Section A-Research paper

RISK ASSESSMENT AND MANAGEMENT FOR BUILDING PROJECTS

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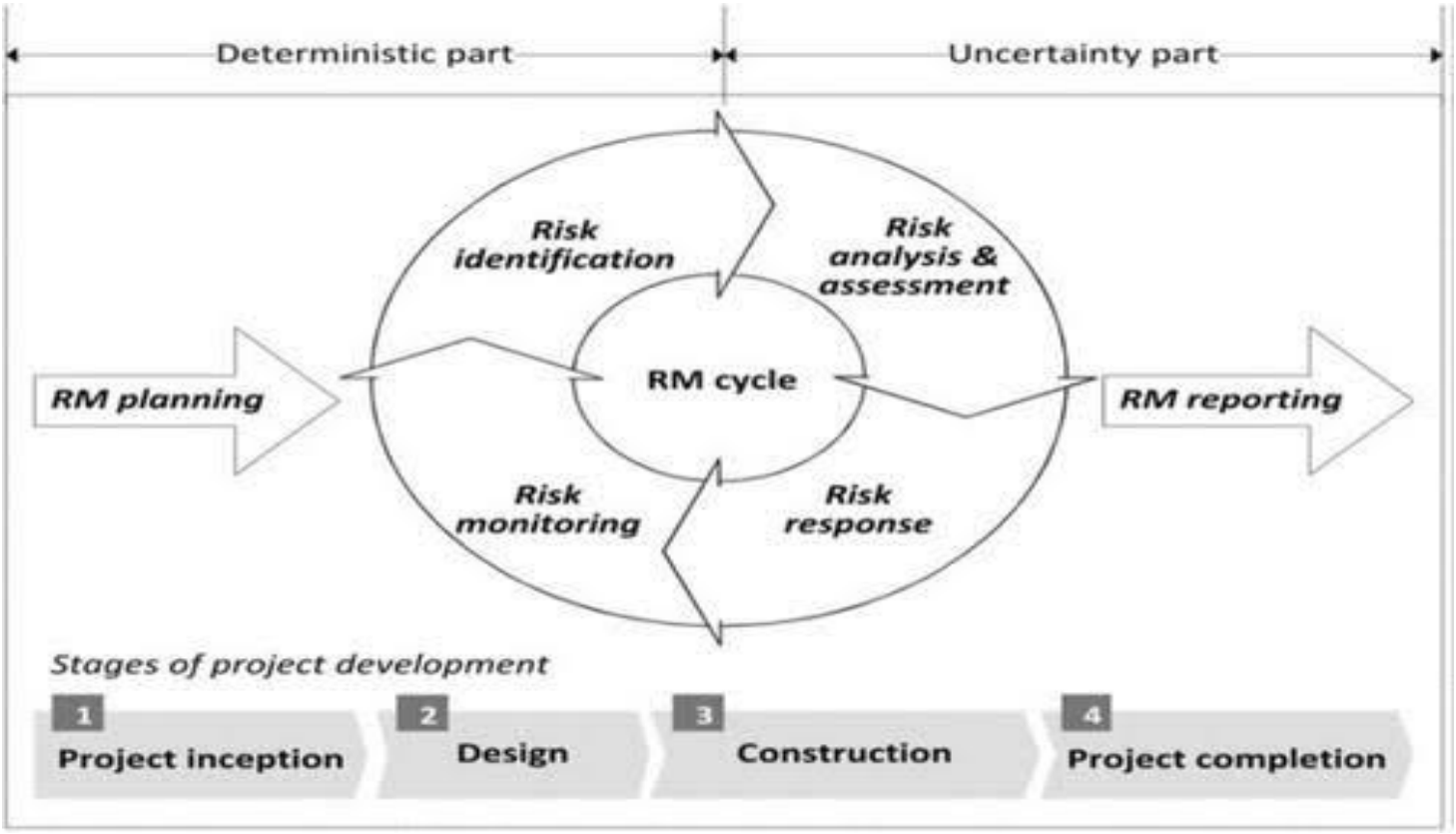
ABSTRACT

Risk assessment and management play crucial roles in the success of building projects. This abstract provides an overview of the key steps and considerations involved in effective risk assessment and management for building projects. The process begins with identifying potential risks, including safety hazards, environmental factors, design flaws, and regulatory compliance issues. Once risks are identified, their probability and potential impact are assessed to prioritize them. Risk mitigation strategies are then developed, involving safety protocols, design revisions, quality control measures, and compliance with regulations. Adequate resources are allocated, and continuous monitoring and review ensure the effectiveness of mitigation strategies. Contingency plans are prepared to address unforeseen events, and clear communication among stakeholders is maintained throughout the project. Documentation and post-project reviews contribute to learning and improvement for future projects. By following these steps, project teams can minimize disruptions, ensure safety, protect budgets, and achieve successful outcomes in building projects.

Construction projects are initiated in complex and dynamic environments resulting in circumstances of high uncertainty and risk, which are compounded by demanding time constraints. Construction industry has changed significantly over the past several years. Risk management is that the systematic process of identifying, analyzing and responding to project risk. It includes maximizing the probability and consequences of positive events and minimizing the probability and consequences of adverse events to project objectives. In this study from the past experiences of the engineers, managers, builders and contractor data was collected and was analyzed by Relative Importance Method (RII). The frequency of the risk factors was found out and ultimately the risk severity was found out. Therefore, the study will help on the risk factors which can be focused on during the construction of project thus completing it within the schedule time.

1.0 INTRODUCTION

Construction projects are started in complex and dynamic environments leading to circumstances of high uncertainty and risk, which are bounded by demanding time constraints. Construction industry has been changed significantly and is continuously changing over the past several years. It is an industry driven primarily by private investors; the presence of securitized real estate has increased considerably. It is susceptible to the various technical & business risks that always often represent greater exposures than people who are traditional. Thus risk assessment need to studied frequently with time. Risk assessment may be a tool to spot those risks during a project and manage it accordingly with proper treatment.Risk assessment and management are fundamental processes in the construction industry, particularly for building projects. Building projects involve various complexities, ranging from safety hazards to financial risks, and it is essential to identify and mitigate these risks effectively. By implementing robust risk assessment and management practices, project teams can enhance project success, mitigate potential losses, ensure worker and occupant safety, and maintain project schedules and budgets.



This introduction provides an overview of the importance of risk assessment and management in building projects. It highlights the need to identify potential risks, evaluate their impact, and implement appropriate

mitigation strategies. Additionally, it emphasizes the significance of ongoing monitoring, communication, and learning from past experiences.

Why Risk Assessment and Management Matter:

Building projects involve numerous stakeholders, including architects, engineers, contractors, regulatory authorities, and occupants. Each stakeholder has unique objectives and requirements, and the effective management of risks ensures that these objectives are met while minimizing negative consequences.

1. Minimizing Disruptions: Risks in building projects can lead to delays, cost overruns, and disruptions in project execution. By conducting comprehensive risk assessments, project teams can identify potential challenges in advance and develop strategies to mitigate or eliminate them. This proactive approach helps maintain project schedules, reduce costly delays, and ensure smooth project execution.
2. Ensuring Safety: Safety hazards are a critical concern in the construction industry. Risk assessment allows project teams to identify potential safety risks, such as hazardous materials, structural deficiencies, or inadequate safety protocols. By implementing appropriate risk mitigation measures, such as safety training programs, safety equipment, and adherence to regulatory standards, project teams can prioritize the well-being of workers and future occupants.
3. Protecting Budget and Resources: Financial risks pose significant challenges in building projects. Without proper risk assessment and management, cost overruns can occur due to unforeseen circumstances, design flaws, or supplier issues. By identifying financial risks early on, project teams can allocate resources appropriately, develop contingency plans, and implement strategies to minimize financial impacts.
4. Ensuring Regulatory Compliance: Building projects must comply with numerous regulations and standards, which vary by jurisdiction and project type. Failure to comply with these requirements can lead to legal and financial consequences. Risk assessment and management processes help identify relevant regulatory obligations and ensure compliance throughout the project lifecycle, avoiding penalties and legal disputes.
5. Stakeholder Communication and Trust: Effective risk assessment and management practices foster open communication among project stakeholders. By proactively addressing potential risks and keeping stakeholders informed, project teams build trust and confidence. Regular communication channels allow for the early identification of emerging risks, collaborative problem-solving, and prompt decision-

making.

6. Learning from Experience: Building projects offer valuable opportunities for learning and improvement. Through post-project reviews and analysis of risk management strategies, project teams can identify successes, challenges, and areas for improvement. This knowledge can be applied to future projects, enhancing risk assessment and management practices across the industry.

Risk management is probably the foremost difficult aspect of project management. A project manager must be able to recognize and identify the basic causes of risks and to trace the causes through the project to their consequences. Furthermore, risk management within the construction project management context may be a comprehensive and systematic way of identifying, analyzing and responding to risks to realize the project objectives. The utilization of risk management from the first stages of a project, where major decisions such as choice of alignment and selection of construction methods are often influenced is vital. The advantages of the risk management process include identifying and analyzing risks, and improvement of construction project management processes and effective use of resources.

1.1 OBJECTIVES OF THE RESEARCH

1. To identify the various risks involved in the construction building projects .
2. To identify the critical risk involved in construction building projects by questionnaire survey.
3. To analyze the risks involved in construction building projects by RII method.
4. To find out the top impacting risk factor and suggestions to evaluate it.

2.0 LITERATURE REVIEW

The following literature survey includes summary of research papers presented in popular journals on topics almost like the current field of study.

1 **Karim El-Dash ,Emad Abd-Raboh , Zakariya El-Dars (2006) "Risk Management In The Design Phase Of Large-Scale Construction Projects**" the study investigated the prime potential risks that affect the planning phase of mega construction projects in Egypt and similar developing countries. The study considered the value,

time, and quality of the projects also because of the responsibility of the risk. The risk events were sorted consistent with the probability needless to say by the response of the participants. The risks were ranked also according to its impact on cost, time, and quality. The severity of the risks was quantified considering the probability of the risk and its impact on the project.

2 **Riaan van Wyk, Akin tola Akintoye (Mar 2007) "Project risk management practice:** the case of a South African utility company " documented the risk management practice of a utility company for its Recovery Plan project to deal with the risks of power interruptions. The company's corporate risk management process and its practice at divisional and project levels are discussed. The key role of stakeholders in risk identification, analysis, mitigation, monitoring and reporting is emphasized by the corporate and this drives its risk management practice.

3 **As Per De Jager and Max Rathmann (2008)," Assessment of the associated risk of a project has a major impact on its cost of capital"**. As per CPI report titled," The Risk Gap: A Map of Risk Mitigation Instruments for Clean Investments, risk, whether real or perceived, is the most important factor influencing the financing in terms of availability of funds and also increasing the return expectations of fund providers. They have divided the risk into following categories: Political, policy and social risk -Political risks are due to illegitimate actions of public authorities that affect, in a discriminatory way, foreign companies/ investors. Policy risks involve legitimate actions of local authorities that affect all agents (local and foreign) in a sector. They originate from local governments simply exercising their power to rule the activities under their jurisdiction. Social risks are due to actions of private individuals or groups in the public opinion.

4 **Desai Megha, Dr Bhatt Rajiv (2013), "A Methodology for Ranking of Causes of Delay for Residential Construction Projects in Indian Context",** the study suggested work on identification of causes of delay in residential construction projects in the Indian context. Literature review and structured interviews were administered on construction projects in the central Gujarat region of India. The work presents the framework of causes of delays in residential construction projects. An approach is usually recommended to hold out ranking of those causes by two different techniques: Relative importance index and Importance index supported degree of severity and degree of frequency. It is hoped that the findings of the paper will help the stakeholders to act on critical causes and further attempt to reduce delay of their projects.

5 **K. Jayasudha Dr. B.Vidivelli and E.R. Gokul Surjith (2014),"Risk Assessment and Management in Construction Projects**" this study should assist management in identifying activities where there's a risk of your time and financial aspects and hence provide a basis for management to require objective decisions on the reduction of risk to an agreed level. These findings are vital for implementing further effective measures to make sure the proper direction of future development. Risk management should be considered a primary tool to assess the project.

6 **K.Jayasudha and B.Vidivelli (2015) "An Assessment and Analysis of Major Risks in Construction Projects"** they study should assist management in identifying activities where there's a risk of financial, Time and Construction aspects and hence provide a basis for management to require objective decisions on the reduction of risk to an agreed level. These findings are vital for implementing further effective measures to make sure the proper direction of future development. Risk management should be considered a primary tool to assess the project. Data collected was subjected to a 5-scale Impact Grid with Scores of Risk. Those scores were used to determine differences in perceived risks of General Manager, Project managers, Project Engineers and Site Engineers which was then analyzed by using the software of SPSS using the formulas of ANOVA test and t- test.

7 **K. Jayasudha and B. Vidivelli (2016) "Analysis Of Major Risks In Construction Projects"** this study should assist management in identifying activities where there's a risk of financial, Time and Construction aspects and hence provide a basis for management to take objective decisions on the reduction of risk to an agreed level. These findings are vital for implementing further effective measures to make sure the proper direction of future development. Risk management should be considered a primary tool to assess the project. Data collected was subjected to a 5-scale Impact Grid with many risks. Those scores were then used to determine difference in perceived risks of General Manager, Project managers, Project Engineers and Site Engineers which was then analyzed by using the software of SPSS.

8 **Hatkar K B and Hedaoo N A, (2016) "Delay Analysis By Using Relative Importance Index Method In Infrastructure Projects**" studied and stated that six factors causing delays, top ten vital important factors are identified which are: Local political interference, Inadequate fund allocation, Improper project planning and scheduling by contractor, Delay ongoing payments by client, Escalation of material prices, weather condition, Delay ongoing payment to suppliers/subcontractors, Insufficient numbers of kit, Incomplete drawing/detail

design and Natural disasters(flood, earthquake, etc).Total seventy six factors causing delay were identified and grouped into eight major groups. The major delays groups were identified are: Contractor related delays and finance related delays. The major effects of delays have been identified which are: Time overrun, Cost overrun and disputes. From a total of thirty two methods of minimizing construction delays, the highest effective methods have been identified which are: Competent/Capable project manager, Perform a pre construction planning.

9 **Muhammed Mufazzal Hosen, Sunkoo Kang, Jonghyan Kim (2018), "Construction Schedule Delay Risk Assessment by Using Combined AHP-RII Methodology For An International NPP Project",** the most contribution of this work was the identification of the most explanation for cause of NPP construction schedule delays for turnkey contractual approached international projects. The second contribution was the event of a multi criteria decision making model for the prioritization of NPP construction delay risk factors. Finally, schedule delay risks were assessed in different levels of NPP construction delay risk factors through severity and frequency of occurrence. The model was developed by using the AHP-RII methodology. This study has produced results and insights that involve one of the most vital aspects, which are the qualitative and quantitative weights in terms of severity and frequency of occurrence of factors that affect delays in NPP construction. Undoubtedly, it is necessary in the NPP construction industry to use quantitative terms when it comes to schedule delay risk. The study found that the main contractor contributes the highest risk of construction schedule delays for NPPs, followed by utility in second place, regulatory agency in third place, and financial and country think about fourth place.

10 **Goran Cirovic "Risk Assessment of Construction Industry"** stated The principal objective of risk analysis and calculation is to provide the selection maker more variants of cost and project duration, perceiving the probability to finish the project within this range. It's also essential to forecast reserves, with which the risk from budget exceeding is reduced. The choice maker makes the choice with what risk level the project are going to be completed support the info at his disposal. During the project completion of these values must be controlled and corrective actions must be proposed.

3.0 RESEARCH METHODOLOGY

Risk assessment and management are essential components of successful building projects. By identifying potential risks and implementing effective strategies to mitigate them, project teams can minimize disruptions,

ensure the safety of workers and occupants, and protect the project's budget and timeline. Here are some key steps and considerations for risk assessment and management in building projects:

- Identify Potential Risks: Starting by conducting a thorough assessment to identify all possible risks that could impact the project. These risks can include safety hazards, environmental factors, design flaws, regulatory compliance issues, financial risks, and more. Engage with project stakeholders, including architects, engineers, contractors, and relevant authorities, to gather insights and expertise.

- Assess Probability and Impact: Once the risks are identified, evaluating their probability of occurrence and the potential impact they could have on the project. This assessment helps prioritize risks based on their significance, allowing the project team to focus their resources on the most critical ones.

- Develop Risk Mitigation Strategies: After prioritizing risks, develop strategies to mitigate or eliminate them. This involve implementing safety protocols, revising the design, enhancing quality control measures, obtaining necessary permits and certifications, conducting thorough inspections, and ensuring compliance with relevant regulations and standards. Collaborate with the project team and external experts to create a comprehensive risk mitigation plan.

- Allocate Resources: Allocating appropriate resources, including time, budget, and personnel, to address the identified risks. Ensure that the necessary funds are available to implement risk mitigation strategies and that designated team members are responsible for overseeing and executing these measures.

- Monitor and Review: Continuously monitoring and reviewing the effectiveness of risk mitigation strategies throughout the project's lifecycle. Regularly assess whether new risks have emerged or existing ones have evolved, and adjust mitigation measures accordingly. Maintain open lines of communication among project team members and stakeholders to facilitate ongoing risk management efforts.

- Contingency Planning: Despite thorough risk assessment and mitigation, unforeseen events can still occur. Developing contingency plans to respond to emergencies or unexpected disruptions promptly. These plans should outline steps to be taken, responsibilities, and communication protocols to minimize the impact of risks that materialize.

- Documentation and Communication: Keeping detailed records of all risk assessments, mitigation strategies, and related documentation. Maintain clear and open communication channels among all project stakeholders, including the client, contractors, and regulatory authorities. Regularly update them on risk management activities and any changes in the risk profile.

- Learn from Experience: After completing the project, conducting a post-project review to evaluate the effectiveness of risk management efforts. Identify lessons learned and best practices that can be applied to future building projects. Continuously improve risk assessment and management processes based on these insights.

A questionnaire was developed by browsing literature on construction risk management. To achieve the objectives of this study, questionnaires were deemed to be the most effective tool for gathering information. These questions helped identify any projects that ought to definitely not be undertaken by the parties and people, although risky, should be examined further after a more rigorous examination of the potential sources of risk. The questionnaire was designed suppported the knowledge of state, consultant, or contractor in large or infrastructure construction projects; the questions were meant to spot their method of risk identification and possible effects of those risks. The general methodology of this study relies largely on the survey questionnaire which is collected from the various multi project construction contractors and project manager of various sizes by mail or by personnel meeting. A thorough literature review was initially conducted to spot the risk factors that affect the performance of construction industry entirely.

The research methodology contains two phases. The first phase included a literature search and interviews. The literature review was conducted through books, conference proceedings, internet and international project management journals. As the outcome of this phase, These causes were categories in nine main groups as : Project related, Owner related, Contractor related, Consultant related, Design-related, Material related, Equipment related, Labour related and External factors counting on their nature and mode of occurrence.

In this method various risks were identified and survey questionnaire is prepared which will be on “5-point Likert Scale” where 1 will be lowest risk and 5 will be highest risk. Using the scale and Relative Importance Index (RII) method the information is analyzed, and the risks that are identified during the survey is ranked.

This ranked risk factor will give us the knowledge of the risks that are highly critical which can act as early warning and helps to neutralize the impact of the risk.

3.1 Likert Scale

A Likert scale is a rating scale, often found on survey forms, that measures how people feel about something. It includes a series of questions that you simply ask people to answer, and ideally 5-7 balanced responses people can choose from. It often comes with a neutral midpoint. When responding to a Likert item, respondents specify their level of agreement or disagreement on a symmetric agree-disagree scale for a series of statements. Thus, the range captures the intensity of their feelings for a given item.

3.2 Relative Importance Index (RII) Method

Relative Importance Index is calculated for each of the indications and ranked accordingly. The RII derived to summarize the importance of every indicator:

$RII = \Sigma W/ (A \times N)$

Where,W = Weight allotted to every risk (by response to questionnaire survey),1 = no impacts,2 = negligible impact,3 = marginal impact,4 = moderate impact,5 = major impact,A = Highest weight (here it's 5),N = Total number of people (responses) who completed Questionnaire survey

The required information obtained from the questionnaire survey may be accessed ranked by using the Relative importance index which is a quantitative method. The obtained data is mathematically added up and ranked using this general RII formula.

3.3 Questionnaire Content

The questionnaire included two main parts:

Part I (General Information): This part comprises general information concerning the respondent (name, age, gender, and the type of work sector) in addition to the classifications of the educational qualification, specialization, job position and work experience.

Part II (Potential barriers): It contains closed questions designed by the five point Likert scale. The scale is (1: Very weak, 2: Weak, 3: Moderate, 4: Strong, 5: Very strong). Each respondent was invited to give a degree of

measure to each question according to what he believes within the environment of the Indian construction sector.

After the collection of the questionnaires, they were analyzed by Relative importance index to determine the relative significance and ranking of the causes.

3.4 Organization Profile

General questions were prepared on information about the company such as the name of the company, major type of work, gender of the worker, the contact person and his/her experience, age of the respondent, a question about where the respondent works in and his/her position.

3.5 Profile of Respondents

Face-to-face delivery was favored to encourage respondents and raise the response rate but another way like email also employed. Questionnaires will be sent to construction professionals involved in large projects.

3.6 Gender, Age and Location

This information is needed to find out the gender of the respondents. The age and location can affect the survey responses hence, suitable questions are designed to seek out information on the same.

3.7 Company Type of Respondents

The contributions of respondents was noted to observe the category of respondents which are project managers, contractors, senior engineers, project engineers etc. this is necessary because each work may not be affected the same due to the development of real estate sector. So based on their positions the responses varied and it is important to know the base of their opinions for us.

3.8 Work Experience of Respondents

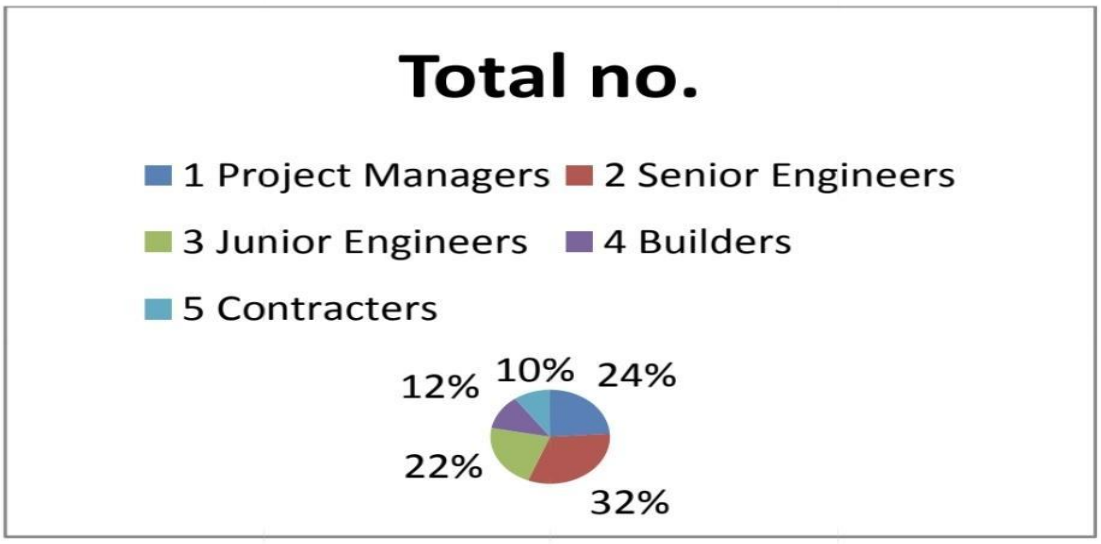
Questions are included to ask the level of experience of the respondents so that it will be easy to understand the reason behind the ranking given by the respondents. Higher experienced staff was expected to provide reasonable answers.

No.	**Experience**	**No. of response**
1	5-10	21
2	10-15	15
3	15-20	9
4	20-25	3
5	25-30	1
6	30-35	1

Table 3.8 Experience of Respondents

3.9 Position of Respondents

The major impact is expected to be acknowledged by the staff working at higher management level, the owners of the firms etc.



3.10 Educational Level

The education level i.e. whether the respondents have done post-graduation, graduation or diploma is noted.

3.11 Questionnaire format and content

After reviewing and studying various literature papers various risk factors were classified and their sub risk.

After consulting various industrial experts, experienced engineers and academic experts the following risk were finalized and a questionnaire was prepared and tabulated as shown below in order to take responses from the respondents.

Factors	Category	Response				
		1	2	3	4	5
Technical Risk	Incomplete Design					
	Changes in site situation after site investigation					
	Improper project planning and budgeting					
	Inadequate specification					
	Excessive approval procedures in administrative government departments					
Time Risk	The contractor does not pay worker wages in due time	2	1	1	3	4
	Improper Project Schedule					
	Extension in time due to force majeure					
Construction Risk	Unsuitable construction program planning	1	1	2	5	3
	The worker does not abide by regular work-hours					
	Plans of design are incompatible with execution.					
	Many modifications on designs are made during execution.					

	The designer does not follow up designs and changes made on them.					
	Inability to execute the project within specified timetable.					
	Necessary technical skills are not available					
	Low productive efficiency of the worker.					
	Some materials do not arrive at the assigned site.					
	Absence of trained manpower.					
	Selection of material and equipments					
	Equipment failure					
	Shortage of equipment					
	New technology implemented					
	Changes in material types and specifications during construction					
	Undocumented change orders	5	3	3	1	4
Design Risk	Designs are changed by the engineers					
	Defective design (incorrect)					
	Lack of consistency between bill of quantities, drawings and specifications					
	Awarding the design to unqualified designers					

	Inter-departmental mis-coordination (structural, mechanical,					

	electrical, etc.)					
	Improper verification of contract documents					
	Breach of contract by project partner					
	Lack of enforcement of legal judgment					
	Uncertainty and unfairness of court justice					
Market Risk	Competition from other similar projects	1	2	3	3	2
	Increase of Labour costs					
	Increase of Material price					
	Unfairness in tendering					
	Unrealistic price variation in material					
	Inadequate forecast about market demand					
Management Risk	Change of top management	3	4	5	3	1
	No past experience in similar projects					
	Internal management problems					
	Improper project feasibility study					
	Poor relation and disputes with					
	Project delay by the management problems					
Financial Risk	Loss due to fluctuation of interest rate	4	3	4	4	4
	Change in bank formalities and tenders					
	Loss due to rises in fuel prices					

	Late payment by clients					
	Cash flow problem					
	Price fluctuation					
	Tax rate increase					
	Foreign currency exchange rate fluctuation					
	Inflation					
	Funding / Payment shortage					
	Cancellation in giving loan					
	Construction prices are low					

	Competition in pricing projects					
	Specialists in project financial analysis are not employed					
Policy and Political Risk	Inexperience when pricing tenders	2	3	3	1	1
	Changes in laws and regulations					
	Requirement for permit and late approvals					
Environmental Risk	Natural Disaster (Floods, earthquakes,etc.)	3	3	5	2	1
	Adverse weather conditions					
	Pollution and Safety rules					
	Difficulty to access the Site (Very far, settlements)					
Social Risk	Problems from near project					
	Local People support for project					
Safety Risk	Accidents on workers	2	3	1	2	2
	Unexpectedly falls of the floors					
	Electrical fires occurred					

	Labour injuries					
	Vehicle crashes on workers					
Physical Risk	Poor quality of materials procured due to damaged in structure	1	2	2	0	1
	Damage to equipment					
	Wastage of materials by workers					
	Equipment and material fire					
	Theft of materials at site					

Table 3.11 Questionnaire Format

4. RESULTS AND DISCUSSIONS

4.1 Calculation of Total frequencies

The finalized questionnaire was circulated by various ways like by taking face to face interviews, by submitting the questionnaire in various companies in jammu region.

Following were the frequencies obtained by the responses of the respondents i.e. from rank 1 to rank 5 where rank 1 is the least and rank 5 is the highest.

No	**Risk factors**	**Rank 1**	**Rank 2**	**Rank 3**	**Rank 4**	**Rank 5**
1	Incomplete Design	8	4	16	11	11
2	Changes in site situation after site investigation	16	17	11	6	0
3	Improper project planning and budgeting	7	18	20	5	0
4	Inadequate specification	7	10	32	1	0
5	The contractor does not pay worker wages in due time	19	6	11	13	1
6	Improper Project Schedule	5	32	13	0	0

7	Extension in time due to force majeure	12	14	21	0	0
8	Insufficient planning	23	11	9	7	0
9	Plans of design are incompatible with execution.	4	2	14	17	13
10	Inability to execute the project within specified timetable	4	17	17	8	4
11	Inadequate construction quality	7	2	11	17	13
12	Material resourcing	19	11	3	17	0
13	Equipment resourcing	14	24	5	7	0
14	New technology implemented	13	17	6	3	11
15	Designs are changed by the engineers	11	10	9	6	14
16	Defective design (incorrect)	8	4	5	14	19
17	Inter-departmental mis-coordination (structural, mechanical, electrical, etc.)	5	4	17	11	13
18	Improper verification of contract documents	5	5	9	21	10
19	Breach of contract by project partner	5	1	9	23	12
20	Lack of enforcement of legal judgment	5	8	14	15	8
21	Competition from other similar projects	6	21	11	6	6
22	Increase of Labour costs	2	16	22	8	2
23	Increase of Material price	1	10	31	6	2
24	Unfairness in tendering	7	11	21	11	0
25	Change of top management	3	13	16	14	4
26	No past experience in similar projects	3	23	11	6	7

27	Internal management problems	6	8	23	13	0
28	Improper project feasibility study	8	12	17	13	0
29	Poor relation and disputes with stakeholders	10	15	4	15	6
30	Loss due to fluctuation of interest rate	10	16	12	8	4
31	Change in bank formalities and tenders	10	18	7	11	4
32	Late payment by clients	3	10	15	20	2
33	Cash flow problem	17	16	3	12	2
34	Foreign currency exchange rate fluctuation	11	23	3	11	2
35	Specialists in project financial analysis are not employed	4	9	19	16	2
36	Inflation	5	9	21	13	2
37	Funding / Payment shortage	5	9	23	10	3
38	Tax rate increase	3	12	31	2	2
39	Inexperience when pricing tenders	11	7	25	3	3
40	Changes in laws and regulations	5	16	20	8	1
41	Requirement for permit and late approvals	17	12	7	8	6
42	Natural Disaster (Floods, earthquakes,etc.)	6	4	16	12	12
43	Adverse weather conditions	5	17	18	5	5
44	Pollution and Safety rules	7	21	21	1	0
45	Problems from near project	20	18	6	6	0
46	Local People support for project	18	10	5	8	9
47	Accidents on workers	5	5	10	18	12
48	Unexpectedly falls of the floors	4	6	10	17	13

49	Electrical fires occurred	7	14	19	6	4
50	Labour injuries	8	9	19	7	7
51	Poor quality of materials procured due to damaged in structure	5	12	10	12	11
52	Damage to equipment	7	10	18	14	1
53	Wastage of materials by workers	8	20	11	11	0
54	Equipment and material fire	6	17	13	14	0
55	Theft of materials at site	4	15	22	8	1

Table 4.1 Total no. of Frequencies

4.2 Calculation of Relative Importance Index and Rank Allotment

The total no of frequencies obtained and the relative importance index was calculated and the ranking was done. Lower the no of rank higher the risk, hence the rank of the risk factors were classified.

No.	RISK FACTORS	TOTAL	RII	RANK
1	Incomplete Design	**137**	**0.409**	**1**
2	Changes in site situation after site investigation	**193**	**0.702**	**52**
3	Improper project planning and budgeting	**177**	**0.644**	**44**
4	Inadequate specification	**173**	**0.629**	**41**
5	Contractor does not pay worker wages in due time	**179**	**0.651**	**45**
6	Improper Project Schedule	**192**	**0.698**	**51**
7	Extension in time due to force majeure	**185**	**0.673**	**50**
8	Insufficient planning	**200**	**0.727**	**54**

9	Plans of design are incompatible with execution	**117**	**0.425**	**3**
10	Inability to execute the project within specified timetable	**159**	**0.578**	**25**
11	Inadequate construction quality	**123**	**0.447**	**7**
12	Material resourcing	**182**	**0.662**	**47**
13	Equipment resourcing	**195**	**0.709**	**53**
14	New technology implemented	**168**	**0.611**	**36**
15	Designs are changed by the engineers	**148**	**0.538**	**16**
16	Defective design (incorrect)	**118**	**0.429**	**4**
17	Inter-departmental miss-coordination (structural, mechanical, electrical, etc.)	**127**	**0.462**	**9**
18	Improper verification of contract documents	**124**	**0.451**	**8**
19	Breach of contract by project partner	**114**	**0.415**	**2**
20	Lack of enforcement of legal judgement	**137**	**0.498**	**10**
21	Competition from other similar projects	**165**	**0.6**	**32**
22	Increase of Labour costs	**158**	**0.575**	**22**
23	Increase of Material price	**152**	**0.553**	**17**
24	Unfairness in tendering	**164**	**0.596**	**30**
25	Change of top management	**147**	**0.535**	**14**

26	No past experience in similar projects	**159**	**0.578**	**25**
27	Internal management problems	**157**	**0.571**	**21**
28	Improper project feasibility study	**165**	**0.6**	**32**
29	Poor relation and disputes with stakeholders	**158**	**0.575**	**22**
30	Loss due to fluctuation of interest rate	**170**	**0.618**	**39**
31	Change in bank formalities and tenders	**169**	**0.615**	**38**
32	Late payment by clients	**142**	**0.516**	**13**
33	Cash flow problem	**184**	**0.669**	**48**
34	Foreign currency exchange rate fluctuation	**180**	**0.655**	**46**
35	Specialists in project financial analysis are not employed	**147**	**0.535**	**14**
36	Inflation	**152**	**0.553**	**17**
37	Funding / Payment shortage	**153**	**0.556**	**19**
38	Tax rate increase	**162**	**0.589**	**28**
39	Inexperience when pricing tenders	**168**	**0.611**	**36**
40	Changes in laws and regulations	**166**	**0.604**	**35**
41	Requirement for permit and late approvals	**176**	**0.64**	**43**
42	Natural Disaster (Floods, earthquakes,etc.)	**130**	**0.473**	**10**
43	Adverse weather conditions	**162**	**0.589**	**28**

44	Pollution and Safety rules	**184**	**0.669**	**49**
45	Problems from near project	**202**	**0.735**	**55**
46	Local People support for project	**170**	**0.618**	**39**
47	Accidents on workers	**123**	**0.447**	**6**
48	Unexpectedly falls of the floors	**121**	**0.44**	**5**
49	Electrical fires occurred	**164**	**0.596**	**30**
50	Labour injuries	**154**	**0.56**	**20**
51	Poor quality of materials procured due to damaged in structure	**138**	**0.502**	**12**
52	Damage to equipment	**158**	**0.575**	**22**
53	Wastage of materials by workers	**175**	**0.636**	**42**
54	Equipment and material fire	**165**	**0.6**	**32**
55	Theft of materials at site	**163**	**0.583**	**27**

Table 4.2 Relative Importance Index and Rank Allotment

4.3 Top Ten Classified Risks

The top 10 risk factors identified are:

RISK FACTORS	RANK
Incomplete design	1
Breach of contract by project partner	2
Plans of design are incompatible with execution	3
Defective design	4
Unexpectedly falls of floors	5
Accidents on workers	6
Inadequate construction quality	7
Improper verification of contract	8
Inter departmental miss-coordination	9
Lack of enforcement of legal document	10

Table 4.3 Top Ten Risk

4.4 Least Harmful classified Risk

The risk factors with minimum risk indentified are :-

RISK FACTORS	RANK
Local people support for project	46
Material resourcing	47
Cash flow problem	48
Pollution and safety rules	49
extension in time due to force majeure	50
Improper project schedule	51
improper project planning and budgeting	52
Equipment Resourcing	53
Insufficient planning	54
Problems from near site	55

Table 4.3 Least Harmful Classified Risk

5. REMEDIES AND SUGGESTIONS

- Contracting documents to be legally registered
- Contracting duration must be specified with adjustment just in case of natural calamity
- Payment mode to be specified supported progress or duration
- Specification or Dimension changes to be recorded in register
- Disputes and Errors to be solved with record proofs
- Meeting to be conducted periodically.
- Insurance on Equipment, Machineries and Manpower to be predetermined
- Political and Local issues to be solved by whom must be pre-determined

- Re-work must be denoted under whose scope supported fault.
- Client to be pay the payment as per modes to the contractor
- Client payment should be through BANK transaction
- Client may monitor the contractor's payment to workers
- Workers' wages also to be paid through BANK transactions.
- Workers' wages to be paid in weekly or monthly payment.
- Delaying payment to Workers will affect the progress of work.
- Do not delay or reduce the wages based on Financial difficulties of contractor
- Incentives or Bonus from profit will enthusiast the workers
- Increment based on experience or efficiency will lead the workers to retain
- Client's Slow payment for completed works will affect contractor pay to labour.
- Skilled staff to be deployed for tendering.
- Technical skilled person to execute the work.
- Highly technically experienced person to be administrate the project.
- Sufficient technical information’s to be provided in drawings and documents.
- Necessary technical trainings to be provide to workers.
- High tech technology equipment and machineries to be used to get fast and accuracy.

6. CONCLUSION

The construction companies got to include risk as an integral part of their project management. Decision making such a risk assessment in construction projects is very important in the construction management. The identification and assessment of project risk are the critical procedures for projecting success. This study determines the key factors of risk in construction industry. A total of 55 factors influencing risks in construction are analyzed through survey which include experts of academic (Professors), government sectors and construction industry were interviewed, and top 10 risk factors were indentified and thus the least affecting risk were also identified. Therefore by understanding the critical risks and also the least risk factors we can plan and schedule to get our project completed on time.

7. REFERENCES

- Karim El-Dash ,Emad Abd-Raboh , Zakariya El-Dars (2006) “Risk Management In The Design Phase Of Large-Scale Construction Projects”
- Riaan van Wyk, Akin tola Akintoye (Mar 2007) "Project risk management practice: the case of a South African utility company”
- De Jager,D; M.Rathmann(2008),” Policy instrument design to reduce financing costs in srenewable energy technology projects”. ECOFYS,Utrecht, The Netherlands,142pp
- K.Jayasudha and B.Vidivelli (2015) “An Assessment and Analysis of Major Risks in Construction Projects” (ISSN: 2321 – 0893)
- K. Jayasudha Dr. B.Vidivelli and E.R. Gokul Surjith (2016) “Risk Assessment and Management in Construction Projects” ISSN 2229-5518
- Dr. Prof.Ajit Patil, Kiran Phad, Pravin Wajirgave, Subhash Kumar, Nikita Ahirrao (2018) “Risk Assessment and Safety Management in the Construction Industry” ISSN : 2319-8753
- De Jager and Max Rathmann (2008),” Assessment of the associated risk of a project has a major impact on its cost of capital”
- Desai Megha, Dr Bhatt Rajiv (2013), “A Methodology for Ranking of Causes of Delay for Residential Construction Projects in Indian Context”.
- K. Jayasudha Dr. B.Vidivelli and E.R. Gokul Surjith (2014),“Risk Assessment and Management in Construction Projects”
- K. Jayasudha and B. Vidivelli (2016) “Analysis Of Major Risks In Construction Projects” ISSN 1819-6608
- Hatkar K B and Hedaoo N A, (2016) “Delay Analysis By Using Relative Importance Index Method In Infrastructure Projects”
- Muhammed Mufazzal Hosen, Sunkoo Kang, Jonghyan Kim (2018), “Construction Schedule Delay Risk Assessment by Using Combined AHP-RII Methodology For An International NPP Project”.

- Dr. Prof.Ajit Patil, Kiran Phad, Pravin Wajirgave, Subhash Kumar, Nikita Ahirrao (2018) "Risk Assessment and Safety Management in the Construction Industry".
- Goran Cirovic "Risk Assessment Of Conrtustion Industry"
- Gavit Shivamkumar Chandubhai, Dr. Jayeshkumar R. Pitroda, Prof. Ashish H. Makwana (2019) "Risk Management In High Rise Construction projects In Surat City"
- Mubin M. Shaikh, "Risk Management In Construction Projects"
- Nerija Banaitiene and Audrius Banaitis, "Risk Management In Construction Projects"
- Nagalla Vasishta, D. Satish Chandra, SS. Asadi, "Analysis Of Risk Assessment In Construction Of Highway Projects Using Relative Importance Index