International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 05, May-2018

Study of Risk Factors in Infrastructure Projects of Pune Region (Using Relative Importance Index)

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***Abstract*—Risk Management is the process of identifying, analyzing and responding to risk factors throughout the life of a project and in the best interests of its objectives. Proper risk management implies control of possible future events and is proactive rather than reactive. An organization may use risk assumption, risk avoidance, risk retention, risk transfer, or any other strategy (or combination of strategies) in proper management of future events.**

The outcome is therefore a risk that is either acceptable or unacceptable. The acceptance or non-acceptance of a risk is usually dependent on the tolerance level for the team handling the risk. If risk management is set up as a continuous, disciplined process of problem identification and resolution, then the system will easily supplement other systems. This includes; organization, planning and budgeting, and cost control.

In this paper an attempt has been made to promote a proper use of Risk management in a given project. Aim is to study and analyze the risk factors in infrastructural projects by using relative importance index. Also the objective is to understand concept of Risk Management and its process in the Project, understand various techniques which are used for solving the risk problems, to study and compare the outcomes with similar completed projects, carry out Questionnaire survey at different sites in Pune Region and also to understand RII method for Risk Management in the construction project.

Keywords— Risk Management, RII, infrastructural projects in Pune, contractors.

INTRODUCTION

Meaning of Risk - Probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through pre-emptive action.

Difference between Risk and Uncertainty: Risk is essentially the level of possibility that an action or activity will lead to lead to a loss or to an undesired outcome. The risk may even pay off and not lead to a loss, it may lead to a gain. Uncertainty, on the other hand, is unpredictable. It has too many unknown variables which do not even allow one to estimate as to what is going to happen.

Risk is essentially the level of possibility that an action or activity will lead to lead to a loss or to an undesired outcome. The risk may even pay off and not lead to a loss, it may lead to a gain.

Risk can also be defined as [6]:

- Exposure to the chance of injury or loss; a hazard or dangerous chance: It's not worth the risk.
  - The hazard or chance of loss.
  - The degree of probability of such loss.
  - The amount that the insurance company may lose.
  - A person or thing with reference to the hazard involved in insuring him, her, or it.
  - The type of loss, as life, fire, marine disaster, or earthquake, against which an insurance policy is drawn.

Risk management strategies and processes

All risk management plans follow the same steps that combine to make up the overall risk management process:

- Risk identification - The Company identifies and defines potential risks that may negatively influence a specific company process or project.
- Risk analysis - Once specific types of risk are identified, the company then determines the odds of it occurring, as well as its consequences. The goal of the analysis is to further understand each specific instance of risk, and how it could influence the company's projects and objectives.
- Risk assessment and evaluation - *Risk* is then further evaluated after determining the risk's overall likelihood of occurrence combined with its overall consequence. The company can then make decisions on whether the risk is acceptable and whether the company is willing to take it on based on its risk appetite.
- Risk mitigation - During this step, companies assess their highest-ranked risks and develop a plan to alleviate them using specific risk controls. These plans include risk mitigation processes, risk prevention tactics and contingency plans in the event the risk comes to fruition.
- Risk monitoring - Part of the mitigation plan includes following up on both the risks and the overall plan to continuously monitor and track new and existing risks. The overall risk management process should also be reviewed and updated accordingly.

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Risk Identification tools and techniques

Documentation Reviews - The standard practice to identify risks is reviewing project related documents such as lessons learned, articles, organizational process assets, etc.

Information Gathering Techniques - The given techniques are similar to the techniques used to collect requirements. Let's look at a few of them:

Brainstorming - Brainstorming is done with a group of people who focus on identification of risk for the project.

Delphi Technique - A team of experts is consulted anonymously. A list of required information is sent to experts, responses are compiled, and results are sent back to them for further review until a consensus is reached.

Interviewing - An interview is conducted with project participants, stakeholders, experts, etc to identify risks.

Root Cause Analysis - Root causes are determined for the identified risks. These root causes are further used to identify additional risks.

Swot Analysis (STRENGTH, Weakness, Opportunities and Threats) - Strengths and weaknesses are identified for the project and thus, risks are determined.

Checklist Analysis - The checklist of risk categories is used to come up with additional risks for the project.

Assumption Analysis - Identification of different assumptions of the project and determining their validity, further helps in identifying risks for the project.

Outputs to Identify Risks - This process of Risk Identification results in creation of Risk Register.

Risk Register - A Risk Register is a living document that is updated regularly throughout the life cycle of the project. It becomes a part of project documents and is included in the historical records that are used for future projects. The risk register includes:

- List of Risks
- List of Potential Responses
- Root Causes of Risks
- Updated Risk Categories

Tools and Techniques: Some of the tools that can be used for qualitative risk analysis include:

Probability And Impact Matrix - The matrix helps in identifying those risks which require an immediate response. The matrix may be customized according to the needs of the project. Most companies do have a standardized template for this matrix and project managers could leverage those templates as well. Use of standardized matrix makes the matrix list more repeatable between projects.

Risk Data Quality Assessment - Data is collated for the identified risks. The project manager will try to find the precision of the data that must be analysed for completing the qualitative analysis of risks. For each risk, in Risk Data Quality Assessment, the project manager needs to determine:

- Extent of the understanding of the risk
- Data available
- Quality and reliability of the data

LITERATURE

Brain-storming sessions and analysis of historical data for similar projects were found to be the most preferred methods of risk identification. Common risks associated with construction projects included financial risks (project funding problem), construction risks and demand/ product risks.

In many construction projects, no systematic approach exists for risk identification; however, the participants can deal with the risk when it happens based on their experience and skills. Risk management identification and its relevant methods are infrequently used by construction industry due to absence of knowledge and proficiency. Further there were limitations also like Lack of knowledge, Initial costs, Time consuming, Prefer experience rather than following risk management, Staffs are not skilled enough to perform risk management, Education level, Professionals are needed.

METHODOLOGY

A questionnaire approach is adopted which requires the development and distribution of a questionnaire survey. To formulate a questionnaire, literature study was done referring relevant research papers.

All the factors related to risk are studied and 10 factors and 10 general questions are short listed which formed the final questionnaire for survey.

Final questionnaire is then directed to the Project Managers at site for railway over bridge and flyovers infrastructure projects in Pune. Weightage given to each factor by the respondent's ranges from 1 to 5, where '1' is less critical and '5' is extremely critical. Size of sampling: Ten (10)

The relative importance index (RII) used to indicate the relative importance of each variable contributing to factors affecting quality performance of the project was calculated with the formula below:

$$\text{Relative Importance Index} = \frac{\Sigma W}{A \times N}$$

Where;

W= Weightage given to each variable by respondent ranging from 1 to 5

A= Highest rating

N= Total no. of respondents

While evaluating the importance of the factors, all those factors having RII greater than or equal to 0.700 have been considered more important. Conclusion are derived from the findings from the RII calculations.

DATA COLLECTION

Infrastructure projects are focused mainly flyovers and railway over bridges in Pune and PCMC area. A questionnaire survey was prepared for the project managers on site. Big scale Contractor firms are focused for survey. All firms are ISO-9000 certified.

Number of Sampling: 10

Following are highly ranked type of risks faced during Construction project.

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Type of Risk's

1. Risk of time and cost overrun (Tight project schedule

Project funding problem, Price inflation of materials)

2. Construction risk or design variation by client. (Design variation, insufficient estimation, insufficiency of preliminary bill, Defective design)

3. Demand / product risk (insufficient supply of materials to deliver on time)

4. Political risk (Political factors or support for project changes)

5. Environmental risk (Extreme weather conditions affecting execution thus causing delay in completion, air, noise, and water pollution)

6. Technological risk (Is there any new methods been implemented in the project to save the time, quality and time constraints?

7. Geographical risk (Site location and conditions)

8. Geotechnical risk (Risk occurred during soil investigation)

9. Communication risk (in design & management)

10. Legal risk (Legislative changes, Local communities pose objections)

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DATA ANALYSIS

The data collected through questionnaire is analyzed using Relative Importance Index.

To calculate the number of respondents (frequency) following formula is used.

Relative Important Index (RII) = $\frac{\Sigma W}{A \times N}$

W= Weightage given to each variable by respondent ranging from 1 to 5

A= Highest rating (in this case it is 5)

N= Total no. of respondents (10)

Thus by using RII method types of Risk factors are ranked accordingly and is shown in the following table.

TABLE 1. : RII CALCULATIONS FOR TYPES OF RISK

Q. No	Types of Risk Factors	5	4	3	2	1	Total Respondents (N)	Weighted Total (W)	RII	Rank
1	Risk of Time and Cost Overrun	6	1	3			10	43	0.86	1
2	Construction Risk or Design variation by Client	2	7	1			10	41	0.82	2
3	Demand / Product Risk	1	6	3			10	38	0.76	3
4	Political Risk	3	1	2	2	2	10	31	0.62	10
5	Environmental Risk	3	1	6			10	37	0.74	6
6	Technological Risk		4	5	1		10	33	0.66	7
7	Geographical Risk		3	6	1		10	32	0.64	8
8	Geotechnical Risk		8	2			10	38	0.76	4
9	Communication Risk		4	4	2		10	32	0.64	9
10	Legal Risk	2	5	2		1	10	37	0.74	5

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FINDINGS

Following are the findings derived from case study.

- Executing a proper Risk Management process during the Project duration helps in completing the project within the given period of time.
- Brainstorming and Delphi technique are mostly used during Project execution.
- The major risk factors needs to be focused more so as to avoid time and cost overrun.
- It is vital for risk management consultants because the methodology forms an experimented framework which helps them with smooth, balanced, and successful implementation of risk management for construction projects.

From the above table 1 Risk of time and cost overrun, Construction risk or design variation by client and demand/product risk are the three major risk factors which are faced during construction project.
Further, geotechnical risk i.e. the risk which is occurred during soil investigation is ranked fourth and legal risk i.e. Legislative changes, local communities pose action is been ranked fifth.
Environmental risk, technological risk and geographical risk were the ranked further, followed by communication risk and political risk.

CONCLUSIONS

TABLE 2. : TOP 5 RISK FACTORS FROM RII CALCULATION

Rank	Types of Risk Factors	RII
1	Risk of Time and Cost Overrun	0.86
2	Construction Risk or Design variation by Client	0.82
3	Demand / Product Risk	0.76
4	Geotechnical Risk	0.76
5	Legal Risk	0.74

1. Risk of Time and Cost Overrun

One major factor that has been identified as reasons for cost overrun in most projects is design errors. It is important to note that proper representation of client's requirement to achieving good technical input to project execution are usually mapped out base on project designs. Thus a design with errors practically means wrong or insufficient representation of project deliverables. This will lead to wrong application of techniques in achieving result, such that as the actual execution phase of the project unfolds these design errors, attempt to correct it will lead to delay and cost overrun.

2. Construction Risk or design variation by Clients

Variations are often sources of dispute, either in valuing the variation, or agreeing whether part of the works constitute a variation at all, and can cost a lot of time and money during the course of a contract. While some variations are unavoidable, it is wise to minimize potential variations and subsequent claims by ensuring that uncertainties are eliminated before awarding contract.

This can be done by:

•Undertaking thorough site investigations and condition surveys.

•Ensuring that the project brief is comprehensive and is supported by stakeholders.

•Ensuring that legislative requirements are properly integrated into the project.

•Ensuring that risks are properly identified.

•Ensuring that designs are properly coordinated before tender.

•Ensuring the contract is unambiguous and explicit.

•Ensuring the contractor's rates are clear.

•Preparing concise drawings, bills of quantities and specifications, providing for all situations which are reasonably foreseeable.

3. Demand / Product Risk

A proper arrangement of Product suppliers must be done during the project execution period to avoid the risk of demand and product. This arrangement of suppliers must be done during the planning phase itself and also alternative options of the suppliers must also be done in advance.

4. Geotechnical Risk

A complete review of all available data must be done. Ensure that Geotechnical Investigation is correctly designed, planned, managed, and executed. Progressive rock face mapping during open cut excavation work must be done. Similarly detailed ground investigation, geophysics, sub-surface surveying must be done properly.

5. Legal Risk

- Project inception, including project feasibility and financing
- Procurement model selection and alternative contracting models
- An analysis of pre-tender documentation, including consortium and joint venture agreements

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- The key stages of a tender, from expression of interest to requests for tender, and legal issues to be managed during this phase
- Analysis of the key project risks and their allocation and adoption between a contractor and client in negotiating a construction contract. Includes consideration of alternative approaches from contractors and clients to negotiation of these obligations
- The interface between the project management and legal disciplines. This includes a consideration of the ethical dilemmas that confront construction professionals. Project implementation and key steps to start a project to encourage an effective project environment
- Risk identification and mitigation strategies employed during the delivery phase and their role in avoiding unnecessary disputation
- Administering claims for time and cost under construction contracts. Managing sub-contract risk
- Managing the 'paper war' during the delivery phase: legal and technical issues and the role and limits of communication between the parties (including legal privilege issues)
- A consideration of the facts of construction dispute resolution.

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