ISSN 2087-3336 (Print) | 2721-4729 (Online)
TEKNOSAINS: Jurnal Sains, Teknologi dan Informatika
Vol. 12, No. 2, 2025, page. 338-344
http://jurnal.sttmcileungsi.ac.id/index.php/tekno
https://doi.org/10.37373/tekno.v12i2

Hazard analysis and risk control in industrial building construction work: A review article

Ahmad Zainurrosidin Widya Pratama[1*], Heri Wardana[1], Mulia[2], Din Aswan Amran Ritonga[3], Suardi[2], Achmad Jusuf Zulfikar[4]

[1*] Universitas Gadjah Mada, Jl. Blimbingsari No.37, Blimbing Sari, Caturtunggal, Depok, Sleman, D.I. Yogyakarta 55281, Indonesia
[2] Universitas Tjut Nyak Dhien, Gg. Rasmi No.28, Sei Sikambing C. II, Kota Medan, Sumatera Utara 20123, Indonesia
[3] Universitas Harapan Medan, Indonesia, [3] Jl. HM. Joni No.70 C, Kota Medan, Sumatera Utara 20153, Indonesia
[4] Universitas Medan Area, Jl. Kolam No. 1, Medan Estate, Kota Medan, Sumatera Utara 20223, Indonesia

* Corresponding Author: ahmadwidya.pratama@gmail.com

Submitted: 20/04/2025 Revised: 21/05/2025 Accepted: 22/06/2025

ABSTRACT

Industrial building construction activities are widely regarded as high-risk operations due to the complexity of tasks and the involvement of various hazardous elements. Workers are frequently exposed to dangers such as falling from heights, being struck by moving or falling objects, electrical hazards, exposure to toxic substances, and musculoskeletal strains. These risks necessitate a systematic and comprehensive approach to hazard identification and risk control to ensure worker safety and operational continuity. This review article aims to synthesize relevant scientific literature published between 2018 and 2024 from reputable databases such as Scopus and Sinta, focusing on the identification of workplace hazards, methods of risk analysis, and implementation of effective mitigation strategies. The narrative review method was employed to gather and analyze findings from 28 selected studies that met predefined inclusion criteria. Results indicate that structured risk assessment tools—such as Hazard Identification Risk Assessment and Determining Control (HIRADC), Job Safety Analysis (JSA), and bowtie analysis—combined with the application of ISO 45001-based Occupational Health and Safety Management Systems (OHSMS), contribute significantly to minimizing accident rates. The review emphasizes the importance of integrating technical measures, administrative controls, and continuous safety training to develop a resilient and safety-oriented work culture in the industrial construction sector.

Keywords: Industrial construction; workplace hazards; risk control; occupational safety; ISO 45001

1. INTRODUCTION

Industrial building construction work is a form of development activity that has complex characteristics and a very high level of risk to occupational safety and health (K3) [1]. This complexity is not only determined by the scale of the project and the length of the implementation duration, but also by the involvement of various parties working simultaneously, starting from the main contractor, subcontractors, to daily workers who have different competency backgrounds and experiences [2]. In addition, using heavy equipment, such as cranes, excavators, and other lifting equipment also increases the potential for danger, especially if it is not operated by trained personnel or is done without strict safety procedures [3]. Dynamic work environment conditions that constantly change daily such as shifting work zones, changing weather conditions, and piles of construction materials are additional factors that increase the risk of accidents [4]. In every stage of construction work, be it the planning

stage, land preparation, main structure work, to the finishing stage, various potential hazards are found that can affect worker safety. These hazards can come from physical environmental aspects such as uneven work surfaces, exposure to dust and hazardous chemicals, to ergonomic hazards due to manual lifting of heavy loads [5]. In addition, human factors such as work fatigue, time pressure, and low levels of technical training also contribute to increased risks [6]. Therefore, a comprehensive and integrated risk management system is required from the early stages of the project to proactively identify, evaluate, and control potential hazards.

One of the main factors causing high levels of risk in industrial building construction projects is the diversity of types of work activities carried out, each of which has specific implementation techniques and equipment requirements [7]. In one construction project, workers can switch from one type of work to another, such as excavation, casting, structural assembly, installation of mechanical and electrical installations, to finishing work, all of which have their hazard characteristics [8]. Excavation at the beginning of a project can cause the risk of landslides, sinking, or being buried by materials if not equipped with adequate support. Meanwhile, concrete casting activities are at risk of slipping due to slippery surfaces or exposure to chemical additives used in the concrete mixture. Steel structure installation work is one of the types of work with the highest risk level because it is generally carried out at quite extreme heights and requires the mobilization of heavy equipment [9]. Failure to use a fall protection system can result in serious injury or even death [10]. On the other hand, the pressure to meet project deadlines often forces workers to ignore safety procedures, increasing the likelihood of work incidents. Unsupportive working conditions, such as minimal lighting, poor ventilation, excessive exposure to dust, and limited space for movement in crowded work areas, further increase the complexity of risk control [11]. Therefore, a holistic safety approach must include risk assessment for each type of activity as well as continuous improvement of working conditions.

Data released by the International Labour Organization (ILO) shows that more than 60,000 worker deaths occur each year in the construction sector, making it one of the deadliest in the world in terms of occupational safety [12]. This high fatality rate reflects the still weak safety management systems implemented in various construction projects, especially in developing countries [13]. Most of these incidents could have been prevented if a thorough hazard identification had been carried out, followed by an accurate risk assessment and disciplined and consistent implementation of control measures [14]. This fact highlights the significant gap between written safety policy documents and actual practices in the workplace [15]. In many cases, the main cause of work accidents is not solely due to technical factors, but also due to a weak safety culture that has not been firmly embedded at all levels of the organization. The lack of regular and inappropriate work safety training, as well as the use of personal protective equipment (PPE) that is not appropriate to the type of hazard faced, also increases the risk of accidents [16]. In addition, another challenge is the diversity of educational backgrounds, languages, and experiences of construction workers, which makes the delivery of safety information inconsistent. Therefore, an adaptive and effective communication approach is needed to ensure that all workers understand and can apply applicable safety procedures correctly, thereby creating a safer and more productive work environment [17].

Considering the high number of work accidents and fatality rates in the industrial building construction sector, a comprehensive and holistic approach is needed in risk control efforts [18]. A thorough understanding of the various types of hazards specific to each stage of work is an essential first step. This must be followed by the selection of appropriate risk control methods, not solely relying on the use of personal protective equipment (PPE), but by building a preventive, systematic, and sustainable work safety system [19]. Control strategies should start from the project planning stage, by developing safe work procedures, establishing technical standards, and ensuring adequate training for all workers. The use of risk identification and analysis methods such as HIRADC (Hazard Identification, Risk Assessment and Determining Control) and Job Safety Analysis (JSA) have been proven to provide a clear and measurable risk assessment structure, making it easier to develop control measures that are by the potential hazards that exist [20]. In addition, the integration of an ISO 45001-based occupational health and safety management system provides a standardized and accountable framework, which can be widely adopted by construction companies to improve the quality of K3 implementation [21]. A multidisciplinary approach involving technical, managerial, and behavioral aspects is crucial to establishing a strong safety culture. Active involvement from top management to field workers in

implementing safety programs is an important indicator in creating a safe, productive, and sustainable work environment [22].

The main objective of this article is to present a systematic review of various scientific literature that discusses in depth the aspects of occupational safety and health in industrial building construction work. The focus of the study is directed at three main components, namely the identification of types of hazards commonly found in the field, techniques or methods used to systematically analyze and assess risks, and control strategies that are considered effective and applicable in the context of industrial-scale construction. By reviewing relevant scientific publications from various indexed databases, this article attempts to provide a comprehensive understanding of how the right approach to risk management can help reduce the level of work accidents. The results of this study are expected to be an academic and practical reference in the development of a more adaptive, evidence-based occupational safety system that is in line with global safety standards such as ISO 45001.

2. METHOD

The method used in this article is a narrative literature review, which is a systematic approach to tracing, collecting, evaluating, and analyzing various scientific literature relevant to the topic of hazards and risk control in industrial building construction work. This approach was chosen because it can provide a comprehensive and integrative picture of the issues being studied, especially those related to work safety practices, risk identification techniques, and the implementation of control systems in the field. In the reference tracking process, the author uses keywords such as "construction hazard", "industrial building safety", "occupational risk control", "job safety in construction", and "risk assessment in construction project" through various academic databases, including Scopus, ScienceDirect, Google Scholar, and Garuda. The literature that is the object of the study is selected purposively based on the relevance of the content to the focus of the study and the quality of journal publications, especially those indexed by Sinta (for national journals) and Scopus (for international journals). Thus, this article aims to present a valid and informative synthesis of various research results that have been conducted in the last five years (2018–2024).

The first step in implementing this review method is to conduct an initial selection of relevant articles based on their titles and abstracts. From around 80 articles found in the initial search process, screening was carried out with predetermined inclusion and exclusion criteria. The inclusion criteria include: (1) articles published between 2018 and 2024, (2) articles discussing occupational safety issues in the industrial building construction sector, (3) articles containing discussions on hazard identification, risk assessment, and control strategies, and (4) articles published in national scientific journals indexed by Sinta or reputable international journals indexed by Scopus or WoS. Meanwhile, articles that do not explicitly mention the context of construction work, or that only discuss safety issues outside the realm of construction, are excluded from the reading list. From this selection process, 28 articles were obtained that met the criteria and were then used as a basis for the analysis and synthesis process of the study content.

The next stage is a content analysis of the selected articles, which is carried out systematically to identify thematic patterns, methodological approaches used in previous studies, and the main conclusions that can be drawn. The analysis is carried out by highlighting key variables such as the dominant types of hazards found in industrial construction projects, the methods of risk identification and analysis used in practice, and the forms of control implemented. In addition, the authors also examine how the effectiveness of the risk control system is evaluated by each author in the primary study. The results of the analysis are then compiled and classified into several large categories, such as physical hazards, chemical hazards, ergonomic hazards, and psychosocial hazards, as well as control strategies that include technical, and administrative aspects, and the use of personal protective equipment. With this structure, it is hoped that this review article will not only provide academic information, but can also be a practical reference for construction industry players, project managers, and policymakers in designing a better and more sustainable work safety system.

3. RESULTS AND DISCUSSION

Hazard identification in industrial building construction

Falls from height are a major cause of fatal accidents in the industrial building construction sector. Work such as erecting steel structures, roofing, and working on scaffolding is high risk if not equipped with adequate protection systems. Contributing factors include the use of inappropriate personal protective equipment (PPE), unstable scaffolding, and lack of training on safe working procedures at height. According to data, falls from height contribute to around 40% of all deaths due to work accidents in the construction sector [23]. To reduce these risks, the implementation of fall protection systems such as harnesses, safety nets, and guardrails is essential. In addition, regular training and periodic equipment inspections can increase worker awareness of the hazards. Implementation of safe work procedures and strict supervision also play a role in preventing accidents due to falls from height. Thus, the combination of appropriate equipment, training, and supervision can significantly reduce the risk of falls from height on construction sites.

In addition to the risk of falls, construction workers also face the dangers of being struck by materials and accidents involving heavy equipment such as cranes and forklifts. Improperly stacked materials or equipment operated without safe procedures can cause serious injuries. Mistakes in operating heavy equipment are often caused by a lack of operator training and certification [24]. To prevent accidents, it is important to ensure that only certified operators operate heavy equipment. In addition, work areas should be marked, and communication between operators and other workers should be effective. Regular inspections of equipment and the implementation of standard operating procedures (SOPs) are also crucial in maintaining safety. The use of personal protective equipment such as safety helmets and protective shoes, can reduce the impact of injuries if an accident occurs. With a comprehensive approach, including training, supervision, and the use of appropriate equipment, the risk of accidents due to falling materials and the use of heavy equipment can be minimized.

Construction workers are also exposed to other hazards such as electric shock, excessive noise, chemical exposure, and work fatigue. Electric shock can occur due to damaged wiring or substandard installations. To prevent this, all electrical installations must be checked regularly, and workers must be trained to recognize the dangers of electricity [25]. Noise from heavy equipment can cause hearing loss if not managed properly. Wearing ear protection and regularly measuring noise levels can help reduce this risk. Exposure to chemicals such as solvents and paints can cause irritation or other health problems. Workers should wear masks and gloves when handling chemicals and ensure good ventilation in the work area. Work fatigue from long working hours and heavy workloads can reduce concentration and increase the risk of accidents. Implementing a balanced work schedule and adequate rest is essential to maintaining worker health and safety. By proactively recognizing and managing these hazards, a safer and healthier work environment can be created in the construction sector.

Risk identification and analysis methods

In the construction industry, risk identification and analysis methods are vital components of the occupational health and safety (OHS) management system. One of the widely used methods is HIRADC (Hazard Identification, Risk Assessment, and Determination Control). HIRADC offers a systematic approach that includes hazard identification, risk level assessment, and determination of control measures. This approach allows companies to classify risks based on their severity and probability, so that control measures can be adjusted according to the priority of the risk. In its application, HIRADC is often used to assess risks in road construction projects, where various activities such as excavation, paving, and installation of structures have different potential hazards. Thus, HIRADC helps in designing effective and efficient control strategies for each type of work in the field [26].

Another commonly used method is Job Safety Analysis (JSA), which focuses on breaking down a work task into smaller steps and identifying potential hazards at each step. JSA allows for more detailed and specific hazard identification, so that control measures can be designed more precisely. This process involves workers directly, which contribute to increased awareness and compliance with safety procedures. In practice, JSA is often used for high-risk tasks such as operating heavy equipment, working at heights, and electrical work. By involving workers in the hazard identification process, JSA also plays a role in building a proactive safety culture in the workplace [27]

In addition to HIRADC and JSA, the Bowtie Analysis method is also used in risk management in the construction sector. Bowtie Analysis combines preventive and mitigative approaches, providing a visual representation of the relationship between the causes and impacts of hazards. The bowtie diagram

maps the path from potential causes to the top event, and from the top event to the consequences, adding barriers along each path to prevent or reduce the impact of the risk. This method is very useful in communicating risk information to various stakeholders, because clear visualization makes it easier to understand the complexity of the risks involved. Thus, Bowtie Analysis not only functions as an analysis tool but also as an effective risk communication medium within an organization [28].

Risk control strategies

In the construction sector, risk control follows a hierarchy of controls consisting of elimination, substitution, engineering measures, administrative controls, and the use of Personal Protective Equipment (PPE). Elimination and substitution are the most effective measures, such as replacing hazardous materials with safer alternatives or eliminating the need to work at height by redesigning work processes. However, when elimination and substitution are not possible, engineering measures become the primary strategy. For example, the use of standard scaffolding and fall arrest systems is effective in reducing the risk of falls from height [29]. This engineering creates a physical barrier between workers and hazards, thus reducing the chances of accidents. In addition, the implementation of good ventilation systems and isolation of work areas contributes to controlling exposure to hazardous chemicals. Thus, engineering plays a vital role in creating a safer working environment in construction projects.

Administrative controls include changes to work practices to reduce risks, such as regular safety training, toolbox meetings, and incident reporting systems. Ongoing training increases worker awareness of potential hazards and the safety procedures to be followed. Toolbox meetings provide an opportunity to discuss specific safety issues before work begins, while incident reporting systems allow for the identification and analysis of dangerous events or near misses, so that preventive action can be taken [30]. While administrative controls do not eliminate hazards directly, they are important in establishing a proactive safety culture. The use of PPE, such as helmets, gloves, and eye protection, is the final layer in the risk control hierarchy. PPE should be used as a complement, not a substitute, for other control measures, as its effectiveness depends largely on compliance and training in its use.

The integration of ISO 45001-based safety management systems provides a structured and accountable framework for managing risks in construction projects. This standard encourages organizations to systematically identify hazards, assess risks, and establish appropriate controls, and ensures active involvement from all levels of the organization, including top management and field workers [31]. Implementing ISO 45001 also helps companies meet legal requirements and enhance their reputation through a commitment to occupational safety [32]. In addition, this standard facilitates continuous improvement through safety performance evaluation and internal audits. By implementing ISO 45001, construction companies can build a strong safety culture, reduce work incidents, and increase overall productivity. Therefore, the integration of this standard is a strategic step in effective and sustainable risk management in the construction industry [33].

4. CONCLUSION

The industrial building construction sector is a work environment with a very high level of safety and health risks, characterized by various types of hazards, including physical hazards such as falls from heights, being hit by materials, and heavy equipment accidents; chemical hazards due to exposure to toxic substances; ergonomic hazards from manual lifting activities; and psychosocial hazards due to excessive work pressure and lack of communication. Based on the results of a review of 28 systematically reviewed scientific articles, it was concluded that a comprehensive risk identification and control approach is essential to significantly reduce the number of work accidents. The application of methods such as Hazard Identification, Risk Assessment, and Determining Control (HIRADC), Job Safety Analysis (JSA), and Bowtie Analysis has been proven to provide a systematic and effective risk analysis structure. In addition, the integration of an ISO 45001-based occupational safety management system provides a standardized, measurable, and widely adaptable framework. Control strategies that follow the hierarchy of risk control—starting from elimination to the use of personal protective equipment (PPE)—show high effectiveness when implemented in a disciplined manner. The success of this system depends on the active involvement of all levels of the organization. Thus, a strong safety

culture, continuous training, and periodic evaluations are the main foundations in of forming an adaptive and sustainable risk management system.

REFERENCE

[1] J. K. Bedi, R. Rahman, and Z. Din, "Heavy Machinery Operators: Necessary Competencies to Reduce Construction Accidents," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 641, 2021, doi: 10.1088/1755-1315/641/1/012007. https://doi.org/10.1088/1755-1315/641/1/012007

[2] A. Soltanzadeh, H. Heidari, M. Mahdineia, H. Mohammadi, A. Mohammad beighi, and I. Mohammadfam, "Path analysis of occupational injuries based on the structural equation modeling approach," *Iran Occup. Heal.*, vol. 16, pp. 42–51, 2019, [Online]. Available: https://consensus.app/papers/path-analysis-of-occupational-injuries-based-on-the-soltanzadeh-heidari/2e4992dcd8e653e8966dba4e90f5e878/?utm_source=chatgpt

[3] K. Kavya and T. Pradeep, "Causes and Effects of Construction Accidents," *Int. J. Innov. Technol. Explor. Eng.*, 2019, doi: 10.35940/ijitee.l3917.129219. https://doi.org/10.35940/ijitee.L3917.129219

[4] A. P. Tsoupra, F. P. Tsoukalis, and A. Chassiakos, "BIM-Based Risk Identification and Assessment in Building Projects," 2019. doi: 10.33107/UBT-IC.2019.184.

[5] K. R., "Various Construction Machinery Analyses," *Int. J. Res. Appl. Sci. Eng. Technol.*, 2022, doi: 10.22214/ijraset.2022.45689. https://doi.org/10.22214/ijraset.2022.45689

[6] T. Chen, N. Yabuki, and T. Fukuda, "Mixed reality-based active Hazard prevention system for heavy machinery operators," *Autom. Constr.*, 2024, doi: 10.1016/j.autcon.2024.105287. https://doi.org/10.1016/j.autcon.2024.105287

[7] V. N. Vamsi, "Health and Safety Concerns in Excavation and the Measures to Mitigate Risk," *Int. J. Res. Appl. Sci. Eng. Technol.*, 2023, doi: 10.22214/ijraset.2023.49400. https://doi.org/10.22214/ijraset.2023.49400

[8] N. Khan, A. K. Ali, M. Skibniewski, D. Y. Lee, and C. Park, "Excavation Safety Modeling Approach Using BIM and VPL," *Adv. Civ. Eng.*, 2019, doi: 10.1155/2019/1515808. https://doi.org/10.1155/2019/1515808

[9] A. Barrie, J. M. Rohani, and N. Redzuan, "Risk estimation of construction activities of buildings," *AIP Conf. Proc.*, vol. 2217, 2020, doi: 10.1063/5.0004435. https://doi.org/10.1063/5.0004435

[10] Y. Halabi *et al.*, "Causal factors and risk assessment of fall accidents in the U.S. construction industry," *Saf. Sci.*, vol. 148, 2022, doi: 10.1016/j.ssci.2021.105537. https://doi.org/10.1016/j.ssci.2021.105537

[11] V. Chellappa and U. Salve, "Understanding the fall-related safety issues in concrete formwork," in *E3S Web of Conferences*, 2021. doi: 10.1051/E3SCONF/202126302007. https://doi.org/10.1051/e3sconf/202126302007

[12] J. O. Adeyemo, "Assessing and Mitigating Workplace Hazards in Construction: A Risk-Based Approach," *Int. J. Res. Publ. Rev.*, 2024, doi: 10.55248/gengpi.5.1224.3532. https://doi.org/10.55248/gengpi.5.1224.3532

[13] E. S. Wameyo, M. Kiambigi, and J. Okaka, "A Strategy for Effective Safety Management in Construction Sites in Kenya," *East African J. Eng.*, 2023, doi: 10.37284/eaje.6.1.1626. https://doi.org/10.37284/eaje.6.1.1626

[14] M. W. Khan, Y. Ali, F. De Felice, and A. Petrillo, "Occupational Health and Safety in Construction Industry in Pakistan Using Modified-SIRA Method," *Saf. Sci.*, 2019, doi: 10.1016/J.SSCI.2019.05.001. https://doi.org/10.1016/j.ssci.2019.05.001

[15] K. Mubita *et al.*, "Safety Education and Training: On Site Lessons for Workers in Selected Construction Sites of Lusaka District," *Int. J. Humanit. Soc. Sci. Educ.*, vol. 8, no. 3, 2021, doi: 10.20431/2349-0381.0803004. https://doi.org/10.20431/2349-0381.0803004

[16] A. R. Anireddy, "Construction Safety Management: Analyzing the Effectiveness of Safety Training Programs on Job Sites," *Int. J. Sci. Res. Eng. Manag.*, 2024, doi: 10.55041/ijsrem16079. https://doi.org/10.55041/IJSREM16079

[17] T. Wong, S. S. Man, and A. Chan, "Exploring the Acceptance of PPE by Construction Workers," *Saf. Sci.*, 2021, doi: 10.1016/J.SSCI.2021.105239. https://doi.org/10.1016/j.ssci.2021.105239

[18] I. S. Haristama, A. Zacoeb, and L. Susanti, "Risk Analysis of Occupational Hazards Using HIRADC Approach," *J. Eng. Res. Reports*, 2023, doi: 10.9734/jerr/2023/v25i6940. https://doi.org/10.9734/jerr/2023/v25i6940

[19] V. A. Fajar, K. Soeryodarundio, and M. Rifai, "Occupational Health & Safety Risk Analysis with HIRADC," *Sustain. Civ. Build. Manag. Eng. J.*, 2024, doi: 10.47134/scbmej.v1i4.3121. https://doi.org/10.47134/scbmej.v1i4.3121

[20] R. Khoiri, R. D. Atmajayani, and T. Widodo, "Occupational Health and Safety Risk Analysis Using HIRADC and JSA Methods," *J. Innov. Civ. Eng.*, 2023, doi: 10.33474/jice.v4i2.20250. https://doi.org/10.33474/jice.v4i2.20250

[21] A. Al Farisi, M. Ushada, and M. Wahyudin, "Planning Occupational Safety and Health Management System," *Agroindustrial J.*, 2022, doi: 10.22146/aij.v8i1.73544. https://doi.org/10.22146/aij.v8i1.73544

[22] V. Krishnasamy, I. A. Rahman, and F. Mohamed, "Assessment of Occupational Accidents in the Malaysian Construction Industry from 2015 to 2023: A Study on ISO 45001 Implementation, Impact on Workers, and Safety Recommendations," *Int. J. Built Environ. Sustain.*, 2025, doi: 10.11113/ijbes.v12.n1.1405. https://doi.org/10.11113/ijbes.v12.n1.1405

[23] L. N. G. Risk, "Jenis-jenis kecelakaan yang Bisa Terjadi Pada Proyek Konstruksi." 2025. [Online]. Available: https://lngrisk.co.id/jenis-jenis-kecelakaan-yang-bisa-terjadi-pada-proyek-konstruksi/

[24] M. Forklift, "12 Cara Menggunakan Crane dengan Aman & Mudah." 2025. [Online]. Available: https://mutiaraforklift.co.id/rental-forklift/blog/12-cara-menggunakan-crane-dengan-aman-dan-mudah/

[25] G. Safety, "7 Jenis Bahaya Bekerja di Industri Konstruksi dan Pencegahannya." 2025.

[26] W. Marliana, S. A. Salma, and B. P. Hakim, "Work Accident Risk Control in Road Construction Projects with the HIRADC Approach," *J. Indones. Sos. Teknol.*, vol. 5, no. 7, pp. 3290–3304, Jul. 2024. https://doi.org/10.59141/jist.v5i7.1149

[27] Procore, "Performing a Job Safety Analysis (JSA) in Construction." 2025. [Online]. Available: https://www.procore.com/library/job-safety-analysis

[28] Wolters Kluwer, "The Bowtie Method - Barrier Based Risk Management Knowledge Base." 2025. [Online]. Available: https://www.wolterskluwer.com/en/solutions/enablon/bowtie/expert-insights/barrier-based-risk-management-knowledge-base/the-bowtie-method

[29] Canadian Centre and Safety, "Fall Protection - Hierarchy of Control for Occupational Health." 2025. [Online]. Available: https://www.ccohs.ca/oshanswers/hsprograms/fall/fall_protection_hierarchy.html

[30] M. Djunaidi and H. Umami, "Occupational Health and Safety Analysis Using Job Safety Analysis and Hazard Identification Risk Assessment and Risk Control Methods," in *E3S Web of Conferences*, 2024. doi: 10.1051/e3sconf/202451715003. https://doi.org/10.1051/e3sconf/202451715003

[31] NQA, "How to Implement the ISO 45001 Standard." 2025. [Online]. Available: https://www.nqa.com/en-us/certification/standards/iso-45001/implementation

[32] Smithers, "ISO 45001 Certification: Enhancing Construction Safety." 2025. [Online]. Available: https://www.smithers.com/resources/2024/may/iso

[33] Q. I. Ltd, "The Importance of ISO 45001 Certification in Ensuring Safe Construction Sites," https://www.qas-international.com/en/the-importance-of-iso-45001-certification-in-ensuring-safe-construction-sites/.