



Review on evaluation of construction project risks and their effects on time and cost performance in kolhapur

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World Journal of Advanced Engineering Technology and Sciences, 2026, 20(01), 261–269

Publication history: Received on 05 May 2026; revised on 21 July 2026; accepted on 24 July 2026

Article DOI: <https://doi.org/10.30574/wjaets.2026.20.1.0310>

Abstract

Construction projects are inherently complex and uncertain due to the involvement of multiple stakeholders, dynamic site conditions, financial constraints, and technical challenges. These uncertainties expose projects to various risks that may adversely affect cost, time, quality, safety, and overall project performance. Risk analysis plays a crucial role in identifying, assessing, and mitigating such risks to improve decision-making and project success. This review paper presents a comprehensive analysis of risk management concepts in construction projects, focusing on risk identification techniques, qualitative and quantitative risk analysis methods, and commonly encountered risks across different project phases. The study also reviews recent literature on risk analysis models, tools, and methodologies adopted in construction project management. Finally, gaps in existing research and future research directions are discussed to enhance the effectiveness of risk analysis practices in the construction industry.

Keywords: Construction projects; Risk analysis; Risk management; Project management; Uncertainty

1. Introduction

The construction industry is one of the most risk-prone sectors due to its fragmented nature, large capital investment, long project duration, and dependence on external factors such as weather, market conditions, and regulatory frameworks. Unlike manufacturing industries, construction projects are unique, site-specific, and temporary, which increases uncertainty and exposure to risks.

Risk in construction projects can be defined as the probability of occurrence of an uncertain event or condition that, if it occurs, has a positive or negative impact on project objectives. Risk analysis is a systematic process of identifying and evaluating potential risks to assess their likelihood and consequences. Effective risk analysis enables project stakeholders to anticipate problems, allocate resources efficiently, and take preventive or corrective actions.

In recent years, the increasing complexity of construction projects and frequent occurrences of project delays and cost overruns have emphasized the need for structured risk analysis frameworks. This review paper aims to examine existing research on risk analysis in construction projects and summarize the key findings, methodologies, and challenges. [4]

1.1. Risk in Construction Projects

Risk in construction projects is commonly defined as an uncertain event or condition that, if it occurs, may have a positive or negative effect on project objectives. However, most construction-related studies focus on the negative impacts of risk, such as losses in cost, time, and quality.

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Risk consists of two key components:

- Probability of occurrence
- Magnitude of impact
- A risk with high probability and high impact is considered critical and requires immediate attention. [7]

Risk in construction projects arises due to uncertainty and lack of complete control over project variables. These risks may originate from technical, financial, managerial, environmental, or external sources. Construction risks can be broadly categorized as:

- **Internal risks:** Related to project organization, design errors, resource availability, and construction methods.
- **External risks:** Associated with economic fluctuations, political instability, regulatory changes, and natural hazards.

The impact of risks can be measured in terms of time delays, cost overruns, quality issues, safety incidents, and disputes among stakeholders. Hence, proactive risk analysis is essential for improving project reliability and sustainability.

1.2. Classification of Risks in Construction Projects

Construction risks can be classified based on their source, nature, and project phase.

1.2.1. Internal Risks

Internal risks originate within the project organization and are generally controllable to some extent. These include:

- Design errors and omissions
- Poor project planning and scheduling
- Inadequate site management
- Low labor productivity
- Equipment breakdowns
- Financial mismanagement

1.2.2. External Risks

External risks arise from factors beyond the direct control of project stakeholders, such as:

- Inflation and market fluctuations
- Changes in government policies and regulations
- Environmental and climatic conditions
- Political instability
- Force majeure events (earthquakes, floods, pandemics)

1.2.3. Project Phase-Based Risks

- **Pre-construction phase:** feasibility risks, land acquisition issues, regulatory approvals
- **Construction phase:** material shortages, labor issues, safety hazards
- **Post-construction phase:** defects liability, operational risks, maintenance challenges. [19]

2. State Of Development

The construction industry is highly exposed to risks due to its complex nature, involvement of multiple stakeholders, uncertain site conditions, and long project durations. Effective risk analysis is therefore essential to minimize cost overruns, schedule delays, quality issues, and safety hazards. Over the years, several researchers have studied construction risks and proposed various qualitative and quantitative risk analysis techniques to improve project performance.

Existing literature shows a gradual shift from experience-based risk handling to structured risk identification and assessment methods, including probability-impact analysis, simulation techniques, and data-driven approaches. However, despite the availability of advanced tools, the practical implementation of risk analysis in construction

projects remains limited. This literature review examines previous studies to understand major construction risks, commonly used risk analysis methods, and existing research gaps, which form the basis for the present study.

Table 4 State of Development

Sr. No.	Author Name	Year	Findings
1	Amita Pawar et al.	2017	Identified gaps and inconsistencies in construction risk knowledge through a questionnaire survey of general contractors in Pune. The study revealed that construction risks mainly affect cost, time, and quality objectives. It concluded that although risk management is essential for minimizing losses and improving profitability, formal risk analysis techniques are rarely used due to lack of awareness and doubts regarding their suitability. [1]
2	Prof. A. A. Talukhaba, J. Okumbe	—	Investigated risk identification and assessment practices among indigenous and multinational construction companies. Brainstorming and documentation review were the most common identification methods. Indigenous firms used probability-based assessment and risk transfer strategies, whereas multinational firms adopted probability-impact matrices and risk reduction strategies, highlighting differences in organizational risk maturity. [2]
3	Pawel Szymanski	2017	Focused on identification and classification of construction risks across project stages. The study emphasized that risk is inherent in all construction activities and affects all stakeholders. Early identification and estimation of risk probability were found to be crucial for effective risk management and for converting risk awareness into tangible project benefits. [3]
4	Agnieszka Dziadoz, Mariusz Rejment	2015	Defined risk as the measurable part of uncertainty characterized by probability and magnitude of loss. The paper presented three risk analysis methods and discussed their advantages, limitations, and application at the pre-estimation stage. It highlighted the use of qualitative variables and emphasized that method selection depends heavily on the decision-maker and project characteristics. [4]
5	Jameelahammad Nadaf et al.	2018	Examined the importance and impact of various risks in construction projects and proposed qualitative risk analysis for risk identification and assessment. Data were collected using questionnaire surveys from contractors, consultants, and clients. The study concluded that systematic risk identification is essential for achieving project objectives. [5]
6	Chaitali S. Pawar et al.	—	Studied risks arising from contract conditions and specifications in construction projects. The qualitative risk analysis method was used to assess risk severity. The study concluded that effective identification, classification, and control of major risks are critical to minimizing cost and time overruns and improving overall project performance. [6]
7	Borysowich	2008	Highlighted that construction risks are non-linear and interdependent, making traditional linear assessment ineffective. The study emphasized the use of simulation tools to model multiple risk scenarios and interdependencies. It concluded that understanding cumulative risk impact is essential for selecting appropriate risk retention and treatment strategies. [7]
8	Alfredo Federico et al.	2014	Emphasized that risk management is a key responsibility of project managers and is ineffective if not implemented from the early project stages. The study concluded that systematic risk management requires structured methodologies combined with professional knowledge and experience for successful project delivery. [8]

9	T. H. Nguyen, G. Bhagavatulya, F. Jacobs	—	Identified that some risks, such as contractor bankruptcy, have low probability but high impact. The study highlighted the critical role of designers, noting that incomplete or improper designs significantly affect cost and schedule. It also revealed poor communication among project stakeholders as a major weakness in risk response strategies. [9]
10	Boateng, Chen & Ogunlana	2019	Analyzed risk factors affecting construction projects using questionnaire surveys and statistical ranking methods. The study identified financial risks, poor planning, and communication gaps as major contributors to cost overruns and delays. [10]
11	Marzouk, El-Dokhmasey & El-Said	2019	Developed a quantitative risk assessment model integrating Monte Carlo simulation to evaluate schedule and cost risks. The results demonstrated improved prediction accuracy compared to deterministic planning approaches. [11]
12	Zhang, Chen & Li	2020	Proposed a BIM-based risk analysis framework to identify and assess construction risks at early project stages. The study showed that BIM integration enhances visualization and proactive risk mitigation. [12]
13	Hosny, Ibrahim & Alshboul	2020	Investigated the relationship between risk management practices and project performance. Findings indicated that projects with structured risk analysis experienced significantly fewer delays and disputes. [13]
14	Osei-Kyei & Chan	2020	Examined risk allocation and analysis in Public–Private Partnership (PPP) construction projects. The study highlighted improper risk allocation as a key reason for project inefficiencies and failures. [14]
15	Alshubbak, Pellicer & Catalá	2021	Identified critical construction risks using structural equation modeling. Results showed that managerial and financial risks have a stronger impact on project success than technical risks. [15]
16	Gunduz & Almuajebh	2021	Applied fuzzy logic and multi-criteria decision-making techniques for construction risk assessment. The study concluded that fuzzy-based models effectively handle uncertainty in expert judgment. [16]
17	Hwang, Shan & Looi	2021	Investigated risk management practices in large infrastructure projects. The findings emphasized early risk identification and continuous monitoring as essential for project success. [17]
18	Eybpoosh, Dikmen & Birgonul	2022	Proposed a dynamic risk assessment model linking evolving risks with project performance indicators. The study demonstrated that risk impacts change significantly across project phases. [18]
19	El-Sayegh, Manjikian & Ibrahim	2022	Studied risk identification and analysis in mega construction projects. Results revealed that external risks such as regulatory changes and market volatility have high impact despite low probability. [19]
20	Patil & Molenaar	2022	Evaluated the effectiveness of qualitative and quantitative risk analysis methods in transportation projects. The study concluded that hybrid approaches provide better decision support. [20]
21	Olatunji, Sher & Gu	2023	Integrated machine learning techniques for predicting construction project risks. The study showed improved accuracy in forecasting delays compared to traditional risk analysis methods. [21]
22	Zhao, Hwang & Yu	2023	Analyzed safety-related risks using data-driven models. The results indicated that proactive risk analysis significantly reduces accident frequency on construction sites. [22]
23	Aladag, Isik & Guneri	2023	Developed a risk prioritization model using hybrid MCDM techniques. The study found that time and cost risks consistently rank higher across different project types. [23]

24	Sanni-Anibire, Mahmoud & Hassanain	2024	Conducted a comprehensive review of construction risk analysis techniques and highlighted emerging trends such as BIM, AI, and real-time risk monitoring systems. [24]
25	Paul, Khatri & Singh	2024	Proposed an AI-based risk assessment framework for construction projects. The study confirmed that machine learning models improve risk prediction accuracy and support proactive decision-making. [25]

2.1. Gap Identification

- Most previous studies focus only on identifying risk factors, with limited emphasis on comprehensive risk analysis.
- Existing literature often addresses specific project types or regions, limiting the applicability of results.
- Many studies rely mainly on qualitative methods, leading to subjective risk assessment.
- Limited use of quantitative and integrated risk analysis techniques in construction projects.
- Risks are generally treated as independent, ignoring their interrelated and dynamic nature.
- Insufficient consideration of risk variation across different project phases.
- Lack of practical frameworks linking risk analysis results to mitigation and decision-making.
- Limited studies addressing combined financial, managerial, technical, safety, environmental, and external risks together.
- Absence of standardized methods for risk prioritization.
- Inadequate focus on region-specific risks, especially in developing countries

3. Review of Experimental Studies

Experimental studies in construction risk analysis primarily focus on validating risk identification frameworks, testing risk assessment models, and evaluating the effectiveness of qualitative and quantitative risk analysis techniques through real project data, case studies, surveys, simulations, and pilot implementations. Unlike purely conceptual studies, experimental research provides practical insights into how risk analysis methods perform under actual construction project conditions. [17]

Several experimental studies have employed questionnaire surveys as the primary data collection tool to identify and assess construction risks. These studies typically involve contractors, consultants, clients, and project managers as respondents. The collected data are analyzed using statistical techniques such as mean ranking, relative importance index (RII), frequency analysis, and probability–impact scoring. [11] [6] [7]

3.1. Challenges of Risk Analysis in Construction Projects

Risk analysis in construction projects faces several challenges due to the diverse nature of project activities, involvement of multiple stakeholders, and dynamic external conditions. These challenges can be broadly categorized into financial, managerial, technical, and external risk groups. [3] [7]

Table 3 Challenges of Risk Analysis [3] [4] [6] [7] [11] [15] [17] [20] [25]

Sr. No	Group	Challenges of Risk Analysis
1	Financial Risks	Incorrect / unrealistic cost estimation
2		Escalation in material prices
3		Delay in payments by client
4		Poor cash flow management
5		Economic inflation & market changes
6		Contractor's poor financial capability
7		Hidden / contingency cost failure
8		Insurance & bond-related issues

1	Managerial Risks	Ineffective planning & scheduling
2		Poor coordination among stakeholders
3		Lack of leadership & management skills
4		Decision-making delays
5		Poor contract administration
6		Lack of stakeholder communication
7		Lack of risk management culture
1	Administrative / Documentation Risks	Poor documentation & record keeping
2		Improper site administration
3		Delayed approval of work processes
4		Inadequate reporting and monitoring
5		Lack of systematic procedures
1	Design & Engineering Risks	Frequent scope/design changes
2		Design errors & omissions
3		Incomplete working drawings
4		Inadequate structural detailing
5		Delay in design approval
6		Lack of BIM / Digital design tools
1	Technical Risks	Improper construction methods
2		Equipment breakdown & downtime
3		Lack of technical expertise
4		Poor selection of construction technology
5		Incorrect interpretation of design
6		Inadequate geotechnical investigation
1	Quality Risks	Low-quality material supply
2		Failure in quality inspections
3		Rework due to poor workmanship
4		Lack of quality testing & QC checks
5		Supplier non-compliance with standards
6		Lack of trained quality personnel
1	Labour & Human Resource Risks	Skilled labour shortage
2		Low worker productivity
3		Labour strikes & disputes
4		High absenteeism & labour turnover
5		Language & communication barriers
6		Lack of training and skill development
1	Health & Safety Risks	Unsafe working environment
2		Lack of PPE enforcement

3		Poor safety supervision
4		Accidents causing injuries/fatalities
5		Lack of safety training
1	Environmental Risks	Adverse weather & monsoon disruption
2		Natural disasters (floods, earthquakes)
3		Pollution & waste management issues
4		Environmental rule violations
5		Groundwater & soil issues
1	Legal/Regulatory Risks	Delays in permits/approvals
2		Change in government regulations
3		Court cases / legal disputes
4		Land acquisition problems
1	External / Socio-Political	Political interference
2		Local community opposition
3		Market instability
4		Logistic/supply chain delays

4. Conclusion

Based on an extensive review of previous research studies related to risk analysis in construction projects, it is evident that construction activities are exposed to a wide range of uncertainties that significantly influence project performance. The literature consistently highlights that ineffective risk analysis is one of the primary reasons for cost overruns, time delays, quality issues, safety incidents, and contractual disputes in construction projects. Researchers across different regions and project types have emphasized the need for systematic and structured risk analysis rather than reliance on experience-based judgment alone.

From the detailed review of earlier studies, various risk factors were identified and grouped under financial, managerial, administrative, design and engineering, technical, quality, labour and human resource, health and safety, environmental, legal/regulatory, and external socio-political categories. These risk factors were repeatedly reported in previous literature as critical challenges affecting construction project outcomes. Therefore, all the above-mentioned factors were carefully selected for the present study, as they represent the most significant and commonly encountered risks in construction projects.

The review also indicates that while several qualitative and quantitative risk analysis techniques have been proposed, their practical implementation remains limited, particularly in developing countries. Most studies rely on qualitative approaches such as expert judgment and questionnaire surveys due to their simplicity, whereas advanced methods require reliable data and technical expertise. Hence, there exists a clear need to assess these identified risk factors systematically to understand their relative significance and impact on construction projects.

In conclusion, the literature review provided a strong theoretical foundation for the present research and justified the selection of risk factors considered in the study. The insights obtained from previous studies guided the development of the research framework and questionnaire design, enabling a comprehensive assessment of construction project risks. The findings of this review underline the importance of structured risk analysis as a vital tool for improving project planning, decision-making, and overall project success.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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