

RESEARCH ARTICLE

Enhancing residential construction safety through governance, ethics, and simulation-based risk assessment

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Abstract - Commencing construction projects in complex and dynamic environments entails substantial unpredictability and risk, both of which are further amplified by strict deadlines. In recent years, the construction sector, particularly residential housing has undergone significant transformations. In this context, implementing robust governance strategies alongside ethical practices is essential to enhance safety and mitigate operational risks. This study examines the hazards commonly encountered in residential construction projects in Kuantan, Malaysia, utilising a governance framework to strengthen safety precautions. To improve the precision of hazard and risk assessments, this research incorporates simulation modelling. We analysed empirical survey data from five construction firms to rank key hazards and potential dangers. These inputs were then used to build a simulation model that forecasts the likelihood and severity of hazard impacts under different governance scenarios. The simulation provided dynamic insights into the efficacy of diverse safety measures and governance protocols. Results demonstrate a significant reduction in hazard probability when strong governance frameworks and ethical standards are applied, validating the model's predictive capabilities. Ultimately, this study underscores the value of integrating simulation models with traditional risk assessment techniques to advance safety, compliance, and sustainability in residential construction management.

Article History

Received : 13 September 2025

Revised : 3 December 2025

Accepted : 24 May 2026

Published : 30 June 2026

Keywords

Governance

Risk management

Hazard identification

Ethics

Construction safety

Residential construction

Simulation model

Preventive measures

1. Introduction

In recent years, the literature has increasingly focused on construction safety, highlighting the vital role of governance and ethical values in effectively managing risks and hazards. Effective governance systems ensure implementation and rigorous compliance with safety measures, fostering a culture of integrity and accountability within the organisation. Ethical concerns in risk management emphasise construction managers' responsibility to protect workers and stakeholders from potential dangers. This systematic approach to decision-making is transparent, adheres to established protocols, and proactively detects and mitigates risks. Integrating ethical governance mechanisms into hazard identification and risk assessment (HIRA) processes is essential for enhancing safety outcomes in residential construction projects. The industry operated successfully, focusing on security, sustainability, and safety. The sector recognised the risks, assessed the potential dangers they posed, and mitigated them to a controllable extent. Infrastructure development played a crucial role in fostering growth across multiple sectors and boosting the country's GDP. Every building project inherently carries hazards that can originate from multiple sources. Every construction project entails a certain degree of risk or hazard. Regardless of scale or sector, all endeavours entail some risk. Every initiative carries some degree of danger. If risks were not adequately recognised and suitable procedures were not devised to address them, the project was likely to fail. Continuous study was necessary to conduct ongoing risk assessments. Risk assessment is a valuable method for identifying and effectively managing hazards that may arise during a project (Shinde & Rewane, 2020). Regardless of the field, every occupation involves some degree of risk, and managers, employers, and business owners are responsible for taking measures to minimise it. The construction industry was no exception. Managing construction projects can be challenging because it requires effectively navigating multiple risks and issues. Hazard identification and risk assessment are procedures for identifying unfavourable circumstances that may result in hazards, analysing the risks associated with those events, and typically estimating the probability, magnitude, and extent of any adverse consequences. The construction industry widely recognises that implementing various risk assessment methodologies has greatly improved the safety of complex processes and equipment. This study examines existing research on governance and ethics in construction safety, specifically how these areas contribute to improving risk management strategies and advancing project sustainability. The remainder of this paper is as follows. The second section reviews the related works. The third section explains the previous work. The fourth section presents a discussion based on the investigation. Finally, the fifth section delivers the conclusion and future work.

2. Literature Review

Effective management of workplace safety hazards is crucial in the construction sector, especially in residential construction, where unique challenges can arise. This essay explores the importance of risk assessment and hazard identification in residential projects, highlighting the need for a methodical approach to ensure worker safety and the

integrity of the building process. This study emphasises the importance of worker involvement, the implications of risk assessment methodologies, and the need for continuous monitoring and adjustment of safety measures, drawing on previous studies. Effective control of workplace safety hazards is crucial in the construction sector, especially in residential construction, where unique challenges can arise. This essay examines the importance of risk assessment and hazard identification in residential projects, highlighting the need for a methodical approach to ensure worker safety and the integrity of the construction process. This study emphasises the importance of worker involvement, the consequences of risk assessment methodologies, and the need for continuous monitoring and adjustment of safety measures, drawing on previous research. The construction sector is inherently risky, with various workplace hazards that can lead to serious injuries or fatalities. Research has shown that implementing a systematic method for hazard identification and risk assessment can significantly mitigate these risks (Jayasudha & Vidivelli, 2016).

This section provides a comprehensive examination of each element that influenced the development of hazard and risk assessment in the construction industry, with a particular focus on residential construction. This study discovered multiple aspects that are both directly and indirectly significant. Each element of this investigation is also reliable. Residential construction companies can assess project safety performance using a risk-analysis-based methodology and a quantitative tool. For this type of company, this has resulted in improved on-site safety performance (Mon, 2020). Cirovic (2009) improves readers' understanding of this targeted study by thoroughly describing each element unique to residential construction and supporting it with relevant illustrations. The main objective of risk assessment and computation is to offer decision-makers additional cost and duration options while evaluating the likelihood that the project will be completed within that range. Predicting reserves is essential to reduce the risk of going over budget. The decision-maker evaluates the risk level associated with project completion based on the facts at hand. It is crucial to monitor these indicators throughout the project and recommend remedial measures.

The HIRA study provides an organised method for assessing hazards and risks. HIRA Safety helps identify objectives for discovered hazards and provides a way to control risk. This qualitative risk assessment technique is especially helpful when a residential construction company wants to understand its risks and determine which ones need immediate attention for mitigation (Marx, 2020). HIRA is unique in that it examines operating procedures, which makes it particularly appropriate for environments with many people and operators. In the context of residential construction, factors contributing to accidents and fatalities often include the industry's physical characteristics, worker characteristics, management challenges, hazardous site conditions, and unique industry dynamics (Rafindadi et al., 2022). Including more information focused on residential building could highlight the specific risks and safety issues this industry faces. Research on residential site conditions, labour demographics, and management practices, for example, could further clarify the need for specialised risk assessment methods.

2.1 Hazard and Risk Assessment

Hazards significantly affect the budget, schedule, and quality of a residential construction project. Effectively mitigating risk during the building process has become increasingly crucial to prevent unforeseen outcomes, especially in large-scale projects with rapid progress. A risk assessment is a systematic method for evaluating work operations, identifying potential hazards, and selecting appropriate measures to prevent or mitigate them. These control approaches aim to eliminate, minimise, or prevent risks of loss, damage, or harm in the workplace. Ensuring staff well-being and security is essential to a project's success. When authorising and supervising a project, investigators pay close attention to the workforce's overall well-being. Conversely, accidents can cause issues or setbacks for team members or the project. Construction sites often pose significant risks that can severely impact workers' health and safety. These dangers can be mitigated by implementing appropriate controls that require personal inspection and evaluation. In the future, a deep understanding of these hazards can enable their identification, analysis, and prediction, allowing avoidance, removal, or minimisation (Alateeq, Rajeena, & Ali, 2023).

The risk assessment process should be utilised to identify and evaluate viable control methods for managing hazards in the construction industry. The project aims to identify hazards to the well-being and security of workers and other individuals, and to determine which concerns require a different assessment approach. The project must be completed without compromising the health and safety of any of the involved parties. Certain hazards, either because of their complexity or specific regulatory requirements, require a distinct strategy. Project managers should thoroughly review the recommended noise guidelines and conduct a noise risk assessment if noise is identified as a potential hazard during the risk assessment (Public Health Scotland, 2020).

Hazards significantly affect the cost, timeline, and quality of residential construction projects. It is more important than ever to mitigate risk effectively during the construction process, particularly for large-scale, fast-moving projects (Alateeq et al., 2023). Risk assessment is an organised approach to assessing work processes, identifying risks, and selecting appropriate countermeasures. These control strategies seek to remove, reduce, or avoid hazards that pose risks of loss or damage at work. Any project's effective completion depends on the safety and well-being of its employees. Investigators consider the workforce's overall well-being when approving and overseeing a project. On the other hand, injuries may cause issues or delays that affect team members and the project overall. In the future, hazard analysis, identification, and prediction can be achieved by gaining a deep understanding of them, allowing avoidance, removal, or minimisation. Construction sites frequently pose significant risks that can seriously affect workers' health and safety. Anticipating these hazards requires implementing appropriate controls that involve personal inspection and evaluation (Alateeq et al., 2023). The risk assessment process should be used to identify and evaluate effective control methods for managing hazards specific to residential construction. The project aims to identify risks to the health and safety of

employees and others and determine which issues require a different evaluation methodology. The project must be carried out without endangering the participants' health or safety. Some risks require customised approaches because of their complexity or specific legal requirements. For instance, project managers should carefully review the suggested noise guidelines and conduct a noise risk assessment if noise is identified as a potential hazard during risk assessment (Public Health Scotland, 2020).

Legally, all organisations must conduct risk assessments, and with the construction industry's recent explosive growth, those associated with construction sites have become increasingly significant. Even when risks or hazards occur, many are ignored or acknowledged only after they happen. According to the Saudi Arabian Health and Safety Association, work-related events in the construction sector cost the sector more than SAR 370 million in hospital bills in 2016. Regardless of their severity, workplace injuries affect employees, their families, and the project's budget and timeline. To improve the safety, effectiveness, and intelligence of construction projects, several initiatives have been started in response (Alateeq et al., 2023). Every organisation is legally required to perform risk assessments. Risk assessment at building sites has become a major issue due to the rapid expansion of the construction sector over the past decade. Despite accidents, they sometimes go unnoticed or are discovered only after a significant amount of time has passed. The Saudi Arabian Health and Safety Association reported that the construction industry incurred medical expenses exceeding SAR 370 million in 2016 due to work-related incidents. Workplace injuries affect workers, their relatives, and the project's budget and schedule, regardless of injury severity. In recent years, multiple initiatives have been established to ensure the safety, efficiency, and intelligence of building projects (Alateeq et al., 2023).

Figure 1
Types of hazards and risks



Source: Laura De Prete (2022)

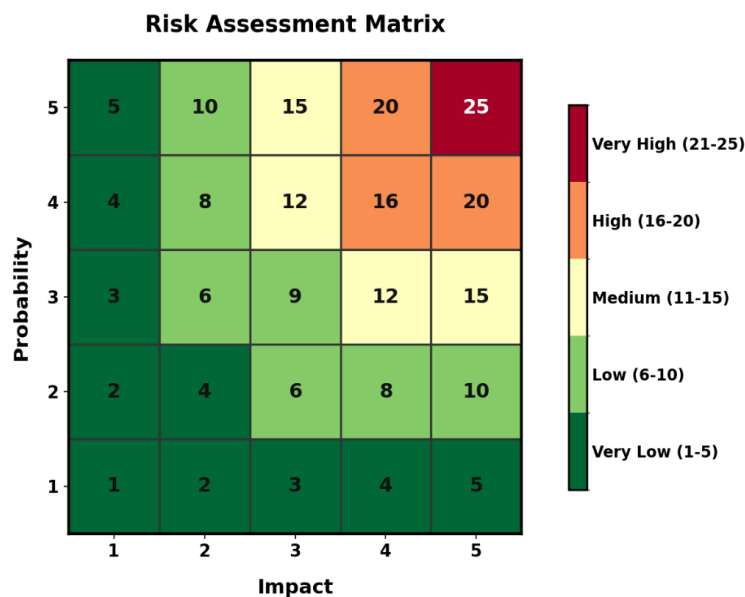
Figure 1 depicts the various categories of hazards and risks. Dehdashti (2020) shows that risk is associated with certain events and locations within learning environments, based on evaluations of potential dangers. The Conoco study defines at-risk behaviours as actions that deviate from established safety protocols, training, and equipment specifications, and that occur on at least 300,000 occasions per fatality. The event referred to is the 2023 WisCon. Event frequency refers to how often it occurs within a specific period, or the total number of times it occurs. A hazard refers to any factor that poses a potential danger or risk to individuals, objects, or the surrounding environment. Dangers can include not only physical hazards but also chemical, biological, or psychological ones. Potentially dangerous elements and circumstances can exist in both natural and man-made environments. Once this is determined, assess the actions needed to effectively remove or manage the potential risk of this event. When assessing a risk in residential construction projects, it is important to examine the potential impact on individuals and objects, as well as any preventive steps that might be taken.

2.2 Hazard Identification

This section, with reference to Figure 2, discusses recent case studies and ongoing projects aimed at deploying HIRA. The risk matrix is based on two key criteria: the probability of hazards arising in the residential construction project and the average severity of those risks. A risk matrix is a tabular tool used in risk assessment to quantify risk by juxtaposing frequency categories with average severity categorisations. This strategy is a direct, straightforward method to improve risk detection and support management decision-making. According to the hierarchy of control, when risk is high, it is important to act promptly to mitigate existing hazards. A medium risk requires implementing temporary solutions as needed and adopting a systematic approach to mitigate hazards. A risk that has been determined to have a low level of assessment may be considered acceptable and, if not necessary, decreased.

Figure 2*Identification of hazards by HIRA, Marx (2020)***2.2.1 Proposed actions of hazard and risk assessment**

Generally, recognising the importance of proactive, team-based risk assessment is essential to the success of research studies, as it enables different viewpoints in identifying hazards and risks, as depicted in Figure 3. To ensure that the HIRA outputs effectively identify workplace risks and lead to successful risk mitigation, it is crucial to follow the previously defined processes strictly. Researchers can assess the relative severity of risks arising during residential development projects in the Kuantan district.

Figure 3*Proposed action of hazard and risk***2.2.2 Ranking types of hazards**

By ranking or prioritising risks, it becomes possible to determine the most significant risk and, thus, identify which one should be addressed first. The indicated quantity scales are model parameters used in semi-quantitative analysis. Rather than producing precise risk estimates, as in quantitative analysis, the goal is to create a ranking scale that is more adaptable than is often achieved in qualitative research. Construction sites are perilous settings where workers are susceptible to injury or illness. These injuries can arise from incidents such as falling from a significant height, experiencing electric shock, sustaining injuries from tools, machinery, or construction trucks, being injured while manually handling objects, or falling ill due to exposure to hazardous substances like chemicals or dust. (Siddiqui, Nandan, & Yadav, 2020). A hierarchy of hazard outcome measures was established using statistical methods to rank them by importance to specialists in the field. The risk assessment process is a multi-step procedure that identifies and analyses potential risks and hazards that could affect the level of risk in a residential construction project. This technique is customised according to specific requirements. Once a hazard has been recognised, it is crucial to evaluate the probability and potential magnitude of harm or injury before deciding on the most effective approach to mitigate the risk. High-risk hazards require faster attention than identified low risks. Researchers may identify a range of potential outcomes associated with the same risk. Assess

the probability of each possible outcome for every danger and determine the one with the greatest importance. Priorities can be determined through risk assessment and hazard identification, in which the most perilous situations are addressed first, while less probable and less likely to cause substantial problems are studied later. (Sabu 2021).

When evaluating the risk posed by a potential hazard, researchers must carefully analyse the factors of how, where, how much, and how long workers are likely to be exposed to it. Assess the risk associated with the hazard using a risk matrix. A risk matrix can be used to assess the risk level associated with each hazard by considering factors such as the probability of occurrence and the severity of physical hazards. Conducting an environmental evaluation allows for the assessment of potential risks and their impacts on the residential construction project. It is advisable to use specialised tools for specific tasks, such as hazard reporting software to promptly communicate identified hazards, excavation safety software to reduce the likelihood of excavation-related accidents, or a versatile tool that combines the general function of these applications (Bakar et al., 2018). Once a hazard is discovered, it is crucial to assess the risk it poses to workers on the residential building project. Researchers can then assess the level of danger and determine the necessary actions based on urgency. The risk assessment step examines the probability and severity of each indicated hazard (Valerie Fernandez et al., 2021). After assessing the likelihood and consequences of each hazard, researchers can prioritise how to address them. Furthermore, risk assessments commonly use a risk matrix to quantify risk by assessing the seriousness and likelihood of a worker's harm from exposure to a hazard. In order to ascertain the appropriate safety precautions to mitigate or manage specific hazards, as well as to establish the priority of these measures based on their occurrence rate and potential impact on the construction project.

3. Methodology

The primary objective of the research is to identify the risks and hazards associated with residential construction projects. Using a quantitative research method is perceived as highly beneficial for addressing the challenges encountered during the study. The literature review serves as the initial stage in the research process, aiming to detect potential risks. The data obtained for the literature review are derived from prior studies. The collected data can be utilised to conduct research and make advanced comparisons, drawing on prior investigations into risk and hazard. Subsequently, the researcher conducted 5-point Likert scale assessment (see Table 1) using a questionnaire sent via official email to building firms in the Kuantan district. The researcher assessed the data gathered from examining the deliverables, deadlines, achievements, and evaluations of each completed residential building project. The researchers analysed the collected data using Excel. To verify the reliability of the tested variables as accurate representations of the variables being analysed, it is necessary to evaluate the research project's success by comparing the maximum degree of risk and danger during construction with the actual variables. This investigation follows an examination of the concept of "hypothesis testing." The analysis used the HIRA technique to collect data and determine the sample size. Consequently, a minimum of five firms have been approached to partake in this research. Microsoft Excel is used to construct a risk matrix to quantify risk and identify the most prevalent hazard in residential construction projects. Quantitative methods apply to various areas of risk management and are recommended over alternative methods. Research design is a systematic approach for collecting, analysing, interpreting, and presenting data in a research investigation. A practical approach is to incorporate conceptual research concepts into feasible empirical research. In other words, the study's methodology details the techniques used to collect and assess relevant data, as well as how this knowledge was applied to address the study's questions. The study established a hierarchy of market risk variables using statistical approaches to determine their relative importance for professionals in the field. Ultimately, the study conducted a comprehensive examination and discussion of the results, comparing the survey outcomes with those of the literature review on the dangers associated with hazards.

Table 1

The Likert scale example used in the questionnaire

Very Low	Low	Medium	High	Very High
1	2	3	4	5

4. Results and Discussion

The study aims to survey construction companies involved in residential construction projects in Kuantan. These companies will be requested to complete a questionnaire. Table 2 presents the research's demographic data on the respondents' profiles, including their position in the company, educational degree, gender, age, and work experience. The investigation was conducted based on responses from 5 participating companies: Builmann Construction Sdn Bhd, Pancaran Dinar Sdn Bhd, Tarmac Builders, MRA Pro Team SB, and Wong Fook Construction Sdn Bhd. The results show that most respondents have expertise in managing highly competent individuals associated with risk, demonstrating their understanding of this field. Most of the educational attainment is in the form of academic degrees, with three companies recruiting individuals who have completed undergraduate programs and two organisations hiring people who have obtained graduate degrees. Most individuals have 5 to 20 years of professional experience. The respondent with the most extensive experience is from Wong Fook Construction Sdn Bhd, with 20 years of industry experience. Most respondents were male, at 80% of the total. Analysis of the participants' responses showed that all risk indicators had an average value of at least 2 on the Likert scale. Experts in the construction sector typically considered all market risk factors significant and relevant to the company's risk analysis.

Table 2

Conceptual demographic information

	Buildmann Construction Sdn Bhd	Pancaran Dinar Sdn Bhd	Tarmac Builders	MRA Pro Team SB	Wong Fook Construction Sdn Bhd
Position in company	Safety & Health Officer	Safety & Health Officer	Admin	Manager	Clerk
Education level	Degree	Degree	Diploma	Diploma	Diploma
Gender	Male	Male	Female	Male	Female
Age	38	34	30	39	40
Working Experienced	14	11	5	17	20

4.1 Likelihood and Severity of Risk Matrix

A quantitative survey conducted across 5 construction companies identified 25 hazards. These hazards were then assessed using a risk matrix that included their severity and probability, resulting in 5 distinct risk levels. Figure 4 presents this information. This corresponds to risk levels ranging from extremely low to very high. The workplace risks were ranked by the elements with the greatest impact: the highest-ranking risks were attributed to the factors that contributed the most, while the lowest-ranking risks were associated with the factors that contributed the least. Higher numerical values indicate greater significance and a greater influence on safety accidents, while lower values indicate less relevance. The pertinent variables were organised in descending order of significance, determined by the average ranking number assigned to each element.

The display shows scales of 5 degrees for seriousness and probability, and 5 degrees for risk. The danger level ranged from very low to very high, with low, medium, and high levels in between. The risk matrix evaluation is created by utilising likelihood and severity data collected from respondents who completed the questionnaire. The acquired data is organised based on the predetermined level of risk. The risk matrix is based on the probability of risks occurring in the construction sector and the average severity of those hazards. A risk matrix is a tabular tool utilised in risk assessment to evaluate risk by comparing the average severity classification with the frequency category. This method provides a rapid, straightforward way to improve the detectability of potential hazards and support management decision-making. According to participants' responses, all risk factors were recognised, and their average Likert-scale score was above 3.

Figure 4

Hazard level using risk matrix assessment

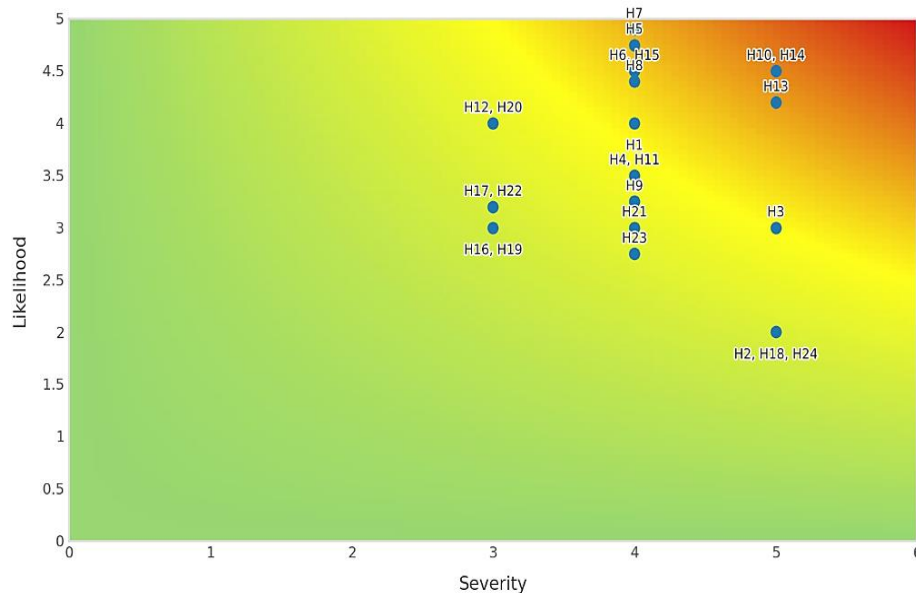


Table 3 presents the rankings of hazard frequency across the questionnaire items. The finalised questionnaire was disseminated through several methods, including online distribution and submission to various companies in Kuantan, Pahang. The frequencies derived from the respondents' answers are presented below, with a ranking scale from 1 (lowest) to 5 (highest). In another section of the questionnaire, participants were asked to estimate how often each hazard might occur. Participants estimated the statistical occurrence rate of each hazard in the construction sector, rather than its severity or likelihood. Participants were instructed to classify risk- and hazard-related components to prioritise them. The research aimed to identify the predominant risk in the construction industry and quantify its frequency of occurrence. The rankings were based on the elements respondents identified as the most significant factors contributing to the industry's most frequent risk.

4.2 Discussion

This study aims to use the probability and risk matrix to determine the prevalence of risks in the construction industry. This method has been employed to identify the prevalent categories of risks and hazards encountered in building projects, specifically those related to residential construction. The objective is associated with ten significant risks: a potential change in top leadership during the project's implementation; lack of prior experience with similar projects; management challenges leading to project delays; difficulties in accessing the construction site due to its remote location; potential issues arising from a nearby project; electrical fires; insufficient feasibility study for the project; poor water quality; multiple design modifications during project execution; and material loss caused by workers (Bakar et al., 2018). The study also identifies risk factors associated with a detrimental risk classification. The results for each risk are displayed in Table 3. The second goal is to assess the risk level of potential hazards that may arise in residential construction projects and determine their frequency. The risk matrix is derived from the probability of risk occurrence in the construction industry and the corresponding average level of seriousness associated with those hazards. The risk assessment matrix visually represents the risk analysis and categorises risks by likelihood, impact, or severity. This has enabled the organisation to understand how risk assessment approaches influence the magnitude of risk in residential construction projects.

Table 3

Ranking for frequency of occurrence of hazards based on questionnaire items

Category	Risk factors	Response				
		Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
Safety hazard	Improper handling of machinery and materials.	5	4	1	3	1
	Electrical fires occurred.	3	3	1	2	1
	Working on unsafe scaffolding	5	4	1	4	1
	Working at height without using protection systems	5	4	1	2	1
	Lack of awareness and understanding of the importance of safety can cause risks on construction sites.	4	4	5	4	1
Physical hazard	Extreme noise can cause hearing damage.	3	4	5	2	1
	Falls, slips, and trips can lead to serious injuries	5	4	5	4	1
	Poor quality of materials procured due to damage to equipment	4	4	5	2	1
	Wastage of materials by workers.	2	3	2	4	1
	Take action against workers who are negligent and do not follow SOP to maintain safety while working.	4	4	5	3	5
Chemical hazard	Unlabelled liquids at the workplace.	5	4	1	2	1
	Breathing problems due to harmful gases.	4	3	1	3	1
	Flammable substances are well maintained.	4	3	5	4	5
	Chemicals are used according to the SOP.	4	3	5	4	5
	Volumes of flammable liquids pose a huge fire risk.	4	3	5	3	1
Management risk	Change of top management during project progress.	3	2	1	2	1
	No experience in similar projects.	3	2	1	2	1
	Improper project feasibility study.	4	2	1	2	1
	Project delay due to a management problem.	3	2	1	2	1
	Specialists in project financial analysis are not employed.	4	2	1	4	1
Environmental risk	Natural disaster (floods, soil erosion, earthquakes, etc.).	3	3	2	3	1
	Difficulty accessing the construction site (Very far from settlements)	2	3	1	2	1
	Many design modifications are made during execution.	4	3	1	2	1
	Poor water quality.	3	3	1	2	1
	Problems from a nearby project.	3	2	1	2	1

The primary objective of this research is to help organisations and project managers develop effective security strategies and improve partner understanding in residential construction projects. The main tasks involve identifying, implementing, and assessing the effectiveness of the planned response, as well as evaluating and monitoring any changes

to response management priorities and risk assessment and hazard categories. This is essential to ensure that individuals involved in the risk identification process can maintain their focus on the diverse range of threats and risk assessments. The project's primary objective is to identify potential risks and hazards that may arise during the construction of a residential building. Subsequently, the assessment may focus on determining the viability of certain alternatives. The research findings suggest that risk management systems can significantly improve project performance in the construction industry by acting as a complementary or synergistic element.

5. Conclusion

This research was limited to construction companies specifically involved in residential projects in the Kuantan area. The construction businesses successfully integrated risk into their project management processes. This research identifies the primary risk elements in the construction firm. We conducted an online survey to evaluate 25 factors that influence building hazards. The researchers administered the survey via a Google Forms questionnaire. The researchers identified the top 10 risk factors and subsequently determined both the most important and least significant dangers. To ensure timely completion of our project, they can schedule and plan by identifying both the highest- and lowest-risk elements. It can be inferred that the research objective was achieved, and that the data were thoroughly analysed. The risk matrix provides a way to quantify the risk levels associated with the most prevalent hazard. Therefore, the results of this section have been empirically validated and are expected to enhance understanding of the relationships among construction safety, industry workers, and policymakers. Construction management must make decisions based on risk assessments.

The critical stages for project success are identifying and assessing risks. Consequently, they acquire a more comprehensive comprehension of building site safety. Ultimately, the proposed model is important to the construction industry, as it offers insights into risk mitigation and the identification of relevant elements. Anyone working in the construction industry must understand the detrimental impact of hazards on the business. Furthermore, it affects the safety of construction workers. Conducting risk assessments and making informed decisions are crucial aspects of construction management. Identifying and assessing project risks are crucial elements of effective project management. Furthermore, further research is imperative, as the current study examined only a portion of the variables crucial to managing building projects in Malaysia and the country's long-term development trajectory. Further research can explore how risk management approaches influence project performance quality and impact, as well as additional variables.

Acknowledgements

The authors sincerely thank Universiti Malaysia Pahang Al-Sultan Abdullah and Universiti Tenaga Nasional for their support in this project.

Funding

This study was not supported by any grants from funding bodies in the public, private, or not-for-profit sectors.

Declaration of Competing Interests

The author declares no conflicts of interest.

CRedit Authorship Contribution Statement

Fatimahtun Zaharah Ahmad Salleh Hudin: Conceptualisation; Methodology; Writing-original draft

Noor Akma Abu Bakar: Methodology; Analysis; Visualisation; Writing-review & revise

Che Akmal Che Yahaya: Methodology; Analysis; Writing-review & revise

Fadzida Ismail: Investigation; Investigation; Verification; Writing-review & revise

Availability of Data and Materials

The data supporting this study's findings are available on request from the corresponding author.

Ethics Declarations

This study did not involve human participants or animals. Ethical approval was therefore not required.

Generative Artificial Intelligence Declarations

The authors claim that artificially intelligent-assisted technologies, such as generative AI, were not used to generate content, ideas, or theories. We have just utilised AI to enhance readability and refine the language. We used it under strict human control and oversight. The authors take full responsibility for reviewing and approving the content.

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