

Qualitative Risk Evaluation Framework and Exploration of Risk Factors for Residential Building Construction Project

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Abstract: *The construction industry inherently involves numerous uncertainties that pose significant risks to project performance, profitability, quality, and productivity. Eliminating all potential risks is neither feasible nor economical; therefore, identifying and prioritizing the most impactful risks is essential. Effective risk management plays a vital role in all stages of a construction project, from planning to completion. This study concentrates on qualitative risk assessment in residential building construction. A detailed literature review was undertaken to identify the most common risk factors associated with residential projects. Based on the collected data, the study applies a qualitative risk analysis framework supported by a probability–impact matrix to evaluate and categorize risks according to their likelihood and potential effect. The findings aim to enhance the understanding of risk prioritization and provide practical recommendations to strengthen risk management practices within residential construction projects.*

Keywords: Risk Management; Qualitative Risk Analysis; Probability–Impact Matrix; Residential Construction; Risk Evaluation Framework; Data Collection; Questionnaire Design

1. Introduction

1.1 Understanding Risk

Risk can be described as an uncertain event or condition that, if it occurs, may positively or negatively influence project objectives. Such uncertainties are inherent in every project, ranging from minor disruptions to major setbacks that can impact cost, time, or quality. Examples of risks include theft, natural calamities such as earthquakes, injuries at the site, or design errors. These risks may lead to financial losses, damage to reputation, or even the suspension of project operations if not properly addressed.

1.2 Concept of Risk Management

Risk management refers to the systematic process of identifying, analyzing, and responding to potential risks that may affect a project's outcomes. The process involves evaluating possible threats, assessing their likelihood and severity, and implementing strategies to mitigate or eliminate their adverse effects. Effective risk management helps organizations anticipate potential challenges and ensures project success through proactive planning and informed decision-making.

1.3 Importance of Risk Management in Construction

In the construction sector, risk management is particularly crucial due to the industry's dynamic and uncertain nature. Construction projects often involve multiple stakeholders, complex designs, changing market conditions, and external environmental factors. Although implementing risk management may increase initial project costs, its long-term benefits—such as reduced losses, improved safety, and better project control—far outweigh the expenses. Conducting a thorough risk analysis at the project's planning stage can significantly minimize financial and operational risks later on.

1.4 Risk Management in Residential Building Projects

The housing and residential construction sector in India is growing rapidly, driven by urbanization and infrastructure development. However, this sector also faces numerous challenges, including cost overruns, labor shortages, regulatory delays, and environmental uncertainties. Hence, systematic risk identification and analysis are essential to enhance project performance and sustainability. Understanding and managing these risks can help developers ensure timely completion, maintain quality standards, and optimize project profitability.

2. Literature Review

Extensive research has been conducted worldwide on the topic of risk management and analysis in construction projects. This section presents a concise review of selected studies relevant to qualitative risk assessment and residential construction.

2.1 Qualitative Risk Analysis in Construction Projects

Jameelahammad Nadaf et al. (2008) explored the various categories of risks encountered in construction projects and analyzed their probability and impact using qualitative techniques. Their research employed structured questionnaires distributed to contractors and consultants to identify high-priority risks. The study highlighted the importance of prioritizing risks through probability–impact and urgency matrices, emphasizing proactive management of high-risk areas.

2.2 Risk Management in Housing Projects

Vyas Nipul D. and Jitendrasinh D. Raol conducted a study focusing on risk management practices within housing projects. Through literature reviews, interviews, and data

collected from construction sites, they identified key risks such as cost overruns, time delays, and quality issues. The research employed a risk matrix to analyze these risks qualitatively and recommended systematic procedures for mitigation and monitoring.

2.3 Combined Qualitative and Quantitative Risk Approaches

Korombel and Tworek (2015) examined risk analysis methodologies in investment projects, emphasizing the integration of qualitative and quantitative techniques. Their study concluded that the choice of method depends on project type, data availability, and scope. They stressed that qualitative analysis provides flexibility for early-stage assessments, while quantitative methods offer precision for detailed evaluations.

2.4 Risks in Housing and Real Estate Construction Projects

Madhav Prasad Koirala conducted a study in Nepal to identify and rank risks associated with housing and real estate construction projects. Using expert validation, literature review, and questionnaire-based data collection, the research identified financial instability, labor shortages, and environmental challenges as major risk categories. The results underscored the value of professional experience and expert input in improving the accuracy of risk evaluation.

2.5 Risk Management in Residential Construction

Johan Bonander and Hampus Ulriksson, in their master's thesis, investigated risk management practices in a Swedish construction company involved in both residential development and building execution. Their findings revealed that the effectiveness of risk management heavily relies on the personal expertise and experience of project stakeholders. The study proposed a four-step process—risk identification, assessment, mitigation, and monitoring—to improve coordination and accountability.

2.6 Qualitative Risk Assessment in Construction Industry

Vladimir Burkov et al. analyzed qualitative and quantitative risk management practices within Russian construction companies. The research provided an overview of algorithmic approaches used to address complex risks in the sector. It also highlighted the importance of combining expert knowledge with structured analytical models to enhance decision-making accuracy.

2.7 Comprehensive Review on Construction Project Risk Analysis

Ermias Tesfaye et al. (2018) presented a detailed review of the evolution of risk assessment tools and techniques used in construction projects over the past two decades. Their study indicated that statistical methods and fuzzy expert systems have been the most widely adopted approaches in modern risk analysis.

2.8 Case Study: Risk Assessment in Residential Projects

Prof. Mohan M. Dusane and Prof. Pankaj P. Bhangale conducted a case study on the Metrozone Project in Nashik, India. Their research aimed to identify, prioritize, and analyze project-specific risks using both qualitative and quantitative methods. They ranked the risks based on criticality scores and developed a questionnaire comprising 15 key risk parameters. The results provided actionable insights for improving project management practices in the Indian residential construction sector.

Summary of Literature Findings

From the reviewed studies, it is evident that risk management is indispensable for the success of construction projects. Most researchers emphasize qualitative risk analysis as a practical and effective tool, particularly in residential construction, where uncertainties are frequent but manageable. The use of structured methods such as the Probability–Impact Matrix and expert-based assessments helps decision-makers allocate resources more efficiently and reduce project vulnerabilities.

3. Objective of the Study

Based on a comprehensive literature review and the real-world challenges observed in residential building construction, the following objectives were formulated for this research:

- To identify potential risk factors that may arise during the construction phase of residential projects.
- To classify these risks according to their probability and impact levels—ranging from *very high* to *very low*.
- To perform a qualitative risk assessment to determine the most critical risks that influence project success.
- To develop a structured framework that assists project managers in prioritizing and addressing these risks effectively.

4. Methodology & Framework

The study adopts a systematic qualitative research approach, incorporating data collection, risk identification, and analysis through a Probability–Impact (P–I) Matrix. The overall process is designed to provide a clear understanding of the risk environment in residential construction projects.

4.1 Risk Identification

Risk identification is a continuous and iterative process that evolves as the project progresses. It involves contributions from multiple stakeholders, including project managers, engineers, contractors, and clients.

Depending on the project maturity level, five stages of risk identification can be outlined:

- Level 1: Informal discussions and brainstorming sessions among project members to suggest possible risks.
- Level 2: Structured reviews focusing on cost, scope, and schedule, supported by stakeholder feedback and lessons from previous projects.
- Level 3: Formal documentation using historical risk

databases and past project reports.

- Level 4: Organization-wide sharing of risk knowledge and best practices.
- Level 5: Continuous improvement through monitoring, feedback, and updating of the risk management process.

Key risks commonly associated with residential building construction include:

- Financial risks
- Environmental risks
- Labor-related risks
- Force majeure risks (e.g., natural disasters)
- Material supply risks
- Design and management-related risks
- Legal and regulatory risks

4.2 Questionnaire Design

To collect primary data, structured questionnaires were developed based on identified risks and previous industry experiences. Two types of questionnaires were utilized:

- 1) General questionnaire – applicable to all types of construction projects.
- 2) Project-specific questionnaire – customized for residential projects with detailed and context-based questions.

These questionnaires were distributed among engineers, contractors, and project managers to obtain expert input for the analysis.

4.3 Data Collection Methods

The study employed both qualitative and participatory data collection techniques to ensure accuracy and reliability:

- 1) Interviews: Conducted with project professionals either individually (one-to-one) or in groups (many-to-one). This allowed the collection of diverse perspectives on potential risks.
- 2) Brainstorming Sessions: Group discussions were organized to generate ideas for identifying and prioritizing risks. During these sessions, participants freely contributed without criticism, encouraging a wide range of insights.
- 3) Delphi Technique: This iterative method involved multiple rounds of expert consultations. Experts provided their opinions through questionnaires, and after reviewing others' responses, they refined their judgments until a consensus was reached.
- 4) SWOT Analysis: Strengths, Weaknesses, Opportunities, and Threats were analyzed to identify both internal and external risk factors.
 - *Strengths* and *Opportunities* represent positive risks that can benefit the project.
 - *Weaknesses* and *Threats* represent negative risks that can hinder progress.

The SWOT outcomes were used to formulate strategies that leverage strengths to mitigate weaknesses and convert opportunities to minimize threats.

4.4 Risk Register Development

A Risk Register was created to systematically record all

identified risks throughout the project lifecycle—from initiation to completion. Each entry in the register includes:

- A brief description of the risk
- The probability of occurrence
- The potential impact on cost, time, and quality
- The responsible person for managing the risk
- Actions taken and status updates

The register is regularly updated to reflect new risks or the resolution of existing ones. Once the project concludes, the finalized risk register is added to the organization's knowledge base for future reference.

4.5 Qualitative Risk Analysis and the Probability–Impact Matrix

Qualitative risk analysis involves assessing how likely each risk is to occur and how severely it could impact the project. This method relies on expert evaluation rather than precise numerical data.

Risks are rated on a five-point scale for both probability and impact:

Scale	Probability	Impact Description
1	Rare	Very Low
2	Occasional	Low
3	Somewhat Frequent	Moderate
4	Frequent	High
5	Very Frequent	Very High

After assigning probability and impact ratings, the results are plotted on a matrix to visualize the overall severity.

Risk Classification Based on Score:

- High Risk (Red Zone, 15–25): Requires immediate mitigation actions.
- Medium Risk (Yellow Zone, 5–14): Needs close monitoring and further analysis.
- Low Risk (Green Zone, 1–4): Can be accepted or periodically reviewed.

This structured approach enables project managers to prioritize risks efficiently and allocate resources to areas that demand the most attention.

5. Conclusion

Risk plays a decisive role in determining the success or failure of construction projects. It directly affects key project parameters such as cost, time, scope, and quality. Effective risk management, therefore, becomes essential to ensure that potential threats are anticipated, assessed, and mitigated before they impact project outcomes.

The present study has explored various aspects of qualitative risk analysis in residential construction projects. Through a detailed review of literature, it was found that residential projects—though relatively less complex than large-scale infrastructure works—still face multiple uncertainties that require systematic management.

The study emphasizes that a structured qualitative risk assessment framework, supported by techniques such as Root Cause Analysis, SWOT Analysis, and the Probability–Impact

Matrix, provides project teams with an effective way to classify and prioritize risks. Among these, the Probability–Impact Matrix has proven to be a particularly practical and adaptable tool for the housing sector.

The findings suggest that while risk management initially adds to project costs, it substantially enhances long-term performance by minimizing losses, avoiding delays, and improving decision-making. Moreover, developing a comprehensive Risk Register ensures that valuable insights and experiences from one project can be utilized in future endeavors.

Overall, the study concludes that integrating qualitative risk analysis into residential construction projects not only strengthens project planning and control but also fosters a culture of continuous learning and proactive management within the construction industry.

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