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Risk Management of an Infrastructure Project, A CaseStudy on Nagpur- Aurangabad- Mumbai Express Highway(Six Lane)

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Abstract: ***The word 'Risk' derived from French word 'risqué' meaning "tending toward impropriety,". The construction process has numerous uncertainties and risks, which increase with the size and the complexity of a project. Study shows that construction industry is subjected to more risk and uncertainties than any other industries. The reason for that is mainly due to complex nature of construction business activities, process, environment and organization. Though now with modern construction technology, it becomes very easy to carry out construction activity with minimum effort but whenever risk is concern, proper planning before execution plays very important role in carrying out construction activity. Minute will be the planning, lesser its impact on project objective. An important implication of this paper is to identifying the key sources of occurrence of risk in project and a way to mitigate the same.Construction Risk Management mustbe given adequate attention in order to ensure a successful project that meets the expectation of project goals and objectives thus risk management practice in a country with respect to highway projects is explored in this study. One by one, listing out all frequent occurring risk, there sources and mitigation way helps us to put pioneer step in data collaboration and provide these risk solutions globally.***
Keywords: Risk, Risk Management, Planning, Risk Mitigation

I. INTRODUCTION

The depth of impact of risk on activity can be understood well from its origin meaning. Project Management Institute (PMI) defines project risk as an uncertain event or condition and that its occurrence has positive or negative effect on at least one project objective, such as time, cost, scope, or quality (PMI 2004). As we know, construction industry is subjected to numerous uncertainties and risks because of its complex nature.

With development of modern construction technique, it become simpler to carry out different activity in project as compare to past though there is no such technique available to predict any risk in construction project. Only best we can do is to learn from past i.e. implementing guidance of senior members or consultant to list out most occurring risk in different infrastructure project and keeping record of each project risk management in such a way that whenever and wherever wants to retrieve information regarding the same can be easily available. Therefore this research is pioneer step for such idea to collaborate the information to retrieve it as and when required.

Risk whenever and wherever occur causing enough trouble in one or other objective of project. Though risk is an unavoidable phenomenon in construction projects therefore proper risk allocation in construction contracts has come to assume prominence because risk identification and risk allocation have a clear bearing on risk handling decisions. According to Smith et al. (2002) Risk is an unforeseen event that occurs during the process of construction projects. Risks that occur in highway projects will lead to inability to achieve desired project objectives. Delays, cost overruns and reduction of availability of resources are negative effect of risk inherent to highway projects. Even in our day to day activity there are certain unforeseen event that occurs which are not predicted causing delay in other activity and may cause unplanted expense. From this example, one can understand the impact of risk because timeand money is only thing that have to be control and therefore Risk mitigation planning is as important as resources required for execution.

Some people are well aware about risk management but this paper will address and educate the reader about important gap in knowledge on this topic. In order to show its application in construction project, a case study is conducted on most decorated project in India 'Samruddhi Mahamarg' also known as Nagpur-Mumbai Super Communication Expressway. This research is done by keeping in mind about this project and risk mitigation will be given based upon its application on Samruddhi Mahamarg.

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II. RESEARCH OBJECTIVES AND IMPORTANCE

1) *Objective:*Collecting and studying various risk encountered during highway projects in India, identifying there source of occurrence and elaborating solution for the same and last but not least implementing the effective risk management for success of project.
2) *Importance:*This research is mainly focus on identifying gap in knowledge on this topic and educates the reader about same. In order to ensure project success, risk management has been identified as most important tool. This research will drive the attention to the occurrence of unpredictable risks during the execution of construction project.In addition to that, studying the relation between risk management and projects success is important because most of the projects take place in unpredictable environmental conditions and uncertain factors affecting the firm also project success is directly or indirectly depends upon precision of risk management plan.

III. RISK MANAGEMENT CYCLE

In order to prepare best and precise risk management plan to ensure project success, its fundaments needs to be understood well. Before preparing risk management plan its components plays an important role in study along with its application process. The cycle can be well pictured with following figure.

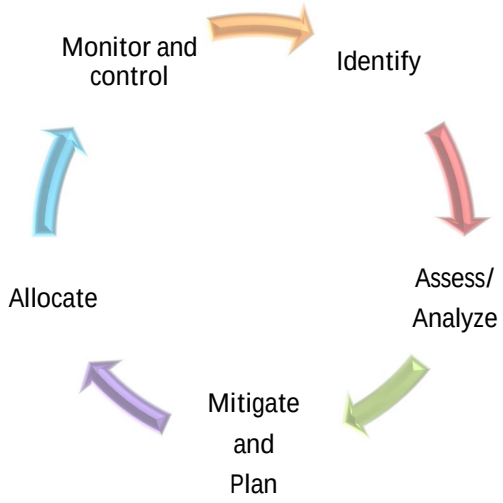

Figure 1: Risk Management Cycle

A. *Risk Identification*

The objectives of risk identification are to identify and categorize risks that could affect the project and document these risks. The outcome of risk identification is a list of risks. What is done with the list of risks depends on the nature of the risks and the project. The items can then be assigned to individual team members to watch throughout the project development process and used for riskallocation purposes. A number of documents and tools are available to support the risk identification process. Table given below provides an example of project-specific documents, programmatic documents, and techniques available for risk identification. Numerous techniques are available to facilitate risk identification after these documents have been reviewed. Brainstorming, scenario planning, and expert interviews are tools highway engineers commonly use in routine engineering and construction management tasks.

Table 1: Risk identification tools and techniques

Project specified Documents	Programmatic Documents	Techniques
Project description	Historic data	Brainstorming
Work breakdown structure	Checklists	Scenario planning
Cost estimate	Final project reports	Expert interviews
Design and construction schedule	Risk response plans	Nominal group methods
Procurement plan	Organized lessons learned	Delphi methods
	Published commercial	Crawford slip methods

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B. Risk Assessment

Risk assessment is the process of quantifying the risk events documented in the preceding identification stage. Risk assessment has two aspects. The first determines the frequency of a risk occurring, the second judges the impact of the risk should it occur (consequence severity). Risks affect project outcomes in diverse ways. Risk effects are usually apparent in direct project outcomes by increasing costs or schedules. Some risks influence the project by affecting the public, public perception, the environment, or safety and health considerations.

1) Risk determines the likelihood of a risk occurring (risk frequency) and judges the impact of the risk should it occur (consequence severity).
2) The risk assessment phase has as its primary objective the systematic consideration of risk events, their likelihood of occurrence, and the consequences of such occurrences.

C. Risk Mitigation and Planning

The objectives of risk mitigation and planning are to explore risk response strategies for the high risk items identified in the qualitative and quantitative risk analysis. The process identifies and assigns parties to take responsibility for each risk response. Formalizing risk mitigation and planning throughout a highway agency will help establish a risk culture that should result in two benefits:

1) Better cost management from planning through construction
2) Better allocation of project risks that align teams with customer-oriented performance goals.

D. Risk Allocation

The contract is the vehicle for risk allocation. Whether the contract is for construction, construction engineering and inspection, design, design-build, or some other aspect of highway construction management, it defines the roles and responsibilities for risks. Risk allocation in any contract affects cost, time, quality, and the potential for disputes, delays, and claims. The goal of an optimal allocation of risk is to minimize the total cost of risk on a project, not necessarily the costs to each party separately. Thus, it might sometimes seem as if one party is bearing more of the risk costs than the other party. The risk allocation principles embedded in the industry's guide specifications are tested and well established in case law. However, their use can promote a one-size-fits-all process of risk allocation.

E. Risk Monitoring and Updating

The objectives of risk monitoring and updating are to

1) Systematically track the identified risks,
2) Identify any new risks,
3) Effectively manage the contingency reserve, and
4) Capture lessons learned for future risk assessment and allocation efforts.

The risk monitoring and updating process occurs after the risk mitigation, planning, and allocation processes. It must continue for the life of the project because risks are dynamic. The list of risks and associated risk management strategies will likely change as the project matures and new risks develop or anticipated risks disappear. Periodic project risk reviews repeat the tasks of identification, assessment, analysis, mitigation, planning, and allocation. Regularly scheduled project risk reviews can be used to ensure that project risk is an agenda item at all project development and construction management meetings

Hence, successful risk monitoring and updating process will systematically track risks, invite the identification of new risks, and effectively manage the contingency reserve. The system will help ensure successful completion of the project objectives. If documented properly, the monitoring and updating process will capture lessons learned and feed risk identification, assessment, and quantification efforts on future projects.

IV. RESEARCH FINDINGS

If risk is not new in nature, it can be mitigate by referring from past data provided that it should be available.Risks which are likely to be occurring during execution of project are thus taken and listed below. These include source of risk, way we can response to risk and description of mitigation activity.

Table 2: Risk Identification and Mitigation Measures

Sr. No.	Source Of Risk	Risk Response	Risk Mitigation Action
1	**Technical and contractual risks**		
a)	Toll collection risk	Risk mitigation	Accurate Estimation of traffic density along proposed route and industrial development in affected area helps to recover toll in time.
b)	Constructional Risk	Risk mitigation	The Project is implemented by way of a fixed price fixed time EPC contract. Hence, the risk on account of price increase in material cost is mitigated.
c)	Insufficiency of the preliminaries Bill	Risk avoidance	General items consideration that had not been covered in the Preliminaries Bill at the bidding stage.
			Taking into consideration the likely amount of price escalation at the bidding stage for recurrent preliminary items for which price escalation is not paid.
d)	Changes imposed by the engineer	Risk avoidance	Early attendance and holding meetings to identify likely changes so as to incorporate them before the start of works (public participation is essential).
			Agreeing on overhead and profit component at the project initiation for new items which might come up during construction. Percentage allowance consideration could help to avoid the same.
		Risk transfer	Claiming for variations which are likely occurred during execution.
			Keeping written records of instructions received.
e)	Tentative Drawings	Risk mitigation	Informing the Engineer whenever a design change is found in written.
f)	Defective Design	Risk mitigation	Conducting design review and expert supervision guidance.
		Risk avoidance	Communicating any design defect in advance to the Engineer in writing before work start.
		Risk transfer	Recovery of any damage through his Professional Indemnity.
g)	Late Handing Over Of Site	Risk retention	Employing outside specialists in the absence of in-house skills helps to start work earlier.
		Risk mitigation	Handing over of the site to the Contractor in its existing condition and not waiting till the land acquisition is completed fully i.e.. Starting work for acquired land.
		Risk transfer	Claiming for the number of delayed days during execution.
			Claiming for the idling cost of labor, equipment, mobilization and demobilization.

Sr. No.	Source Of Risk	Risk Response	Risk Mitigation Action
h)	Scope Change	Risk retention	Use of unallocated funds or money of the Treasury in financing the increased amount due to increase in work.
		Risk mitigation	Confining to the old profile of the road which helps to reduce cost of project.
		Risk transfer	Claiming for an extension of time (EOT).
2	**Economic, financial and political risks**		
a)	Delayed Payments	Risk retention	Paying interest on delayed payments and acting promptly so as to avoid a recurrence in future.
b)	Dependence on foreign funds	Risk avoidance	Reducing the scope changes so as not to exceed the limited funds.
			Conducting a design review and identifying alternate methods of construction available nearby to eliminate high cost items from the scope.
c)	Regulations and difficulty in obtaining permits	Risk mitigation	Working together and submitting correct data to obtain permits for the works.
		Risk avoidance	While estimating, examining the rules and regulations applicable in the area of the project and reflecting on their cost implication.
			Using borrow pits in private lands and disposing excavated materials in the same with the written authority of land owners to avoid conflict.
d)	Inflation	Risk mitigation	Reducing the scope changes so not to exceed the limited funds
		Risk retention	Use of reserved funds and money of the Treasury to pay for price escalations due to change in scope.
e)	Legislative changes	Risk retention	Requesting the Contractor to produce evidence for the payments to laborers and consumption of diesel for the months during which these were not reflected in price indices and help to keep records.
3	**Managerial risks**		
a)	Contractor competence	Risk avoidance	Obtaining the Performance Bond of work from the Contractor.
		Risk mitigation	Having a long-standing stake with employees and sub-contractors which encourage good workmanship.
			Regular monitoring and strict supervision of the workmanship of both subcontractors and their own to ensure quality work.

Sr. No.	Source Of Risk	Risk Response	Risk Mitigation Action
b)	Dealing with utility agencies	Risk retention	Paying for the shifting of services.
		Risk avoidance	Incorporating any existing service into the design if the cost of shifting is unbearable.
			Taking away work from the custody of authorities with their consent if their response to that particular work causes a delay.
		Risk transfer	Claiming damages from utility agencies when they are responsible for damages if any.
		Risk mitigation	Commencement of shifting of services few years prior to the start of the project. Conducting meetings with utility agencies at regular intervals
		Risk mitigation	Planning work in an alternate place if obstructions are met, thus causing a skip in locations.
		Risk avoidance	Advising workers on taking care over work so as to avoid damage to any utility appurtenances. Strict monitoring of work is advisable.
c)	Defective construction work	Risk mitigation	Cooperating with the Engineer in changing the design of any defective work wherever and were ever possible.
			Reuse of material for any other possible work if it becomes unsuitable for the intended work.
		Risk retention	Urging the Engineer to rethink the adequacy of the completed work in fulfilling the intended function before determining whether defective work should be demolished.
d)	Late Approvals	Risk avoidance	Taking prior approval to proceed with works.
		Risk mitigation	Keeping alternate locations handy to work in case work is delayed due to absence of approval.
			Encouraging the Engineer to ensure the presence of laboratory staff at the right time and should maintain written records.
		Risk transfer	Keeping written records about the time of informing the laboratory staff to do a test and the time of arrival, so the delay can be quantified and claimed.
		Risk avoidance	Remaining steadfast in the belief in “No work without the consultant’s supervision.

Sr. No.	Source Of Risk	Risk Response	Risk Mitigation Action
e)	Low labor and equipment productivity	Risk mitigation	Assigning laborers with targets and providing incentives to motivate them.
			Maintaining a close supervision on workers performance in written.
		Risk avoidance	Recruiting laborers possessing vocational training qualification.
			Drawing up labor contracts.
			Possessing enough and efficient equipment.
f)	Procurement of resources	Risk retention	Subcontracting of works
			Having one's own machinery and plant
			Looking for the easiest ways to procuring methods
g)	Public security and safety	Risk mitigation	Provision of barricades and other safety measures
			Regular safety inspections and night inspections for safety arrangement
			Appointment of safety officers and safety assistants
h)	Relations with neighborhood	Risk mitigation	Appointment of officials to attend to public complaints and a committee to attend to third party damage.
		Risk retention	Provision of safety measures for the public.
			Provision of basic facilities which had been removed due to construction taking into consideration the human needs
			Reinstatement of access roads which had been obstructed due to work.
		Risk mitigation	Taking a middle-of-the-road approach to avoid unnecessary dealings.
		Risk avoidance	Inspection of houses for cracks prior to the start of the roadwork so as to avoid unreasonable claims.
			Continuous inspection of houses where the relatedness of reported cracks to road works is in doubt.
			Rejection of claims for house cracks which are due to improper construction of house and not due to project.
		Risk transfer	Insurance of third party property and bodily damages.

Sr. No.	Source Of Risk	Risk Response	Risk Mitigation Action
4	**External and site condition risks**		
a)	Act of God	Risk mitigation	Cooperation with the Contractor
		Risk retention	Allowing an EOT to the Contractor
		Risk transfer	Transferring the cost of removal of debris from earth slips to an insurer
		Risk retention	Release of equipment for immediate reconstruction work after the tsunami
b)	Adverse weather conditions	Risk retention	Allowing an EOT to the Contractor
			Compensating parties affected because of measures taken against the effects of weather
		Risk transfer	Claiming material damages from insurance
		Risk retention	Keeping costs of material damages below the deductible amount of the insurance policy
c)	Unforeseen site ground conditions	Risk avoidance	Allocation of adequate provisions to fill materials in areas where the soil condition is weak
		Risk transfer	Recovering underground cable damage from the insurer
			Rejecting claims for damage to underground cables which had not been laid according to the required standards

V. CONCLUSION

Risks which are likely to be occur of defective design, late approvals, late handing over of the site, tentative drawings and unforeseen site ground conditions had thwarted the Contractor on many occasions. Moreover, relations with neighbourhood and public security and safety were also very important in pursuing these social capital development projects. 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.

These were the 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. Majority of responders (80%) indicated that risk assessment was important for highway construction projects. It has been used more often in design build projects than design bid build highway projects. This might be due to the fact that formal risk assessment is more required and it is considered an essential part in planning phase. Operational risks are events that would have an adverse impact towards a particular construction project like highway if occur once it is commissioned. Although different Asian countries explored in this research might have different type of operational risks due to geographical and cultural differences, still there is a great potential for each risk identified to occur in the highway projects.

Mentioned risks are major one which when occur may cause significant impact on project goal in either cost or scheduled time delay. This research found useful for executers during the construction and operational phase risk mitigation. Although these risks

should not be neglected and taken into prime consideration to avoid them and also keeping record of risk mitigation in practice could help in determining the relative importance of these research and future risk mitigation in any highway projects.

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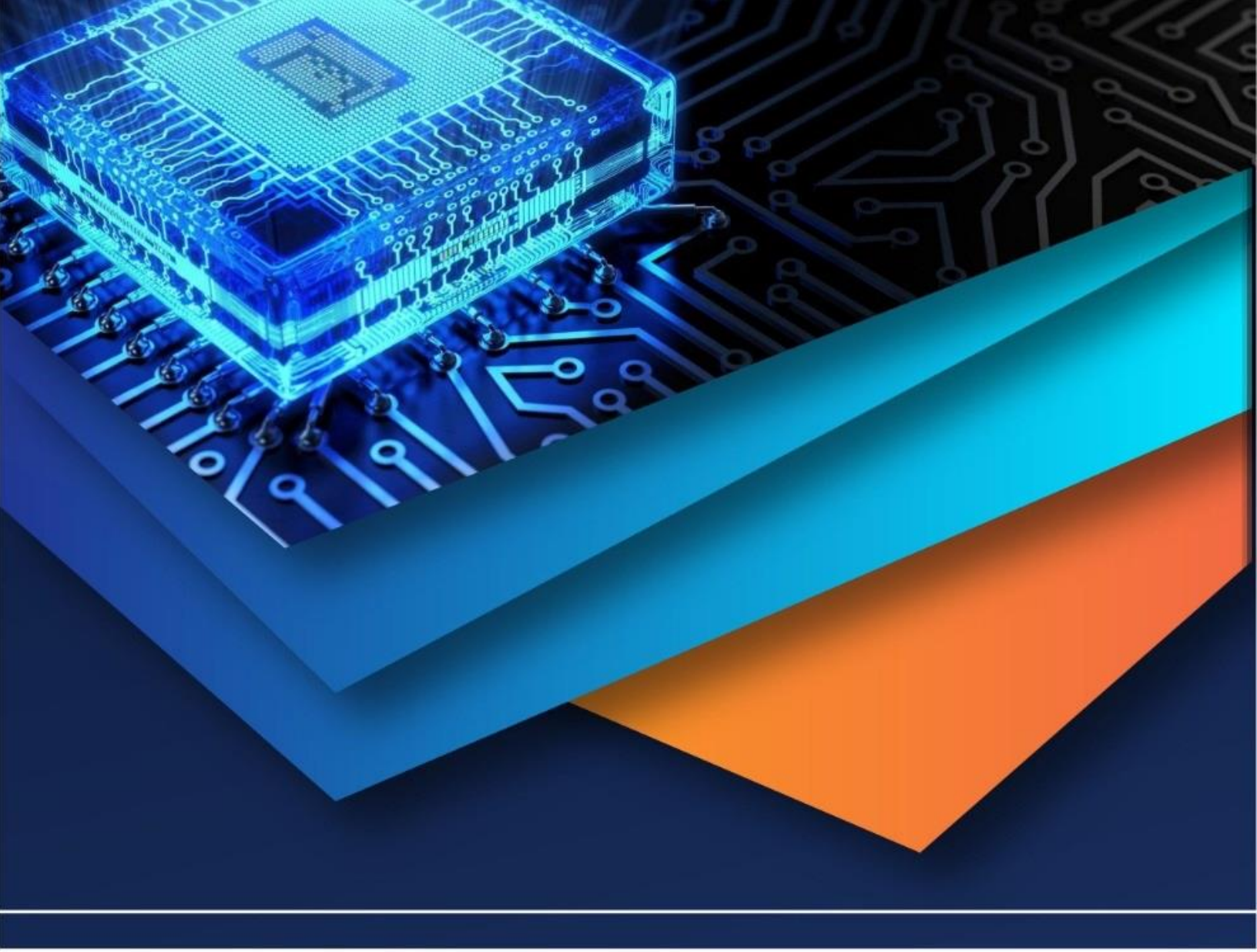

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