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Investigation on the Nature of Safety Rule Violations in High-Rise Construction Projects

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ABSTRACT

The construction sector has consistently demonstrated a greater risk of fatal and non-fatal occupational accidents than other economic sectors, particularly with respect to high-rise building construction projects. Despite searing progress in the regulatory domain and the progressive formulation of a new safety agenda for the industry, the truth is that safety incidents involving fatalities and injuries still perpetuate with varying degrees of intensity. This is further aggravated by the loss of vital project resources such as materials, equipment, and labour, which is counter-productive, unsustainable, and occasionally polluting. What is abundantly clear is that the human factor, when dealing with safety intricacies and observation, still plays a considerable role in determining key safety objectives' accomplishment. With that in mind, the aim of this study was to delve deeper into this issue among practitioners at the forefront of high-rise building construction in Malaysia. Specifically, it investigates, analyses, and ranks the degree of severity of the safety rule violation repercussions, the frequency, and the perpetrators. A questionnaire survey approach was devised and distributed to respondents from among the developers, consultants, contractors, and relevant authorities. The collected data were analysed using the SPSS package by determining the average index, standard deviation, variance, and frequency analysis. The results have shown that the lack of fire protection was perceived to have the most severe repercussions, while the lack of risky, near-miss accident reporting and the LOTO procedures during servicing and maintenance activities were the most frequent safety rule violations. In addition, the contractor party was the most regular violator of the safety regulations, understandably by virtue of its numbers. In conclusion, these outcomes could facilitate safety authorities and professionals in devising pragmatic schemes that best utilise both persuasive and punitive mitigation measures for better safety outcomes.

1. Introduction

1.1 Literature Review

The construction sector is widely recognized as one of the most dangerous industries globally, as it poses a higher risk of occupational accidents, including both fatal and non-fatal, compared to other

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industries. In particular, high-rise building projects, which involve intricate and complex processes, present numerous safety challenges and concerns [29]. Workers are constantly exposed to various hazards, such as the use of heavy machinery, exposure to hazardous chemicals, and working at heights, which can have severe consequences on their well-being.

According to data from DOSH, the construction sector has a significantly higher rate of fatalities compared to other industries, which is five times higher [30]. The nature of the work performed in the construction sector exposes workers to varying degrees of risks, depending on the type of work being done. For example, working on scaffolding poses different hazards than working with asbestos. One of the most significant dangers that workers in maintenance and construction face is the risk of falling from a height. Falls are the primary cause of injuries and deaths in the construction sector, accounting for 33% of all construction worker fatalities in the US from 1985 to 1989 [40].

In Hong Kong, fall incidents accounted for 55% of fatal accidents, highlighting the severity of this hazard [16]. Workers on construction sites are always at risk of falling from any height, and scaffolding-related accidents are common. Scaffolding serves as a working platform and a material supporting prop, and falls from or collapse of scaffolding can result in severe injuries or even fatalities. Though rare, scaffolding accidents involving the general public can occur, but accidents involving contractors and workers are more common.

Another common hazard associated with working at heights is being struck by falling objects. Workers can be hit by machinery, materials, or goods being carried vertically or horizontally, resulting in severe injuries or fatalities, with the head often being the first point of impact [15]. According to OSHA [31], being struck by falling objects is the leading cause of death in construction, accounting for 35% of all fatalities in 2020. In addition, being struck by falling objects is the second leading cause of nonfatal injuries in construction, accounting for 18% of all injuries.. Hence, adequate protective measures must be put in place to prevent or reduce the number of such incidents.

As such, the study on construction safety violations holds significance because safety concerns in the construction industry persist and evolve over time. Despite the presence of regulations and safety protocols, violations persist, endangering the welfare of workers and compromising the integrity of construction sites. Gaining insights into the nature of these violations is essential to devise proactive strategies that prevent such incidents and enhance safety practices.

Given the context, the study has established the following objectives to address the issue at hand: evaluate the severity and frequency of safety violations occurring in the construction industry and identify the individuals or entities responsible for committing these safety violations. By pursuing these objectives, the study aims to deepen the understanding of the extent and impact of safety violations within the construction sector. This comprehensive analysis will shed light on the severity and frequency of these violations, allowing for a more informed approach to address and mitigate the risks. Additionally, identifying the perpetrators behind these violations is crucial for assigning accountability and developing targeted interventions to improve safety practices. Through these efforts, the study seeks to contribute to the overall improvement of safety standards in the construction industry and safeguard the well-being of workers and the integrity of construction sites.

1.2 Accident Causation in High-Rise Construction

The construction industry is notorious for being prone to accidents due to the inherent complexity and coordination required during high-rise building projects. With multiple skilled workers and various technologies needed for a project's successful completion, the chances of accidents occurring increase significantly. Consequently, preventing accidents is challenging, and

accident models are often utilized to analyse the causes better. To ensure long-term recovery and prevent future accidents, addressing the underlying causes of accidents is crucial.

Several studies have identified the primary causes of accidents in the construction industry. Huang and Hinze [42], for example, found that fall accidents were caused by workers' misjudgement of hazardous conditions, insufficient or non-existent personal protective equipment (PPE), and inoperative safety measures. Arifuddin *et al*. [6] also discovered that poor housekeeping, faulty ladders, or technically inadequate work platforms can lead to falls. Similarly, the Department of Occupational Safety and Health (DOSH) [11] has identified several factors contributing to high-rise construction accidents, such as flawed management systems, ineffective safety policies, a lack of safety awareness, job site circumstances, no safety inspections or signs, and the unique nature of the job site. Human negligence, such as incorrect lifting caused by unsteady working surfaces and mishandling of fall-protection equipment, can also aggravate the issue.

Furthermore, many high-rise building accidents occur due to inadequate preventive measures, particularly in temporary structures prone to failure due to repeated dismantling and reuse. Workers may lack the necessary knowledge and technical expertise to foresee possible risks and avoid accidents, highlighting the importance of adequate safety training. The use of hazardous working platforms may also pose a significant risk to workers' safety, particularly if the equipment is not utilized, maintained, or stored appropriately.

Scaffolding accidents are also a common occurrence in the construction industry, caused primarily by construction errors, lack of protective equipment, inappropriate foundation, inadequate technical condition of the scaffolding, and excessive burden imposed on the scaffold. Chi *et al*. [10] and Ismail and Ghani [20] found that scaffolding accidents were often caused by body actions, such as climbing, walking, and leaning against, distraction, inadequate capacities, incorrect use of PPE, lack of compliant scaffolding, and coming into collision with falling items.

However, even with adequate safety training and equipment, workers may refuse to wear PPE due to discomfort or view it as disruptive to their productivity. Ardeshir and Mohajeri [4] identified that workers engage in unsafe work practices due to a lack of safety culture, massive production pressure, insufficient resources and time, and inadequate training. Thus, employers must adopt more comprehensive strategies and approaches to promote safe behaviour among workers.

Figure 1, as shown below, displays the causes of construction accidents extracted from reports examined by DOSH from the year 2000 to 2004. Majid *et al*. [17] simplified the list of accidents causation based on the DOSH reports, highlighting the need for a more proactive approach to address the root causes of accidents in the construction industry.

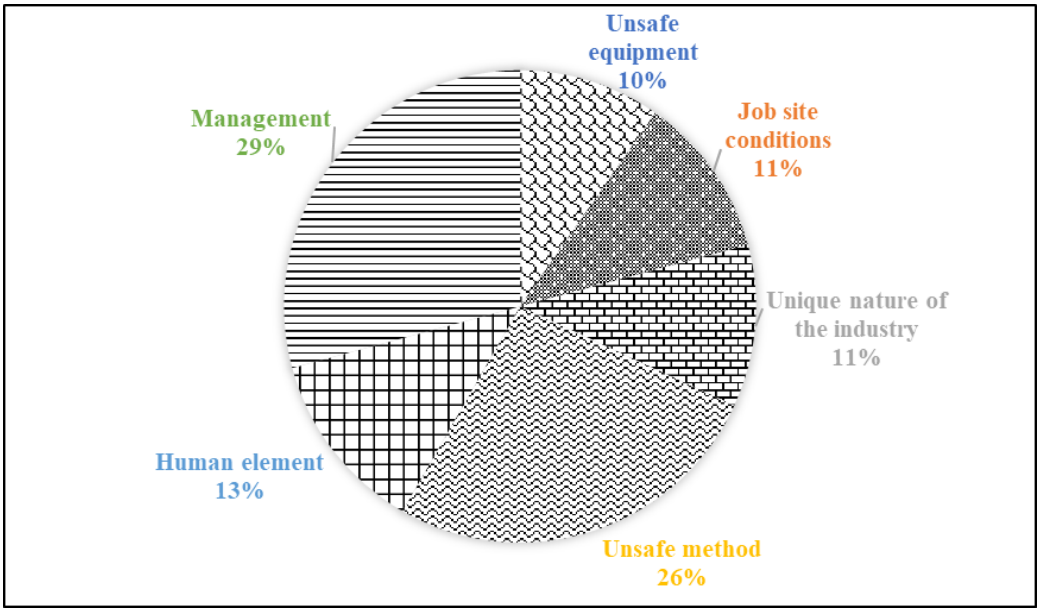

Fig. 1. Analysis of Accidents Causation in the Construction from DOSH Reports
Source: Distribution of Causes of Construction Accidents from DOSH Reports [17]

1.3 Safety Practices in High-Rise Construction

The construction industry is known to pose a high level of risk to workers' safety, making safety a critical concern. Despite significant improvements in construction safety, the industry continues to lag behind most other sectors in terms of safety, particularly in developing countries where reliable statistics are available. Malaysia is a developing country where the construction sector has grown considerably, but safety standards are not adequately enforced, and the current occupational and health conditions in the industry are considered inadequate and disorganized [26]. However, incorporating safety and health measures into a management system in Malaysia's construction industry can significantly enhance cost-effectiveness, quality control, and environmental conservation. Ensuring high-quality standards during high-rise building construction is essential to achieving optimal performance and improving construction quality.

The construction project's management team plays a crucial role in creating a safe workplace and influencing employees' safety attitudes [28]. Understanding safety procedures on construction sites can prevent the severity of construction incidents, as noted by Hallowell *et al.* [33]. Therefore, it is crucial to prioritize safety measures in the construction sector to protect the well-being of workers and the public and avoid accidents that can cause severe injuries or death.

According to OSHA, the PPEs are essential in reducing exposure to various types of hazards that can result in significant occupational injuries and illnesses. These hazards include chemical, radiological, physical, electrical, mechanical, and other industrial hazards. All PPEs including clothing, hardhats, shoes, eyeglasses, masks, and assisted breathing devices should be designed and constructed safely and kept clean and reliable to ensure worker safety. Comfort is also crucial in encouraging workers to utilize PPE properly. Ill-fitting PPE can be unsafe and may pose a security threat. Furthermore, the individual or supervisor must ensure that adequate PPE is worn at all times, especially in hazardous work areas. PPE standards vary according to the work environment, and employees must adhere to these standards before executing job assignments. For example, workers on a building construction site may be well protected if they wear a hardhat, safety vest, goggles, gloves, steel-toed shoes, long pants, and a long-sleeved shirt [23].

Equipment safety is of utmost importance in preventing accidents from occurring while working at heights. There are numerous equipment operations involved in high-rise construction projects, including crane operation, vibrating tool operation, and other heavy machinery. Despite the critical role that safety equipment plays in preventing accidents, past studies, such as Gheisari and Esmaeili [14], F. Ismail and Muhamad [19], Majid *et al.* [17], Suárez-Cebador *et al.* [36], Williams *et al.* [39], and Wu *et al.* [41], have pointed out the negligence of construction personnel in terms of safety equipment usage. One potential solution to this is to increase safety education and training for workers involved in high-rise construction projects, emphasizing the importance of safety equipment usage and its proper handling. Employers and project managers must ensure that safety equipment is available and accessible for workers, and that it is regularly inspected and maintained to ensure its effectiveness. Furthermore, it is essential to evaluate the current safety equipment protocols and identify any areas for improvement. This can be achieved through regular safety audits and risk assessments, which can help identify potential hazards and weaknesses in the safety equipment and protocols currently in place.

Ensuring the proper maintenance of heavy equipment is an essential component of workplace safety in the construction industry. Heavy machinery is prone to serious accidents if not correctly maintained. The maintenance is critical to identifying problems before they become serious. Over time, operational parts may suffer from extended wear and tear or become destructed. As such, inspection of all hydraulic systems, cab controls, lights, safety features, and tires visually are required to detect flaws. By identifying potential issues early, it is possible to mitigate the risk of accidents. During maintenance, it is essential to preserve individual components in their original shape as much as possible. This not only guarantees safety but also ensures that production speed is not affected. However, it is also essential to ensure that faulty equipment is never reinstated into operation to complete a project on time. Rather, it is necessary to decommission the heavy equipment if the components are unavailable or the unit cannot be fully repaired to operating requirements. Pushing failing equipment to its limits only raises the likelihood of a workplace mishap that might hurt or kill a person.

Hazard communication, also known as HazCom, is a vital standard framework that employers and manufacturers must establish to ensure the proper conveyance of the dangers associated with chemicals during handling, transportation, and any other type of exposure. In the construction industry, workers are often required to handle chemicals that can cause various health risks, including irritation and physical threats such as flammability and corrosion. To comply with the HazCom standard, OSHA requires chemical manufacturers and distributors to assess the hazards of the chemicals they handle and disseminate that information through labelling and safety data sheets. It is essential for employees to have access to this information to ensure their safety while working with hazardous chemicals. In addition, OSHA mandates that construction personnel attend a training program to comprehend more about handling hazardous chemicals. Unfortunately, OSHA has discovered that some construction sites lack a HazCom program and safety data sheets, which can lead to safety violations and inappropriate handling of hazardous chemicals. This can expose workers to dangerous health risks such as irritation and corrosion. To prevent such accidents, employers must ensure that a list of hazardous chemicals used is kept up-to-date and easily accessible on the site. Furthermore, any container containing hazardous material must be labelled with product identification and hazard warnings to prevent accidental exposure to workers.

The LOTO procedures are critical safety measures that are implemented in various workplaces, including construction sites. These procedures ensure that equipment is shut down and rendered inaccessible during maintenance or repair work, protecting workers from potential harm caused by hazardous machinery or equipment. Failure to properly implement the LOTO procedures can lead to

serious injuries or even fatalities. Unexpected starting or the release of stored energy during machine and equipment service and maintenance can result in catastrophic harm or death to employees, which is why it is crucial to follow proper LOTO procedures. It is required that workers who operate in an area where energy control procedures are used must be trained in the purpose and usage of the energy control procedures. They must also be aware of the restriction against attempting to restart or rejuvenate locked or tagged out machines or other equipment. Furthermore, employees who are authorized to lockout tools and equipment and execute service and maintenance operations must be trained to recognize the magnitude and applicable hazardous energy sources in the construction site to control the power. It is essential to ensure that all employees are fully trained on the proper LOTO procedures to prevent accidents and keep everyone safe.

The occurrence of fire hazards in high-rise construction projects can be quite significant, with several contributing factors, making them complex and unpredictable. These risks are particularly high in areas such as the building site, where a massive amount of effort is required, and the construction time is usually lengthy. Moreover, the environment in which the construction work is carried out is constantly changing, increasing the unpredictability of fire hazards [18]. Furthermore, due to the large number of combustible and flammable materials present on the construction site, there are numerous fire and heat sources, which can create an environment with significant fire hazards. Once a fire breaks out, it can be challenging to control and extinguish, making it all the more crucial to have adequate fire protection measures in place. Additionally, it was discovered that providing safety training plays a vital role in enhancing the awareness of fire safety among building occupants and the broader community [22]. Consequently, a lack of awareness about fire safety among the general public can result in injuries, fatalities, and damage to property caused by fires.

At construction sites, the use of electrical equipment is commonplace, and the dynamic, rough nature of construction activity can result in wear and tear to equipment, including insulation cracks, short circuits, and exposed wires. These issues can create a ground fault that transmits electricity into a worker's body, causing electrical burns, explosions, fires, or even death if there is no ground-fault protection in place. As such, OSHA has advised installing ground-fault circuit interrupters (GFCIs) on all 120 volts, single-phase, 15 and 20-ampere receptacles, or alternatively implementing an ensured equipment grounding conductor program (AEGCP). Furthermore, using electrical equipment inappropriately can be harmful to the equipment and cause injury to employees. It is crucial to use equipment that meets OSHA requirements and is certified to ensure safety safeguards are in place. Failure to do so can lead to equipment damage or employee injuries, putting both the worker and the construction site at risk.

1.4 Perpetrators of Safety Rule Violations

When it comes to safety measures on construction sites, there are various players involved, including contractors, local government officers, safety officers, consultants, and clients. According to Osei-Asibey *et al.* [8], accidents and hazards in the construction industry can often be attributed to the actions or inactions of these stakeholders, as their responsibilities are interconnected and interdependent. If one party fails to fulfil their duty, it can lead to significant risks of accidents and dangers.

According to Anyanwu [3], contractors play a critical role in translating working drawings, designs, timelines, and requirements into actual structures. They bear complete legal responsibility for supplying the necessary materials, labour, equipment, and services to complete a building project successfully, as stated by Utěšená *et al.* [38]. To ensure the safety of their workers, contractors must provide a secure working environment that is free of recognized risks that could cause fatal or severe

physical damage. In addition, they are responsible for ensuring that their employees adhere to all health and safety requirements on the construction site, as noted by Donkoh and Aboagye-Nimo [12]. Despite these requirements, Awwad *et al.* [7] found that only eight out of ten contractors in the Middle East have implemented safety procedures on construction site projects. Moreover, some contractors have been found to violate safety procedures to manage costs related to workers' wages and project costs. This is concerning, given that construction sites are inherently hazardous environments where accidents and injuries can occur easily, as noted by Osei-Asibey *et al.* [8].

Consultants also play a crucial role in ensuring that safety measures are observed and maintained in construction sites, in accordance with the set standards. However, despite the importance of their role in maintaining safety, some consultants are only focused on implementing the minimum safety standards set by the contractor and owner, without creating and enforcing their own safety protocols. It is important to note that the consultant's responsibilities go beyond meeting the minimum safety requirements. They are expected to use their professional knowledge and experience to identify any potential safety risks and hazards and recommend the most appropriate safety measures to be implemented. Moreover, consultants should work in close collaboration with other stakeholders in the construction project to ensure that safety measures are effectively integrated into the project design and execution. In many cases, consultants are responsible for developing safety plans and programs, conducting safety audits, and ensuring that safety training is provided to all workers. They also play a critical role in conducting safety inspections, which help to identify potential safety hazards and mitigate them before they cause harm. Therefore, consultants have a significant responsibility in maintaining safety standards in construction sites, and they should always strive to go beyond the minimum safety requirements to ensure the safety of all workers involved in the project.

According to Awwad *et al.* [7], clients have an essential role in enhancing contractors' safety commitment on construction projects. The study suggests that clients should consider the contractor's previous safety records when awarding contracts and include safety incentives in the contracts to promote safety adoption. These findings are consistent with the observations made by Donkoh and Aboagye-Nimo [12], who stressed that clients who procure the work have a vital role in establishing robust safety and health regulations on construction sites. However, despite the importance of clients in maintaining safety measures on construction sites, only a few clients have designated administrative staff responsible for visiting and inspecting the safety procedures at the construction site [2]. Therefore, it is crucial for clients to take a more proactive role in ensuring that their contractors are adhering to safety standards by not only providing incentives but also actively monitoring the implementation of safety measures. This approach can help to minimize the incidence of accidents and hazards, ultimately resulting in a safer construction industry.

DOSH has established the safety and health officer (SHO) position to aid employers in fulfilling their legal responsibilities. The main objective of the SHO is to help protect workers from potential construction-related hazards by providing guidance and assistance to employers. To ensure compliance with safety regulations, the client and contractor are recommended to hire an SHO if the total contract value exceeds RM20 million. Moreover, the SHO's main responsibility is to ensure that all workplace regulations are adhered to and to promote safe working practices. Despite the crucial role of the SHO, there have been instances of accidents on construction sites resulting from their negligence in enforcing safety measures. Razak *et al.* [34] highlights the importance of the SHO in ensuring workplace safety, but it is also essential to note that human error or neglect may occur, leading to accidents. It is, therefore, necessary for the SHO to be well-trained and knowledgeable about safety procedures to prevent such incidents from occurring. Additionally, employers should

have a comprehensive safety program that includes regular training and inspections to supplement the SHO's efforts.

1.5 Gaps of Research

Research into safety violations within high-rise construction projects has gained increasing relevance for enhancing workplace safety and mitigating accidents in the construction industry. While existing studies have touched upon various aspects of safety, such as safety factors and prevention techniques in high-rise building projects [27] and fire safety in high-rise buildings [5], several researchers have explored the human psyche and stimulation concerning construction safety issues. Notable examples include investigations in the behavioural and psychological realm [21], the impact of technology and automation [25], worker training and education [32], safety culture and leadership [35], and ergonomics and musculoskeletal considerations [37].

Moreover, other research endeavours have addressed safety regulations and compliance [13], data analytics and predictive models [43], communication and collaboration dynamics [1], as well as case studies and best practices [9]. Nevertheless, there exists a notable gap in recent research that explicitly concentrates on safety violations in the context of high-rise construction. Although there is a study somewhat related to this area, which explores a model of the social contagion effect of coworkers' safety violations on individual workers within construction crews [24], it does not specifically target high-rise construction.

Further research is imperative to identify the precise safety violations that commonly occur in high-rise construction and to formulate effective preventive strategies tailored to this specific construction context.

2. Methodology

2.1 Sample

The sample consisted of 160 from among the contractors (59.4%), the developers (18.8%), the consultants (15.6%) and the authorities (6.2%) working in high-rise building construction projects in Penang. The gender makeups are as follows: 56.2% male and 43.8% female. Their positions within the respective organization are as follows: design engineers (31.3%), project engineers (21.8%), project managers (18.8%), site supervisors (12.5%), owners (6.3%), site safety supervisors (3.1%), public officials (3.1%) and quantity surveyors (3.1%). The respondents' working experience also varied from not exceeding 5 years at 37.5%, not exceeding 10 years at 40.6% and beyond 10 years for the rest at 21.9%. In addition, the respondents were predominantly working with the private sector at 93.7% while only 6.3% were with the public sector. These variations had delivered balanced view and fresh perspective into the subject matter.

2.2 Survey

An online survey technique in a form of questionnaire was used to gather data about the perspective of property managers on sustainability issues. The questionnaire was divided into five sections namely Section A to E. Section A solicited demographic information of the respondents' organizations while Section B of the respondents themselves. The gist of this research commenced from Section C with the severity in terms of potential hazards and demanding proportionate responses due to the safety rule violations, followed by Section D with the frequency of the safety rule violations occurrence and concluding with Section E on the category of perpetrators of the safety

rule violations. To gauge the wide-ranging perspectives of the last three section, a 5-point Likert scale had been employed with the following classifications: 1-strongly disagree, 2-disagree, 3-moderately agree or neutral, 4-agree and 5-strongly agree. The distribution of the questionnaire had been targeted to two localities namely the state of Penang and Kedah due to research-access proximity and progressively developing urban settings. A pilot test of the survey was first administered to prospective respondents to scrutinize its content and coverage expediencies. Appropriate revisions were made based on their comments and suggestions. This was followed with the real exploratory survey in the manner prescribed before.

2.3 Analysis

The data obtained through the online survey were first subjected to the reliability, normality, and linearity tests to ensure the goodness of measure. In all cases, compliance to required thresholds were observed. Then, further analysis was carried out using SPSS software for descriptive statistical parameter. Demographic data were expressed by frequency of captured responses and were stated either in numbers or percentages. On the other hand, perspective data were treated for means of captured responses and ranked in descending order of magnitude. The standard deviation method was adopted to identify and eliminate outliers in statistical data. This approach involves flagging data that fall beyond three standard deviations from the mean.

3. Results

3.1 Severity of Safety Rule Violations

Table 1 shows the rank of the severity in terms of potential hazards and proportionate responses due to the safety rule violations in high-rise building management services based on the perspective of the practitioners of the trade. The following indicators can be construed arranged in the order of importance: lack of fire protection (mean of 4.03), lack of ladder safety (mean of 3.97), lack of chemical inventory and care in handling, lack of risky, near-miss, and accident reporting, lack of proper electrical wiring, lack of scaffold safety and lack of trench/excavation safety (shared mean of 3.94), lack of hazard communication (mean of 3.91), lack of crane safety, lack of fall protection at height (safety harness) and lack of proper electrical systems design (shared mean of 3.88), lack of stairway or elevator shaft safety, lack of respiratory protection and lack of eye and face protection (shared mean of 3.84), and the LOTO procedures during servicing and maintenance activities (mean of 3.81). The practitioner respondents have also placed lack of employees' health screening, lack of torso protection, lack of maintenance for machines and equipment, lack of care in handling high voltage overhead/underground power lines, lack of general machine guarding, lack of vibrating tool safety, and lack of head and hearing protection as relatively lesser concerns. Of even less concerns involved lack of health moratorium in the workspace and living space, lack of elevated storage surfaces safety, lack of Powered Industrial Truck (PIT) safety (forklift), lack of care in performing site clearance and walkthrough, and lack of building material inventory and care in handling.

It is worth to note, most of the respondents have collectively realized that the lack of fire protection in violation of the safety regulations has the most severe potential hazards and demanding proportionate responses. This is understandable given that high-rise construction projects involve a large amount of flammable materials, such as wood, insulation, and chemicals, which are necessary for the construction process. These materials are susceptible to catching fire and can spread the fire quickly throughout the building. Additionally, the height of high-rise buildings poses challenges for firefighters, as traditional firefighting methods may not be sufficient to extinguish a fire in a timely

manner. This can result in greater damage and higher risk to the safety of the workers and occupants of the building. As such, implementing effective fire protection measures during the construction of high-rise buildings such as fire alarms, sprinkler systems, smoke detectors as well as fire extinguishers, and fire evacuation systems, such as fire exits and emergency lighting can help prevent or mitigate the risks of fires.

The next issue revolves on the ladder safety. It has perhaps derived from the concern that ladders can be unstable, especially on uneven surfaces, and workers can easily lose their balance and fall from height. Improper use of ladders, such as overreaching or using a ladder that is too short, can increase the risk of falls. Additionally, ladders can be damaged by exposure to the elements or by misuse, which can lead to structural failure and accidents. Falling from ladders are one of the leading causes of injury and death on construction sites, and when working at heights of several stories, the risks are even greater.

Table 1
Descriptive statistic on the severity of safety rule violations

Rank	Safety Rule Violation	Mean	Standard Deviation	Variance
1	Lack of fire protection	4.03	0.782	0.612
2	Lack of ladder safety	3.97	0.822	0.676
3	Lack of chemical inventory and care in handling	3.94	0.878	0.770
3	Lack of risky, near-miss, and accident reporting	3.94	0.619	0.383
3	Lack of proper electrical wiring	3.94	0.716	0.512
3	Lack of scaffold safety	3.94	0.801	0.641
3	Lack of trench/excavation safety	3.94	0.801	0.641
4	Lack of hazard communication	3.91	0.689	0.475
5	Lack of crane safety	3.88	0.942	0.887
5	Lack of fall protection at height (safety harness)	3.88	0.976	0.952
5	Lack of proper electrical systems design	3.88	0.793	0.629
6	Lack of stairway or elevator shaft safety	3.84	0.884	0.781
6	Lack of respiratory protection	3.84	0.574	0.330
6	Lack of eye and face protection	3.84	0.723	0.523
7	Lack of Logout/Tagout (LOTO) procedures during servicing and maintenance activities	3.81	0.644	0.415
8	Lack of employees' health screening	3.78	0.832	0.693
9	Lack of torso protection	3.72	0.683	0.467
9	Lack of maintenance for machines and equipment	3.72	0.813	0.660
9	Lack of care in handling high voltage overhead/underground power lines	3.72	0.991	0.983
10	Lack of general machine guarding	3.69	0.859	0.738
10	Lack of vibrating tool safety	3.69	0.859	0.738
10	Lack of head and hearing protection	3.69	0.965	0.931
11	Lack of health moratorium in the workspace and living space	3.66	0.827	0.684
11	Lack of elevated storage surfaces safety	3.66	0.827	0.684
11	Lack of Powered Industrial Truck (PIT) safety (forklift)	3.66	0.827	0.684
12	Lack of care in performing site clearance and walkthrough	3.63	0.942	0.887
12	Lack of building material inventory and care in handling	3.63	0.907	0.823

3.2 Frequency of Safety Rule Violations Occurrence

Table 2 shows the frequency of the safety rule violations occurrence in high-rise building management services based on the perspective of the practitioners. The following indicators can be construed arranged in the order of importance: lack of risky, near-miss, and accident reporting and the LOTO procedures during servicing and maintenance activities (shared mean of 3.97), lack of eye and face protection and lack of employees' health screening (shared mean of 3.94), lack of health moratorium in the workspace and living space, lack of order and hygiene in the workspace and living space and lack of respiratory protection (shared mean of 3.91), and lack of wall/floor openings safety, lack of trench/excavation safety, lack of hand protection and lack of torso protection (shared mean of 3.81). The practitioner respondents have also placed lack of building material inventory and care in handling, lack of stairway or elevator shaft safety, lack of maintenance for machines and equipment, lack of hazard communication, lack of elevated storage surfaces safety, lack of ladder safety, lack of scaffold safety, and lack of proper electrical systems design as relatively lesser concerns. Of even less concerns involved lack of fall protection at height (safety harness), lack of on-the-level storage surfaces safety, lack of crane safety, lack of Powered Industrial Truck (PIT) safety (forklift), lack of fire protection, lack of chemical inventory and care in handling, lack of care in performing site clearance and walkthrough, and lack of proper electrical wiring.

One of the primary concerns involved risky, near-miss, and accident reporting. It refers to the act of reporting any situation, event, or occurrence that could potentially lead to an accident or injury. In the construction industry, this type of reporting is crucial to maintaining safety on the job site. The importance of reporting cannot be overstated as it can save lives, prevent injuries, and improve safety culture. Unfortunately, the lack of reporting is a common issue in the construction industry. There are several reasons why workers may not report incidents. Fear of reprisal and blame is one of the most common reasons. Workers may worry about losing their job or being blamed for an incident if they report it. Additionally, many workers may not understand the reporting procedures or may not trust management to take appropriate action.

The other primary concern involved the LOTO procedures. They are critical for ensuring the safety of workers during servicing and maintenance activities in high-rise buildings. The lack of proper LOTO procedures during servicing and maintenance activities can result in serious accidents and injuries, as well as fatalities. There are several reasons why the lack of proper LOTO procedures is so important in high-rise buildings during construction. One of the main reasons is the fact that high-rise buildings typically contain a large number of machines and equipment that require servicing and maintenance. These machines and equipment are often located in hard-to-reach areas, which can make it difficult for workers to access them safely. Another reason is that they help to prevent the release of hazardous energy. Many machines and equipment in high-rise buildings contain hazardous energy, such as electricity, hydraulic pressure, and steam. If this energy is released accidentally, it can cause serious injury or even death. Furthermore, they can result in a lack of accountability and responsibility. If workers are not required to follow proper LOTO procedures, they may be more likely to take shortcuts or skip steps in the servicing and maintenance process. This can increase the risk of accidents and injuries and can also make it more difficult to identify the root cause of any accidents that do occur.

The next two dual concerns involved lack of eye and face protection and lack of employees' health screening. Eye and face injuries can result from exposure to flying debris, dust, chemical splashes, and other hazards. In high-rise construction projects, the risk of these types of injuries is even higher due to the height and scale of the work being performed. Despite this, the lack of proper eye and face protection is a recurring issue in many high-rise construction sites. Eye and face injuries can have

serious consequences, including permanent vision loss or disfigurement. Workers who suffer such injuries may be unable to work for long periods or may never be able to work again. In addition, the cost of medical treatment, lost wages, and other expenses can be significant. This is why it is crucial to provide adequate eye and face protection for workers in high-rise construction projects. There are several reasons why the lack of eye and face protection is so frequent in high-rise construction sites. One of the primary reasons is a lack of proper training. Workers may not be aware of the risks involved in their work or may not understand how to properly use protective equipment. Another reason is the perception that wearing protective equipment is uncomfortable or interferes with the work. Employers may also fail to provide adequate protective equipment or may not enforce the use of protective equipment on the job site.

In the same measure, lack of employees' health screening is a prevalent issue in high-rise buildings during construction, which can lead to severe health problems. Health screening is a vital process that assesses an employee's medical condition to determine whether they are fit for work. It involves various procedures such as medical examinations, laboratory tests, and health assessments. The purpose of health screening is to identify any underlying health issues that could put employees at risk of injury or illness while working in high-rise buildings. For instance, an employee with a heart condition may be at risk of suffering from a heart attack while working at a high altitude. Thus, health screening ensures that workers are healthy enough to perform their duties safely. However, many construction companies overlook the importance of health screening and do not implement adequate screening programs. This could be due to various reasons such as the perceived cost of screening or the lack of knowledge about its benefits. Consequently, employees are not screened before commencing work, which puts them at risk of developing health issues that could have been prevented with proper screening. This can lead to various health problems. For instance, workers may be exposed to hazardous substances such as asbestos and lead, which can cause respiratory problems and cancer. Additionally, the long working hours and high stress levels associated with construction work can lead to mental health problems such as depression and anxiety. Without proper health screening, employees may not be aware of these underlying health issues, which could lead to severe consequences.

According to OSHA, the most common safety violations have varied over the years. In 2019, scaffolding issues were prevalent, followed by excavation shoring issues in 2020, electrical equipment issues in 2021, powered industrial trucks issues in 2022, and personal protective equipment issues in 2023. However, DOSH has consistently emphasized the significance of fall protection issues from 2019 to 2023. This aligns with the findings of a research study where fall protection issues remained among the top ten types of violations.

Table 2
Descriptive statistics on the frequency of safety rule violations occurrence

Rank	Safety Rule Violation	Mean	Standard Deviation	Variance
1	Lack of risky, near-miss, and accident reporting	3.97	0.538	0.289
1	Lack of Logout/Tagout (LOTO) procedures during servicing and maintenance activities	3.97	0.647	0.418
2	Lack of eye and face protection	3.94	0.619	0.383
2	Lack of employees' health screening	3.94	0.619	0.383

3	Lack of health moratorium in the workspace and living space	3.91	0.641	0.410
3	Lack of order and hygiene in the workspace and living space	3.91	0.530	0.281
3	Lack of respiratory protection	3.91	0.689	0.475
4	Lack of wall/floor openings safety	3.81	0.821	0.673
4	Lack of trench/excavation safety	3.81	0.821	0.673
4	Lack of hand protection	3.81	0.693	0.480
4	Lack of torso protection	3.81	0.535	0.286
5	Lack of building material inventory and care in handling	3.78	0.659	0.434
5	Lack of stairway or elevator shaft safety	3.78	0.706	0.499
5	Lack of maintenance for machines and equipment	3.78	0.659	0.434
5	Lack of hazard communication	3.78	0.751	0.564
6	Lack of elevated storage surfaces safety	3.75	0.842	0.710
6	Lack of ladder safety	3.75	0.880	0.774
7	Lack of scaffold safety	3.72	0.924	0.854
7	Lack of proper electrical systems design	3.72	0.729	0.531
8	Lack of fall protection at height (safety harness)	3.69	0.998	0.996
8	Lack of on-the-level storage surfaces safety	3.69	0.821	0.673
8	Lack of crane safety	3.69	0.780	0.609
8	Lack of Powered Industrial Truck (PIT) safety (forklift)	3.69	0.644	0.415
8	Lack of fire protection	3.69	0.780	0.609
8	Lack of chemical inventory and care in handling	3.69	0.780	0.609
8	Lack of care in performing site clearance and walkthrough	3.69	0.693	0.480
9	Lack of proper electrical wiring	3.66	0.653	0.426

3.3 Perpetrators of Safety Rule Violations

Table 3 shows the rank of the category of perpetrators of the safety rule violations in high-rise building management services based on the perspective of the practitioners. For simplistic consideration, 5 major categories were devised involving the contractors, developers/owners, safety personnel, visitors, consultants, and the authorities. The following indicators can be construed arranged in the order of importance: contractor (mean of 4.09), developer/owner (mean of 3.44), safety personnel (mean of 3.41), visitor (mean of 3.38), consultant (mean of 3.31), and authority (mean of 3.06).

To make sense of these conclusions, it is beneficial to associate the factors that cause the safety rule violations with that of the strength of numbers and length of stay at site of each of the specified group. It can be readily accepted that the contractor entity for all intent and purposes has the most significant number and engagement to site compared to the other categories. As such, it has the biggest opportunity and tendency to violate the safety rules in the course of the performance of its

role. The factors that lead to safety rule violations involve lack of proper training and education, human factors, equipment failure, pressure to meet deadlines, poor communication, language barriers, lack of proper planning and risk assessment, inadequate supervision, lack of safety culture, substance abuse, weather conditions, and lack of Proper Personal Protective Equipment. The proximity of the contractor entity to the circumstances as prescribed in the factors coupled with the aforementioned strength in numbers and length of stay at the site would inevitably lead to the opportunity and tendency to subvert the safety rulings.

Table 3
Descriptive statistics of the perpetrators of safety rule violations

Rank	Perpetrators of Safety Rule Violation	Mean	Standard Deviation	Variance
1	Contractor	4.09	0.734	0.539
2	Developer/Owner	3.44	0.982	0.964
3	Safety personnel	3.41	1.073	1.152
4	Visitor	3.38	1.008	1.016
5	Consultant	3.31	0.738	0.544
6	Authority	3.06	0.801	0.641

4. Conclusions

The primary aims of this study were to investigate the severity of safety rule violations during high-rise construction projects, as well as their frequency and the parties responsible for committing them. After reviewing the literature, the research assessed a total of 32 safety rule violations related to personal protective equipment (PPE), work processes, workspaces, and equipment safety. It identified six groups of perpetrators, including contractors, consultants, developers, owners, authorities, and visitors. The study's results suggest that these violations have a significant impact on safety in high-rise construction projects. The research also aimed to rank the severity and frequency of safety rule violations and identify the perpetrators responsible for them. They used descriptive statistics to analyse the data collected. The study found that the most severe safety rule violations, in terms of potential hazards and proportionate responses, were the lack of fire protection, ladder safety, and chemical inventory and care in handling. Conversely, the least severe violation in this category was the lack of foot protection, which is not surprising given the nature of damages usually associated with fire events.

The most frequent safety rule violations were the lack of risky, near-miss, and accident reporting, the LOTO procedures during servicing and maintenance activities, the lack of eye and face protection, the lack of employees' health screening, the lack of health moratorium in the workspace and living space, the lack of order and hygiene in the workspace and living space, and the lack of respiratory protection. The lack of foot protection was the least frequent safety rule violation in the same measure. The high frequency of the lack of risky, near-miss, and accident reporting indicated that non-incidence safety rule violations were not taken seriously by the personnel involved and not even reported through the proper channel, so the actual occurrence of infractions may be much higher than recorded.

The contractor was primarily liable for violating safety regulations, followed by the developers or owners and the safety personnel. Surprisingly, the authority had the least infraction. The regular presence of certain personnel at the project site, such as the construction team, potentially contributed to the likelihood of committing safety rule violations.

To conclude, the study achieved its objectives and contributed significant findings to future research in this area. The study's results could assist safety experts and professionals in improving project performance, minimizing safety rule breaches in high-rise construction projects, and increasing awareness and caution when working in this field.

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