International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

A Study on Exploring and Prioritizing Critical Risks in Construction Project Assessment

Allapuram Swetha[1], M. Gopal Naik[2], Srikanth Gundurouthula[3]

[1]Research Scholar, Department of Civil Engineering, University college of Engineering (A), Osmania University, Hyderabad, Telangana, India-500007
[2]Professor, Department of Civil Engineering, University college of Engineering (A), Osmania University, Hyderabad, India -500007
[3]Research Scholar, Department of Civil Engineering, University college of Engineering(A) , Osmania University, Hyderabad, Telangana, India-500007

Abstract
According to Mc Kinsey Report (2015) large construction projects take 20% large time and 80% more budget to get finished. This highlights the importance of Risk Assessment to ensure work safety, cost management and quality construction.The aim of the study is to identify and investigate critical risks in the evaluation of construction projects by utilizing the Principal Component Analysis (PCA) and the Weighted Average Index method. The risk factors for project assessment were identified in the following domains: Budget and Cost Management Risk, Schedule and Time Management Risk, Scope and Planning Risk, Safety and Regulatory Compliance Risk, Resource Management Risk, Communication and Stakeholder Management Risk, and Environmental and Sustainability Risk, through an extensive literature review and expert interviews. A survey was distributed to building operators in Hyderabad, India. The Weighted Average Index technique was used to evaluate 180 completed responses and identify risk indicators. To find underlying patterns, Principal Component Analysis (PCA) was used to gain a better understanding of the connections between these variables. Results identified reliance on essential resources, insufficient risk assessment, cash flow restrictions, and safety issues as top considerations, with currency exchange rate swings and delayed information dissemination ranking lower but still substantial. These insights provide essential advise to stakeholders in order to successfully minimize risks and improve project results. By using systematic risk assessment and management methodologies, building projects in Hyderabad and elsewhere may handle hurdles more effectively, assuring long-term sustainability and resilience.

Keywords: Construction Risk Factor, Weighted Average Index, Principal Component Analysis.

1. Introduction

The construction sector depends a lot on project risk factors to decide how things will grow. When it comes to planning, carrying out, and finishing, municipal building projects are very difficult. These problems happen because of things like poor ways of buying things, changes in currency exchange rates, delays in moving the project forward, and higher prices for subcontractors. Critical resource dependencies, transportation delays, and bad weather all add stress to an already complicated project. Inadequate risk evaluation during the early planning phase, changes to client requests after the project has begun, and worries about safety and regulatory compliance all provide additional challenges. Furthermore, project management activities are hampered by resource management constraints, communication challenges, and environmental sustainability concerns. It is critical that players in Hyderabad's building industry prioritize resolving these risk issues. This will assist ensure that projects are completed swiftly, financially effectively, and in accordance with quality and safety standards. Ultimately, this will benefit the city's urban growth and advancement.

In addition, construction projects might be further complicated by issues such as personnel shortages, supply chain interruptions, and inadequate infrastructure, in addition to the problems stated above. The city's fast process of becoming more urbanized and the increase in population exacerbate the need for housing, commercial spaces, and infrastructure, making the strain on building activities worse. Furthermore, the presence of cultural diversity and the existence of regulatory intricacies present distinct difficulties for those involved in a project, necessitating the use of cautious navigation and adaptation tactics. In order to effectively reduce these complex risks, stakeholders must use cutting-edge technology, develop solid project management processes, and foster collaboration among all parties involved.

Since the late twentieth century, there has been extensive study into risk assessment in the construction business. **Edwards and Bowen (1998)** evaluated and analyzed construction and project risk management articles published between 1960 and 1997 in order to discover trends and focuses in research and practice. The research identifies knowledge gaps and discrepancies in the treatment of construction and project risk. The findings showed that the political, economic, financial, and cultural aspects of construction risk, as well as those related to quality assurance and occupational health and safety, require further research attention. Temporal dimensions of risk, as well as risk communication, are major research topics. **Cooper (2005)** discussed on quantitative risk evaluations for large hydropower and oil and gas projects, using unique approaches such as the Controlled Interval and Memory procedures. This resulted in new models, specialized software, and a number of articles. After leaving Southampton, he worked in finance in the UK, USA, Hong Kong, and Australia, managing a variety of risks including trading, compliance, and balance sheet risk. His key thesis was that enormously complex projects are usually too risky to manage properly, necessitating the employment of less sophisticated risk management strategies. The book is based on these simplified concepts, which were first established in the New South Wales Government Risk Management Guidelines in 1993.**Cagno et. al., (2007)** created a methodology for analyzing main risks in complex projects that consists of three detail levels and three risk categorization aspects. The approach enables the identification and classification of project significant risks, related principal sources of uncertainty, and the most exposed activities and stakeholders, resulting in the creation of a project risk map that takes into account all organizational and operational coordinates. The assessment of risk allocation for each project element has a significant impact from a managerial and contractual standpoint; in particular, it enables the identification of project elements affected by potential risk overload and the effective definition of a suitable set of mitigation actions. The model is found to beneficial at various degrees of detail, taking into consideration the stages of the project life cycle. **Abdelgawad and Fayek**

(2010) sought to enhance the practicality of Failure Mode and Effect Analysis (FMEA) by utilizing it for risk management in the construction sector. The conventional FMEA method, although often employed, has certain limitations. As a result, fuzzy logic and fuzzy Analytical Hierarchy Process (AHP) are being employed to overcome these drawbacks. The study looks at the usage of fuzzy expert systems to determine a relationship between impact (I), probability of occurrence (P), detection/control (D), and the criticality of risk occurrences. A case study demonstrates how fuzzy FMEA and fuzzy AHP may overcome the constraints of classical FMEA. The findings highlight the technique's effectiveness in assisting project management teams in implementing corrective actions as soon as possible. **Grimaldi (2012)** investigated project risk management in the context of increased market competition and project complexity. Projects are time-limited activities that result in the production of unique products or services. The difference between actual and expected quality, time, and cost performance has a significant impact on a project's success. Ineffective management of these issues is a major contributor to budget overruns, delays, and failure to reach performance objectives. This issue is especially dangerous in industries such as construction and information technology, as projects become more complex, increasing dangers. The study demonstrates that risk management and assessment are critical at all phases of the project. It distinguishes between uncertainty caused by natural changes or insufficient knowledge and project risk, which is defined as occurrences or situations that are difficult to forecast and have an impact on project objectives. **Oleg Kaplinski (2013)** provided a utility theory-based approach to risk analysis for building projects. The technique takes into account a variety of data inputs, including construction circumstances, economic aspects including supply-demand dynamics and seasonality, as well as historical data. The content includes decision-making situations, odds that depend on certain conditions, and functions that figure out how desirable or useful results are. The utility function is found by comparing a certain result to a lottery with very different outcomes. This is done to help people make decisions who tend to either avoid or prefer risk. This research looks at the financial effects of various decision-making methods and can help you come up with good risk management plans for building projects. **Rashidi Komijan(2018)** presented a methodology for measuring risk management indicators by tying them to the risk chain, with the goal of improving risk response strategies in construction projects. The model focuses on the change-formation phase, during which changes are often caused by a series of interrelated hazards. The study establishes and examines detectability and trackability indices within the established framework by analyzing manageability indicators based on risk driver observables. These measurements assist risk minimization. An actual building project is used to demonstrate the framework's ability to analyze risk scenarios and identify and mitigate risk causes. The results show that risk routes are always changing and need quick action to keep bad things from happening. For this reason, project teams need to be good at finding risk indicators so they can handle risks proactively and change how they're dealt with. **Yazdani (2019)** offered a new technique to assess risks in order to address the issue of assessing and selecting projects based on a variety of considerations. To generate the decision matrix, the fuzzy analytic network process (FANP) takes into account risk factor interdependencies as well as failure mode and effect analysis (FMEA) rates. Finally, the distance from the average solution compares projects and identifies the optimal solution. The offered technique enables project managers to evaluate and apply fuzzy linguistic values. A building case study is used to compare the proposed strategy to existing approaches in the literature. **Siraj**

(2019) investigates common risk identification tools and procedures, risk categorization methods, and common dangers in construction projects. A comprehensive evaluation and extensive content analysis of 130 chosen publications from reputable and relevant academic journals published over the previous three decades was carried out. The results of the content analysis revealed that the majority of the selected articles identified risks for construction projects—primarily infrastructure projects—in Asia and Europe, and in most cases, the identified risks were either classified based on their nature or listed without classification. In the chosen publications, information-gathering methods were mostly employed to identify hazards, whereas diagramming and analysis were seldom used. Inflation, design flaws, and government rules, regulations, and policies impacting the project were the biggest dangers. The publication offers scholars and industry practitioners with data on the most prevalent construction project hazards and overcomes the lack of a systematic evaluation and content analysis of risk identification papers. **Wuliyanto et. al., (2024)** aim to improve cost and time performance in tunnel building projects by better risk management. The authors used a three-stage approach: first, they identified the most influential factors using Dynamic Modeling and assessed risk manageability with SPSS; second, they built risk management models using System Dynamics methodology; and finally, they ran simulations and scenarios based on questionnaire results to identify the best strategies for mitigating potential impacts. The findings demonstrated that Dynamic Modeling improved risk factor identification and analysis while also reducing cost and time delays. Early risk factor identification enables proactive steps to limit their negative implications, hence increasing project success. **Ezatollah Abbasiana et. al., (2024)** examined the qualitative and quantitative risk assessment of joint oil field projects, concentrating on Iran's energy diplomacy and its 28 Middle Eastern oil and gas fields. A production sharing deal for the Sepehr and Jafir oil fields and an oil contract for the North Azadegan field buyback are compared using a risk assessment matrix and projected monetary value analysis. Despite political concerns, the production sharing agreement offers the lowest investment risk for National Oil, with an estimated value of $7.228 billion. The study demonstrates that political stability increases oil facility investment, as major oil companies invest in Iraqi oil fields. **Priyanto, Budi et. al., (2024)** evaluate and assess the risks involved with a house development project to guarantee effective risk management and project success. The risk factors were identified and evaluated using a standardized survey questionnaire. The study used SPSS 26.0 software and mean score statistics. The risks were evaluated according to how often and how bad the incidents were that people reported. Projects to construct homes in Sukoharjo Regency were determined to be fraught with 31 critical risk concerns. There were three identified areas of high risk: inaccurate cost estimates, a lack of backup plans for unforeseen expenses, and inadequate funding for the project. Furthermore, nine indications were classified as intermediate risk. Having a thorough awareness of the degrees of risk associated with each aspect allows for the creation and execution of more effective project risk management techniques. **Aslam, M., & Baffoe-Twum, E. (2024)** investigated the critical element of risk management in the building of pre-stressed girder bridges, intending to assess, analyze, and provide mitigation measures for causes leading to delays and schedule overruns. Through a literature study and stakeholder interviews in Pakistan, it emphasizes the need of activity-specific risk assessments. Based on the findings, it is clear that the vast majority of the identified risks, precisely 74%, can be successfully controlled. Furthermore, 17% of the risks are recommended to be transferred, while 9% should be kept without any mitigating measures. The study validates earlier research findings and identifies new hazards, emphasizing considerable differences in the amount of risk associated with various project activities. Piling is considered the most dangerous activity, whereas girder installation is seen to be the least dangerous. The study finishes with risk-mitigation principles, which provide useful insights into effective risk management in bridge construction projects.

Improving upon previous studies, the current study aims to evaluate and assess the most important risk characteristics in construction projects in order to reduce possible dangers. To realize this aim the study is carried out to fulfill the two objectives. The first objective involves identifying project assessment risk factors through the utilization of the Weighted Average Index method. The second goal is to analyze these risk variables using Principal Component Analysis. The research aims to enhance the identification of main hazards connected with building projects.

2. Methodology

In this research, the study delves into estimating the relative Project Assessment Index in the construction industry. This index was developed in a series of processes, each of which contributed to its usefulness. The study identifies Project Assessment Risk Factors by a thorough examination of previous literature and interviews with field specialists. This stage guarantees that the ensuing analysis takes into account all important aspects. The study prioritizes the Project Assessment Index using the Weighted Average Index method. For this, the study considers 80 questions segmented into various project assessment risk factors, namely Quality Risk, Budget and Cost Management Risk, Schedule and Time Management Risk, Scope and Planning Risk, Safety and Regulatory Compliance Risk, Resource Management Risk, Communication and Stakeholder Management Risk, and Environmental and Sustainability Risk, based on previous reviews by Edmundas et al. (2010), Ahmed (2019), Srinivasan & Venkatesh (2020), and Ahmad Zuhdi et al. (2022). To collect replies, stakeholders who are directly involved in construction activities were chosen because they can provide valuable insights into various aspects of the project, including planning, scheduling, quality control, and risk management. The respondents included site supervisors, site engineers, project managers, architects and designers, contractors and subcontractors, material suppliers and vendors, inspectors and regulators, and owners and clients. The primary data was collected from various construction segments, namely residential, commercial, industrial, infrastructure, institutional, environmental, high-rise, government, and healthcare construction. A well-defined questionnaire was distributed to 230 respondents, out of which 180 completed the questionnaire fully, making the sample size of the study 180. Next , the study then applied the Weighted Average Index method to prioritize the project assessment risk factors, preparing the relative Project Assessment Risk Index and prioritizing the top twenty project assessment risk factors. The study investigated the elements most linked with project assessment risks using factor analysis, especially the Principal Component Analysis approach.

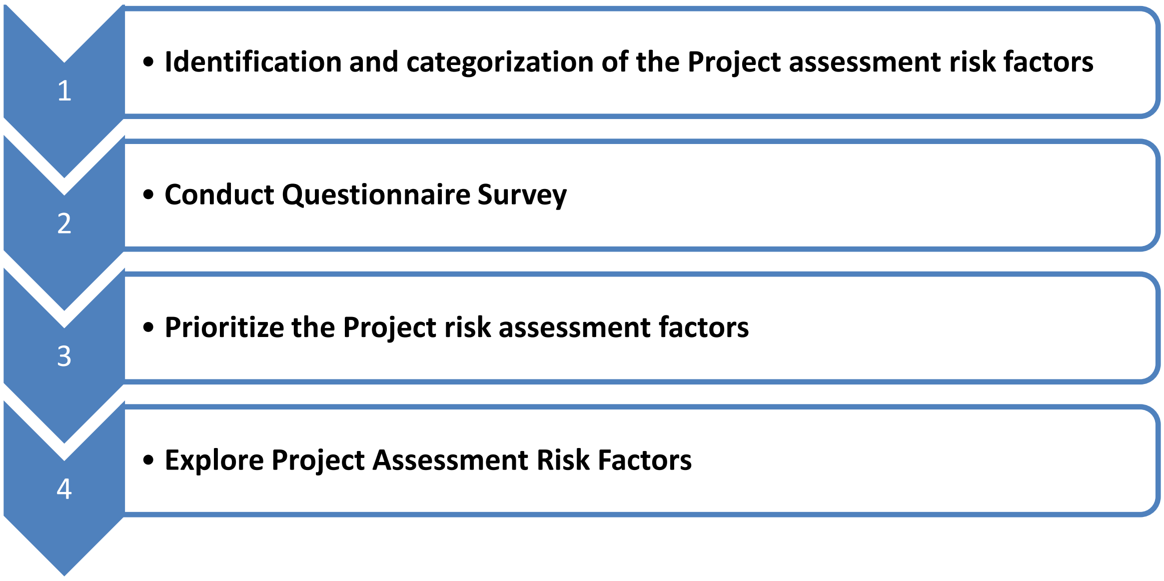

Figure 1. Flowchart of methodology adopted

By using this step-by-step method, the study improves knowledge and control of significant hazards in building projects.

Step 1: Identification and categorization of the Project assessment risk factors

To establish a rational approach and methodology for reducing construction delays, the study extensively reviewed existing practices and methodologies related to delay factors. Literature on the factors causing construction project delays was collected by exploring various journal databases, including Scopus, IEEE Xplore Digital Library, ScienceDirect, and others.

Step 2: Conduct Questionnaire Survey:

A questionnaire was used to collect data on Project Risk Assessment framing habits, methodologies, procedures, and quantitative aspects. The paper closely examines eight construction project risk assessment stakeholder groups. The data is credible and relevant since it comes from qualified industrial specialists.

Step 3: Project risk assessment factor can be prioritized by employing the Weighted Average Index Method.

The Weighted Average Index method is a statistical technique for measuring changes in a set of linked variables over time. This approach weights each data point depending on its relevance or importance and then computes the average of the weighted values. This results in a more accurate picture of trends than a simple average. The resultant index number indicates the average value of the data items, weighted by their relevance. Similarly, this study computed the relative Project Assessment Risk Index using 5 point liker scale. as shown in Equation

$$\text{RPI} = \frac{\sum A_i R_i}{n * R_T} = \frac{\sum W}{A \, . N}$$

Where Ai represents the weight that the scale measures, while Ri represents the number of responses that are associated with that weight. Variable Ai, RT, displays the aggregate quantity of responses. In this specific framework, the variable i varies from 1 to n, where n represents the utmost weight being measured on the scale. The Relative Project Risk Assessment Index (RPI) was generated and the risk categories were assigned weights using this methodology in the study.

Step 4: Exploring the Risk Factors of Project Assessment in the Construction Industry Through Exploratory Factor Analysis

EFA is a useful way to find and pull out important parts of the many external, project-related, and internal risk factors that come up in building tasks. This way of analyzing data lets experts and researchers look into the structure of different risk factors, which can help them find trends or links between them. The most important thing to know about evaluating the risk of building projects is that they use EFA to find the main factors that significantly affect the project's total risk. EFA promotes the discovery of latent variables, which indicate common underlying themes or constructs inherent in external, project-specific, and internal hazards, by examining the interrelationships between various risk factors. EFA may identify factors with high loadings among a variety of risk indicators and then group them together as latent Project Risk Assessment factors.

3. Study Area

In India, Hyderabad is the main city of Telangana and a busy place for building and improving infrastructure. In recent years, there have been a lot more construction projects in the area because of its rich history, lively culture, and quickly growing economy. The construction business in Hyderabad has a significant impact on the city's architectural landscape and overall growth. The city's iconic structures, like as the Charminar and the Golconda Fort, demonstrate the outstanding expertise of the architects involved. In addition, Hyderabad boasts various contemporary skyscrapers, corporate hubs, residential complexes, and infrastructural projects.

The construction sector in Hyderabad is diverse, spanning residential, commercial, industrial, and infrastructural development. This industry attracts both domestic and foreign investors, developers, and construction companies, resulting in a dynamic and competitive market environment. The city's favorable economic environment, strong infrastructural foundation, talented labor pool, and government support have all accelerated the sector's expansion.

Nevertheless, the building business in Hyderabad faces many challenges. Building projects can be significantly impacted by regulatory ambiguity, economic fluctuations, scarcity of manpower, and disruptions in the supply chain. Project delays and cost overruns may occur due to regulatory changes or delays in obtaining clearances. During periods of economic decline, investor excitement may wane and demand for real estate may decrease, which can have a negative impact on the viability of projects. Moreover, the scarcity of trained workers or disruptions in the supply chain might impede the progress of a project and result in increased construction costs.

Hyderabad is now engaged in many construction projects, including residential complexes, information technology parks, commercial hubs, and hotel venues. The city is expanding its metro rail system, bridge, and highway network. In response to the evolving needs of residents and businesses, the construction sector in Hyderabad has embraced innovative architectural concepts, eco-friendly construction methods, and advanced technology. Hyderabad's prominence in the Indian construction sector has been bolstered by its strong focus on achieving excellence and fostering inventiveness.

Nonetheless, the tremendous speed of building in Hyderabad raises issues such as project delays, safety standards enforcement, and environmental preservation. To overcome these challenges, the industry is adopting new technologies, using better project management processes, and incorporating sustainable building practices.

4. Analysis Results and Discussion

The study identified the Project Assessment Risk Factors by conducting a comprehensive analysis of previous literature and conducting interviews with industry professionals. This stage guarantees that every relevant factor are taken into account in the ensuing analysis. The study gives priority to the Project Assessment Index by employing the Weighted Average Index approach. For this, the study considers 80 questions segmented into various project assessment risk factors, namely Quality Risk, Budget and Cost Management Risk, Schedule and Time Management Risk, Scope and Planning Risk, Safety and Regulatory Compliance Risk, Resource Management Risk, Communication and Stakeholder Management Risk, and Environmental and Sustainability Risk.

4.1 Identifying Project Assessment Risk Factors

The study aims to prioritize the Project Assessment Index using the Weighted Average Index approach. In order to accomplish this, the study analyzes 80 questions that are classified according to various project assessment risk factors. There are a number of potential threats to a project's success, including issues with quality, time, money, schedule, scope, planning, safety, regulatory compliance, resources, communication, and sustainability. Twenty indicators with a Relative Project Assessment Risk Index were identified during the research and are shown in Table 1 along with their ratings.

Table 1. Relative Project Assessment Risk Index

Code	Project Risk Factors	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total responses	Relative Project Risk Index	Rank
BCMR9	Inefficient procurement processes leading to higher purchasing costs.	8	33	51	59	29	180	0.676	5
BCMR10	Currency exchange rate fluctuations for projects.	4	22	74	62	18	180	0.676	5
BCMR6	Delays in project progress leading to increased labor and overhead costs.	12	20	70	50	28	180	0.669	10
BCMR4	Escalation of subcontractor and supplier costs.	9	38	54	53	26	180	0.654	20
STMR3	Dependency on critical resources or materials with long lead times.	11	24	30	85	30	180	0.710	1
STMR1	Adverse weather conditions affecting construction activities and productivity.	10	26	56	65	23	180	0.672	9
STMR9	Transportation delays affecting the delivery of materials and equipment to the construction site.	20	27	49	50	34	180	0.657	19

SPR5	Inadequate risk assessment and mitigation strategies during the planning process.	7	22	53	69	29	180	0.701	2
SPR3	Changes in client requirements or preferences after project initiation.	11	29	56	56	28	180	0.668	12
SRCR8	Lack of proper signage, warnings, and barriers to prevent accidents and injuries.	20	16	54	55	35	180	0.677	4
SRCR1	Inadequate safety training and awareness programs for construction workers.	16	21	61	45	37	180	0.673	8
SRCR2	Unsafe working conditions and practices leading to accidents and injuries.	16	24	52	60	28	180	0.667	14
SRCR5	Inadequate supervision and oversight of subcontractors and construction activities.	19	22	54	56	29	180	0.660	16
RMR8	Cash flow constraints affecting timely payments to subcontractors and suppliers.	7	22	70	52	29	180	0.682	3
RMR7	Dependency on single-source suppliers leading to supply chain disruptions.	10	18	69	66	17	180	0.669	10
RMR10	Inadequate workforce planning and recruitment strategies leading to staffing gaps.	11	33	53	50	33	180	0.668	12
CSMR4	Language barriers and cultural differences impacting effective communication and collaboration.	16	16	64	52	32	180	0.676	5
CSMR5	Delayed or inadequate dissemination of project information and updates to relevant stakeholders.	26	18	46	56	34	180	0.660	16
CSMR9	Mismanagement of stakeholder expectations regarding project scope, timelines, and deliverables.	12	27	64	50	27	180	0.659	18
ESR9	Energy inefficiency in building design and construction leading to increased carbon footprint.	11	27	58	61	23	180	0.664	15

Table 1 depicts an assessment of major project risk indicators, together with their relative project risk index and accompanying ranks, divided into domains such as BCMR, STMR, SPR, SRCR, RMR, CSMR, and ESR. The variables ranked give vital insights into the most important risk factors influencing project evaluation in the construction sector. For example, the highest-ranked risk factor, Dependency on vital resources or commodities with extended lead times (STMR3), emphasizes the need of controlling and minimizing such dependencies to ensure project success. Currency exchange rate variations for projects (BCMR10), rated twentieth, emphasizes the necessity of managing currency risks to reduce project costs and profitability. The significance of stringent construction site safety measures, effective cash flow management, and robust planning is underscored by the high-ranking issues of inadequate risk assessment and mitigation strategies during planning (SPR5), cash flow constraints affecting timely payments to subcontractors and suppliers (RMR8), and lack of proper signage, warnings, and barriers to prevent accidents and injuries (SRCR8).

On the other hand, risk factors such as hazardous working conditions and practices that result in accidents and injuries (SRCR2) and ineffective procurement processes that result in higher purchasing costs (BCMR9) highlight the significance of giving priority to worker safety and improving procurement processes to reduce project risks.

Moreover, the presence of variables like insufficient safety training and awareness programs for construction workers (SRCR1) and dependence on single-source suppliers leading to disruptions in the supply chain (RMR7) emphasize the significance of investing in extensive worker training programs and broadening the supply chain to enhance project resilience. Variables that rank lower emphasize the importance of effective stakeholder engagement and communication throughout the project lifecycle to mitigate risks associated with changing requirements and information gaps, such as delayed or inadequate dissemination of project information and updates to relevant stakeholders (CSMR5) and changes in client requirements or preferences after project initiation (SPR3). Furthermore, the presence of risk factors such as a lack of energy efficiency in building design and construction, which results in a higher carbon footprint (ESR9), and transportation delays that impede the transportation of materials and equipment to the construction site (STMR9) highlight the importance of incorporating sustainable practices and efficient logistics management to reduce environmental damage and address transportation-related disruptions.

The existence of variables, such as inaccurate stakeholder expectations regarding a project's extent, timelines, and outcomes (CSMR9), highlights the risks associated with misaligned goals and deliverables. Active involvement of stakeholders and transparent communication are crucial. In order to reduce budget overruns and ensure project profitability, it is essential to assess and manage cost and currency risks throughout the duration of the project. This is especially crucial given risk factors such as rising subcontractor and supplier prices (BCMR4) and foreign exchange rate volatility for projects (BCMR10). As a result, proactive risk management and mitigation procedures are critical to ensuring the project's success and achieving the desired outcomes.

4.2 Exploring Project Assessment Risk Factors in the Construction Industry

After identifying and adopting the top twenty project assessment risk indicators. Using the Principal Component Analysis technique, the study looked at the factors most closely related to project assessment risks.

The KMO Measure of Sampling Adequacy and Bartlett's Test of Sphericity are used to check how flexible the datasets are for the research. The KMO (Kaiser-Meyer-Olkin) measure of sampling adequacy obtained a value of .791, indicating that the dataset used in the analysis is suitable for conducting factor analysis. For factor analysis, a KMO score close to one indicates that the study's variables are quite strongly connected. Bartlett's Test of Sphericity produced an expected chi-square value of 1445.194 using 190 degrees of freedom and a significance level of.000. This supports the acceptability of the data for component analysis by implying that the correlation matrix is somewhat distinct from an identity matrix. Stated otherwise, the strong linkages shown by the dataset's variables emphasize the need of factor analysis in order to grasp the fundamental structure of the risk factors of the project evaluation.

Table 2. Component Extraction using Principal Component Analysis

Code	Project Risk Factors	1	2	3	4	5	6
BCMR9	Inefficient procurement processes leading to higher purchasing costs.	0.519					
BCMR10	Currency exchange rate fluctuations for projects.	0.531					

BCMR6	Delays in project progress leading to increased labor and overhead costs.						
BCMR4	Escalation of subcontractor and supplier costs.	0.597					
STMR3	Dependency on critical resources or materials with long lead times.		0.612				
STMR1	Adverse weather conditions affecting construction activities and productivity.		0.585				
STMR9	Transportation delays affecting the delivery of materials and equipment to the construction site.		0.661				
SPR5	Inadequate risk assessment and mitigation strategies during the planning process.			0.683			
SPR3	Changes in client requirements or preferences after project initiation.			0.631			
SRCR8	Lack of proper signage, warnings, and barriers to prevent accidents and injuries.			0.691			
SRCR1	Inadequate safety training and awareness programs for construction workers.				0.712		
SRCR2	Unsafe working conditions and practices leading to accidents and injuries.				0.529		
SRCR5	Inadequate supervision and oversight of subcontractors and construction activities.				0.571		
RMR8	Cash flow constraints affecting timely payments to subcontractors and suppliers.					0.661	
RMR7	Dependency on single-source suppliers leading to supply chain disruptions.					0.573	

RMR10	Inadequate workforce planning and recruitment strategies leading to staffing gaps.					0.633	
CSMR4	Language barriers and cultural differences impacting effective communication and collaboration.						0.606
CSMR5	Delayed or inadequate dissemination of project information and updates to relevant stakeholders.						0.641
CSMR9	Mismanagement of stakeholder expectations regarding project scope, timelines, and deliverables.						0.577
ESR9	Energy inefficiency in building design and construction leading to increased carbon footprint.						0.539

Table 2 displays the Project Assessment Risk factors for a construction project that was done using PCA, categorizing different risk variables based on their potential impact on project success. Concerns have been expressed concerning inefficient procurement methods (BCMR9), currency exchange fluctuations (BCMR10), and the risks posed by delays (BCMR6) and subcontractor cost escalation (BCMR4). STMRs include dependency on critical resources with long lead times (STMR3) and transportation delays (STMR9), which are exacerbated by adverse weather (STMR1). SPRs include poor risk assessment (SPR5) and changes in customer demands (SPR3), which necessitate revisions to the timeline and budget. SRCR focuses on safety measures, although challenges such as a lack of appropriate signals and training (SRCR1, SRCR8) and insufficient monitoring (SRCR5) may result in accidents and delays. RMR include cash flow constraints (RMR8) and reliance on single-source suppliers (RMR7), while Communication and Stakeholder Management Risks (CSMR) include language challenges (CSMR4), late information delivery (CSMR5), and mismanaged stakeholder expectations (CSMR9). Finally, ESR addresses concerns regarding energy-inefficient designs (ESR9), which have an impact on the project's carbon footprint and regulatory compliance.

5. Conclusion

The study used a comprehensive strategy to identify and investigate significant hazards in building project evaluation. The study sought to improve knowledge of the inherent risks in construction projects by first identifying project assessment risk variables using the Weighted Average Index approach and then investigating these aspects using Principal Component Analysis (PCA). The study found a wide range of risk factors in many different fields, including budget and cost control, schedule and time management, scope and planning, safety and regulatory compliance, resource management, communication and stakeholder management, and environmental and sustainability. Emphasizing the need of proactive risk management measures, the risk indicators highlighted the wide spectrum of hazards existing in building projects. Especially, characteristics like dependability on key resources, inadequate risk assessment during planning, and safety issues seemed as top priority, pointing areas that demand focused attention to properly reduce project risks. Moreover, the study underlined the need of efficient stakeholder involvement, open lines of contact, and long-term strategies in reducing project risks and obtaining good project outcomes. Moving ahead, the insights gained from this study may be used to design customized risk management plans adapted to the individual demands and difficulties of construction projects, resulting in enhanced project delivery and stakeholder satisfaction.

6. Future Scope

More study in this area might dive deeper into the dynamics of stakeholder relationships and their implications for project risk management. It would also be good to investigate the efficacy of new technologies like Building Information Modeling (BIM) and Artificial Intelligence (AI) in decreasing building project hazards. Investigating the impact of regulatory frameworks and government policies on risk management methods may give useful information for industry stakeholders. Furthermore, longitudinal studies that follow the growth of risk variables across the project's lifespan would improve our understanding of risk dynamics.

Reference:

1. Abbasian, E., et al. (2024). The quantitative and qualitative assessments of investment risk in government development projects (Case study: Joint oil fields of Iran and Iraq). *Iranian Economic Review, 28*(1), 250-272.
2. Abdelgawad, M., & Fayek, A. R. (2010). Risk management in the construction industry using combined fuzzy FMEA and fuzzy AHP. *Journal of Construction Engineering and Management, 136*(9), 1028–1036.
3. Aslam, M., & Baffoe-Twum, E. (2024). Mitigating schedule overruns in pre-stressed girder bridge construction: Assessing risks and proposing mitigation strategies. *Ain Shams Engineering Journal, 15*(5), 102673.
4. Cagno, E., Caron, F., & Mancini, M. (2007). A multi-dimensional analysis of major risks in complex projects. *Risk Management*, *9*(1), 1–18.
5. Cooper, D. F., Grey, S., Raymond, G., & Walker, P. (2005). *Project risk management guidelines*. Hoboken, NJ: Wiley.
6. Edwards, P. J., & Bowen, P. A. (1998). Risk and risk management in construction: A review and future directions for research. *Engineering, Construction and Architectural Management, 5*(4), 339-349.
7. Grimaldi, S., Rafele, C., & Cagliano, A. C. (2012). A framework to select techniques supporting project risk management. In N. Banaitiene (Ed.), *Risk management–Current issues and challenges* (pp. 67–96).
8. Jaber, A. Z. (2019). Assessment risk in construction projects in Iraq using COPRAS-SWARA combined method. *Journal of Southwest Jiaotong University, 54*(4), 3-13.
9. Kapliński, O. (2013). Risk management of construction works by means of the utility theory: A case study. *Procedia Engineering, 57*, 533-539.
10. Mc Kinsey & Company (2015). "The construction productivity Imperative" *Report* Priyanto, B., Set-

yaningsih, I., & Setyadi, A. (2024). Revealing risk factors and risk levels in housing construction projects in Sukoharjo Regency, Indonesia. *E3S Web of Conferences, 517*, 05011. https://doi.org/10.1051/e3sconf/202451705011

11. Rashidi Komijan, A., Hosseini, M. R., & Niaki, S. T. A. (2018). Risk manageability assessment to improve risk response plan: Case study of construction projects in Iran. *Journal of Construction Engineering and Management*, *144*(5), 05018012.
12. Siraj, N. B. (2019). Risk identification and common risks in construction: Literature review and content analysis. *Journal of Construction Engineering and Management*, *145*(9), 03119004.
13. Srinivasan, G., & Venkatesh, M. P. (2020). Risk assessment of construction project in India. *IOP Conference Series: Materials Science and Engineering*. https://doi.org/10.1088/1757-899X/993/1/012044
14. Wuliyanto, P., Husin, A. E., & Imron, A. (2024). Dynamic modeling risk manageability in tunnel projects to improve performance. *AIP Conference Proceedings, 2710*(1). https://doi.org/10.1063/5.0085509
15. Yazdani, M. (2019). Improved decision model for evaluating risks in construction projects. *Yazdani, Morteza*, *04019024*(5), 04019024.
16. Zavadskas, E. K. (2010). Risk assessment of construction projects. *Journal of Civil Engineering and Management*, *16*(1), 33-46.
17. Zuhdi, A., et al. (2022). A risk management analysis on project construction of integrated student dormitory building MTSN 1 Malang City. *Journal of Architecture and Civil Engineering, 7*(6), 05-16.