

Assessment and Management of Risks in High-Rise Building Construction Projects: A Case Study-Based Analysis

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Abstract: Rapid urbanization has significantly increased high-rise construction projects, which are complex and risk-prone due to scale, stakeholders, and high investment. This study focuses on assessing and managing risks affecting cost, time, quality, and safety. A structured methodology involving literature review, case studies, and a questionnaire survey was adopted. A total of 33 risk factors were identified under financial, technical, environmental, safety, and regulatory categories. Data collected from 62 professionals showed high reliability (Cronbach's Alpha = 0.899). The Risk Severity Index (RSI) method was used to prioritize risks. Results reveal that technical and design-related risks are the most critical. Key risks include frequent design changes, contract disputes, and poor supervision. These risks significantly contribute to cost overruns and delays. A risk management framework is proposed focusing on BIM, design finalization, and contract management. The study concludes that proactive planning and systematic risk management are essential for project success..

Keywords: High-rise construction, risk management, risk assessment, Risk Severity Index (RSI), construction project management, cost and time overrun

I. INTRODUCTION

The construction of high-rise buildings has become a defining feature of modern urban development, particularly in rapidly growing countries such as India. Increasing population density, limited land availability, and rising demand for residential and commercial spaces have accelerated the growth of vertical construction. However, high-rise construction projects are highly complex and involve multiple stakeholders, advanced technologies, large financial investments, and extended project durations.

Due to these complexities, such projects are exposed to various types of risks that can significantly affect project objectives such as cost, time, quality, and safety. These risks can be broadly categorized into financial, technical, environmental, safety, and regulatory risks. Common issues such as cost overruns, delays, design errors, labor shortages, safety hazards, and regulatory approvals frequently impact project performance.

Risk in construction can be defined as the probability of occurrence of uncertain events that may adversely influence project outcomes. In high-rise construction, risks are amplified due to factors such as vertical construction challenges, dependency on advanced equipment, stringent safety requirements, and sensitivity to environmental conditions.

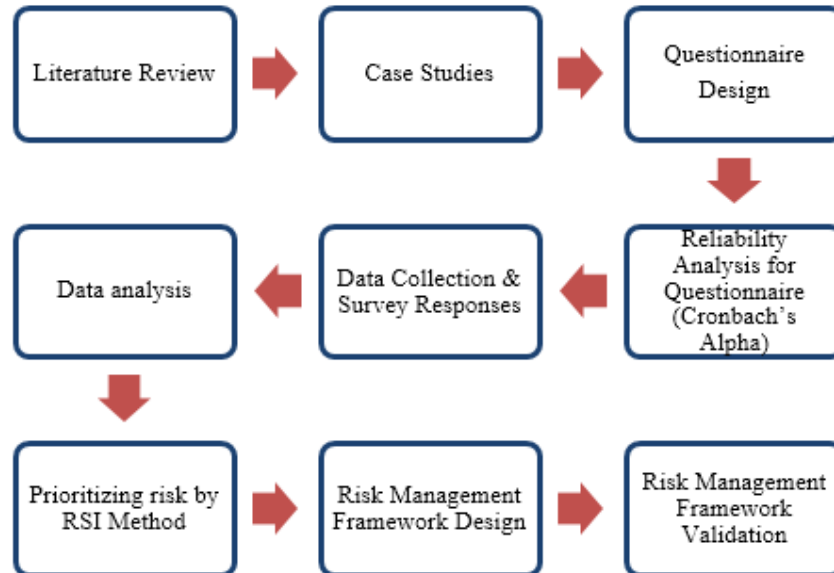
Effective risk assessment and management are therefore essential to ensure successful project completion. Risk management helps in identifying potential threats, analysing their impact, and implementing mitigation strategies to minimize their effects.

Despite the growing importance of risk management, many construction projects still face recurring problems such as delays, cost overruns, and design changes. This highlights the need for a systematic approach to identify, analyze, and prioritize risks.



The main objective of this study is to assess and manage risks in high-rise construction projects using a structured approach involving literature review, case studies, and questionnaire analysis. The study also aims to develop a practical risk management framework to improve project performance and decision-making.

II. METHODOLOGY



The present study adopts a systematic and structured methodology to assess and manage risks in high-rise building construction projects. The research framework consists of risk identification, case study analysis, questionnaire survey, and statistical data analysis.

Initially, an extensive literature review was conducted to identify major risk factors affecting construction projects. Previous studies confirm that questionnaire-based approaches combined with statistical tools such as Cronbach's Alpha and Risk Severity Index (RSI) are effective for construction risk assessment (Tripathi & Mittal, 2025; Wuni, 2025). Based on the literature and expert insights, a total of 33 risk factors were identified.

To validate the practical relevance of these risks, two high-rise construction projects located in Rajkot were selected for case study analysis. Interviews were conducted with experienced site engineers to understand real-time challenges and critical risks faced during project execution.

Based on the findings, the identified risks were classified into five major categories:

1. Financial Risks:

Cost overruns due to inaccurate estimates, delay in payments, increase in material prices, contractor cash flow issues, inflation and taxation changes, low or delayed sales, and cost increase due to design changes.

2. Technical Risks:

Material availability issues, frequent design changes, poor workmanship, faulty structural design, equipment breakdown, site condition problems, inadequate supervision, poor coordination, lack of skilled labor, and lack of project management.



3. Environmental Risks:

Adverse weather conditions, drainage issues, pollution complaints, delay in environmental approvals, improper waste management, and heat impact on labor productivity.

4. Safety Risks:

Lack of safety planning, inadequate training, non-use of PPE, working-at-height failures, fire hazards, and communication barriers.

5. Regulatory & Legal Risks:

Delay in approvals, delay in fire NOC, regulatory changes, and contract disputes.

A structured questionnaire was developed incorporating all 33 risk factors. The questionnaire was designed using a 5-point Likert scale ranging from 1 (very low) to 5 (very high) to evaluate the severity of each risk. The survey was conducted among 62 professionals including contractors, builders, engineers, and academicians to ensure diverse and reliable responses.

The collected data were analysed using statistical tools. Reliability analysis was performed using Cronbach’s Alpha, which yielded a value of 0.899, indicating excellent internal consistency of the data, consistent with similar studies in construction risk assessment.

For prioritization of risks, the Risk Severity Index (RSI) method was used. RSI is widely adopted in construction research to rank risks based on their relative importance. The RSI was calculated using the following formula:

$$RSI = \frac{(\sum W)}{(A \times N)}$$

Where,

W = weight assigned to each risk (1–5),

A = highest weight (5),

N = total number of respondents.

Table 1 RSI Interpretation Scale

RSI Range (%)	Interpretation
80–100%	Very High Risk
60–79%	High Risk
40–59%	Moderate Risk
20–39%	Low Risk
Below 20%	Very Low Risk

Since mean values were computed, RSI was simplified using average scores for each risk factor. Based on RSI values, risks were ranked to identify the most critical factors affecting project performance after that for top-5 risk based on the analysis and findings, a practical risk management framework was developed.

III. RESULT

The results show that most of the identified risks fall within high to very high severity levels, emphasizing the importance of systematic risk management in high-rise construction projects.

The top five critical risks based on RSI ranking are:

1. Frequent design changes during execution (RSI = 88.06%)
2. Contract disputes and arbitration delays (RSI = 86.78%)



3. Inadequate site supervision and monitoring (RSI = 85.80%)
4. Faulty structural design and calculation errors (RSI = 85.80%)
5. Cost increases due to design variations (RSI = 85.48%)

The findings indicate that technical and design-related risks are the most dominant. Frequent design changes significantly affect project cost, time, and quality, often resulting in rework and inefficiencies. Financial risks such as cost overruns and payment delays are closely associated with these technical issues.

Regulatory risks, particularly contract disputes, were identified as major contributors to delays due to unclear contract clauses and poor documentation. Safety risks showed moderate to high severity, while environmental risks were comparatively lower but still relevant.

Validation of Results

The validation of the study was carried out through reliability analysis and comparison with real-world case studies. The high Cronbach's Alpha value (0.899) confirms the consistency and dependability of the collected data. Furthermore, the alignment between questionnaire results and case study observations strengthens the validity of the findings.

Additionally, the identified critical risks and their rankings are consistent with previous research studies, which highlight design issues, contract management problems, and supervision deficiencies as major risk factors in high-rise construction projects. This agreement with existing literature further validates the study outcomes.

Risk Mitigation Strategies

Based on the identified critical risks, the following mitigation strategies are proposed:

Frequent design changes can be minimized by finalizing designs at the initial stage through proper planning and stakeholder coordination. The adoption of Building Information Modelling (BIM) helps in improving design accuracy and coordination.

Contract disputes can be reduced by preparing clear and detailed contract documents, defining roles and responsibilities, and implementing effective dispute resolution mechanisms.

Inadequate site supervision can be addressed by appointing experienced personnel, implementing strict monitoring systems, and ensuring effective communication among project teams.

Faulty structural design risks can be mitigated through proper design checks, peer reviews, adherence to standards, and use of advanced design software.

Cost escalation due to design variation can be controlled through proper cost estimation, strict change management practices, and minimizing unnecessary modifications during execution.

Overall project risk can be reduced by improving planning, enhancing coordination, adopting modern technologies like BIM, and ensuring proper safety practices and training.

The implementation of these mitigation strategies can significantly improve project performance in terms of cost, time, quality, and safety.

IV. CONCLUSION

The present study assessed and managed risks in high-rise building construction projects using a structured approach involving literature review, questionnaire survey, and case study analysis. A total of 33 risk factors were identified and analyzed using the Risk Severity Index (RSI) method. The results revealed that technical and design-related risks are the most critical, with frequent design changes, contract disputes, inadequate supervision, faulty structural design, and cost escalation emerging as major challenges. The reliability of the data was confirmed by a Cronbach's Alpha value of 0.899, and validation through case studies demonstrated strong agreement with real-world construction practices.



The study concludes that ineffective planning, poor coordination, and weak management practices are the primary causes of risks affecting cost, time, quality, and safety. To address these issues, key mitigation strategies such as design finalization, adoption of BIM, improved contract management, and effective site supervision are recommended. Implementation of these measures can significantly enhance project performance and reduce uncertainties. Future research can focus on integrating advanced technologies such as artificial intelligence, real-time risk monitoring systems, and digital project management tools to further improve risk prediction and control in high-rise construction projects.

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