Construction Eng. and Management. Vol-127, Feb.-2001.
- [9] S.Q Wangh, M.F.Dulaim& M.YAguria,,Risk management framework for construction project in developing countries.
- [10] A.S.Akintoye, and M.J.MacLeod, Risk Analysis and Management in Construction, International Journal of Project Management, vol-015(1)-1997.
- [11] R.Graves, “Qualitative Risk Assessment”, Professional Magazine of the ProjectManagement Institute Oct- 2000.
- [12] L.Galway, “Quantitative Risk Analysis for Project Management”, Raand Publication, Feb-2004.
- [13] W.Baker, H.Reid, “Identifying and Managing Risks, French Forests, N.S.WPearson Education-2005.
- [14] Garg, R., Garg, R. and Singla, S., 2021. Experimental Investigation of Electrochemical Corrosion and Chloride Penetration of Concrete Incorporating Colloidal Nanosilica and Silica fume. Journal of Electrochemical Science and Technology, 12(4), pp.440-452.
- [15] Kansal, C.M., Singla, S. and Garg, R., 2020, November. Effect of Silica Fume & Steel Slag on Nano-silica based High-Performance Concrete. In IOP Conference Series: Materials Science and Engineering (Vol. 961, No. 1, p. 012012). IOP Publishing.
- [16] Bhatta, D.P., Singla, S. and Garg, R., 2021. Microstructural and strength parameters of Nano-SiO<sub>2</sub> based cement composites. Materials Today: Proceedings, 46, pp.6743-6747.
- [17] Dhiman, S., Garg, R. and Singla, S., 2020, November. Experimental investigation on the strength of chipped rubber-based concrete. In IOP Conference Series: Materials Science and Engineering (Vol. 961, No. 1, p. 012002). IOP Publishing.
- [18] Khan, M.N., Singla, S. and Garg, R., 2020, November. Effect of Microsilica on Strength and Microstructure of the GGBS-based Cement composites. In IOP Conference Series: Materials Science and Engineering (Vol. 961, No. 1, p. 012007). IOP Publishing.
- [19] Fani, G.M., Singla, S. and Garg, R., 2020, November. Investigation on Mechanical Strength of Cellular Concrete in Presence of Silica Fume. In IOP Conference Series: Materials Science and Engineering (Vol. 961, No. 1, p. 012008). IOP Publishing.
- [20] Gatoo, A.H. and Singla, S., 2020. Feasibility of plastic and rubber emulsified road pavements & its contribution to solid waste management in India. Int J Adv Sci Technol.