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ANALYSIS OF RISK FACTORS IN INDIAN CONSTRUCTION INDUSTRY

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***Abstract*: - Risks are quite a common in construction sector. Time, Cost and Quality are the three main factors having significant impact on construction project performance. The overall aim of this research is to evaluate the risks at the project site based on its impact. This paper aims on the domain of risk management by studying the risk identification procedure, criticality of various risks and risk factors in construction project, evaluation of the current risk allocation practices & perception of project participants and development of modelling & assessment framework for the critical risks in the projects. Also, this study comprises of a questionnaire survey and interview with the various experts to highlight the limitations of existing circumstances of the construction project practices in terms of risk management.**

Keywords: - *Risk management, Risk score. Cost, Quality, Time.*

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I INTRODUCTION

The construction industry is one of the largest segments in the Indian economy. It contributes around 8% to the country's GDP and creates more than 45 million jobs directly or indirectly (Goldstein 2020). People's life is directly impacted by the quality of building and infrastructure so well-functioning of construction industry is must in developing a society.

In Indian construction industry, in order to improve current scenario, it is advised to implement risk management process in the construction projects and, therefore, to uplift the efficiency and quality of industry.

Risk management is a continuous process, which is carried out in almost all the different stages through which any project passes, by finding out the various risks associated with it, using the cause and effect method and to provide optimum solution with the least impact on the project based on the risk register formed without taking any other factors into consideration. This process involves four major steps which are to be completed along the way:

1. Risk recognition
2. Risk analysis
3. Risk prevention techniques
4. Risk control and monitoring

. Therefore, this research delves into the process of risk management along with its impact of various risks on the construction project.

II LITERATURE REVIEW

When risk management became the most affecting parameter to measure the degree of success of any project, they had carried out a study to find the gaps & inconsistencies in the risk management of the construction project, and found out that for the minimization of various losses of time, cost & quality, and for the enhancement of profitability, one needs to study various risk in project & to use various risk analysis method, while executing the project. [1]

Risk has become an indispensable part of any construction project in the age of accelerating globalization, and it is present in each and every step of every construction project. Management is a complex, long-term, and broad process that begins long before the investment and can last long after it has been completed. Risk management does not imply preventing it; rather, it involves correctly defining it and assessing all related opportunities and hazards.[2]

The risks will be defined and assessed based on past experience, and the appropriate mitigation for the risks will be provided. Risk management is an excellent method for managing risk in each step of a project, it should be stressed. For both the owner as well as the contractor, using this approach in practical scenarios would

improve the chances of project success by a lot. Focusing on all the risks that usually occur during the Pre-construction, Construction, Post-construction phase, and how to completely resolve those risks, it may be helpful to mitigate all the conflicts likely to be made between the client and the contractor.[3]

"A Study of Risk Management Techniques for Construction Projects in Developing Countries" was carried out to foresee whether the primary technique of using the documented theory approach to mitigate all different types of risks which are highly prioritized is effective and it was concluded that the use of this technique is more than persisted upon and thus the need should be catered upon as this directly affects the measures taken in account to minimize all the risks of the project. Instead of the current intermittent approach to risks, a more holistic approach to risk management is needed.[4]

III PROPOSED APPROACH

The research objectives are categorized into three sections: identification of critical risks, risk allocation and management perceptions and risk assessment for Indian projects. A mixed approach of questionnaire survey, interviews (among designers, developers, site engineers, contractors, field experts and consultants) and literature review were used for attaining the above objectives. An overview of the applied methodology and statistics is given below.

Design methodology

The proposed methodology in order to reach specified degree of mitigation, consists of mainly 4 steps as shown in the figure 1 :

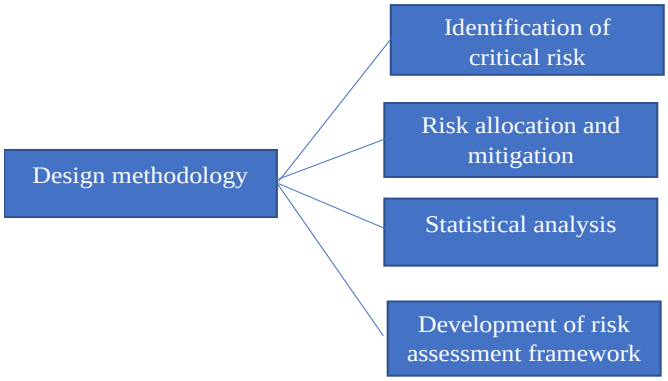

Figure 1 Design Methodology

Identification of critical risks: A questionnaire survey was conducted among the major stake holders/ participants (developers, site engineers, designers, contractors, field experts and consultants) of Indian construction industry to identify the most critical risk and risk factors in construction projects. The survey responses were statistically analysed. A matrix known as "probability and impact matrix" was used to compare the criticality of risks and risk factors.

i. **Risk allocation and mitigation** A mixed approach of perception analysis through questionnaire survey and literature review was used to evaluate risk allocation and mitigation in Indian projects. Risk analysis was carried out to calculate the risk management capability, risk allocation & risk sharing weightage and regression analysis has been carried out to identify the level of risk acceptance factors.

ii. **Statistical analysis**: A detailed study on statistical tests consisting of hypothesis testing using T-test, F-test, one way analysis of variance (ANOVA) and Tukey Kramer test have been carried out for identification of critical risks and risk analysis based on the data provided by the respondents after categorizing them into specified groups.

iii. **Development of risk assessment framework**: A risk probability and impact assessment model has been developed as a generic and analytic framework. Ten and five "very critical risks" based on time factor and cost factor respectively were identified based on the previous survey and case studies and were modelled. The adequacy and correctness of the contents of the modelled risks were evaluated through experts working in the area of Indian construction industry. Risk assessment of an actual project was carried out in order to test the validity of the proposed risk model and to demonstrate the use of the proposed framework.

Design Analysis

i. **Categorize the data.:** After collecting all the responses of the survey and categorizing them as per their use in the analysis part, the process of filtering some biased responses was carried out and after final categorization, 100 Responses were taken into consideration for the analysis.

ii. **Statistical test :** Before proceeding to carry out any checks on our data, it is very essential to find out certain simple statistics for further ease of execution. This step is to compute the basic statistic data i.e. sum, mean and variance to decide the further steps of the analysis.

Check 1 – P-value test: The Probability value or commonly known as the P-value test, is used to find out the probability of the extreme results when the study area of any hypothesis/dataset is questioned.

For this, we consider a null hypothesis stating that each and every

value of the dataset is in all ways similar and then we perform this test to check the validity of the null hypothesis. If null hypothesis is found to be true, the dataset is inaccurate and it cant be further used for any application. However, if it is false the check is satisfied and we need to move on to the next check.

TABLE 1 P-VALUE TEST

P – VALUE TEST				
Groups	*Count*	*Average*	*Variance*	*P-value*
Legal disputes between various parties	100	3.14	1.132	12.527×10^{-9}
Resource scarcity	100	3.22	1.507	
Inadequate contractor's experience	100	3.57	1.177	
Poor site supervision & management	100	3.75	1.361	
Errors while execution on site	100	3.45	1.280	
Frequent changes in drawings and specifications	100	3.32	1.371	
Less equipment efficiency	100	2.99	1.101	
Weather Conditions	100	2.73	1.391	
Government regulations / Policies	100	2.99	1.242	
Accidents during construction	100	3.17	1.698	

Check 2 –F-value test : Similar to P-value test, F-value test is a statistic test which follows the F-distribution method which is used to compare statistical models which in turn is useful to find the model which fits the best to the survey data result. This test however contains two values, F-value and F-critical value.

F-value is obtained by processing our data under the distribution curve whereas F-critical value is obtained from the graph already available for the same no. of datasets to set the boundary limits. For our null hypothesis to be false, F-value should be greater than f-critical value.

TABLE 2 F-VALUE TEST

F – VALUE TEST					
Groups	*Count*	*Average*	*Variance*	*F Value*	*F crit*
Legal disputes between various parties	100	3.14	1.132	6.866	1.889
Resource scarcity	100	3.22	1.507		
Inadequate contractor's experience	100	3.57	1.177		
Poor site supervision and management	100	3.75	1.361		
Errors while execution on site	100	3.45	1.280		
Frequent changes in drawings and specifications	100	3.32	1.371		
Less equipment efficiency	100	2.99	1.101		
Weather Conditions	100	2.73	1.391		
Government regulations / Policies	100	2.99	1.242		
Accidents during construction	100	3.17	1.698		

Check 3 –Tukey-Kramer test : Tukey Test is a test which compares the average of one group with other groups and thus, makes pairs of two between all the groups possible. Two scientists Tukey and Kramer proposed a framework for pairwise testing of averages using a One-way ANOVA test with unequal sample size. The results of this test are as shown in the table below:

Absolute difference = |(average of group 1) - (average of group 2)|

Critical Range = $Q^*\left(\sqrt{\frac{Mean\ square\ within\ group}{Count}}\right)$

If Absolute difference is greater than critical range than Mean is significantly different.

TABLE 3 TUKEY KRAMER TEST

Time Related Factors			
Comparison Bet'n Factors	Absolute Difference	Critical Range	Results
1 - 2	0.26	0.530	Means are NOT Very Different
1 - 3	0	0.530	Means are NOT Very Different
1 - 4	0.11	0.530	Means are NOT Very Different
1 - 5	0.54	0.530	Means are Very Different
1 - 6	0.27	0.530	Means are NOT Very Different
1 - 7	0.25	0.530	Means are NOT Very Different
1 - 8	0.1	0.530	Means are NOT Very Different
1 - 9	0.03	0.530	Means are NOT Very Different
1 - 10	0.15	0.530	Means are NOT Very Different

ANOVA TEST: Analysis of variance (ANOVA), as the name suggests, is a statistical method that separates the variance value into different parts which can be used to find out the total variance for each group. A one-way ANOVA test is done for 3 or more groups and as we have 10 groups this can be performed here.

As output of this test, we will get the division of variance percent-wise into two major components – Variance between & within groups. Using the addition of both components we will find out the total variance and final mean respectively.

On performing the Anova test, we can get the value of Variance total at the last row which is the sum of both Variance between groups & various within groups. Based on this value, we need to remove all the variance from the mean and get a Final Mean value for each and every group and in order to do so, the following steps are done:

Percent Variation (for 1st group) = Total ANOVA + variance of that group

= 13.947 + 1.132 = 15.0788

Final Mean = Average – (Percent variation*average/100)

= 3.14 – (0.150788 * 3.14) = 2.667.

Similarly, calculate for all the groups and the Final mean value of each factor is known which can be further used to calculate the Risk Score for each factor.

TABLE 4 ANOVA TEST

ANOVA TEST			
Source of Variation	*SS*	*df*	*MS*
Between Groups	81.941	9	9.1045
Within Groups	1312.77	990	1.3260
Total	1394.711	999	

TABLE 5 ANOVA TEST RESULTS (TIME)

ANOVA TEST				
Time factors	**Count**	**Average**	**Variance**	**Final Mean**
Legal disputes between various parties	100	3.14	1.132	2.667
Resource scarcity	100	3.22	1.507	2.722

Inadequate contractor's experience	100	3.57	1.177	3.030
Poor site supervision and management	100	3.75	1.361	3.176
Errors while execution on site	100	3.45	1.280	2.925
Frequent changes in drawings and specifications	100	3.32	1.371	2.811
Less equipment efficiency	100	2.99	1.101	2.540
Weather Conditions	100	2.73	1.391	2.311
Government regulations / Policies	100	2.99	1.242	2.536
Accidents during construction	100	3.17	1.698	2.674
Cost factors				
Inaccurate Project Cost estimation	100	3.53	1.039	3.262
Poor site supervision and management	100	3.49	1.262	3.217
Construction / Execution delays	100	3.58	1.297	3.299
Political Complexity	100	2.84	1.267	2.618
Unrealistic Contract duration	100	3.39	1.392	3.120

IV OBSERVATION AND RESULTS

The impact and occurrence of various time and cost related factors in the risk management procedure. In Conclusion, the P-value (12.527×10^{-9}), F- value (6.866) and F - critical (1.889) justify the validity of survey carried out and fit for further analysis. Poor site supervision and management, Errors while execution on site and Inadequate contractor's experience are emerged out as top three influencing risk factors as far as time duration of construction project is concerned and their variance values are 1.361,1.280 and1.177 respectively, and in the similar way construction delays and Poor site supervision and management are considered as the top two factors affecting the cost of the project with 1.236 and 1.273 as their variance values which justifies the reliability of our results.

The end result (allocation of ranks) is carried out by calculating the risk score based on the final mean values.

TABLE 6 RANK ALLOCATION

Rank Allocation				
Time related factors	**Rating**	**Occurrence**	**Risk Score**	**Rank**
Poor site supervision and management	3.176	2.747	0.349	1
Errors while execution on site	2.925	2.532	0.296	2
Inadequate contractor's experience	3.030	2.391	0.290	3
Frequent changes in drawings and specifications	2.811	2.512	0.282	4
Resource scarcity	2.722	2.301	0.251	5
Less equipment efficiency	2.540	2.383	0.242	6
Accidents during construction	2.674	2.147	0.230	7
Legal disputes between various parties	2.667	2.079	0.222	8
Government regulations / Policies	2.536	2.168	0.220	9
Weather Conditions	2.311	2.271	0.210	10

Cost Related Factors	Rating	Occurrence	Risk Score	Rank
Construction / Execution delays	3.299	3.299	0.435	1
Poor site supervision and management	3.217	3.100	0.399	2
Inaccurate Project Cost estimation	3.262	2.995	0.391	3
Unrealistic Contract duration	3.120	2.737	0.342	4
Political Complexity	2.618	2.398	0.251	5

V JUSTIFICATION OF FACTORS

Construction delays: The two major factors taken into consideration i.e. time and cost which are solely responsible for major outcomes of a project in respect to the risks associated are very important to both the client and the contractor. Also 57% of all the projects in the Indian construction industry are directly or indirectly exposed to time overrun, which causes a foul impact.[5] Thus, Construction delay is considered to be one of the most frequently occurring issues among the industry which has a huge impact on risks associated with given project at any given point of time.[6]

Poor Site supervision and management: Site supervision suggest the general direction, coordination and oversight of the on-site work processes. In the construction industry, in contrast to the manufacturing industry, project differ and each project is exclusive in nature clogging the method of standardization.[7]

Errors while execution on site: The primary purpose for crucial defects is human mistakes. The defects cause the growth of possibility of production failure, which cause time and value overruns in lots of unimaginable ways.[8]

Inadequate Contractors' Experience: A wide variety of controllable and uncontrollable issues can critically interrupt the task method and generate an inclination of delays. Therefore, due to the excessive prevalence of those issues, we need to allocate resources and time in mitigating them which leads to overall progress in the project. .[9]

VI CONCLUSION & FUTURE SCOPE

A. Conclusion

In this report, we have briefly explained the steps to tackle risks produced/foreseen at any construction project. The above includes Risk Identification, Risk assessment and Risk Mitigation.

After conducting the entire study, it is clear that Time & Cost are the main two variables in terms of risk, which should be thoroughly analysed. It was aimed to prepare the sustainable and feasible framework for assessment the corresponding risk at the sites. The typical Risks associated with Residential & Commercial buildings are listed out and a survey is conducted of 100 people, who are having enough experience of site work. The result of the survey provides us the priorities and impact of various risks associated.

The end result will be helpful for engineers and contractors to priorities the factors in a particular order and tackling them based on their order of priority.

B. Future Scopes

Based on the final analysis after the procurement of the risk score, they can be used in the following:

i. Giving weights to factors and carry out analysis.
ii. Using Risk Score and the assigned factors we can calculate different risk parameters such as time, cost and quality based on Event Tree Approach, Indicator Based Approach, & Bayesian Belief Network.
iii. Based on different types of buildings, different adjustments can be made.
iv. On selecting the factors, their impact and occurrence we can develop different matrices which show the individual parameters for each of the factors. Those matrices are

a. Probability Matrix
b. Impact Matrix
c. Risk Score Matrix.

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