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Analysis Of Occupational Safety And Health (Osh) Risk Management In The Advanced Phase Of A High-Rise Building Construction Project

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Abstract

This study aims to analyze the implementation of Occupational Safety and Health (OSH) risk management during the advanced phase of a high-rise building construction project. The study employed a descriptive qualitative approach through field observations and literature review. Workplace accident analysis was carried out using the Injury Frequency Rate (IFR) and Injury Severity Rate (ISR), supported by Poisson distribution analysis to predict accident probability. Risk identification and assessment were conducted based on the AS/NZS 4360:2004 standard. The results showed that no workplace accidents occurred during the observation period, resulting in an IFR value of 0 with a total of 110,160 working hours recorded. Meanwhile, the ISR analysis indicated only 4 lost workdays, showing that the incidents occurring during the project were relatively minor. The study also identified several potential occupational hazards during the advanced construction phase, particularly related to work at height and overlapping activities between subcontractors. This study contributes by integrating statistical accident prediction using the Poisson distribution with qualitative risk assessment based on AS/NZS 4360:2004 in high-rise construction projects. The findings indicate that consistent implementation of OSH risk management can minimize workplace accidents and support safer construction operations in high-rise building projects.

Keywords: Occupational Safety and Health (OSH), risk management, high-rise construction, IFR, ISR

1. INTRODUCTION

The construction of high-rise buildings has become an important part of urban development in developing countries such as Indonesia. Increasing population growth and limited land availability have encouraged the development of vertical infrastructure with higher levels of complexity and risk (Vitrano et al., 2024). High-rise building construction projects involve various work activities carried out simultaneously, requiring careful planning and strict implementation of Occupational Safety and Health (OSH) management (Tejamaya et al., 2021). In particular, the advanced phase of construction is considered one of the most critical stages because activities such as mechanical, electrical, plumbing, façade installation, and interior finishing are conducted concurrently within limited work areas and at considerable heights (Giménez et al., 2024). The complexity of activities during the advanced construction phase increases the potential for workplace accidents (Gómez-García et al., 2025). Workers are exposed to various hazards, including falls from height, falling materials, electrical hazards, and unsafe interactions between subcontractors operating in the same area (Jakobsen et al., 2025). Historically, n Indonesia, the construction sector continues to contribute significantly to workplace accident cases, particularly in high-rise building projects where coordination and safety supervision remain major challenges (Walujodjati and Rahadian, 2021). Several construction accidents reported in recent years indicate that weak hazard identification, lack of supervision, and inadequate implementation of safety procedures are still among the main causes of workplace incidents in construction projects. (Muhammad and Susilowati, 2021).

Effective Occupational Safety and Health (OSH) risk management is therefore essential to minimize workplace accidents and support the smooth implementation of construction activities (Tamim and Ismail, 2020). The implementation of safety management during the advanced phase requires not only compliance with formal regulations, but also continuous supervision, clear communication, and strong coordination among all project stakeholders (Anwar et al., 2016). This includes continuous hazard identification, routine safety briefings, and strict implementation of permit-to-work systems, particularly for high-risk activities such as work at height, lifting operations, and electrical installations (Permata Sari et al., 2022). In addition, safety awareness among workers and strong commitment from project management play important roles in creating a safer working environment (Rethyna, 2018). Routine inspections, hazard reporting systems, and emergency preparedness measures are also necessary to ensure that potential risks can be controlled properly during project execution (Marwah et al., 2024).

Given these challenges, it is also important to recognize that the effectiveness of OSH risk management cannot be separated from how well it is integrated into daily project operations (Hudoyo et al., 2025). In many cases, safety procedures are formally established but not consistently implemented on site due to gaps in supervision, limited resources, or differing levels of understanding among workers. This indicates the need for a more grounded evaluation that not only reviews documented safety plans but also examines actual practices in the field (Ramajayanti et al., 2023). Attention should be given to how risks are communicated, how workers respond to safety instructions, and how quickly corrective actions are taken when unsafe conditions are identified. Furthermore, the involvement of all project stakeholders plays a decisive role in ensuring that risk management measures function as intended (Juan Leonardo, 2023). Contractors, subcontractors, and site supervisors must share a common perspective on safety priorities to avoid fragmented implementation. Coordination meetings, routine inspections, and feedback mechanisms are essential to bridge potential gaps between planning and execution (Tong et al., 2025). By strengthening this collaborative approach, OSH management in the advanced phase can move beyond compliance and towards a more responsive system that adapts to the evolving conditions of high-rise construction project. In addition, organizational commitment plays a crucial role in shaping how safety is prioritized throughout the project lifecycle. Management decisions related to time, cost, and resource allocation often have a direct impact on safety performance. When safety is treated as an integral part of project success rather than an additional requirement, it is more likely that sufficient attention and resources will be allocated to risk control measures (Badal et al., 2025). This includes providing adequate supervision, maintaining equipment reliability, and ensuring that safety standards are not compromised in pursuit of deadlines (Hauke et al., 2022). A strong commitment from top management can also influence the attitudes of all personnel on site, creating a more consistent and accountable safety culture (Wulandari et al., 2024).

Previous studies on construction safety management have generally focused on hazard identification and qualitative risk assessment in construction projects (Rantala et al., 2024). However, limited studies have specifically evaluated Occupational Safety and Health (OSH) risk management during the advanced phase of high-rise building construction by integrating Injury Frequency Rate (IFR), Injury Severity Rate (ISR), Poisson distribution analysis, and qualitative risk assessment based on AS/NZS 4360:2004 (Pribadi et al., 2024). Therefore, a more comprehensive analysis is needed to better understand the effectiveness of safety management implementation during this critical phase of construction work. Based on these considerations, this study aims to analyze the implementation of Occupational Safety and Health (OSH) risk management during the advanced phase of a high-rise building construction project (LIN et al., 2026). The study evaluates workplace safety performance using IFR and ISR indicators, applies Poisson distribution analysis to estimate accident probability, and conducts qualitative risk assessment based on the AS/NZS 4360:2004 standard (Afonso-Fernandes et al., 2026). The findings of this study are expected to provide practical insights that can support the improvement of safety management implementation in similar high-rise construction projects. (Alfaries et al., 2026).

2. METHOD

This study employs a qualitative approach using descriptive methods. This approach was chosen to identify and analyze potential risks and hazards, as well as to evaluate the implementation of SMK3 in building construction projects. The descriptive method serves to describe the conditions or problems occurring in the field. Through this approach, the research's line of reasoning is directed toward comprehensively understanding the issues and seeking relevant solutions based on field findings. The primary focus of the research lies in the analysis of occupational safety aspects, supported by survey activities and a literature review. Data collection was conducted through direct observation in the field, as well as a review of various relevant literature sources, so that the data obtained could provide a more complete picture of the conditions under study.

This high-rise building construction project is located in East Java and is part of the region's ongoing infrastructure development. The project site was selected with consideration for the need for adequate facilities and ease of access for the surrounding community. The construction is designed to meet technical and functional standards in accordance with its intended use. In its implementation, this project involves various stages of construction work, ranging from preparatory work, structural work, to architectural and utility work. Each stage carries different potential occupational risks, necessitating the consistent application of an Occupational Safety and Health Management System (OSHMS). This aims to minimize the likelihood of workplace accidents and ensure the safety of all workers involved in the project. Additionally, the surrounding environmental conditions of the project are also a key consideration, encompassing safety, comfort, and the impact on the local community. Therefore, regular monitoring and control of project execution are conducted to ensure the project proceeds as planned, on schedule, and continues to prioritize workplace safety. The research location is shown in Figure 1 below.

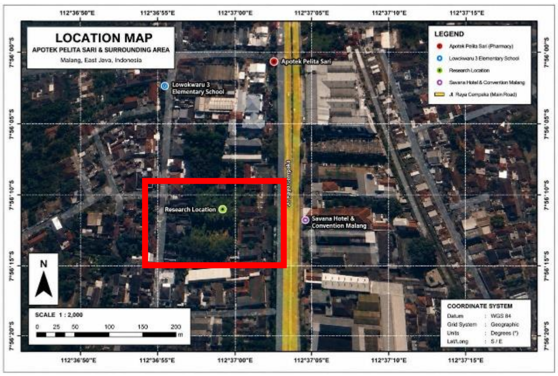

Fig. 1 Research Location Map

3. DISCUSSION

3.1 Analysis of Workplace Accidents Using ISR and IFR Calculations

Workplace accident analysis is a crucial step in evaluating safety performance on a construction project. Through this analysis, it is possible to determine how frequently accidents occur and the extent of their impact on the workforce. Consequently, the results of the analysis are not only used for evaluation but also as a basis for developing preventive measures to minimize similar incidents in the future. In this study, workplace accident analysis was conducted using the Injury Frequency Rate (IFR) and Injury Severity Rate (ISR) indicators. IFR is used to measure the frequency of workplace accidents over a specific period, while ISR is used to assess the severity of accidents based on the number of workdays lost due to the incident. These two indicators provide a more comprehensive picture of workplace safety conditions on-site.

To support risk control efforts, the Poisson distribution approach was used as a statistical method to predict the likelihood of accidents occurring. This method helps in understanding accident patterns so that preventive measures can be planned more effectively. Additionally, workplace safety performance is analyzed through the accident frequency rate and the accident severity rate, respectively describe the intensity of incidents and the resulting impact. Then, the analysis is performed using the following formulas:

Injury Frequency Ratio (IFR) =

$$\frac{Number\ of\ workplace\ accidents\ x\ 1{,}000{,}000}{Number\ of\ person-hours\ worked}$$

And also the formula:

Injury Severity Ratio (ISR)=

$$\frac{Number\ of\ lost\ time\ x\ 1{,}000{,}000}{Number\ of\ person-hours\ worked}$$

The next step is to evaluate workplace accidents by calculating several key indicators, namely:

1. Injury Frequency Rate (IFR), which is a measure used to determine how frequently workplace accidents occur within a specific period. This calculation is based on data regarding the number of employees, total working hours, and the number of accidents that occurred on-site.

2. Injury Severity Rate (ISR), an indicator that describes the severity of workplace accidents that occur. This value is obtained by comparing the number of workdays lost due to accidents with the total available working time, thereby providing an overview of the impact of accidents on overall work activities.

Table 1. Table of workplace accidents, number of workers, and working hours

No.	Month	Number of accidents	Number of workers	Number of work hours	Number of lost days
1.	July	0	90	18000	1
2.	August	0	90	18720	1
3.	September	0	90	18000	1
4.	October	0	90	18720	0
5.	November	0	90	18720	0
6.	December	0	90	18000	1
	Jumlah	0	540	110.160	4

Based on the data obtained, a calculation of the frequency ratio of work-related injuries was conducted, starting in July 2025.

Table 2. Table of IFR and ISR Results

No.	Month	IFR	ISR
1.	July	0	55,5
2.	August	0	53,4
3.	September	0	55,5
4.	October	0	0
5.	November	0	0
6.	December	0	55,5

Based on the data and number of workplace accidents in Table 2, no accidents occurred during the project period; therefore, it can be stated that:

$$\lambda = \frac{occurrence\ of\ an\ accident}{month/year}$$

$\lambda \frac{0}{6} = 0$

With an average incident rate of 0, the probability or likelihood of a workplace accident occurring over a one-year period can be considered negligible. This indicates that work activities during the project were conducted safely. Furthermore, assuming that workers' daily working hours are 8 hours, the probability of an accident remains at 0. This means that during this period, there were no indications of workplace accidents, so the implemented workplace safety system can be said to be functioning effectively.

3.2 Risk Identification AS/NZS 4360

Once all potential hazards at each stage of high-risk work have been successfully identified, the next step is to conduct a qualitative risk analysis in accordance with the AS/NZS 4360:2004 standard. This analysis is conducted by considering two main aspects: the likelihood (probability) of a risk occurring and the severity of the resulting impact (consequences).

Through this approach, the risk level of each identified potential hazard can be determined. The results of this assessment are then used as the basis for determining the probability of occurrence and the severity of consequences for each risk in high-risk work. The results of this risk processing and assessment refer to research conducted by Muhamad Aqila (2023), which is further presented in tabular form, as shown in Tables 3 and 4 below.

Table 3. Likelihood Table

Level	Explanation	Definition
1.	Rare	Almost impossible
2.	Unlikely	Sometimes happens
3.	Possible	Might happen
4.	Likely	Very likely to happen
5.	Almost certain	Almost certain to happen

Table 3 outlines the classification of the likelihood of workplace risks to illustrate the probability of undesirable events occurring. Level 1 (Rare) indicates that the risk is highly unlikely to occur. Level 2 (Unlikely) means the risk still exists but is very rare and occurs only under specific conditions. Level 3 (Possible) indicates that the risk is likely to occur if triggering factors are present. Level 4 (Likely to Occur) has a high probability and is frequently encountered in similar jobs. Level 5 (Almost Certain) indicates that the risk is almost certain to occur, particularly in high-risk jobs without adequate controls. This classification makes risk assessment more systematic and helps determine control priorities.

Table 4. Table of Consequence Levels

Ratting	Severity	Description
5	Catastrophic	Significant financial loss or resulting in the death of a worker
4	Major	Significant financial losses or injuries to workers that need to be addressed
3	Moderate	Disruptions to work and medical care can be addressed at the site of the incident
2	Minor	The financial loss is minimal; first aid is needed
1	Insignificant	The financial loss was very small and did not result in any injury

Table 4 outlines the consequence levels of potential risks in a given job. This table is used to assess the magnitude of the impact if a risk were to actually occur, ranging from financial losses and work disruptions to worker safety. At the lowest level, rating 1 (Insignificant), the resulting impact is very small. Financial losses are negligible and do not result in worker injuries. Next, at rating 2 (Minor), the impact is still considered mild, typically involving only minor losses, and any injuries can be adequately addressed with first aid. Rating 3 (Moderate) indicates that the impact is beginning to be felt, such as disruptions to the workflow. In this situation, medical attention may be required, but it can still be provided at the scene without the need for complex follow-up care. At Rating 4 (Major), the consequences are already quite serious. The risk can lead to significant financial losses as well as worker injuries requiring further treatment. This situation usually requires special attention as it can significantly disrupt work operations. Meanwhile, the highest level a rating of 5 (Catastrophic) indicates extremely severe consequences. Risks at this level can result in massive financial losses and even loss of life. Therefore, risks with consequences of this magnitude must be a top priority in risk management.

3.3 Analysis of the Occupational Safety and Health (OSH) Management System

In the implementation of building construction projects, the application of the Occupational Safety and Health Management System (OSHMS) generally adheres to the provisions of Ministry of Public Works and Public Housing Regulation No. 21 of 2019 on the Construction Safety System. This is evident in the service providers' efforts to identify potential hazards, conduct risk assessments, and develop construction safety programs as outlined in the Construction Safety Plan (CSP) document. These provisions align with the regulations set forth in Chapter III of the aforementioned regulation. Thus, it can be concluded that the implementation of the SMKK in this building construction project has complied with applicable regulations. This is further supported by the handling of minor incidents on-site, such as a minor fire caused by worker negligence.

The incident was quickly brought under control, preventing it from escalating into a more serious situation. The emergency response measures taken demonstrate that the safety control system is functioning in accordance with regulations, including those stipulated in Article 25 regarding emergency preparedness and response. The goal of implementing this safety culture is to raise awareness of the importance of occupational safety and health, thereby creating a safer, more comfortable work environment that supports productivity throughout the building construction project.

4. CONCLUSION

Based on the results of the study, it can be concluded that the implementation of Occupational Safety and Health (OSH) risk management during the advanced stages of high-rise building construction projects has been effective. This is evidenced by the absence of workplace accidents during the study period, with an Injury Frequency Rate (IFR) of 0, reflecting a high level of workplace safety on-site. Nevertheless, there were still a limited number of lost workdays, as reflected in the Injury Severity Rate (ISR); however, these incidents were classified as minor and could be addressed quickly without causing significant impact. The hazard identification and risk assessment process, which adheres to the AS/NZS 4360:2004 standard, has helped in determining risk control priorities in a more systematic manner. Furthermore, the implementation of an Occupational Safety and Health (OSH) Management System in accordance with applicable regulations has demonstrated strong alignment in both planning and on-site implementation. Rapid response to emergencies also serves as an indicator that the implemented control system is functioning effectively. Overall, this success is attributable to effective coordination among project stakeholders and a commitment to fostering a culture of workplace safety.

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