Evaluating and Mitigating Risks in Construction Projects: A Critical Analysis

Mihir Patel. A, Jayraj Solanki[2], Darshan Shah[3] and Pareshkumar Patel[4]
[1]*Student, UV Patel College of Engineering, Ganpat University*
[2]*Head PG, Department of Civil Engineering, UV Patel College of Engineering, Ganpat University*
[3]*Assistant Professor, Department of Civil Engineering, UV Patel College of Engineering, Ganpat University*
[4]*Assistant Professor, Department of Civil Engineering, UV Patel College of Engineering, Ganpat University*

Abstract: **Construction is a complicated and vital industry, key to economic development and infrastructure growth. Construction is a diverse field with a broad range of projects, including residential and commercial buildings, as well as massive infrastructure projects like bridges, highways, and industrial facilities. Because the industry is so varied and subject to ongoing change, construction is necessarily a high-risk activity. Population increase and growing demand for infrastructure further drive the pressure for large-scale construction activities, exacerbating the problems encountered. As a result, risk identification and management became fundamental elements of contemporary project management. Risk management assists stakeholders—clients, contractors, consultants, and suppliers—in reducing adverse effects on project performance, more specifically in terms of cost, time, and quality. It entails the detection of factors that could adversely impact a project's schedule, cost, or quality, measuring their potential impact, and designing methods of mitigating such risks. This research identifies major risk factors, classifies them, evaluates their effect on project performance, and suggests a model for successful risk mitigation.**

Index Terms: **Construction Risk Management, Risk Mitigation Strategies, Project Risk Evaluation, Construction Project Performance**

I. INTRODUCTION

Construction is among the most dynamic and intricate industries in the world, contributing to the economic growth and development of infrastructure. It involves a broad spectrum of projects, ranging from residential and commercial properties to huge infrastructure projects such as roads, bridges, and factories. Because of this broad scope, the construction business itself involves frequent changes that make it a high-risk venture. With the growing population and urbanization, the need for large-scale construction work increases, putting more stringent challenges on handling risk. Thus, risk identification and assessment have evolved into an indispensable part of contemporary construction project management. Risk management is equally important to contractors, clients, consultants, and suppliers as it enables them to reduce harmful effects on the cost, time, and quality of the project. Effective risk management includes the identification of possible risk factors, determination of their effect on project goals, and the implementation of measures to avoid them. The profession seeks to eliminate harm-causing risks while seizing opportunities that can help, and thus ensure the effective completion of construction projects. Since uncertainty is a fundamental aspect in construction, handling these risks is essential to the success and survival of projects.

II. LITERATURE REVIEW

Bu Qammaz and AlMaian emphasize the need to identify and model critical success factors (CSFs) for effective risk management for construction projects, given the susceptibility of the industry to risks and the lack of CSF research concerning the construction phase, and recommend a structured model that stresses the necessity of an enabling environment to improve risk management practices and project success. [1] Baloi (2012) critically examines different risk analysis techniques—such as Probability Theory, Certainty Factors, Dempster-Shafer Theory, and Fuzzy Logic—highlighting appropriateness according to the nature of

construction project risks and promoting method choice commensurate with data quality and uncertainty type. [2] Elsaeed (2017) delves into proactive risk analysis—covering identification, assessment, and mitigation—how it can improve the performance of public construction works by closing gaps in uncertainties, better decision-making, and assuring improved cost, time, and quality. [3]Ahmet Oztas and Onder Okmen (2005) introduce the Judgmental Risk Analysis Process (JRAP), a Monte Carlo–based approach coupling subjective judgment to execute efficient risk appraisal and decision-making in uncertain construction projects. [4] Rather (2018) also reviewed the literature thoroughly to determine and assess principal construction industry risks—financial, operational, environmental, and legal—emphasizing the necessity of an integrated and proactive risk management system in order to enhance project performance and make projects sustainable. [5] Tessemaa (2022) illustrates that consistent risk management, being effective throughout every project phase, is essential to enhance project success through reduction of delays, cost escalation, and issues of quality. The research highlights the need for continuous and proactive risk evaluation to guarantee stakeholder satisfaction as well as overall project performance.Minato and Ashley (year) offer a comprehensive risk analysis model that divides projects into separate work packages and employs the beta coefficient to measure the relationship between distinct tasks and total project risk. This method supports more effective decision-making through recognizing key elements and providing focused risk mitigation in multifaceted project situations. Serpella et al. (2014) highlight the complexities of risk management in Chilean construction, promoting a systematic, knowledge-driven process to maximize efficiency and decision-making. Their suggested three-step process seeks to overcome inefficiencies by combining experience with systematic risk assessment, enhancing the outcome of projects for stakeholders.Yeung and Chan (2019) discuss the serious yet under-addressed problem of fire risks in Hong Kong construction sites through the creation of an integrated fire risk assessment model using surveys, interviews, and the Reliability Interval Method. Their research identifies the most important factors that affect fire safety and puts emphasis on the central contractor's responsibility, and introduces an adaptable framework to enhance fire risk management in all construction environments. [6]

The objective of this study is to identify the most significant risk factors that affect construction projects and classify them into distinct groups to better understand them. Based on the analysis of these risks, the study evaluates their impact on project performance in terms of cost, time, and quality. Understanding the nature and consequences of these risks allows for the development of a large framework of mitigation strategies that can be adapted to address specific construction project issues. Lastly, this research targets enhancing risk management procedures, reducing uncertainties, and project overall performance and output to more efficient and successful construction project delivery.

III. METHODOLOGY

The research approach adopted for the present study incorporated an in-depth and sequential approach to determining the practical aspects of risks in the construction industry. The study started with an intensive literature review to obtain data regarding the theoretical foundation, historical background, methodologies, and field applications of risk factor. The present study utilizes a quantitative approach to ascertain the impact of risk factors on construction projects. These data were gathered using a systematic survey questionnaire sent to professionals in the construction industry, such as project managers, engineers, and contractors. The survey questionnaire was developed from proven risk management approaches and literature, addressing the potential for and influence of different risks like financial, environmental, technical, and managerial. Purposive sampling was utilized to guarantee that the respondents possess applicable project experience. Data collected were then analyzed with Microsoft Excel using descriptive statistics and a Risk Severity Index (RSI) to determine and rank significant risks. A correlation analysis was also undertaken to investigate correlations between risk categories. Ethical standards were upheld at all stages of research, and informed consent was sought from all participants with confidentiality assured. The results are intended to enhance more effective risk mitigation measures and enhance project performance in the construction sector. To determine the results and render them practice-focused, 50 industry professionals including

engineers, contractors, and consultants were interviewed. These professionals were approached individually and questioned to understand whether such risk factor considerations are being executed in real-time industry applications. Their remarks were of crucial importance to confirm the practicability, acceptability, and effectiveness of the proposed other risk factor and risk avoid suggestion.

IV. DATA COLLECTION & DATA ANALYSIS

The process of data collection for the creation and validation of the smart construction estimating tool involved three primary components. Information based on project drawings was read through a sample building plan using AutoCAD and manual measurement using scales. Principal measurements included wall lengths, numbers of door/windows, and a reference wall height as 10 feet. All these inputs allowed the estimation of materials such as bricks, plaster, doors, and fittings. Second, material and labor prices were obtained from local hardware suppliers, construction contractors, and government-verified Schedule of Rates (SOR) to ensure realistic and market-related cost estimation. Third, a user survey was conducted from quantity surveyors, site engineers, and civil engineering students. Users were invited to use the tool and provide feedback on usability, accuracy, time saved, and areas for improvement.

For comparison, a comparative comparison was done between estimation through manual and smart tool-based approaches from the same building plan. The smart tool reduced estimation time from 1 hour to approximately 10–15 minutes, with better accuracy and ease of use. Survey feedbacks were analyzed through Excel-based graphs, which revealed that 80% of the respondents considered the tool easy to use and 75% saved significant time. The test confirmed the tool as functional and identified potential areas for improvement based on feedback from end-users.

V. RESULTS & DISCUSSION

This study focuses around important items of building construction on which risk analysis has resulted. The study compares results from real case studies with expert perceptions obtained through surveys. Certain risks of factors were assessed: Financial risk, Design Risk, safety related factors.

From the Data Analysis of the collected data from the Questionnaire Survey, the results shows that according to the majority survey result for the financial risk- Cost Overrun.

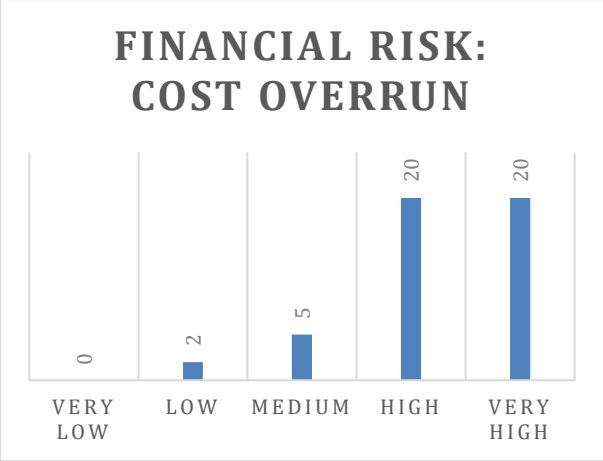

Figure 1 Financial risk: Cost overrun

From the Data Analysis of the collected data from the Questionnaire Survey, the results shows that according to the majority survey result for the financial risk- Payment postponed by clients.

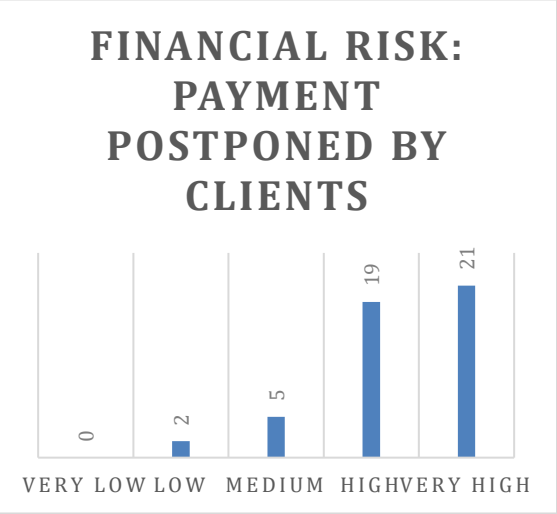

Figure 2 Financial risk: Payment postponed by clients

From the Data Analysis of the collected data from the Questionnaire Survey, the results shows that according to the majority survey result for the Design risk- Defective design.

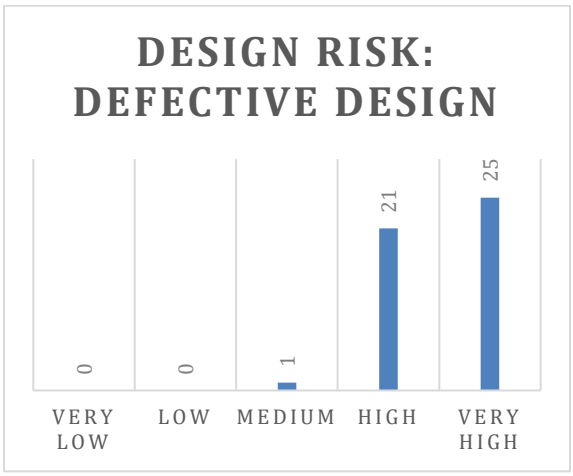

Figure 3 Design risk: Defective design

From the Data Analysis of the collected data from the Questionnaire Survey, the results shows that according to the majority survey result for the Design risk- Defective design.

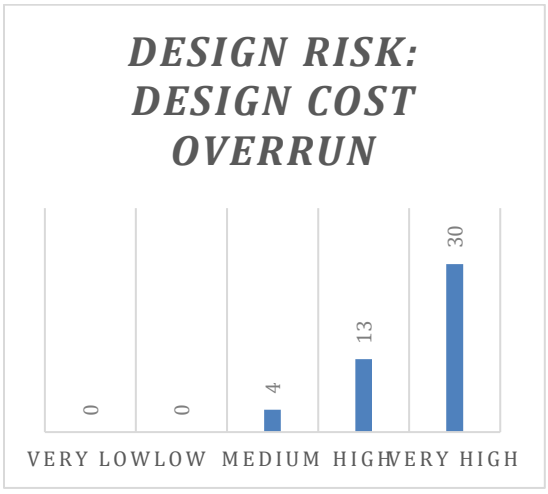

Figure 4 Design risk: Design cost overrun

From the Data Analysis of the collected data from the Questionnaire Survey, the results shows that according to the majority survey result for the safety related risk- Inadequate utilization of (PPE).

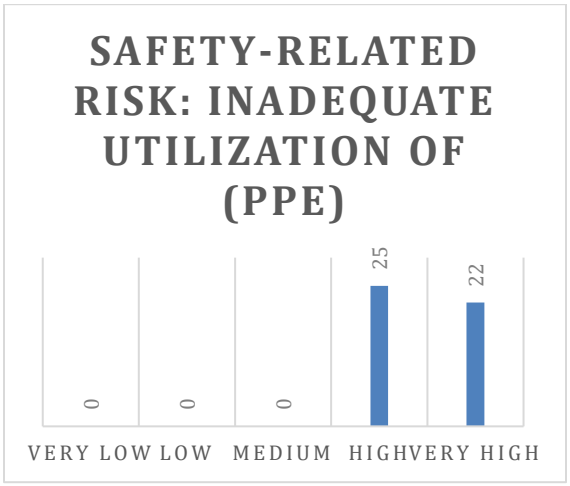

Figure 5 Safety-related risk: Inadequate utilization of (PPE)

From the Data Analysis of the collected data from the Questionnaire Survey, the results shows that according to the majority survey result for the safety related risk- Improper placing of materials.

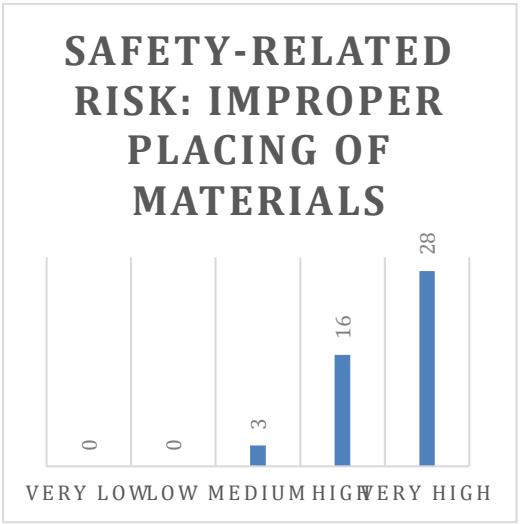

Figure 6 Safety-related risk: Improper placing of materials

VI. CONCLUSION

Based on the findings of this research, it is apparent that effective risk analysis and management are critical to ensure successful project completion in construction. The research properly identified, classified, and evaluated risks that emerge at the planning, execution, and maintenance phases of construction. By using critical evaluation of these risks, the study offers timely information about their possible impacts and has effective mitigation strategies that can be used to lower or eradicate their adverse impacts. It also revealed that some of the risks have a higher prospect of affecting construction projects. These include Design, Financial, and Safety Risks, which were considered most significant with high coefficient values of 0.94, 0.89, and 0.91, respectively. These results indicate the importance of addressing these risks with severe risk management controls since they can result in severe delays, cost escalation, and safety hazards if not effectively managed. Project Management, Plants & Equipment, and Resource Risks were further recognized to have high risk on project performance but lower than Design, Financial, and Safety Risks. It is a must that the project managers and the stakeholders realize the comparative importance of these risks and prioritize countermeasures accordingly. Finally, the study underscores the importance of an active, integrated risk management system for construction projects. The findings reemphasize the importance of their identification at an early stage and performing a full-scale analysis of them and then developing targeted strategies to contain their impact. Through the implementation of these measures, construction practitioners can enhance the project's outcome, remove persistent uncertainties, and make construction projects achieve long-term performance and sustainability.

REFERENCES

[1] A. S. B. Q. a. R. Y. AlMaian, "A critical success factors model for effective implementation of risk management process in the construction projects," *Journal of Engineering Research,* vol. 8, no. 3, pp. 50-70, September 2020.

[2] M. S. M. Elsaeed, "PERFORMANCE IMPROVEMENT FOR PUBLIC CONSTRUCTION PROJECTS USING RISK ANALYSIS," *Journal of Engineering Sciences,* vol. 45, no. 6, pp. 878-899, November 2017.

[3] O. O. Ahmet Oztas, "Judgmental risk analysis process development in construction projects," *Building & Environment Elsevier,* October 2004.

[4] G. M. U. D. Rather, "Risk Management in Construction Projects," *The International Journal of Engineering and Science (IJES),* vol. 7, no. 12, pp. 56-62, 2018.

[5] D. Baloi, "Risk Analysis Techniques in Construction Engineering Projects," *Journal of Risk Analysis and Crisis Response,* vol. 2, no. 2, June 2012.

[6] X. F. R. H. L. R. Alfredo Federico Serpellaa, "Risk management in construction projects: a knowledge-based approach," *Elsevier,* vol. 119, no. 14, 2014.

[7] V. C. M. K. a. M. S. A. Mukhammet Fakhratov, "Risk Management implementation and presenting the applicable methodology for its implementation in construction projects," *E 3S Web of Conferences,* vol. 10014, no. 20, 2020.

[8] D. W. M. C. John F. Y. Yeung, "Developing a Holistic Fire Risk Assessment Framework for Building Construction Sites in Hong Kong," *Journal of Construction Research,* vol. 01, no. 01, June 2019.