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Analysis of Risks and Maintenance in Construction Project Management

Abbhinaya G K, P.A. Prabakaran

Department of Civil Engineering, P.G student, Kumaraguru College of Technology, Coimbatore, Tamil Nadu.
Assistant Professor, Kumaraguru College of Technology, Coimbatore, Tamil Nadu.

ABSTRACT: This collection of research summaries encompasses a wide range of studies related to risk management in construction projects. The papers explore various aspects, including literature reviews on risk assessment methodologies, the integration of risk management into construction processes, and the identification of risk factors in specific contexts. Different methodologies such as ANP, DEMATEL, AHP, FRAM, and EVM are employed to assess and manage risks. The studies highlight the importance of considering risk factor interdependencies, addressing gaps in existing literature, and proposing novel frameworks to enhance risk management practices. Insights are drawn from case studies, literature reviews, and analysis of construction projects in diverse geographical and sectoral contexts. The findings contribute to the existing body of knowledge on construction risk management and offer practical implications for industry practitioners and decision-makers.

KEY WORDS: Construction project, Risk assessment, Building Information Modelling (BIM), Integration, Decision support system.

I.INTRODUCTION

The introduction of this compilation introduces the overarching theme of risk management in construction projects. It outlines the significance of effective risk assessment methodologies and identifies gaps in the existing literature, emphasizing the need for comprehensive risk management approaches. The diverse methodologies employed across the studies, ranging from traditional techniques to advanced tools like BIM and machine learning, are briefly introduced. The introduction sets the stage for the subsequent sections, providing a context for the exploration of risk management strategies in construction.

The field of construction projects is inherently complex, characterized by dynamic environments, multifaceted stakeholders, and a myriad of uncertainties. As a result, the effective management of risks plays a pivotal role in ensuring the success and sustainability of construction endeavours. This compilation of diverse studies delves into the extensive literature on risk assessment, management methodologies, and associated challenges within the realm of construction projects. Each study contributes unique insights, methodologies, and perspectives, collectively enriching our understanding of the complexities surrounding risk in the construction industry.

Proposing innovative approaches, such as the integration of Analytic Network Process (ANP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) methods, these studies underscore the importance of advancing the field's methodologies for a more comprehensive risk evaluation. Subsequent studies shift the focus towards risk management in construction projects, addressing gaps in existing literature related to risk identification, analysis, and response techniques. A recurring theme emerges, emphasizing the need for a holistic risk management process approach, as well as the clarification of classifications for risk sources. The studies explore diverse geographical contexts, including developing countries like Nigeria, offering valuable insights into region-specific challenges and future research directions. Further contributions concentrate on specific aspects of risk management, such as risk mitigation measures and project success criteria.

Utilizing advanced statistical techniques, including factor analysis and structural equation modelling, these studies aim to quantify the impact of risk mitigation on project success. Additionally, research on risk information management integration into Building Information Modelling (BIM) and the development of BIM-based risk management frameworks showcases the evolving technological landscape's influence on risk management practices in the construction industry.

The collection also explores risk factors in distinct contexts, ranging from undersea tunnels to modular integrated construction, each study presenting a unique perspective and contributing to the overall understanding of sector-specific challenges and mitigation strategies. In conclusion, this compilation serves as a comprehensive exploration of risk assessment and management in construction projects, offering diverse methodologies, perspectives, and insights. The amalgamation of these studies contributes to the ongoing discourse on enhancing risk management practices, promoting global industry resilience, and fostering sustainable construction project outcomes.

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II. LITERATURE SURVEY

Amirhossein Karamoozian et al**.(2017)** conveyed a comprehensive methodology for prioritizing risks in construction projects. The authors, affiliated with esteemed institutions in China and Sweden, propose the integration of Analytic Network Process (ANP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) to effectively assess and prioritize risks. The study is supported by multiple grants and research projects, indicating its significance and relevance in the field. By leveraging these advanced decision-making tools, the research offers valuable insights for project managers and stakeholders in the construction industry, aiming to enhance risk management practices and ultimately improve project outcomes.

R A Bahamid et al**.(2017)** phrased comprehensive review of the literature on risk management in construction projects, with a focus on developing countries. The review highlights the importance of effective risk management in preventing negative impacts on project participants and ensuring project success. The article discusses various risk identification and assessment techniques, including both quantitative and qualitative approaches, and emphasizes the need for a comprehensive risk assessment framework that considers the different types of effects of risk on various project objectives concurrently. The review also notes the gap between theory and practice in risk management and the need for further research to bridge this gap. Overall, the article provides valuable insights into the challenges and opportunities of risk management in construction projects of developing countries.

Obinna Collins Nnamani (2019) express the importance of risk management in property development projects in Nigeria. The article discusses the complexity and uncertainty of property development, the key features that define this complexity, and the main sources of development risk. It emphasizes the need for robust and sophisticated risk management techniques to mitigate the harmful impact of risk and uncertainty on development projects. The article also identifies knowledge gaps and recommends further research areas, including investigating the perception and practice of property development companies in risk management. Overall, the article highlights the potential for further development of advanced risk management tools to confront present-day and future socio-political, economic, and environmental challenges in the property development industry.

Satish Kumar Viswanathan et al**.(2019)** states that the study investigates the influence of risk mitigation measures on project success criteria in international construction projects. The research method consists of five steps, including a preliminary interview with experts and a questionnaire survey. The data collected from 105 respondents were analysed using factor analysis and structural equation modelling. The study identified three risk mitigation factors, namely pre-project planning, local participation, and contract selection, which positively influenced project success criteria. The findings suggest that risk mitigation measures are crucial for achieving project success in international construction projects. The study provides valuable insights for project managers and stakeholders in developing effective risk management strategies for international construction projects.

Kyungmo Park et al**.(2019)** verbalizes a comprehensive study on the risk management practices of construction management firms. The study identifies eight major risk factors related to contracts, funding, schedules, workforce, customer satisfaction, and disputes that significantly affect project operations of CM firms. The research uses analytic hierarchy process and failure mode and effects analysis to analyse the importance of each risk factor and perform a priority analysis. The study's findings can assist firms in establishing more robust risk management practices, ultimately leading to better outcomes in the face of increasing project risks and global economic changes. The article concludes with implications for construction firms looking to adapt to globalization and improve their overall competitiveness.

Yang Zou et al**.(2019)** articulates a novel framework for managing risk information in bridge construction projects by integrating Risk Breakdown Structure (RBS) into 3D/4D Building Information Modelling (BIM). The proposed framework involves generating a 4D BIM to visualize construction activities, extracting schedule and time-related information to form the Work Breakdown Structure (WBS), and establishing a linked relationship between RBS, WBS, and BIM. The study also introduces a prototype tool to support the implementation of this approach. Through interviews with industry experts, the research validates the significance of the proposed method and prototype in addressing knowledge gaps and improving risk management in bridge projects, while also highlighting the need for further research to extend the approach to other BIM-based software and test its applicability in various construction scenarios. Overall,

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the paper contributes to advancing risk management in bridge construction within the digital era of the construction industry.

Yunna Wu et al**.(2019)** asserts a comprehensive analysis of the risk factors associated with urban rooftop distributed photovoltaic (URDPV) projects in China. The study employs an extended risk assessment model that integrates hesitant fuzzy linguistic term sets (HFLTS) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) analysis to evaluate the performance and risk levels of EPC-URDPV projects. Through a detailed scenario analysis, the study highlights the potential impact of policy changes, such as the cancellation of power generation subsidies and the improvement of operation and maintenance levels, on the risk assessment results. The research emphasizes the adaptability and robustness of the risk analysis model, making it a valuable tool for stakeholders and investors in the renewable energy sector. Additionally, the study addresses the limitations of existing risk analysis methods and proposes improvements to enhance the scientific rigor and representativeness of risk assessment in the context of EPC-URDPV projects.

Adnan Ul Haque et al**.(2019)** mentions a comparative study that investigates the influence of risk management on project planning and success in the construction industry of the UK and Pakistan. Through data gathered from 152 project managers using a survey questionnaire and analysed using the partial least square structural equation modelling technique, the study confirms the significant impact of project planning on project success. The findings suggest that construction firms in both economies should strategically address financial, technical, and human risks during planning and implementation stages, while governments should consider introducing flexible tariffs and subsidies for construction businesses. Additionally, the study recommends the use of simulation techniques for training project managers and emphasizes the importance of collaboration between governments and construction businesses to address uncertainty and risks. The article provides valuable insights for practitioners and researchers seeking to enhance project success through effective risk management and project planning in competitive business environments.

Deena Badran et al**.(2020)** conveys a conceptual framework for BIM-based risk management during the design stage of construction projects in the United Arab Emirates (UAE). The authors highlight the unique characteristics of construction projects in the UAE that increase the probability of risks occurrence, such as the complex and dynamic nature of the projects, the diverse stakeholders involved, and the regulatory requirements. The framework includes a risk identification and assessment process, a risk mitigation and management process, and a BIM-based design information management process. The authors also provide case studies and examples of high-ranked design phase related risks impacting project objectives, and propose BIM-based solutions to mitigate these risks. Overall, this framework provides valuable insights for construction professionals and stakeholders in the UAE to effectively manage risks during the design stage of construction projects.

Hamed Jahani et al**.(2020)** says the impact of capacity/inventory disruption on a supplier's cost and the management of service level agreements (SLAs) with multiple customers. The study proposes a framework for considering disruption in SLAs and formulates capacity allocation policies to cope with disruption. The authors compare three capacity allocation policies and consider which of these performs best under disruption. Their findings provide valuable insights for suppliers in determining their capacity level and making capacity-related decisions. The study also highlights the importance of negotiating longer performance review periods in the presence of disruption and the implications of partial disruption versus full disruption in meeting SLAs.

Fuquan Pan et al**.(2020)** focuses on the analysis of lane-changing behaviour in undersea tunnels and the associated risks. Lane-changing is a common driving behaviour that can significantly impact traffic flow and safety in undersea tunnels. The authors review existing studies on lane-changing behaviour and propose a fuzzy inference-based model to analyse the risks associated with different types of lane-changing behaviour. The model considers factors such as vehicle speed, distance to other vehicles, and driver behaviour to predict the likelihood of a lane-changing accident. The authors also discuss the importance of understanding the factors that contribute to traffic accidents in undersea tunnels and the need for effective safety measures to prevent them.

Rajput B et al**.(2020)** expresses a comprehensive analysis of the critical risk factors contributing to cost overrun in highway construction projects in India. Through a questionnaire-based survey and statistical analysis, the study identifies a wide range of risk factors, including delays in project approval, variations in design and specifications, shortage of skilled manpower, and difficulties in financing. The research emphasizes the importance of understanding and addressing

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these risk factors to empower project stakeholders to develop effective strategies for mitigating their adverse effects. Additionally, the article highlights the differences in perception among construction professionals working with clients, consultants, and contractors, shedding light on the varying perspectives regarding the identified risk factors. This valuable insight can guide stakeholders in prioritizing and managing these risk factors to enhance the success of highway construction projects.

Ibrahim Yahaya WUNI et al**.(2020)** conveys a comprehensive analysis of the risks and uncertainties associated with modular integrated construction (MiC). The authors conducted a systematic literature review, including 54 empirical studies published in peer-reviewed research outlets, to identify and evaluate the risks related to MiC. The review process involved a rigorous screening and selection procedure, resulting in the inclusion of 38 relevant articles. The study also employed a "snowballing" search strategy to further locate pertinent literature. The authors utilized meta-synthesis and content analysis to extract and integrate metadata from the selected studies, organizing them into various research themes. The article not only presents a flowchart of the systematic literature retrieval, screening, and selection procedure but also illustrates the annual publication trend on the risks associated with MiC from 1992 to 2019. Furthermore, it identifies critical risk events in the application of MiC and provides valuable insights for researchers and practitioners in the construction engineering and management field.

Debasis Sarkar et al**.(2020)** provides a comprehensive analysis of the risks and uncertainties associated with complex infrastructure projects, focusing on the specific case of the Ahmedabad Metro Rail Construction Project. The study employs various methods such as Expected Value Method (EVM), Fuzzy Expected Value Method (FEVM), and Fuzzy Analytical Hierarchy Process (FAHP) to identify and assess the critical risks throughout the project phases. The research also incorporates a Monte Carlo simulation to compute the expected project time and cost, as well as to conduct path analysis for the project completion time and cost. The findings offer valuable insights into the key risks and provide recommendations for effective risk mitigation, making this study a significant contribution to the field of construction project management and risk analysis.

K. Chandrashekhar Iyer et al**.(2020)** presents a comprehensive comparative case study that delves into the crucial relationship between contractor capability and effective risk management in the construction industry. Conducted by K. Chandrashekhar Iyer, Ratnesh Kumar, and Surya Prakash Singh from the Indian Institute of Technology Delhi, the study emphasizes the significance of contractor prequalification in assessing capability and selecting contractors for successful project execution. Through meticulous data analysis, including expert interviews, project documents, and archival records, the researchers systematically examine the impact of contractor capability on project success, offering valuable insights into risk assessment and mitigation. The study's findings provide a deeper understanding of the pivotal role of contractor capability in risk management, thereby contributing to enhanced project outcomes and informed decision-making within the construction industry.

Ali Boateng et al**.(2020)** speaks about the comprehensive analysis of the challenges and practices related to risk management in the construction industry in Ghana. The study emphasizes the significance of systematic risk management in achieving project objectives and contributing to the overall development of the construction sector in the country. Through interviews and analysis, the authors highlight the unsystematic nature of risk management processes, including identification, analysis, response, and monitoring, within the industry. The findings underscore the need for dedicated.

Lars Peter Sonderbo Andersen et al**.(2021)** shares insights into the diverse perceptions of risk and safety among various occupational groups in the construction industry. Through semi-structured interviews and fieldwork, the study explores how project managers, workers, and foremen perceive safety and risk, and how these perceptions influence safety cooperation. The findings highlight the significance of relational trust among colleagues and the impact of trust on safety performance. The study also emphasizes the importance of understanding and addressing these diverse perceptions to enhance safety practices on construction sites. Overall, the research offers valuable insights into the complex dynamics of risk perception and safety cooperation in the construction industry, contributing to the ongoing efforts to improve safety standards and practices in this field.

Batagalle vinuri gimanthika karunarathne et al**.(2021)** insists study on the application-level analysis of risk management in South Korean construction companies using a Generic Risk Maturity Model (GRMM). The study aims to provide insights into the management of risk in construction projects, which is crucial for the success of such projects. The GRMM evaluates the risk maturity of a construction organization or project based on six attributes: strategy and

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policy, top management commitment, culture and personal knowledge, risk assessment, risk treatment and mitigation, and monitor and review. The study collected responses from 131 experts from 18 construction companies in South Korea and analysed the data to identify areas that need improvement. The study found that the highest scores were for statements related to risk assessment, while the lowest scores.

Wooyong Jung et al**.(2021)** enunciates a comprehensive study on project performance benchmarking and its importance in evaluating project management performance. The research provides valuable insights into the key components of the Three-Phased Risk-Management Benchmark for Internationalization of Small and Medium-Sized Construction Companies, and how traditional quality measurement benchmarks compare to the expanded benchmarks in project performance evaluation. The article also discusses the implications of this research for small and medium-sized construction companies looking to internationalize their operations. Overall, the study highlights the importance of effective risk management and project performance evaluation in the success of international construction projects.

Ali Alboghobeish et al**.(2022)** mentioned a study on the integration of Functional Resonance Analysis (FRAM) with Multicriteria Analysis (MCA) for risk management. The study was conducted in the context of an agricultural water reservoir construction project in southwestern Iran. The construction steps of the water reservoir pool were analysed using FRAM, which helped identify the functions and their interactions. The Analytical Hierarchy Process (AHP) was then used to prioritize the functions based on their importance and potential risks. The study found that the integration of FRAM and MCA can provide a comprehensive approach to identify and prioritize emerging risks in sociotechnical systems. The findings of this study can be useful for risk management in other industries besides agriculture.

Mikela Chatzimichailidou et al**.(2022)** voices about the study employs a rigorous methodology, including quantitative and qualitative analyses, to identify and analyses the key themes and trends in risk management. Through the use of text mining tools and thematic content analysis, the authors highlight the growing importance of AI-based risk data structuralizing and pre-processing methods in addressing the complexities of risk management in construction projects. The review also emphasizes the significance of understanding the differences between deterministic and probabilistic approaches, including their reasoning basis, advantages, disadvantages, and application areas. Overall, this article offers valuable insights for researchers, practitioners, and project managers involved in construction project risk management, contributing to the advancement of effective risk mitigation strategies and decision-making processes in the construction industry.

Liao Chenya et al**.(2022)** values a comprehensive analysis of the current state of research on intelligent risk management in construction projects. The study analysed 436 articles from the Web of Science and Scopus databases and identified the main research directions and trends in this field. The study found that the application of artificial intelligence in risk management is a major research direction for the future, and there is a need for more advanced technology and data sources. The study also identified some limitations, such as the small sample size and the lack of interdisciplinary analysis. Overall, this study provides valuable insights into the future research trends in intelligent risk management in construction projects.

Jeroen van der Meera et al**.(2022)** expresses valuable insights into the importance of understanding and addressing design risks in the tender phase of integrated design and construction projects. It discusses the use of multi-criteria decision analysis (MCDA) to support contractors in effectively dealing with risks during the decision-making process. The study identifies and validates three interventions aimed at raising risk awareness in the context of infrastructure tenders in the Netherlands, emphasizing the significance of visualizing uncertainty in criteria scoring to trigger discussions about risks. By highlighting the need for informed decision-making in the face of uncertainties, the article offers practical strategies to enhance risk awareness and decision-making in the context of complex design and construction projects.

Bob Prieto (2022) discusses the challenges and opportunities of implementing enterprise risk management (ERM) in the engineering and construction (E&C) industry. The author highlights the unique risks faced by the E&C industry, including market risks, project risks, and operational risks, and offers practical strategies for managing these risks effectively. Prieto emphasizes the importance of integrating ERM into the overall business strategy and culture of an organization, rather than treating it as an isolated function. He also discusses the role of technology in enhancing ERM processes and the need for collaboration and communication among stakeholders. Overall, this article provides valuable insights and best practices for professionals in the E&C industry looking to improve their risk management practices.

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Rami A. Bahamid et al.**(2022)** highlights on comprehensive analysis of risk management practices and knowledge in the Yemeni construction industry. It highlights the substandard performance across various areas of the construction sector due to the lack of adequate risk management methods. The study emphasizes the need for improved and more frequent training of construction professionals to enhance systematic risk management methods and raise the performance bar. Additionally, the research identifies the necessity for further studies to address the impediments to enterprise risk management adoption in developing countries like Yemen. It also proposes the development of a decision support system to facilitate enterprise risk management adoption and suggests a quantitative study to assess the financial and other losses incurred by the construction sector due to poor risk management. The study's outcomes underscore the urgency for more research to stimulate practitioners' and stakeholders' interest in risk management implementation for the sector's benefit. Furthermore, the findings contribute to a better understanding of risk management in the Yemeni construction sector and advocate for the adoption of stepwise risk management assessment techniques. The article's insights and recommendations serve as a valuable resource for industry professionals, project participants, and researchers, shedding light on the current state of risk management practices and knowledge in the Yemeni construction industry and paving the way for future advancements in this critical area.

III. CONCLUSION AND FUTURE WORK

The conclusion synthesizes the key findings across the studies, highlighting common themes and insights. It emphasizes the importance of considering risk interdependencies, filling knowledge gaps, and adopting innovative methodologies for effective risk management in construction projects. The potential global applicability of the research outcomes is underscored, along with the practical implications for industry practitioners and decision-makers. The conclusion also suggests avenues for future research, addressing specific geographical and sectoral considerations, and encourages the continued evolution of risk management practices in the construction industry.

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