

Job Safety Analysis for Hazard Identification in A Cement Company Warehouse Operations

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ABSTRACT

Occupational safety in warehouse environments remains a major challenge due to complex material-handling activities that involve both mechanical and ergonomic risks. This study aimed to identify and analyze potential hazards in the Procurement and Warehouse Department of PT XYZ using the Job Safety Analysis (JSA) method and to propose effective control measures based on the Hierarchy of Control. The research employed a descriptive observational approach, including field observations, interviews, and risk evaluation using the Likelihood × Severity Scoring system. The analysis identified thirteen potential hazards across seven job activities, with 43% categorized as high risk, 43% as medium, and 14% as low. The most significant risks were identified in forklift operation and manual material handling, contributing to mechanical and musculoskeletal hazards. The study concludes that the JSA method effectively provides a structured framework for risk identification and prioritization. The implementation of engineering, administrative, and ergonomic controls is essential to enhance safety performance and support sustainable workplace health, in alignment with ISO 45001:2018 and SDG 3 – Good Health and Well-Being.

Keywords: Job Safety Analysis, occupational safety, warehouse, risk assessment, ergonomic hazard.

1. Introduction

Occupational Health and Safety (OHS) play a crucial role in maintaining workers well-being while ensuring the continuity of industrial operations. A safe workplace not only aims to prevent accidents but also contributes to increased productivity and long-term organizational sustainability (Mahendra & Iftadi, 2025). In Indonesia, Workplace accidents remain a persistent issue, particularly within the manufacturing, logistics and warehousing sectors, which collectively account for more than one-third of industrial accidents nationwide (Samma et al., 2021). This condition highlights the importance of systematic hazard identification and risk control across all industrial functions, including supporting divisions such as procurement and warehouse operations.

Previous studies indicate that occupational hazards are inherently multifactorial, encompassing mechanical, physical, ergonomic, and chemical risks. These hazards are often intensified by

inadequate safety procedures and inconsistent adherence to safe work behaviors. For example, identified 27 potential hazards in a mechanical industry, with half of them classified as high or very high risk (Philippus et al., 2023). Their findings suggest that even organizations with established OHS systems may still experience substantial residual risks due to operational complexity and human error. In warehouse settings, similarly reported frequent near-miss incidents related to hoist operations, primarily driven by unsafe actions and insufficient ergonomic awareness (Rahmawati & Hakim, 2022).

To address these risks, various structured analytical tools have been widely implemented in industrial safety management, including Job Safety Analysis (JSA), Hazard Identification, Risk Assessment and Determining Control (HIRADC), and Hazard and Operability Studies (HAZOP). Mahendra & Iftadi (2025) demonstrated that the HIRARC framework effectively reduces hazard exposure in

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manufacturing environments by integrating systematic risk assessment with the Hierarchy of Control. Likewise, Nurhayati & Purnomo (2023) applied HIRADC in the seafood processing industry and identified 40 potential hazards, eight of which were categorized as high risk, indicating the adaptability of this method across different industrial contexts.

Among these approaches, JSA offers a practical and task-oriented method by breaking down work activities into discrete steps, enabling the identification of specific hazards, associated risk levels, and appropriate control measures. This method has been shown to be particularly effective in work environments dominated by manual handling and repetitive physical activities (Kurnia et al., 2025). In addition to supporting risk prioritization, JSA enhances communication between management and workers regarding safe work practices. Reported that the integration of HIRA and JSA in building-material retail operations significantly improved hazard recognition related to manual lifting, awkward postures, and dust exposure, which are common contributors to musculoskeletal disorders (MSDs).

Ergonomic risk factors are widely recognized as major contributors to occupational injuries, particularly in manual material handling activities (Rajendran et al., 2021). Zhao et al. (2022) found that approximately 33% of warehouse workers experienced lower back pain, while more than half reported musculoskeletal discomfort associated with awkward postures during high- and low-level binning tasks. These findings are consistent with Rajendran et al. (2021), who emphasized that improper lifting techniques, repetitive motions, and prolonged static postures significantly increase the prevalence of MSDs across industrial sectors. In response to these challenges, recent studies have begun to incorporate motion analysis and digital ergonomics to quantify body posture and movement, thereby improving the precision of ergonomic risk assessments (Zhao et al., 2022).

Despite the growing availability of safety assessment frameworks, many organizations continue to face difficulties in ensuring consistent hazard identification and control, particularly in non-production areas such as warehouses and logistics units (Rahmawati & Hakim, 2022). These areas often receive less attention within safety management systems, even though they play a critical role in supporting overall operational performance. As noted by Sławińska et al. (2024), the integration of digital risk management tools and simulation-based modeling can strengthen workplace sustainability by enabling real-time monitoring of occupational risks and ergonomic loads in the warehouse and logistics activities.

However, most existing studies on warehouse safety adopt a generalized industrial perspective and rarely address the specific operational characteristics of warehouses within heavy manufacturing sectors, such as the cement industry. Warehouse operations in the cement industry typically involve handling heavy and bulky materials, cement bags, spare parts, and palletized loads, often under conditions of repetitive manual handling and exposure to dust. These characteristics may intensify ergonomic strain and unsafe behaviors, indicating that conclusions drawn from general warehouse studies may not fully reflect the risk profile of the cement industry warehouses.

PT XYZ is a manufacturing company operating in Central Java, Indonesia, whose warehouse division plays a vital role in supporting production continuity through material storage, handling, and internal distribution. Warehouse activities at PT XYZ include manual lifting and carrying, pallet stacking, material inspection, and coordination with logistics operations, all of which present potential mechanical, ergonomic and environmental hazards. Despite the strategic importance of these activities, systematic identification and analysis of workplace hazards in the warehouse division remains limited.

Therefore, this study aims to address this gap by identifying and analyzing potential workplace hazards in the warehouse division of PT XYZ using the Job Safety Analysis (JSA) method. This study aims to compile an updated Job Safety Analysis (JSA) to support the identification and control of potential hazards (Mindandi & Iftadi, 2023). By systematically mapping job steps, assessing risks based on likelihood and severity, and proposing control measures aligned with the Hierarchy of Control, this study provides context-specific insights into occupational risk management within the cement industry warehouse operations. The findings are expected to contribute to improved safety performance and support the implementation of sustainable occupational health management practices in non-production areas (ILO, 2024).

2. Methodology

This study employed a descriptive observational approach using the Job Safety Analysis (JSA) method to systematically identify potential hazards, assess associated risk levels, and propose appropriate control measures. The JSA framework was selected because it allows each job process to be analyzed step by step, facilitating the recognition of unsafe conditions and unsafe actions that could lead to accidents. Similar methodological approaches have been applied in manufacturing, warehousing, and construction settings to enhance safety performance through structured risk evaluation (Mahendra & Iftadi, 2025).

The research was conducted at the Procurement and Warehouse Department of PT XYZ, a manufacturing company located in Central Java, Indonesia. The department’s activities include the receipt, storage, and distribution of materials and equipment, which involve repetitive physical handling, operation of lifting tools, such as forklifts and hoists, and manual transfer of goods. These operations carry multiple risks, particularly mechanical, ergonomic, and physical hazards, which are comparable to those reported in previous studies of industrial

warehouse environments (Rahmawati & Hakim, 2022).

Data collection involved field observation, documentation, and semi-structured interviews with workers and supervisors to gain insight into daily operational routines and safety practices. Each identified task was systematically decomposed into specific job steps following The Job Safety Analysis (JSA) procedure. For each job step, potential hazards were identified based on observed unsafe conditions and unsafe actions, while the frequency of exposure was assessed by considering task repetition, duration of exposure, and the number of workers involved. The level of risk was then analyzed by evaluating the potential severity of the consequences should an incident occur. The risk analysis referred to the qualitative criteria of likelihood and severity, adapted from the Australian/New Zealand Standard AS/NZS 4360:2004, where the overall risk value (R) was calculated by using Equation (1) with L being the likelihood level and S being the severity level.

$$R = L \times S \dots\dots\dots (1)$$

Table 1 shows the Qualitative Likelihood Assessment Scale, and Table 2 shows the severity criteria. Based on the resulting risk value, each hazard was classified into low, medium, high, or extreme risk categories using a modified risk matrix (Nurhayati & Purnomo, 2023).

Table 1. Qualitative Likelihood Assessment Scale

Likelihood Level	Category	Description
5	Almost Certain	will definitely happen under all conditions
4	Likely	often occurs in almost all conditions
3	Moderate	rarely occurs under certain conditions
2	Unlikely	may occur under certain conditions, but the probability of occurrence is low
1	Rare	almost never happens

Based on the identified hazards and their corresponding risk levels, control measures were developed by applying the Hierarchy of Control approach. This hierarchy prioritizes risk reduction strategies starting from the most effective level, namely elimination, followed by substitution, engineering controls, administrative controls, and finally, the use of personal protective equipment (PPE) as the least effective measure.

Table 2. Severity (S) Criteria Based on AS/NZS 4360:2004

Severity Level	Category	Description
1	Insignificant	no injuries, very minor material damage
2	Minor	requires first aid treatment, moderate material damage
3	Moderate	requires medical treatment and results in temporary loss of limb function
4	Major	injuries resulting in total disability/loss of bodily function, disruption of production processes, significant material losses
5	Catastrophe	resulting in death, significant material loss

In this study, hazards classified as high and extreme risk were first evaluated for the possibility of elimination or substitution. If these options were not feasible, engineering controls were proposed to reduce exposure, followed by administrative measures such as work procedures, training, and warning signs. PPE was recommended only when residual risks remained after other control measures had been applied.

This structured application of the hierarchy ensures that preventive controls are prioritized over reactive measures, in line with previous studies emphasizing proactive Safety management (Mahendra & Iftadi, 2025). The proposed control measures were further discussed with the company’s safety officers to ensure their practicality and

alignment with the existing Occupational Health and Safety Management System (OHSMS).

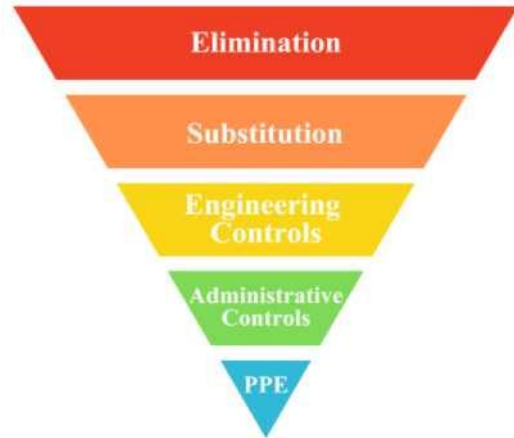


Figure 1. Hierarchy of Control Applied in Risk Control Analysis

Figure 1 illustrates the Hierarchy of Control framework used in this study to develop risk control recommendations, prioritizing elimination and substitution over engineering, administrative controls, and personal protective equipment (PPE). The likelihood and severity ratings were determined jointly by the researcher, warehouse supervisors, and safety personnel based on field observations and interviews findings to ensure consistency and practicality relevance.








All collected data were analyzed descriptively and presented in tabular form to illustrate the relationship between job steps, potential hazards, risk ratings, and control measures. This analytical process followed the practice of earlier JSA-based studies that aimed to transform qualitative observations into actionable safety strategies (Kurnia et al., 2025). The final output of the analysis provided an overview of the warehouse’s dominant hazards and suggested preventive actions to enhance overall safety performance, supporting the organization’s alignment with ISO 45001:2018 standards and the broader goals of sustainable occupational health.

3. Results and Discussion

Following the observation, interviews, and risk scoring procedures described in the methodology, the Job Safety Analysis (JSA) was carried out for each major work activity in the Procurement and Warehouse Department of PT XYZ. A total of seven key work steps were analyzed, covering the

processes of receiving materials, transporting goods using forklifts or hoists, stacking and storage, packaging, and labeling, housekeeping, documentation, and loading operations. Each job stage was assessed based on its potential hazards, possible consequences, existing controls, and risk rating calculated through the Likelihood

Table 3. Job Safety Analysis of Warehouse Activities at PT XYZ

Figure	Job Step / Activity	Potential Hazard	Possible Consequence	Existing Control	Risk Level (L×S)	Recommended Control (Hierarchy of Control)
	Receiving materials from supplier	Manual lifting and improper posture	Muscle strain, lower back pain	Basic training, use of gloves	3×4 = 12 (High)	Use mechanical aids (hand pallet), provide lifting training, and apply for a job rotation
	Moving materials using forklift	Collision, falling load, limited visibility	Injury, fracture, fatality	Forklift license, warning signs	4×4 = 16 (High)	Install mirrors at intersections, define traffic lanes, enforce PPE, and speed limits
	Stacking materials on racks	Overreaching and unstable stacking	Falling objects, head injury	Racking inspection	3×4 = 12 (High)	Set maximum stacking height, use a step ladder, provide supervision
	Packaging and labeling	Repetitive motion, awkward posture	Wrist and shoulder pain	Workbench and PPE available	3×3 = 9 (Medium)	Redesign workstation height, schedule micro breaks
	Cleaning and housekeeping	Slippery floor, sharp objects	Slip, fall, cuts	Floor mopping schedule	2×3 = 6 (Medium)	Improve drainage, provide non-slip shoes
	Documentation and data entry	Prolonged sitting, screen glare	Eye strain, neck stiffness	None	2×2 = 4 (Low)	Provide ergonomic chair and lighting adjustment
	Hoist operation during loading	Rope or hook failure, operator inattention	Crushed objects, hand injury	Operator license	3×3 = 9 (Medium)	Conduct pre-use inspection, apply lockout-tagout (LOTO) procedure

Notes:

Likelihood (L) and Severity (S) were assessed on a 1–5 scale in accordance with AS/NZS 4360:2004. Risk levels were categorized as Low (1–4), Medium (5–9), High (10–16), and Extreme (≥17).

Severity formula as outlined in the methodological framework. The summarized results of this analysis are presented in the Table 3.

The likelihood and severity scores assigned to each hazard in Table 3 were determined based on field observations, task characteristics, and interview findings. For example, in the activity of receiving materials from suppliers, the likelihood was rated as “possible” ($L = 3$) because manual lifting tasks were performed repeatedly on a daily basis based on the work of multiple workers without consistent use of mechanical aids, increasing the probability of exposure to ergonomic strain. The severity was rated as “major” ($S = 4$) since improper lifting posture has the potential to cause musculoskeletal disorders, particularly lower back injuries, which may result in lost workdays or long-term health effects. This scoring approach was consistently applied to other activities by considering task frequency, duration of exposure, load characteristics, and the potential consequences of an incident occurred. Table 3 also indicates the specific level of the Hierarchy of Control applied in each recommended action. Engineering controls were prioritized for high-risk activities, such as the use of mechanical aids, installation of mirrors and a workstation redesign, as these measures directly reduce exposure to hazards. Administrative controls, including training, supervision, and work procedures were proposed to support engineering interventions, while PPE was recommended as a complementary measure when residual risks remained.

Forklift operation emerged as the highest-risk activity not merely due to its high severity score, but because of the interaction between confined warehouse layouts, limited visibility, and frequent material movement. In cement industry warehouses, forklifts routinely transport heavy and bulky loads, which increases stopping distance and reduces maneuverability. These conditions amplify the consequences of operator error or delayed reaction, explaining why forklift-related hazards consistently receive high-risk ratings.

This finding highlights the need for traffic management and spatial design improvements as a priority in warehouse safety management for cement manufacturing environments.

Unlike general warehouse operations, cement industry warehouses handle materials with higher weight density and dust exposure, which intensifies both mechanical and ergonomic risks. The dominance of manual handling and stacking-related hazards in this study suggests that conventional training-based controls alone are insufficient. Without engineering interventions, such as mechanical lifting aids and optimized rack design, the likelihood of musculoskeletal disorders will remain high despite administrative measures.

To provide a clearer visual representation of the overall risk distribution, the percentage of hazards in each risk category is shown in Figure 1. The diagram illustrates that medium-risk activities constitute the majority of hazards identified, followed by high-risk and low-risk categories.

Although the proposed control measures are technically feasible, their implementation may face practical challenges, particularly related to cost, operational disruption, and worker adaptation. Engineering controls, such as installing mirrors or redesigning storage racks, require initial capital investment and may temporarily affect workflow. Administrative measures depend heavily on worker compliance and supervision consistency, while reliance on PPE alone may be limited by discomfort and improper use. Therefore, prioritizing controls based on risk level and integrating them gradually into existing operations is essential to ensure sustainable implementation.

Figure 2 shows the distribution of risk levels identified in the Warehouse Department of PT XYZ. As shown in Figure 2, 43% of the identified hazards were high risk, 43% were medium risk, and 14% were medium risk. The highest risk scores were found in moving materials using a forklift ($R=16$), receiving materials from the supplier ($R=12$), and stacking

materials on racks ($R=12$). These activities involve physical handling of large or unstable loads, consistent with findings in other industrial studies where material-handling operations contribute most to occupational injury rates (Kurnia et al., 2025; Mahendra & Iftadi, 2025).

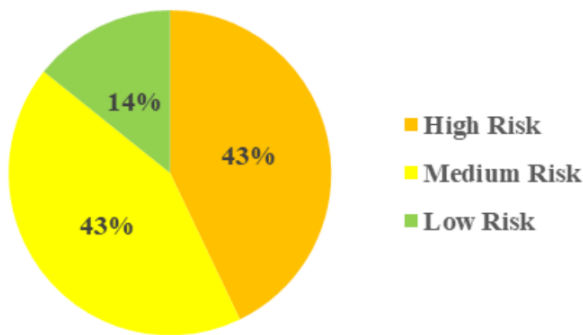


Figure 2. Distribution of risk levels identified in the Warehouse Department of PT XYZ

The most dominant hazards observed in PT XYZ's warehouse was mechanical and ergonomic in nature. Workers frequently performed lifting and carrying tasks without mechanical assistance, resulting in repetitive bending and overexertion. Observations also recorded postures involving trunk flexion beyond 60° , which, according to Rajendran et al. (2021) increases musculoskeletal load and the risk of lower back disorders. Interviews revealed that 60% of employees experienced occasional lower back pain, while 35% complained of shoulder or neck strain. These ergonomic symptoms closely align with the findings of Zhao et al. (2022), who reported that warehouse workers performing high- and low-shelf binning tasks had a 33% prevalence of back pain due to awkward postures.

The mechanical hazards were primarily associated with forklift movement in confined aisles, hoist operations, and falling materials from improperly stacked pallets. The JSA recorded that some pallets were stacked beyond safe height limits, and that safety cones were inconsistently used during material movement. These findings support previous literature that links insufficient spatial design and supervision to increase incident probability in logistics environments

(Rahmawati & Hakim, 2022). Noise exposure in the warehouse averaged between 82 and 86 dBA, remaining within acceptable limits, but indicating the need for monitoring and periodic hearing checks, consistent with the control standards recommended by Nurhayati & Purnomo (2023).

From a control perspective, engineering and administrative measures were prioritized. Engineering interventions included improving lighting at loading zones, repairing uneven floor surfaces, and installing convex mirrors at intersections, and optimizing rack height to minimize overreaching. Administrative measures included stricter supervision, revised Standard Operating Procedures (SOPs) for stacking, and refresher training on forklift and hoist operations. Workers were also advised to consistently use PPE helmets, gloves, and safety shoes, especially during loading activities. These recommendations align with the Hierarchy of Control approach widely used in industrial risk management (Mahendra & Iftadi, 2025), which prioritizes elimination and engineering measures over reliance on PPE.

Another important finding was the lack of near-miss reporting and limited documentation of minor incidents. Although PT XYZ had implemented a safety management system, the analysis showed that it was more reactive than preventive. Similar organizational behavior was reported by Rahmawati & Hakim (2022), who emphasized that underreporting of near-miss events weakens the effectiveness of safety programs and hinders learning processes. Encouraging worker participation in hazard reporting and integrating JSA results into monthly safety reviews would improve feedback mechanisms and foster a proactive safety culture.

The overall results demonstrate that applying the JSA method at PT XYZ provided a structured foundation for identifying, assessing, and controlling workplace hazards. It helped transform qualitative field observations into quantitative risk levels and targeted action

plans. When integrated with ergonomic assessment (Zhao et al., 2022). JSA can serve as a baseline for digitalized safety monitoring systems that enable real-time risk evaluation. Such integration would further support PT XYZ alignment with ISO 45001:2018 standards and the Sustainable Development Goal (SDG) 3 Good Health and Well-being.

In summary, the results confirm that the Procurement and Warehouse Department still exhibits several medium-to-high risks, primarily associated with manual handling activities and mechanical operations. The implementation of JSA-based interventions, including ergonomic redesign, strengthened administrative controls, and preventive monitoring, can substantially mitigate these hazards, although such measures may require additional resources, such as investment in engineering improvements, training activities, and continuous supervision. These implications should be regarded as preventive efforts rather than operational burdens, as effective hazard control can reduce accident-related costs, work interruptions, and long-term occupational health impacts. Overall, the findings reinforce existing evidence that structured job analysis not only lowers the probability of workplace accidents, but also improves worker awareness and supports the development of a resilient safety culture, in line with global OHS research trends (Kurnia et al., 2025; Mahendra & Iftadi, 2025; Zhao et al., 2022).

4. Conclusion

This study aimed to identify and analyze potential workplace hazards in the Procurement and Warehouse Department of PT XYZ using the Job Safety Analysis (JSA) method and to propose control measures based on the Hierarchy of Control. The findings revealed that the warehouse environment was dominated by mechanical and ergonomic hazards, primarily arising from manual lifting, forklift operation, and stacking activities. From the seven main job steps, thirteen hazards were identified, with 43% classified as high risk, 43% as medium, and 14% as low. The highest risks occurred during forklift movement and manual

handling, where poor posture and inadequate supervision increased the likelihood of accidents and musculoskeletal disorders.

The implementation of the JSA method provided a structured framework to quantify risk levels and guide effective control priorities. Engineering improvements, ergonomic adjustments, and administrative reinforcement were identified as key actions to mitigate hazards and enhance operational safety. The study concludes that adopting JSA, as a continuous monitoring tool, can strengthen PT XYZ's occupational health and safety performance, align its practices with ISO 45001:2018, and support the Sustainable Development Goal (SDG) 3 – Good Health and Well-Being by fostering a proactive and sustainable safety culture within the organization.

Future studies may focus on implementing selected control measures and evaluating their impact on safety performance to complement the hazard identification findings of this study.

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