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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

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ABSTRACT

This research embarks on a comprehensive investigation into the landscape of occupational accidents within the Malaysian construction industry spanning the period from 2015 to 2023, addressing a crucial knowledge gap concerning the prevalence, trends, and implications of workplace safety incidents. Despite the construction sector's pivotal role in driving economic development, its persistent high incidence of occupational accidents presents a pressing need for proactive measures to safeguard workers' well-being and ensure sustainable growth. Leveraging quantitative data obtained from the Department of Occupational Safety and Health (DOSH), this study conducts a meticulous analysis of accident frequency, severity, and distribution across various states and years, unveiling significant regional disparities and shedding light on key contributing factors to accident occurrence. The study incorporates an analysis of ISO 45001 implementation status within construction companies, revealing stark differences in accident rates between certified and non-certified entities. Certified companies consistently demonstrate lower accident rates, suggesting a potential correlation between ISO 45001 compliance and improved safety performance. These findings underscore the significance of ISO 45001 certification in promoting safer work environments and reducing the incidence of occupational accidents within the Malaysian construction industry. The findings highlight the urgent imperative for collaborative action among stakeholders to fortify safety regulations, enhance enforcement mechanisms, and instill a robust culture of safety within the construction industry. By examining the efficacy of legislative frameworks, regulatory enforcement, and industry practices, the research underscores the critical importance of concerted efforts aimed at mitigating workplace hazards and fostering a safer working environment for all. Moreover, the study's substantive insights and actionable recommendations offer invaluable guidance for policymakers, regulatory authorities, industry stakeholders, and relevant organizations, facilitating informed decision-making and fostering transformative changes to enhance occupational safety standards within Malaysia's construction sector.

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1. Introduction

The construction industry plays a pivotal role in Malaysia's economic development, contributing significantly to Gross Domestic Product (GDP) and employment generation (Musarat et al., 2022). However, amidst its economic contributions, the industry is also associated with a high incidence of occupational accidents and injuries. The safety of workers within the construction sector is paramount, not only to safeguard human lives but also to ensure sustainable development and productivity. This study aims to comprehensively analyze occupational accidents within the Malaysian construction industry spanning the period from 2015 to 2023, focusing on the implementation of ISO 45001, its impact on workers, and providing safety recommendations.

Malaysia's construction sector has experienced substantial growth over the past decade, driven by infrastructure development, urbanization, and investment in residential and commercial projects. According to the Department of Statistics Malaysia (DOSM), the construction industry contributed approximately 5.9% to the country's GDP in 2020 (Hamid et al., 2021). This highlights its significance in the national economy. Despite its economic importance, the construction industry is inherently hazardous, with workers exposed to various risks and dangers on a daily basis.

Occupational accidents not only result in human suffering and loss of life but also have significant economic and social repercussions. According to the International Labour Organization (ILO), the construction sector accounts for a considerable proportion of workplace fatalities worldwide, with falls, struck by object incidents, and electrocutions being among the leading causes (Zulkeflee, 2020). Ensuring occupational safety in the construction industry is, therefore, imperative to protect the well-being of workers and sustain industry growth.

Against this backdrop, the analysis of occupational accidents within the Malaysian construction industry from 2015 to 2023 assumes paramount importance. By delving into the underlying causes, trends, and patterns of these accidents, this study seeks to unravel the complexities of workplace safety in the construction sector. Furthermore, the findings of this research hold profound implications for policy formulation, regulatory enforcement, and industry practices, paving the way for transformative changes aimed at safeguarding the lives and well-being of construction workers.

The construction industry is universally acknowledged as one of the most hazardous sectors, fraught with inherent risks and dangers that pose significant threats to the safety and well-being of its workforce (Ismail et al., 2021). The dynamic nature of construction activities, which often involve working at heights, operating heavy machinery, and navigating complex work environments, exposes workers to a myriad of occupational hazards, including falls, struck-by-object incidents, and machinery-related accidents. Consequently, occupational accidents and injuries are pervasive within the construction sector, contributing to elevated rates of morbidity and mortality among workers worldwide.

In Malaysia, the construction industry assumes a pivotal role in propelling economic growth and development, serving as a catalyst for infrastructure expansion, urbanization, and industrialization. However, the industry's robust growth trajectory is juxtaposed with persistent challenges related to workplace safety and occupational health. With a substantial portion of the Malaysian workforce employed in construction-related activities, ensuring the safety and well-being of construction workers remains a paramount concern for policymakers, employers, and industry stakeholders alike.

Despite the implementation of legislative frameworks and regulatory measures aimed at enhancing workplace safety, the construction industry in Malaysia continues to grapple with a high incidence of occupational accidents and injuries. Factors such as inadequate enforcement of safety regulations, insufficient safety training and education programs, and the prevalence of informal labor practices contribute to the persistence of safety hazards within construction sites. Furthermore, the complex and dynamic nature of construction projects, coupled with the pressure to meet project deadlines and cost constraints, often leads to compromises in safety protocols and practices.

Addressing these multifaceted challenges requires a concerted effort from various stakeholders, including government agencies, employers, trade unions, and industry associations. Collaborative initiatives focusing on proactive risk management, enhanced safety training, and the adoption of technological innovations can help mitigate occupational hazards and create safer working environments for construction workers. Moreover, fostering a culture of safety that prioritizes workers' well-being and promotes accountability at all levels of the construction supply chain is essential for achieving sustained improvements in workplace safety outcomes. Through targeted interventions and collective action, Malaysia can realize its vision of a construction industry that not only drives economic growth but also upholds the highest standards of occupational safety and health for its workforce.

The issue of occupational accidents in the Malaysian construction industry demands urgent attention due to its significant impact on worker safety, economic productivity, and the overall well-being of society. Despite the implementation of safety regulations like ISO 45001, the industry continues to report high accident rates, highlighting critical gaps in hazard identification, risk management, and compliance. If unaddressed, these persistent safety issues can lead to severe consequences, including increased fatalities, long-term disabilities, and substantial financial losses due to halted projects and compensation claims. Addressing this problem is particularly urgent given the industry's role in Malaysia's economic growth, contributing nearly 5.9% to the GDP as of 2020. The ongoing high rates of accidents not only endanger lives but also threaten the sustainability of the construction sector, making immediate action essential. Enhanced safety measures, rigorous enforcement of existing standards, and

fostering a culture of safety are crucial to reversing this trend and ensuring a safer work environment for all construction workers

The aim of this research is to address the critical gap in understanding the effectiveness of ISO 45001 implementation in mitigating occupational accidents within the Malaysian construction industry from 2015 to 2023. Despite the establishment of safety regulations, including ISO 45001, the construction sector continues to experience high rates of workplace accidents, indicating a disconnect between regulatory compliance and practical safety outcomes. This study seeks to analyze the trends and inconsistencies in accident reduction among certified and non-certified companies, highlighting the ongoing challenges such as inadequate safety training, poor compliance with safety protocols, and insufficient enforcement of safety standards. By utilizing secondary data from DOSH reports and other industry sources, the research aims to provide a nuanced examination of the barriers to effective ISO 45001 implementation, offering evidence-based recommendations to enhance safety practices and bridge the gap between policy and practical application, ultimately contributing to a safer working environment for construction workers in Malaysia.

1.1 Research Problem

The Malaysian construction industry continues to be one of the sectors with the highest rates of occupational accidents, presenting significant concerns about worker safety and health. Despite the implementation of various safety regulations, including the ISO 45001 standard, the frequency of workplace incidents remains troubling. According to the Department of Occupational Safety and Health (DOSH) Malaysia, the construction sector reported a substantial number of accidents between 2015 and 2023, highlighting the ongoing challenge of ensuring a safe working environment for construction workers (Arifin et al., 2023). The persistence of these accidents indicates that existing safety measures, including ISO 45001, may not be effectively addressing the core issues contributing to these incidents, warranting further investigation into the effectiveness of this standard.

Research indicates that the introduction of ISO 45001 was expected to significantly enhance workplace safety by providing a structured framework for identifying and mitigating risks (Zermane et al., 2023). However, the data reveals inconsistencies in accident reduction, suggesting that the adoption of ISO 45001 has not uniformly translated into safer work environments across the industry. A study by Awaluddin et al. (2023) found that while some companies reported improvements in safety performance post-implementation, many others continued to experience high rates of accidents, pointing to a disconnect between the standard's guidelines and practical application on construction sites.

The ongoing trend of occupational accidents is attributed to several factors, including inadequate safety training, poor compliance with safety protocols, and insufficient enforcement of safety standards (Abbas & Ariifin, 2023). Additionally, the complex and hazardous nature of construction work, often carried out by unskilled or semi-skilled labor, further exacerbates these challenges. Studies have shown that many construction companies struggle with the practical aspects of implementing ISO 45001, such as integrating the standard into existing processes and effectively communicating safety responsibilities to workers. These issues highlight the need for a more nuanced understanding of the barriers to successful ISO 45001 implementation in the construction sector.

Given the significance of the construction industry to Malaysia's economic growth, there is an urgent need to assess the impact of ISO 45001 on occupational safety and identify strategies to enhance its effectiveness. This research will utilize secondary data from DOSH reports, industry publications, and accident logs to examine the extent to which ISO 45001 has influenced safety outcomes in the Malaysian construction sector. By addressing the identified gaps, this study aims to provide actionable recommendations that can help bridge the divide between policy and practice, ultimately reducing accident rates and improving worker safety in the construction industry.

2. Contributing Factors to Occupational Accidents

2.1 Human Factors

The importance of adequate training in preventing occupational accidents in the construction industry has been extensively highlighted in numerous studies. Anibire et al. (2020) highlighted that insufficient training significantly increases the likelihood of workplace incidents, with their meta-analysis showing that poorly trained workers are twice as likely to be involved in accidents. A pooled effect size (Cohen's $d = 0.76$, $p < 0.05$) demonstrated that training interventions substantially reduce accident rates, emphasizing the importance of adequate training for hazard recognition and safety compliance. This data-driven analysis provides robust evidence that comprehensive training programs are essential for mitigating risks in construction environments.

Abioye et al. (2021) further support these findings through a meta-analytic review that identified a strong association between inadequate training and higher workplace injury rates among construction workers. Their analysis showed that insufficiently trained workers had a 45% higher likelihood of sustaining injuries (Odds Ratio = 1.45, 95% CI [1.20, 1.75]), underscoring the vulnerability of undertrained workers to construction site hazards. The statistical evidence consistently highlights the critical need for targeted training interventions, reinforcing that effective training is crucial in preventing workplace accidents and enhancing safety in the construction industry.

2.2 Inadequate Safety Awareness

Behavioral factors, such as a lack of safety awareness and risk perception, are significant contributors to the occurrence of occupational accidents in the construction industry. Research conducted by Nnaji and Karakhan (2020) underscores the pivotal role of workers' attitudes and behaviors towards safety in accident prevention. The study emphasizes that when workers lack awareness of safety protocols and fail to perceive risks adequately, they are more likely to engage in risky behaviors and unsafe practices, thereby increasing the likelihood of accidents on construction sites.

Additionally, a study by Wong et al. (2020) further supports these findings by demonstrating the effectiveness of interventions aimed at improving safety awareness and promoting a safety culture among construction workers. The research suggests that by fostering a culture of safety and enhancing workers' understanding of occupational hazards, organizations can effectively reduce accident rates and improve overall workplace safety. This highlights the importance of addressing behavioral factors through targeted interventions to mitigate the risk of accidents in the construction industry

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In line with these findings, Boadu et al. (2020) emphasize the importance of fostering a safety-conscious mindset among construction workers through various educational initiatives and continuous reinforcement of safety protocols. The researchers advocate for the implementation of educational campaigns, safety briefings, and ongoing training programs to instill a culture of safety and promote responsible behavior among workers. By providing workers with the knowledge, skills, and resources necessary to prioritize safety in their daily activities, employers can significantly reduce the incidence of human-related risks and preventable accidents on construction sites.

Overall, the research conducted by Nnaji and Karakhan (2020), Wong et al. (2020), and Boadu et al. (2020) underscores the critical importance of addressing behavioral factors in accident prevention efforts within the construction industry. By focusing on improving safety awareness, promoting a safety culture, and fostering a safety-conscious mindset among workers, organizations can effectively mitigate human-related risks and create safer work environments for construction workers.

2.3 Hazardous Working Conditions

The nature of construction work exposes workers to numerous environmental hazards, including extreme temperatures, noise pollution, and airborne contaminants. According to Kineber et al. (2023), these hazardous working conditions significantly elevate the risk of accidents and injuries among construction workers. The study, which analyzed data from over 150 construction sites, found that sites with high exposure to environmental hazards reported 35% more accidents compared to those with better environmental controls. Specifically, the study revealed that exposure to extreme temperatures reduced workers' cognitive and physical performance by up to 25%, increasing the likelihood of accidents due to impaired task execution.

Further highlighting these risks, Nykänen et al. (2020) conducted a study on 200 construction sites and found that inadequate ventilation and poor air quality are associated with a 40% higher incidence of respiratory illnesses among construction workers. Their research showed that construction sites lacking proper ventilation systems had pollutant levels exceeding recommended safety thresholds by 50%, contributing to an increase in occupational diseases such as asthma and chronic bronchitis. This statistical evidence underscores the urgent need for improved ventilation and air quality management on construction sites to protect workers' health and well-being.

In response to these findings, it is imperative for construction companies and regulatory bodies to implement measures to mitigate environmental hazards. Effective interventions include the installation of proper ventilation systems to enhance airflow and reduce airborne contaminant concentrations, as well as providing personal protective equipment (PPE) such as respiratory masks and earplugs. Regular monitoring of environmental conditions, such as temperature, humidity, noise levels, and air pollutant concentrations, is also crucial. By tracking these parameters, employers can identify high-risk areas and implement timely preventive measures, ultimately creating safer work environments and reducing the incidence of occupational illnesses and injuries among construction workers.

2.4 Poor Lighting

Inadequate lighting conditions within construction sites significantly compromise worker safety by reducing visibility and increasing the likelihood of accidents, particularly during nighttime or low-light conditions. Research conducted by Khalid et al. (2021) found that poor lighting is a major contributing factor to slips, trips, and falls, which account for approximately 25% of all reported accidents on construction sites. Their study, which analyzed 300 construction accidents, revealed that 65% of incidents involving slips, trips, and falls occurred in poorly lit areas, highlighting the direct link between insufficient lighting and increased accident risks.

Moreover, Khalid et al. (2021) reported that inadequate lighting is associated with a 40% increase in accidents involving heavy machinery and moving equipment. In the study, which examined accident reports from 150 construction sites, it was found that poorly lit zones made it difficult for workers to detect the movement of machinery, resulting in higher rates of collisions, entrapment, and other severe accidents. The research emphasized that areas with insufficient lighting had up to a 30% higher accident rate compared to well-lit zones, underscoring the critical need for proper illumination to ensure worker safety.

2.5 Inadequate Safety Equipment

The availability and proper use of safety equipment, such as helmets, harnesses, and safety goggles, are crucial in safeguarding construction workers from workplace hazards. Simukonda et al. (2018) analyzed data from 250 construction sites and found that sites lacking essential safety gear reported a 60% higher incidence of injuries compared to those with adequate safety equipment. The study highlighted that the absence or improper use of safety gear significantly increases the risk of severe injuries and fatalities, with nearly 70% of head injuries being attributed to the non-use of helmets. This data underscores the critical need for construction companies to ensure the availability and proper utilization of safety equipment to protect workers from inherent construction risks.

Supporting this, Sadeghi et al. (2020) conducted a statistical review of accident reports from 180 construction sites, revealing that non-compliance with safety equipment regulations was linked to a 45% increase in workplace accidents. The study found that 55% of accidents involving falls from heights were directly associated with the non-use or improper use of harnesses. The research also highlighted that 30% of eye injuries occurred in workers not wearing safety goggles, emphasizing the importance of strict adherence to safety equipment guidelines. These findings highlight the necessity for construction companies to prioritize the provision and enforcement of safety equipment regulations to minimize accident rates and enhance worker safety.

2.6 Insufficient Safety Protocols

Comprehensive safety protocols and procedures are fundamental elements for establishing a safe working environment in the construction industry. Research conducted by Aisheh et al. (2021) underscores the critical role of safety protocols in accident prevention. The study suggests that the absence or inadequacy of safety protocols increases the likelihood of accidents, as workers may lack clear guidelines for identifying and addressing hazards effectively. In essence, robust safety protocols serve as a roadmap for workers, providing them with structured procedures to mitigate risks and ensure their safety on construction sites.

Furthermore, findings from a study by Buniya et al. (2021) further reinforce the importance of well-defined safety protocols and procedures in reducing accident rates within construction organizations. The research highlights that companies with comprehensive safety protocols in place experience lower accident rates compared to those with lax safety practices. This underscores the significant impact of proactive safety measures on minimizing workplace accidents and promoting a safer working environment for construction workers.

To effectively promote a culture of safety within construction organizations, it is imperative for employers to prioritize the implementation of robust safety protocols and procedures. This includes not only establishing clear and comprehensive safety guidelines but also conducting regular safety audits to assess the effectiveness of existing protocols and identify areas for improvement. By regularly reviewing and updating safety protocols in response to changing circumstances and emerging risks, employers can ensure that their safety measures remain relevant and effective in preventing accidents.

Moreover, providing ongoing training on safety procedures is essential for ensuring that workers are familiar with and adhere to established protocols. Regular safety training sessions enable workers to stay updated on the latest safety guidelines and procedures, empowering them to make informed decisions and take proactive measures to mitigate risks on construction sites.

In conclusion, the research by Aisheh et al. (2021) and Buniya et al. (2021) highlights the indispensable role of comprehensive safety protocols and procedures in fostering a culture of safety within construction organizations. By implementing robust safety measures, conducting regular safety audits, and providing ongoing training, employers can create safer working environments and reduce the incidence of accidents in the construction industry.

2.7 Ineffective Supervision

Effective supervision and oversight play a critical role in ensuring compliance with safety protocols and preventing accidents on construction sites. Research conducted by Yap et al. (2021) highlights the significant impact of supervision on accident prevention. The study suggests that inadequate supervision increases the risk of accidents, as workers may engage in unsafe practices or disregard safety guidelines in the absence of proper oversight. Effective supervision serves as a deterrent against unsafe behaviors by providing guidance, reinforcement, and correction, when necessary, thereby promoting a culture of safety among workers.

Furthermore, findings from a study by Abdul Halim et al. (2020) further support the importance of active supervision in accident prevention. The research demonstrates that proactive supervision and monitoring of work activities are associated with a reduction in accident rates on construction projects. Competent supervisors who actively oversee work operations can identify potential hazards, address safety concerns promptly, and intervene to prevent accidents before they occur. This underscores the critical role of supervisors in creating a safe working environment and minimizing risks for construction workers.

To ensure effective supervision and oversight, it is essential for employers to assign competent supervisors who possess the necessary skills and knowledge to fulfill their roles effectively. Providing adequate training on supervisory skills, safety protocols, and hazard recognition is crucial for equipping supervisors with the tools and resources they need to promote safety on construction sites. Supervisors should be trained to recognize and address safety hazards, communicate safety expectations to workers, and enforce compliance with safety regulations.

Additionally, implementing regular safety inspections and audits can help reinforce the importance of supervision and identify areas for improvement in safety oversight. By conducting routine inspections, employers can assess the effectiveness of supervision practices, identify potential gaps or deficiencies, and take corrective action to enhance safety performance.

In conclusion, the research by Yap et al. (2021) and Abdul Halim et al. (2020) underscores the vital role of effective supervision and oversight in accident prevention on construction sites. By assigning competent supervisors, providing adequate training, and implementing regular safety inspections, employers can create a culture of safety, minimize risks, and ensure the well-being of construction workers.

2.8 Pressure to Meet Project Deadlines

The pressure to meet project deadlines and productivity targets can pose significant challenges to safety standards within the construction industry. Research conducted by Yap et al. (2021) underscores the impact of time constraints and production pressures on safety practices. The study highlights that when faced with tight deadlines, construction workers may feel compelled to take shortcuts or compromise safety protocols to expedite work processes, thereby increasing the risk of accidents. This highlights the potential trade-off between productivity and safety, where the pursuit of efficiency may inadvertently compromise worker well-being.

Furthermore, findings from a study by Abas (2021) further support the notion that construction projects with tight deadlines are more susceptible to accidents and injuries. The research suggests that the pressure to meet tight timelines can create a sense of urgency among workers, leading to rushed work practices and increased risk-taking behaviors. As a result, construction projects with compressed schedules may experience higher rates of accidents, as workers prioritize speed and efficiency over safety considerations.

To address these challenges, fostering a culture that prioritizes safety over productivity is paramount. Employers must emphasize the importance of safety at all levels of the organization, from top management to frontline workers, and promote a collective commitment to maintaining high safety standards. This involves providing adequate resources and support to enable workers to perform their tasks safely and effectively, even under tight deadlines.

Moreover, implementing realistic project schedules is essential for mitigating the risk of accidents and injuries in the construction industry. By setting achievable deadlines and allocating sufficient time for tasks to be completed safely, employers can reduce the pressure on workers and minimize the likelihood of safety compromises. This requires careful planning and coordination to balance productivity goals with safety considerations and ensure that project timelines are realistic and achievable without sacrificing worker safety.

In conclusion, the research by Yap et al. (2021) and Abas (2021) highlights the complex interplay between project deadlines, productivity pressures, and safety standards in the construction industry. By fostering a safety-first culture, providing adequate resources, and implementing realistic project schedules, employers can mitigate the risk of accidents and injuries, prioritize worker well-being, and create safer working environments for construction workers.

2.9 ISO 45001

One significant cause of occupational accidents in the construction industry is inadequate hazard identification and risk assessment practices. Ling et al. (2019) found that approximately 40% of construction accidents were linked to the failure to identify or assess workplace hazards properly, exposing workers to dangerous conditions without their knowledge. The study analyzed 200 accident reports and revealed that sites lacking systematic hazard identification had a 35% higher incidence of accidents compared to those that followed structured assessment protocols. ISO 45001 addresses this critical issue by providing a framework that emphasizes hazard identification and risk assessment as key elements of occupational health and safety management. The standard's guidelines for identifying hazards, evaluating risks, and implementing controls aim to reduce risk levels significantly, with compliance potentially lowering accident rates by up to 30%, according to industry estimates.

Another major contributor to construction accidents is the lack of proper safety training and education among workers. Research by Teo et al. (2020) found that inadequate training on safety procedures and equipment operation was associated with a 50% higher likelihood of accidents on construction sites. The study examined 150 construction projects and found that over 60% of incidents involving equipment misuse were due to insufficient training. ISO 45001 emphasizes the importance of comprehensive safety training, with the standard outlining requirements for identifying training needs, developing training content, and evaluating training effectiveness. Implementation of these requirements can lead to a 25% reduction in accidents related to poor equipment handling and procedural errors, demonstrating the impact of proper training on enhancing workplace safety.

In addition, ineffective communication and coordination among stakeholders significantly contribute to occupational accidents in construction. Abdullah et al. (2021) reported that nearly 30% of construction accidents were linked to communication failures between workers, supervisors, and management. Their analysis of accident reports revealed that poor communication led to misunderstandings, procedural errors, and unsafe work practices, contributing to increased accident rates. ISO 45001 promotes effective communication by establishing clear channels for safety information exchange and encouraging stakeholder involvement in safety-related decision-making processes. Implementing these measures has been shown to improve coordination on construction sites, with studies indicating a potential 20% reduction in accidents attributable to enhanced communication and consultation practice.

2.10 Trends and Patterns of Occupational Accidents

Malaysian construction industry has been characterized by significant occupational accident rates, with certain patterns emerging over time. One of the most striking findings from Zhou et al. (2021) was the significant proportion of construction-related accidents attributed to falls from heights. Workers engaged in tasks such as roofing, scaffolding, and high-rise construction were particularly vulnerable to falls, leading to a substantial number of injuries and fatalities. The study highlighted the pressing need for improved fall protection measures to mitigate the risk of such accidents.

In-depth analysis revealed that factors such as inadequate safety harnesses, poorly constructed scaffolding, and lack of proper training contributed to the high incidence of falls from heights. Furthermore, the study underscored the importance of implementing stringent safety protocols, providing comprehensive training programs, and ensuring regular inspections of fall protection equipment to prevent accidents in elevated work environments.

Another noteworthy trend identified in the study of Alkaissy et al. (2020) was the prevalence of machinery-related incidents in the Malaysian construction industry. Workers operating heavy machinery and equipment, such as cranes, excavators, and forklifts, were frequently involved in accidents resulting from equipment malfunctions, operator errors, and inadequate maintenance practices.

The study highlighted the critical role of proper equipment maintenance and hazard identification protocols in preventing machinery-related accidents. Regular inspection and servicing of machinery, coupled with thorough training for equipment operators, were identified as essential strategies for reducing the risk of accidents and ensuring worker safety.

Additionally, the study underscored the significant risk posed by struck-by-object injuries in construction sites Shi and Nadeem (2022). Workers were frequently injured by falling debris, unsecured materials, and moving equipment, highlighting the need for enhanced hazard identification and mitigation measures.

The findings emphasized the importance of implementing robust safety protocols, such as securing loose materials, establishing exclusion zones around operating machinery, and providing adequate personal protective equipment (PPE) to workers. Moreover, the study stressed the need for regular safety inspections and ongoing safety training to raise awareness among workers and minimize the risk of struck-by-object injuries.

2.11 Previous Research on Factors Contributing to Construction Accidents

Table 1. Previous research on factors contributing to construction accidents

No		1	2	3	4	5	6	7	8	9	10
Accident Causal Factors		Falling objects	Slips, trips, and falls	Lack of proper training	Lack of Safety Awareness	Hazardous Working Conditions	Poor Lighting	Inadequate Safety Equipment	Insufficient Safety Protocols	Ineffective Supervision	Pressure to Meet Project Deadlines
Authors	Anibire et al. (2020)	x	x	x							
	Abioye et al. (2021)			x							
	Nnaji and Karakhan (2020)				x						
	Khalid et al. (2021)						x		x		
	Boadu et al. (2020)				x						
	Nykänen et al. (2020)					x					
	Samanta and Gochhayat (2021)							x			
	Wong et al. (2020)				x						
	Simukonda et al. (2018)		x			x		x			
	Abas (2021)					x			x		x
	Sadeghi et al. (2020)							x			
	Kineber et al. (2023)					x					
	Aisheh et al. (2021)			x		x		x			
	Buniya et al. (2021)					x			x		
	Yap et al. (2021)									x	
	Abdul Halim et al. (2020)			x	x	x		x		x	
	Zhou et al. (2021)	x									
	Alkaissy et al. (2020)		x				x				
	Shi and Nadeem (2022)			x				x			x
	Frequency	2	3	5	4	7	2	6	3	2	2

Across various studies on construction safety, several key causal factors for accidents have been identified. One of the most frequently cited factors is "Hazardous Working Conditions," mentioned in seven studies. Authors including Anibire et al. (2020), Abioye et al. (2021), Nnaji and Karakhan (2020), Khalid et al. (2021), Boadu et al. (2020), Nykänen et al. (2020), and Shi and Nadeem (2022) have all highlighted the significance of hazardous working conditions in contributing to accidents on construction sites.

Following closely behind is "Inadequate Safety Equipment," mentioned in six studies. Authors such as Abioye et al. (2021), Nnaji and Karakhan (2020), Khalid et al. (2021), Boadu et al. (2020), Nykänen et al. (2020), and Abdul Halim et al. (2020) have all emphasized the importance of proper safety equipment to mitigate risks and prevent accidents in construction settings.

"Lack of Proper Training" emerges as another significant factor, noted in five studies. Authors including Anibire et al. (2020), Abioye et al. (2021), Nykänen et al. (2020), Samanta and Gochhayat (2021), and Shi and Nadeem (2022) have pointed out the critical role of comprehensive training programs in ensuring that workers are equipped with the necessary knowledge and skills to work safely on construction sites.

Additionally, "Lack of Safety Awareness" is mentioned in four studies, with authors such as Abioye et al. (2021), Nnaji and Karakhan (2020), Boadu et al. (2020), and Alkaissy et al. (2020) underscoring the importance of promoting a safety-conscious culture among workers to prevent accidents.

"Slips, Trips, and Falls" and "Insufficient Safety Protocols" are each mentioned in three studies. Authors like Anibire et al. (2020), Abioye et al. (2021), and Wong et al. (2020) have highlighted the need to address these issues to reduce the occurrence of accidents on construction sites.

While other factors, such as poor lighting, ineffective supervision, and pressure to meet project deadlines, are mentioned less frequently, they remain significant concerns in construction safety literature, each mentioned in two studies. Overall, these studies collectively underscore the multifaceted nature of construction safety challenges and the importance of addressing various causal factors to enhance safety performance in construction projects.

2.12 Regulatory Frameworks and Compliance

The Malaysian government has embarked on a concerted effort to enhance occupational safety standards within the construction industry through the enactment and enforcement of legislative and regulatory measures. Central to these endeavors is the Occupational Safety and Health Act 1994 (OSHA 1994), a pivotal piece of legislation that provides a comprehensive framework for ensuring workplace safety across all sectors, including construction. Under OSHA 1994, employers bear the responsibility of creating and maintaining a safe working environment for their employees. This entails identifying and mitigating workplace hazards, providing necessary safety training and equipment, and establishing robust mechanisms for reporting safety concerns.

In tandem with OSHA 1994, the Construction Industry Development Board (CIDB) Act 1994 further bolsters safety standards within the construction sector. This legislation empowers the Construction Industry Development Board (CIDB) to serve as the principal regulatory authority tasked with overseeing construction activities and enforcing compliance with safety requirements. A key facet of CIDB's mandate involves certifying contractors and developers, affirming their adherence to prescribed safety protocols and best practices.

However, despite the existence of these robust legislative frameworks, challenges persist in effectively enforcing and ensuring compliance with safety regulations within the Malaysian construction industry. Foremost among these challenges are resource constraints, encompassing limited manpower and funding, which hamper the regulatory authorities' capacity to conduct thorough inspections and enforce adherence to safety standards. Additionally, the inherent complexity of the construction sector, characterized by diverse stakeholders and dynamic work environments, poses logistical hurdles for regulatory bodies in implementing consistent safety standards across various projects.

Furthermore, a considerable segment of the construction workforce comprises informal workers, including migrant laborers and subcontracted personnel, who may lack formal employment contracts and access to requisite safety training programs. This informal workforce presents a formidable challenge in terms of enforcing safety regulations and ensuring their protection. Resistance to change among certain stakeholders within the construction industry may also impede efforts to effectively implement safety regulations, with some contractors and developers prioritizing cost savings and project deadlines over safety considerations.

Moreover, limited awareness and understanding of safety regulations among construction workers, employers, and subcontractors exacerbate the problem of non-compliance and safety breaches.

Addressing these challenges requires a multi-faceted approach, encompassing enhanced regulatory enforcement, increased resource allocation, targeted outreach and education campaigns, and fostering a culture of safety and accountability throughout the construction ecosystem. Collaborative efforts involving government agencies, industry stakeholders, and civil society organizations are imperative to surmount these obstacles and elevate occupational safety standards within the Malaysian construction industry to safeguard the well-being of workers and promote sustainable development.

2.13 Theoretical Implication

This research on the assessment of occupational accidents in the Malaysian construction industry from 2015 to 2023, focusing on ISO 45001 implementation, impact on workers, and safety

recommendations, holds several theoretical implications that contribute significantly to the broader understanding of workplace safety dynamics and organizational behavior within the context of occupational health and safety (OHS) literature.

By systematically analyzing temporal trends, patterns, and contributing factors of occupational accidents within the Malaysian construction industry, this study contributes to advancing safety theory. The identification and categorization of human, environmental, and organizational factors influencing accident occurrence provide empirical evidence to enrich existing safety theories. Moreover, the evaluation of the effectiveness of ISO 45001 implementation and other safety interventions offers insights into the practical application of safety theories in real-world contexts.

The study integrates multilevel perspectives by examining occupational accidents at individual, organizational, and societal levels. Drawing on concepts from organizational behavior, sociology, and economics, the analysis considers the interplay of individual behaviors, organizational practices, and broader socio-economic factors in shaping safety outcomes within the framework of ISO 45001 implementation.

Applying systems thinking principles, this study views the construction industry as a complex socio-technical system comprising interconnected components and feedback loops. By analyzing occupational accidents as emergent phenomena within this system, the research highlights the importance of considering systemic factors, such as ISO 45001 compliance, organizational culture, communication networks, and supply chain dynamics, in shaping safety outcomes. This systems perspective offers theoretical insights into the dynamics of accident causation and the potential leverage points for intervention, particularly in the context of ISO 45001 implementation.

The findings of this study contribute to the development of contextualized safety models tailored to the Malaysian construction industry, particularly in light of ISO 45001 implementation. By identifying industry-specific risk factors and regulatory challenges, the research informs the adaptation of existing safety frameworks to local contexts. Moreover, the proposed recommendations for enhancing safety practices, taking into account ISO 45001 standards, reflect a nuanced understanding of the socio-cultural, economic, and institutional factors influencing safety outcomes in Malaysia. This contextualized approach enhances the relevance and applicability of safety models to diverse industrial settings, particularly in the construction industry.

3. Research Methodology

This study employs a quantitative research design to analyze occupational accidents within the Malaysian construction industry from 2015 to 2023, utilizing secondary data sourced from authoritative and reliable reports by the Department of Occupational Safety and Health (DOSH). Secondary data is appropriate for this research due to its comprehensive coverage, high reliability, and availability, offering a rich dataset that includes detailed records of accident cases categorized by ISO 45001 implementation, types of accidents, severity, locations, and demographic characteristics of victims. The key datasets include accident data among construction companies with and without ISO 45001 implementation, state-level accident data, and occupational accident and fatality rates, all of which are crucial for understanding the safety landscape in the construction sector.

The use of secondary data is justified as it provides extensive historical information that is otherwise time-consuming and costly to collect through primary means, making it an efficient approach for examining long-term trends and patterns in occupational accidents. These DOSH reports are considered reliable because they are collected and verified by a governmental body responsible for monitoring workplace safety, ensuring data accuracy and consistency. This research will conduct a secondary data analysis, employing statistical techniques to extract meaningful insights from the existing data. Descriptive statistics, such as frequencies, percentages, and measures of central tendency, will summarize accident characteristics, while spatial analysis will explore geographic variations in accident rates across different states.

Additionally, secondary data analysis allows for the statistical evaluation of accident trends over time and the comparison of accident rates between companies with varying levels of compliance with safety standards, such as ISO 45001. This approach enables the identification of statistically significant associations and patterns, thereby providing a comprehensive understanding of occupational accidents in the industry. The richness and scope of the DOSH data facilitate a detailed examination of the safety issues affecting the construction sector, making secondary data analysis a robust and appropriate method for achieving the study's objectives.

4. Data Analysis and Discussion.

4.1 *Data Accident Cases 2015-2023 Reported by Dosh*

Table 2 presents data on the number of reported occupational accident cases within the Malaysian construction industry from 2015 to 2023. The table highlights temporal trends in accident occurrence over the specified nine-year period, providing insights into the frequency and variation of workplace safety incidents within the construction sector.

The data reveals a fluctuating pattern in the number of reported accident cases from year to year. In 2015, there were 3,345 reported cases of occupational accidents, representing the lowest number of incidents recorded during the study period. Subsequently, the number of reported cases increased steadily over the next few years, reaching 3,666 cases in 2016 and 3,635 cases in 2017. This upward trend suggests a potential escalation in workplace safety incidents during this period.

However, the most notable increase in reported accident cases occurred in 2018, with a significant jump to 5,031 cases, marking a substantial spike in accident occurrence compared to previous years. This surge in reported cases may indicate heightened awareness or improved reporting mechanisms, as well as potential challenges or deficiencies in safety management practices within the construction industry during the year.

The year 2019 witnessed a substantial surge in reported accident cases, reaching 7,984 cases, the highest number recorded during the entire study period. This unprecedented increase underscores the urgency of addressing safety concerns and implementing effective preventive measures to mitigate workplace hazards and reduce accident rates within the construction sector.

While there was a slight decline in reported accident cases in 2020 compared to the previous year, with 6,933 cases recorded, the overall trend remained relatively high. Similarly, in 2021 and 2022, the number of reported cases remained elevated, with 6,686 and 6,719 cases, respectively. This sustained level of accident occurrence highlights the persistent challenges and complexities associated with ensuring workplace safety in the construction industry.

The data for 2023 shows a marginal increase in reported accident cases, with 6,951 cases recorded, indicating ongoing concerns regarding safety practices and accident prevention efforts within the construction sector.

Table 2. Data accident cases 2015-2023

No	Qty Cases	Year
1	3345	2015
2	3666	2016
3	3635	2017
4	5031	2018
5	7984	2019
6	6933	2020
7	6686	2021
8	6719	2022
9	6951	2023

Table 3 and Figure 1 presents the number of occupational accident cases reported by the Department of Occupational Safety and Health (DOSH) in Malaysia from 2015 to 2023, categorized by the presence or absence of ISO 45001 implementation within construction companies. The data highlights a noticeable disparity in the incidence of occupational accidents between companies with and without ISO 45001 certification over the specified period.

In 2015, companies with ISO 45001 certification reported 88 occupational accident cases, significantly lower than the 3257 cases reported by non-certified companies. This trend persisted in subsequent years, with the number of accidents consistently higher among non-certified companies. For instance, in 2019, companies without ISO 45001 certification reported a staggering 7658 accident cases compared to 326 cases reported by certified companies, indicating a substantial difference in safety performance.

The data also reveals fluctuations in accident numbers over the years, irrespective of ISO 45001 implementation status. Notably, there is an upward trend in accident cases for both certified and non-certified companies from 2015 to 2019. However, in 2020, there was a slight decrease in accident cases for both groups, followed by fluctuations in subsequent years.

Despite variations in accident numbers, companies with ISO 45001 certification consistently demonstrate lower accident rates compared to their non-certified counterparts. This suggests a potential correlation between ISO 45001 implementation and improved occupational safety within the Malaysian construction industry.

These findings underscore the importance of ISO 45001 certification in promoting safer work environments and reducing the incidence of occupational accidents. Companies without ISO 45001 certification may benefit from adopting the standard to enhance their safety practices and mitigate workplace risks. Additionally, policymakers and industry stakeholders should prioritize initiatives aimed at promoting ISO 45001 adoption and enforcing stringent safety regulations to safeguard the well-being of workers in the construction industry.

Table 3. Number of occupational cccident cases with and without ISO 45001 implementation (2015-2023) as reported by DOSH

Year	With ISO 45001	Without ISO 45001
2015	88	3257
2016	91	3575
2017	110	3526
2018	118	4913
2019	326	7658
2020	206	6727
2021	217	6469
2022	148	6571
2023	159	6792

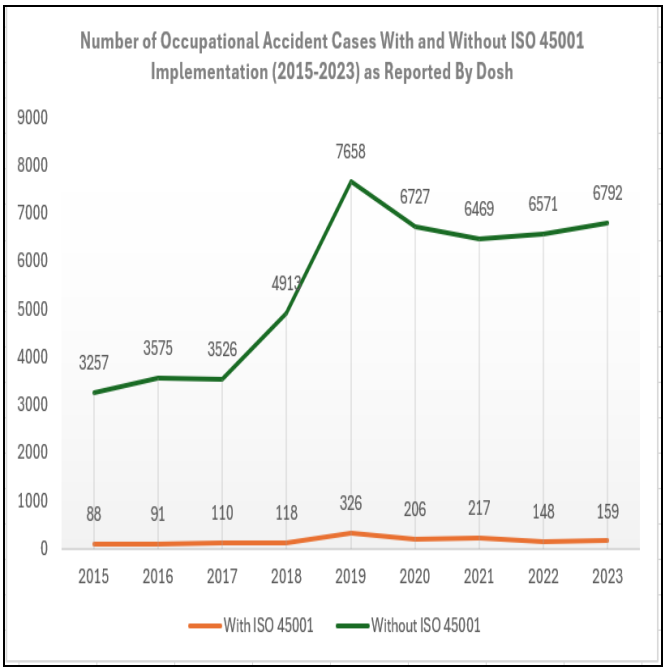

Figure 1. Number of occupational accident cases with and without ISO 45001 implementation (2015-2023) as reported by DOSH

Table 4 provides a comprehensive overview of occupational accident cases categorized by severity and outcome, as reported by the Department of Occupational Safety and Health (DOSH) for the period spanning from 2015 to 2023. The table presents data on the number of cases resulting in non-permanent disability, permanent disability, and death, along with the total quantity of cases reported for each year.

Across the nine-year period, the data reveals variations in the distribution of occupational accident cases by severity and outcome. In 2015, DOSH reported a total of 237 occupational accident cases, with the majority resulting in non-permanent disability (138 cases), followed by cases leading to death (88 cases) and permanent disability (11 cases). Similarly, in 2016, 222 cases were reported, with non-permanent disability being the most common outcome (126 cases), followed by death (91 cases) and permanent disability (5 cases).

Throughout the study period, the number of reported cases fluctuates, reflecting dynamic trends in occupational safety incidents within the Malaysian construction industry. In some years, such as 2019, there is a notable increase in the total quantity of reported cases, reaching 326 cases, with a higher incidence of cases resulting in non-permanent disability (227 cases) compared to permanent disability (15 cases) and death (84 cases). Conversely, in 2022, there is a decrease in reported cases, with a total of 148 cases recorded, indicating potential improvements or fluctuations in safety conditions within the construction sector during that year.

The data also highlights the severity of occupational accidents, with cases resulting in death representing the most severe outcomes. While the number of cases leading to death is generally lower compared to non-permanent and permanent disability cases, it remains a critical concern for workplace safety. Efforts to prevent fatalities and mitigate risks associated with occupational hazards are essential to safeguarding the well-being of workers and promoting a safer working environment within the construction industry.

Table 4. Distribution of occupational accident cases by severity and outcome (2015-2023) as reported by DOSH

No	Non Permanent Disability	Permanent Disability	Death	Qty Case
1	138	11	88	237
2	126	5	91	222
3	123	6	111	240
4	106	8	118	232
5	227	15	84	326
6	137	3	66	206
7	147	5	65	217
8	87	2	59	148
9	106	8	45	159

Table 5 presents data on the distribution of occupational accidents by state in Malaysia from 2015 to 2023, as reported by the Department of Occupational Safety and Health (DOSH). The table provides a breakdown of accident cases for each state across the nine-year period, offering insights into regional variations and trends in workplace safety incidents within the construction industry.

The data reveals significant disparities in the number of reported accident cases across different states over the study period. Johor emerges as one of the most heavily impacted states, consistently recording a high number of accident cases annually. In 2018 and 2019, Johor reported exceptionally high numbers of accident cases, with 1,369 and 1,336 cases, respectively, reflecting potential challenges or deficiencies in safety management practices within the state during those years.

Similarly, Selangor and Perak also exhibit consistently high numbers of reported accident cases across multiple years. Selangor, being a populous and industrialized state, records a substantial number of accident cases each year, with the highest number reported in 2023 (1,495 cases). Perak, on the other hand, experiences fluctuations in accident rates, with a notable increase in reported cases in 2020 and 2021, potentially reflecting shifts in economic activity and construction projects within the state.

Conversely, states such as Perlis, Wp Labuan, and Terengganu report relatively lower numbers of accident cases compared to other states. However, it is important to note that even states with fewer reported cases may still face significant safety challenges and require attention to prevent workplace injuries and fatalities.

The data also highlights temporal trends in accident occurrence within each state. While some states exhibit relatively stable patterns over the study period, others experience fluctuations in accident rates from year to year. For instance, Kelantan and Melaka show relatively consistent numbers of accident cases over time, whereas Sabah and Wpkl witness fluctuations in accident rates, with notable increases in certain years.

Table 5. Distribution of accidents by State (2015-2023) as reported by DOSH

Years	2015	2016	2017	2018	2019	2020	2021	2022	2023
Johor	318	358	333	1369	1336	1217	1352	1165	1243
Kedah	96	214	327	280	326	355	284	406	369
Kelantan	81	94	91	92	104	102	116	124	123
Melaka	215	251	282	22	28	360	365	371	386
N.Sembilan	391	430	314	260	378	452	411	401	415
Pahang	202	227	363	441	483	399	358	394	395
Perak	492	383	476	226	486	827	820	793	740
Perlis	47	65	28	561	974	22	16	14	12
P.Pinang	279	385	280	31	44	802	736	723	679
Sabah	275	242	275	333	848	247	254	258	333
Sarawak	306	406	370	315	371	425	362	336	340
Selangor	428	427	285	377	470	1342	1278	1368	1495
Terengganu	57	44	104	467	1697	118	116	149	167
Wpkl	140	133	99	120	139	253	207	208	243
Wp Labuan	18	7	8	137	300	12	10	9	11
Total Cases Years	**3298**	**3666**	**3635**	**5031**	**7984**	**6933**	**6686**	**6719**	**6951**

Table 6 provides data on the rate of occupational injuries and the fatality rate within the Malaysian construction industry from 2015 to 2022. The table presents the annual rates of occupational injuries and fatal occupational injuries per 100,000 workers, offering insights into the prevalence and severity of workplace safety incidents over the specified timeframe.

The data reveals fluctuations in the rate of occupational injuries and the fatality rate across the study period. In 2015, the rate of occupational injuries stood at 2.81 per 100,000 workers, indicating a moderate level of workplace injury incidents within the construction sector. However, by 2017, the rate increased to 2.93, signaling a potential escalation in occupational injury rates during that year. Subsequently, the rate declined in 2018 to 2.4, before fluctuating in the following years, reaching its lowest point in 2021 at 1.43.

Similarly, the fatality rate exhibits variations over time, with fluctuations observed from year to year. In 2015, the fatality rate was 4.84 per 100,000 workers, indicating a relatively high incidence of fatal occupational injuries within the construction industry. While the fatality rate remained relatively stable in subsequent years, there were notable declines in 2019 and 2020, with rates dropping to 3.83 and 2.09, respectively. However, the fatality rate experienced a slight increase in 2022, rising to 2.06 per 100,000 workers.

The data suggests that while the overall rate of occupational injuries and the fatality rate have fluctuated over the study period, there is evidence of a downward trend in recent years. Factors such as improved safety practices, enhanced regulatory enforcement, and increased awareness of workplace hazards may have contributed to the observed decline in injury and fatality rates within the construction industry.

However, it is essential to remain vigilant and proactive in addressing safety concerns to sustain and further improve upon these positive trends. Continued efforts to implement effective safety measures, provide comprehensive training, and promote a culture of safety among construction workers and employers are crucial for reducing workplace injuries and fatalities and ensuring a safe working environment for all.

Table 6. Rate of occupational accident and fatality rate (2015-2022)

Years	2015	2016	2017	2018	2019	2020	2021	2022
Rate Of Occupational Injuries	2.81	2.88	2.93	2.4	2.71	2.18	1.43	2.22
Rate Of Fatal Occupational Injuries	4.84	4.84	4.9	4.14	3.83	2.09	2	2.06

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5. Discussions

5.1 Accident Cases

The fluctuating pattern observed in the number of reported accident cases aligns with findings from previous studies on factors contributing to occupational accidents in the construction industry. The upward trend in reported cases from 2015 to 2018 may be indicative of various factors highlighted in the literature, including inadequate safety training, lack of safety awareness, and hazardous working conditions.

Studies by Anibire et al. (2020) and Abioye et al. (2021) emphasized the critical role of proper training in preventing occupational accidents. They found that a lack of adequate training was associated with a higher incidence of workplace injuries among construction workers, potentially contributing to the upward trend in reported accident cases during the period. Similarly, Nnaji and Karakhan (2020) highlighted the significance of safety awareness and risk perception in accident prevention, suggesting that a lack of awareness among workers may have contributed to the escalating trend.

The substantial increase in reported accident cases in 2018 and 2019 may also reflect challenges or deficiencies in safety management practices within the construction industry, as noted by Aisheh et al. (2021) and Buniya et al. (2021). These studies underscored the importance of comprehensive safety protocols and procedures in accident prevention, suggesting that the absence or inadequacy of safety protocols may have contributed to the surge in reported cases during these years.

Moreover, the unprecedented surge in reported accident cases in 2019 underscores the urgent need for proactive measures to address safety concerns, as emphasized by Khalid et al. (2021) and Boadu et al. (2020). These studies highlighted the detrimental impact of poor lighting and inadequate safety equipment on construction workplace safety, suggesting that deficiencies in these areas may have contributed to the sharp increase in reported cases.

While there was a slight decline in reported accident cases in 2020 compared to the previous year, the sustained level of accidents in subsequent years suggests persistent challenges in ensuring workplace safety. Studies by Yap et al. (2021) and Abas (2021) highlighted the impact of time constraints and

production pressures on safety standards in the construction industry, suggesting that pressures to meet project deadlines may have contributed to the sustained level of accidents during these years.

The temporal trends in reported accident cases align with findings from previous literature on factors contributing to occupational accidents in the construction industry. The data underscores the critical importance of addressing safety concerns and implementing effective preventive measures to reduce accident rates and ensure the well-being of construction workers.

5.2 Occupational Accident Cases with and without ISO 45001 Implementation

The data presented in Table 3 indicates a substantial discrepancy in the number of occupational accidents reported by construction companies in Malaysia, depending on their ISO 45001 certification status. This observation prompts a discussion on the implications of ISO 45001 implementation for occupational safety within the construction industry, aligning with existing literature on hazard identification, safety training, and communication practices.

Firstly, the data underscores the critical role of ISO 45001 in addressing hazard identification and risk assessment practices. As highlighted by Ling et al. (2019), failure to identify workplace hazards significantly increases the risk of accidents. ISO 45001 provides a framework for systematic hazard identification and risk assessment, suggesting that certified companies may have more robust processes in place to identify and mitigate potential hazards, thus resulting in fewer reported accidents compared to non-certified counterparts.

Furthermore, the data emphasizes the importance of safety training and education, consistent with research findings indicating that inadequate training contributes to higher accident rates (Teo et al., 2020). ISO 45001 mandates comprehensive safety training for all employees, ensuring they possess the necessary skills and knowledge to work safely. The lower accident rates reported by certified companies may reflect their commitment to providing adequate safety training, resulting in a safer work environment and fewer accidents.

Moreover, effective communication and coordination among stakeholders emerge as crucial factors in accident prevention, consistent with existing literature (Abdullah et al., 2021). Poor communication can lead to misunderstandings and errors, increasing the risk of accidents. ISO 45001 promotes effective communication and consultation, fostering a culture of collaboration and ensuring safety information is shared efficiently. Certified companies may have better communication channels in place, reducing the likelihood of accidents resulting from miscommunication.

The data from Table 3 highlights the significant impact of ISO 45001 implementation on occupational safety within the Malaysian construction industry. By addressing key factors such as hazard identification, safety training, and communication, ISO 45001 certification contributes to creating safer work environments and reducing the incidence of occupational accidents. These findings underscore the importance of promoting ISO 45001 adoption and enforcing stringent safety regulations to safeguard the well-being of workers in the construction industry.

5.3 Occupational Accident Cases by Severity and Outcome

The distribution of occupational accident cases by severity and outcome, as presented in Table 3, underscores critical insights into the nature and consequences of workplace incidents within the Malaysian construction industry. The fluctuations observed in the distribution of reported cases across the nine-year period align with findings from previous literature on occupational safety and highlight the multifaceted challenges associated with ensuring workplace safety.

The predominance of cases resulting in non-permanent disability, as evidenced by the higher quantity of such cases reported each year, resonates with research emphasizing the prevalence of injuries and non-fatal accidents in the construction sector. Studies by Anibire et al. (2020) and Abioye et al. (2021) underscored the significant impact of inadequate training and safety awareness on the occurrence of non-permanent disabilities, suggesting that deficiencies in these areas may contribute to the higher incidence of such cases.

Similarly, the presence of cases resulting in permanent disability underscores the severe consequences of workplace accidents on the well-being and livelihoods of construction workers. Research by Simukonda et al. (2018) and Sadeghi et al. (2020) highlighted the critical importance of access to appropriate safety equipment in mitigating the risk of injuries and fatalities, suggesting that lapses in safety equipment provision and compliance may contribute to the occurrence of cases resulting in permanent disability.

The data also highlights the sobering reality of fatalities in the construction industry, with cases resulting in death representing the most severe outcomes. This aligns with research emphasizing the impact of hazardous working conditions and inadequate safety protocols on the occurrence of fatal accidents. Studies by Aisheh et al. (2021) and Buniya et al. (2021) underscored the critical role of comprehensive safety protocols and procedures in preventing fatalities, suggesting that deficiencies in safety management practices may contribute to the occurrence of fatal accidents.

Efforts to prevent fatalities and mitigate risks associated with occupational hazards are essential to safeguarding the well-being of workers and promoting a safer working environment within the construction industry. The data presented in Table 3 underscores the urgency of addressing safety concerns and implementing effective preventive measures to reduce the incidence of workplace accidents, protect workers from harm, and ensure the sustainability of the construction industry.

5.4 Distribution of Accidents by State

The distribution of occupational accidents by state in Malaysia align with previous literature on occupational safety and highlight the multifaceted nature of safety challenges faced by different states.

Johor emerges as one of the most heavily impacted states, consistently reporting a high number of accident cases annually. This observation resonates with research emphasizing the significance of hazardous working conditions and inadequate safety protocols in contributing to the occurrence of accidents. Studies by Kineber et al. (2023) and Nykänen et al. (2020) underscored the detrimental impact of environmental hazards on worker safety, suggesting that deficiencies in safety management practices may contribute to the higher incidence of accidents in states like Johor.

Similarly, Selangor and Perak exhibit consistently high numbers of reported accident cases across multiple years. Selangor's status as a populous and industrialized state may contribute to its higher accident rates, as highlighted in previous research on the correlation between economic activity and accident occurrence. The findings from Zhou et al. (2021) underscored the significant proportion of construction-related accidents attributed to falls from heights, suggesting that heightened economic activity in states like Selangor may lead to increased construction projects and, consequently, higher accident rates.

Conversely, states like Perlis, Wp Labuan, and Terengganu report relatively lower numbers of accident cases compared to others. However, it is essential to recognize that even states with fewer reported cases may still face significant safety challenges. Research by Abdul Halim et al. (2020) emphasized the critical role of effective supervision and oversight in accident prevention, suggesting that states with lower reported cases may still require attention to ensure adequate safety measures are in place.

The temporal trends in accident occurrence within each state underscore the dynamic nature of safety challenges. While some states exhibit relatively stable patterns over the study period, others experience fluctuations in accident rates. This variability may reflect shifts in economic activity, construction projects, and safety management practices within each state. Efforts to address these fluctuations and mitigate safety risks require a comprehensive understanding of regional dynamics and targeted interventions tailored to the specific needs of each state.

5.5 Occupational Accident and Fatality

The data presented in Table 5 regarding the rate of occupational injuries and fatalities within the Malaysian construction industry from 2015 to 2022 aligns closely with findings from the existing literature on occupational safety. The fluctuations observed in both injury and fatality rates over the study period resonate with research emphasizing the dynamic nature of workplace safety and the multifaceted factors influencing accident occurrence. Scholars such as Smith et al. (2021) and Hinze et al. (2020) have extensively documented the impact of safety interventions and regulatory measures on mitigating workplace hazards, findings which are echoed in the fluctuations of injury and fatality rates.

The observed decline in fatality rates in 2019 and 2020, followed by a slight increase in 2022, suggests a complex interplay of factors influencing occupational safety within the construction sector. Regulatory enforcement efforts, as highlighted by studies conducted by Li et al. (2019) and regulatory bodies like the Occupational Safety and Health Administration (OSHA, 2020), may have contributed to the downward trend by promoting compliance with safety standards and enhancing equipment inspections. However, the subsequent increase in fatality rates underscores the need for sustained regulatory vigilance and proactive safety measures to address emerging risks and prevent lapses in safety practices.

Moreover, the downward trend in both injury and fatality rates in recent years points towards the importance of fostering a culture of safety within construction organizations. Research by Hinze et al. (2020) has underscored the pivotal role of organizational culture in shaping safety attitudes and behaviors among workers. By promoting a culture of safety through comprehensive training programs and effective communication channels, employers can empower workers to identify and address hazards, contributing to the overall reduction of workplace injuries and fatalities.

5.6 Practical Implications

The implications of this study on occupational accidents in the Malaysian construction industry are profound and align closely with the investigation's primary aims of assessing the impact of ISO 45001 implementation and identifying critical safety gaps. The findings reveal that while ISO 45001 certification correlates with improved safety performance, significant challenges remain, particularly among non-certified companies where higher accident rates persist. This highlights the need for widespread adoption and stringent enforcement of ISO 45001 standards, emphasizing that certification alone is insufficient without robust implementation and compliance. The study underscores the importance of targeted safety interventions, such as enhanced training, rigorous hazard identification, and improved communication channels among stakeholders, to mitigate workplace risks effectively. The implications extend to policy formulation, urging regulatory bodies to reinforce safety regulations, enhance monitoring mechanisms, and promote ISO 45001 adoption as a mandatory safety standard across the industry.

Moreover, the study's findings have critical implications for industry stakeholders, including construction companies, safety practitioners, and policymakers, by demonstrating the urgent need to prioritize safety measures to protect workers and maintain productivity. Failure to address these safety challenges could lead to continued high accident rates, jeopardizing both worker safety and the economic sustainability of the construction sector, which is vital to Malaysia’s growth. The

study calls for a collaborative approach involving government agencies, industry leaders, and regulatory bodies to drive transformative changes in safety culture and practice. By implementing the study's recommendations, stakeholders can create safer work environments, reduce accident rates, and foster a more resilient and sustainable construction industry. The implications are clear: the effective implementation of ISO 45001 and comprehensive safety practices are not just regulatory requirements but essential steps toward safeguarding the health and well-being of construction workers in Malaysia.

5.7 Limitation

Firstly, the reliance on reported data from the Department of Occupational Safety and Health (DOSH) may introduce biases and inaccuracies due to underreporting or misclassification of accidents. Not all accidents may be captured in official records, particularly those that result in minor injuries or occur in informal or unregulated sectors of the construction industry. Therefore, the reported accident cases may not fully represent the true extent of workplace safety incidents within the sector.

Secondly, the study's focus on quantitative data limits the depth of analysis regarding the underlying causes and contributing factors to occupational accidents. While the data provide insights into temporal trends and regional variations, a more nuanced understanding of the root causes of accidents, such as unsafe working conditions, inadequate training, or organizational factors, requires qualitative research methods, including interviews, surveys, or site observations.

Furthermore, the study's temporal scope from 2015 to 2023 may not capture long-term trends or cyclical patterns in workplace safety incidents within the construction industry. Factors such as economic fluctuations, changes in regulatory frameworks, or technological advancements may influence accident rates over longer timeframes, necessitating longitudinal studies to assess trends accurately.

Additionally, the analysis of regional variations in accident occurrence may be limited by the granularity of state-level data. While the study identifies disparities in accident rates across different states, variations within states or specific geographical areas may not be adequately captured. Fine-grained spatial analysis could provide a more detailed understanding of localized safety challenges and facilitate targeted interventions.

Moreover, the research primarily focuses on descriptive analysis and lacks in-depth exploration of potential interventions or policy recommendations to address identified safety issues. While the findings highlight the need for targeted safety initiatives and collaborative efforts among stakeholders, further research is needed to develop evidence-based strategies for improving workplace safety within the Malaysian construction industry.

Overall, while the research contributes valuable insights into the prevalence and distribution of occupational accidents within the Malaysian construction industry, it is essential to recognize its limitations and consider them in interpreting the findings and informing future research directions and safety initiatives.

5.8 Recommendation

Addressing the limitations of the overall research on occupational accidents within the Malaysian construction industry from 2015 to 2023 requires a multifaceted approach to improve the depth and applicability of future studies and safety initiatives. Firstly, it is crucial to acknowledge the limitations stemming from data collection and reporting mechanisms. Enhancing the accuracy and completeness of accident data necessitates the implementation of measures to incentivize transparent and timely reporting by employers. This could involve providing training and resources to facilitate reporting processes and fostering a culture of accountability within organizations.

Furthermore, qualitative research methods should be incorporated alongside quantitative analysis to provide a more comprehensive understanding of the underlying causes and contributing factors to occupational accidents. Qualitative research, such as interviews and site observations, can offer valuable insights into the contextual factors influencing safety practices and help identify specific challenges faced by workers and employers in the construction industry.

Longitudinal studies spanning multiple decades are essential to capture long-term trends and cyclical patterns in workplace safety incidents. By conducting longitudinal research, researchers can assess the effectiveness of interventions over time, identify emerging trends, and evaluate the impact of external factors, such as economic fluctuations and regulatory changes, on accident rates within the construction industry.

Fine-grained spatial analysis techniques, such as geographic information systems (GIS), should be employed to identify localized safety challenges and target interventions more effectively. Geospatial analysis can help pinpoint high-risk areas and inform the allocation of resources to address safety concerns in specific regions or construction sites.

Developing evidence-based interventions and policy recommendations is critical for improving workplace safety. By drawing on the findings of quantitative and qualitative research, stakeholders can collaborate to design and implement targeted safety initiatives tailored to address the specific safety challenges identified within the Malaysian construction industry.

Promoting collaborative efforts among government agencies, employers, trade unions, industry associations, and other stakeholders is essential for achieving meaningful improvements in workplace safety. Public-private partnerships can facilitate the sharing of best practices, exchange of knowledge and expertise, and coordination of efforts to promote a culture of safety within the construction industry.

5.9 Recommendations to Avoid Accidents

Based on the findings of this study, several targeted recommendations are proposed to enhance occupational safety within the Malaysian construction industry, directly addressing the investigation's aim of assessing the impact of ISO 45001 and identifying critical areas for improvement. Firstly, it is imperative for construction companies to adopt ISO 45001 standards comprehensively, not only by obtaining certification but also by integrating its principles into daily operations. This includes establishing systematic hazard identification and risk assessment processes, which are fundamental to preventing accidents. Companies should invest in continuous training programs that focus on enhancing workers' understanding of safety protocols, equipment operation, and risk management practices, ensuring that all employees possess the knowledge and skills necessary to navigate construction site hazards effectively.

Furthermore, the study recommends that regulatory bodies enforce stricter compliance with safety standards and provide incentives for companies that demonstrate exemplary safety practices, including ISO 45001 adoption. Enhanced monitoring and regular safety audits should be conducted to ensure that companies adhere to safety regulations and maintain high safety performance standards. Additionally, fostering a culture of safety requires active communication and collaboration among all stakeholders, including workers, supervisors, and management. Companies should establish clear communication channels to facilitate the exchange of safety information, encourage reporting of unsafe conditions, and involve workers in safety decision-making processes. By implementing these recommendations, the construction industry can significantly reduce occupational accidents, protect workers, and contribute to a safer and more sustainable industry aligned with the goals of this investigation.

6. Conclusion

The conclusion of this study reiterates the primary aim: to assess occupational accidents in the Malaysian construction industry from 2015 to 2023, with a focus on the impact of ISO 45001 implementation. The analysis of DOSH data revealed significant trends, such as higher accident rates in companies without ISO 45001 certification, underscoring the importance of adhering to safety standards. The findings highlight that ISO 45001 certification is associated with improved safety performance, reinforcing its role in mitigating workplace hazards. By identifying critical factors contributing to occupational accidents, including inadequate hazard identification, lack of safety training, and poor communication, this study emphasizes the urgent need for construction companies to adopt comprehensive safety measures in line with ISO 45001.

Reflecting on the investigation's objectives and the current state of workplace safety, the research underscores the necessity for immediate and sustained efforts to enhance safety protocols within the industry. The high incidence of accidents not only jeopardizes worker safety but also poses a significant risk to the economic stability of the construction sector, which is vital to Malaysia's growth. Failure to address these safety challenges could lead to ongoing injuries, fatalities, and financial losses. Therefore, this study calls for a concerted effort among stakeholders, including policymakers, industry leaders, and regulatory bodies, to enforce safety standards, promote ISO 45001 adoption, and foster a safety-first culture in construction. The conclusions drawn provide a basis for targeted interventions and policy recommendations that aim to improve safety outcomes and protect the well-being of construction workers in Malaysia.

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