



Construction Safety and Performance in High Rise Building Construction Projects in Malaysia: A Review

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Keywords	Abstract
Construction High rise building Safety performance Forth industrial revolution Accidents	In Malaysia, significant high-rise projects are in jeopardy to unsafe conditions that might lead to accidents and as a corollary, threaten the project's safety result. An accident on a construction site might result in serious physical harm. Workers falling from heights and being injured by falling objects were the most common mishaps in the Malaysian construction sector. The aim of this article is to review the literature on safety performance of high-rise building construction industry in Malaysia. This study focuses on reviewing the literature on high-rise building safety performance, construction safety management, high-rise building accident causes, high-rise building safety prevention techniques and safety in high rise building related to the fourth industrial revolution. The study's findings concluded that effective construction safety actions such as accidents preventive would improve the high-rise construction industry's performance in Malaysia.

1. INTRODUCTION

The construction sector plays a significant role in the growth process in many countries around the world which contributes to economic growth especially in high rise building construction (Young et al., 2019). Referring to the data by Department of Occupational Safety and Health (DOSH), the construction industry experienced the most occupational injuries in 2017, with 15 deaths out of 70 as of May 2017 [48]. Due to the shrinking usable land space in Malaysia, the request for high-rise building projects remain to rise that cause an increase in fatalities and accidents.

High-rise building construction presents a significant safety issue due to high-altitude operation and the excavation of deep foundation trenches, leading to significantly higher accident rates and severe injuries than medium and low-rise buildings. Every day, injuries and fatalities are brought on by falls and the force of falling objects. As a result, the majority of construction projects create dangerous conditions that could result in accidents and, as a result, have an effect on how safely they function. [13].

Based on statistic of accidents in the northern region of Malaysia in Table 1, it clearly shows that year after year, the number of accident cases skyrockets [18]. Accidents in the construction sector are frequently attributed to the industry's particular design, human behaviour, unsuitable site circumstances, unsafe work practises, machinery, and procedures [27].

Year	Accident Cases (2017)	Accident Cases (2018)	Accident Cases (2019)	Accident Cases (2020)
Perak	476	561	974	827
Perlis	28	31	44	22
Penang	280	333	848	802
Kedah	327	280	326	335

Table 1 Accidents Cases in Northern Region Malaysia [18]

In addition, multi-story or high-rise structures are associated with a greater danger of operating at height, heavy machinery, and vertical transit. Falling from height is one of the most common causes of accidents in highrise constructionsMost falls occur from working platforms, frames, ladders, or scaffolding. According to the research, the two main factors that be partly responsible to accidents in Malaysia's construction industry are personnel engaging in unsafe work practises and administrative flaws in the organization's safety management system. [32]. Construction organisations should enact safety measures and build a safety management system in order to reduce accident rates. Thus, this study compiles high-rise building safety performance, construction safety management, high-rise building accident causes, high-rise building safety prevention techniques and safety in high rise building related to the fourth industrial revolution.

2. HIGH RISE BUILDING SAFETY PERFORMANCE

Malaysia's construction sector is at the centre of the world. Demand for goods and services has fuelled the country's expansion with high-rise construction projects. The construction industry is a significant sector that has made significant contributions to national growth [44]. However, the Malaysian construction industry is plagued by high accident and fatality rates, as well as a lack of integration of health and safety aspects into work tenets [38]. Safety outcome is frequently calculated using unfavourable metrics such the number of injuries, days missed, injury rates, and accident expense.

The construction sector has invested 3–5% of Gross Domestic Product and gave a vital part in the country's development over the last 20 years [26]. Conversely, in the Malaysian construction industry, poor time performance is the most common, and as a result, the majority of projects in Malaysia are characterised as being late or delayed. One of the main caused is safety performance. Clients and stakeholders are dealing with substantial financial waste, quality losses, and hassles as a result of building project delays when accidents happen.

Massive construction projects in Malaysia are subjected to risky conditions that might result in accidents and the outcome, compromise the project's safety performance. Accidents in the construction business are caused by the industry's unique character, human behaviour, bad state of site conditions, unsafe work methods, equipment, and procedures, all of which are influenced by poor safety management. As a result, every employer must provide training and comprehensive safety programmes that may continuously enhance safety performance and lessen the possible hazards in building projects [13].

Assessing contractors' own safety performance is necessary to ensure that their employers are informed of their safety status. Improving construction sector Occupational Health and Safety performance is critical because it symbolises the quality of completed projects and, more significantly, the safety of those who work in the field [5]. Previously, goal and feedback methods (known as lagging indicators) such as Incident Rate (IR), Accident Rate (AR), and Experience Modification Rate (EMR) were used to assess and evaluate safety performance (EMR). It is considered that a study on safety performance measurement is still missing in Although the Construction Malavsia. Industry Development Board (CIDB) has developed a tool called Safety and Health Assessment System in Construction (SHASSIC) to measure the performance of the construction industry's safety and health, the indications or elements that support the tool are not complete [1].

According to figures released by the Department of Safety and Health, fatalities on construction sites are five times greater than in other industries, with high-rise buildings being one of the main contributors. In comparison to other industries, statistics show that the construction industry has the largest number of deaths, with 81 persons killed in 2018, and working at height is one of the factors contributing to the high rate of construction accidents. Human factors, equipment factors, management issues, and environmental variables all play a role in high-rise building accidents [4]. Furthermore, because of the uniqueness and nature of the activities, the complexity of the working environment, and the construction of highrise building projects is a risky employment, yet, safety issues remain crucial in the construction sector [11].

On the one hand, the most significant drawback of accidents is the delay in building work, cost overrun, negative influence on the organization's reputation, and loss of worker confidence. Because of the continuing development of high-rise building projects, safety issues in the construction industry deserve complete attention.

3. CONSTRUCTION SAFETY MANAGEMENT

The health and safety work organisation and policy in a company, the management responsibilities, the practises, procedures, and resources for denoting and execute safety and health policy, and the planning process for accident and ill health prevention are all covered by the safety management system. It can also be decount as a set of well-defined, company-wide processes that enable effective risk-based decision-making in daily operations.

Management and preparedness are two techniques for avoiding unexpected mishaps. Because accidents are unforeseeable, efficient security management can help to reduce workplace injuries [23]. In order to decrease the frequency of fatal accidents and property damage or loss, a competent safety management system should be established and executed given the safety awareness and be embedded as a culture in all construction activities, as well as incorporating all relevant parties [9].

Construction of high-rise buildings is a complicated process that is impacted by a wide range of variables. Effective safety management is crucial to the success of construction projects. Management organization has direct effects on the management measures, technical and management plans, and worker safety quality. The technical and management plan and management measures are subject to decision-making by the safety committee, which oversees and implements safety management.

The education and training programmes put on by the safety committee assist workers to improve safety quality, competency and skills because the safety management members gives employees resources to prevent accidents and meet safety objectives. In the end, the primary goal of construction safety management is to regulate employee conduct and safeguard them against accidents. By supplying a scientific, technological, and management strategy, the safety management organisation in the United States will be able to control human behaviour [31].

4. HIGH RISE BUILDING ACCIDENTS CAUSES

Among the most dangerous industries is construction. Injuries and fatalities continue to rise in comparison to other industries, despite the Occupational Safety and Health Statute of 1970's improvements to the act and regulations. In 2012, there were 856 fatalities in the construction sector, which represented 16% of total fatalities across all industries in Malaysia. Over 60,000 fatalities have been documented in the construction business annually [6].

Lack of knowledge of the task and subpar equipment upkeep frequently result in accidents. A labourer might get first aid or medical assistance, if necessary, even if the majority of incidents go unreported. Most of the time, advanced medical care or perks are unavailable. However, serious industrial accidents that result in a worker's death can be reported because there is a risk of financial loss and legal action [37].

Some unofficial investigations conducted as part of the same study found a few key causes of safety underperformance, including the construction sector is falling behind in terms of mechanisation and industrialization. The current regulatory system's inadequate and incentive-free insurance mechanisms, poor and incentive-free safety standards, failure to establish safety as a top industry priority, failure to make safety a problem for company survival, and unfavourable business environment have all led to adversarial business stakeholders. relationships between conflicts. disagreements, lawsuits, and litigation, deflecting attention away from safety [25]. The theories of investigation can be divided into two main categories based on the variables leading to a fall accident in a building project, which are as follows:

i) Personal accident

The approach is supported by theories stating that human errors are the main factor leading to the accident. Human error is referred to as the human component. One of them is a failure to employ personal protection equipment (PPE). In general, before beginning work, a corporation should prepare training for each employee on how to use personal protection equipment. During the safety induction course, this training can be completed. The purpose of the training is to ensure that the employees have the necessary skills to do their work at the building site with the fewest possible safety risks. This is crucial since some employees are not particularly conscientious, have a low level of education, and lack experience. ii) Accidental organisation

The strategy is supported by theories that state that multiple causes, including internal human factors and external elements related to poor management, organisation, and working conditions, among others, can cause accidents. As a result, the strategy stresses that human factors are not the only or even the primary causes of accidents.

Scaffolding accidents, falls from great heights, being struck by falling objects, and accidents involving machinery and equipment are the four main categories of high-rise mishaps. The scaffolding could fall at any time, endangering the workers. The large part of scaffold accidents were caused by the use of subpar scaffolding materials combined with negligent and incompetent construction activity. The absence of safety precautions at building sites is typically one of the factors contributing to the occurrence of fall accident [22].

Besides that, struck by falling object accidents can be defined as people who work at construction site is struck by the equipment, private vehicles, falling materials, vertically hoisted materials and horizontally transported material. One of the causes is improper rigging method. One of the things that will make the cranes in the construction of high-rise buildings fall is overburden. Accidents are unpredictable events that can happen for a variety of reasons, including improper training, outdated tools and working platforms, a poor safety mindset, messy living quarters, a failure to use personal protective equipment (PPE), and issues with subcontracting and procurement procedures. It is also might be caused by a lack of training [9].

Moreover, the use of unsafe working platforms also may put workers at risk when the equipment is not properly used, maintained or stored [14]. Other unsafe behaviours include failing to follow the recommended safety procedures, building barbarically, and choosing to continue working in hazardous condition [22]. Working without any PPE may significantly increase the likelihood that an accident may occur. Workers may refuse to wear PPE for a variety of reasons, including discomfort with the gear while performing their duties on site and perception of it as a distraction from their work. The International Labour Organization has indicated that some employees felt uneasy when wearing any type of PPE, which in turn affected their work performance [39].

5. HIGH RISE BUILDING SAFETY PREVENTION TECHNIQUE

Negative measures including the number of injuries, days missed, injury rates, and accident costs are typically used to determine safety outcome. The purpose of measuring safety performance is to assess how well construction business management prevents accidents by defining safety objectives and targets. Despite the fact that the

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scale of the business plays a part in the safety of construction contractors, if an accident occurs frequently on a project, the contractor will be penalised and have a poor reputation. Therefore, both big and small contractors need to keep up with their reputations for health and safety by maintaining their safety effectiveness [39].

To lower the number of accidents in high-rise building projects, numerous researchers have devised safety preventative strategies. Safety climate relates to individual impressions of safety practises, procedures, and policies in a workplace. Precursor analysis, leading indicators, and safety risk analysis are other methodologies that have been used to anticipate construction safety performances. With the coordination of hazard prevention techniques during the design phase of construction, safer and user-friendly plants can be created [39].

It was discovered that the Graphical Inherent Safety Assessment Technique (GISAT) was used to access the inherent safety features during the design process [3]. Additionally, the Modified-Safety Improve Risk Assessment (Modified-SIRA) assessment technique was applied to foresee the safety risks in construction projects. Besides that, the construction safety in high-rise building projects can be enhanced with the aid of a decision analytic method to safety evaluation [26]. Behaviour analysis is fundamentally important in construction safety in order to reduce the rates of accidents and fatalities. Therefore, in high-rise building construction, morphological image filtering on high-speed video sequences as instruments for dynamic measurements can be utilised to determine the direction and speed of a falling object [21].

Additionally, the safety evaluation technique can be used on construction sites according to the Fuzzy Extended Analytic Hierarchy Process (FEAHP) [28]. The Multiple Criteria Decision Making (MCDM) technique was recommended in order to access and choose the suitable solutions for construction safety [16]. Working at heights is one of the leading causes of accidents that result in fatalities and injuries in high-rise construction projects. Building information modelling (BIM) is connected with real-time location systems and has been demonstrated to improve safety performances [19].

Additionally, the use of PPE in high-rise building projects ensures the safety of construction personnel. However, construction workers' irresponsibility results in improper PPE wear while work, which is a severe worry. As a result, a cutting-edge cyber-physical system (CPS) was developed to monitor in real-time how building site employees are donning PPE [10]. Table 2 shows the framework for accidental safety factor and prevention techniques.

Table 2 Framework for Accidental Safety Factor and Prevention Techniques [39]



6. SAFETY IN HIGH RISE BUILDING RELATED TO FOURTH INDUSTRIAL REVOLUTION

Since the advent of hard helmets and safety goggles, modern technology has continued to be used in the construction industry. The fusion of big data, engineering brilliance, and structure in the current period has lately improved the health of workers on construction sites. The development of new technologies is continually being highlighted by the usage of technology [48]. A number of researchers have talked about the use of developing technology using fourth industrial revolution, such as drones, GIS, sensing and warning technologies, 4D Computer-aided Design and Building Information Modelling [39].

6.1 Online Databases

Online systems have been used to create a number of facets of construction safety, including hazard recognition, awareness and training, safety surveillance and evaluation, and safety inspection. To categorise potential site hazards and establish proficiency, use online databases instead. To aid potential designers, contractors, and coordinators in their evaluations, a web prototype tool has been created. The online framework makes use of artificial intelligence to gather data for the assessment process, aid in risk detection, and evaluate risks. A webbased surveillance platform called the Concurrent Hierarchical State Machine identifies potential site dangers and sends out alerts to prompt urgent action [18]. Through remote access, the framework speeds up data searching, uploading, gathering, and documentation [39].

6.2 Building Information Modelling (BIM)

BIM use enables visual site appraisal and the identification of potential risks. BIM's implementation into the structure has led to the creation of movies for staff health and safety training. Through visual health and safety training, the BIM model aids site workers in improving their perspective of the existing site circumstances. Construction personnel are given enough time to do safety-related strategic planning before beginning building activity. By examining the data collecting process and utilising sensors for data gathering, the BIM can successfully lower the risk of site mishaps [17].

Implementing the BIM system in construction design solves health and safety concerns with a simpler structural layout and safety plans, including methods for site information management, as well as promoting stakeholder participation on health and safety through time-controlled simulation. A theoretical approach was used to evaluate BIM's protection efficacy.

6.3 3D and 4D Computer-aided Design

The 3D computer-aided design is used by related health and safety experts to plan, investigate accidents and maintain facilities. Additionally, 4D computer-aided design is employed in the design of safety processes to highlight dangerous regions and safety-related components throughout the project. The project team can employ 3D and 4D technology to evaluate potential risks during the early phases of construction. Cost overruns caused by design changes are minimised through early risk detection. Using the 4D computer-aided design visualisation model, a rule-based construction safety management system was created. Because height-related accidents and injuries were more frequent than other building site mishaps, the course was created to recognise height fall threats automatically [8].

7. CONCLUSION

This study has given a general review of accident causes and safety precautions at high rise building construction sites. The lack of training, unskilled labour, unsafe behaviour, hazardous conditions, inadequate site safety management, and a lack of awareness of risky behaviours at the workplace were the main causes of accidents at high-rise buildings. In conclusion, despite the fact that various preventive measures have helped to reduce the number of accidents, the high fatality rate makes it impossible to be satisfied. The study demonstrates the safety and performance of construction of high-rise building. Therefore, it is crucial that all parties work together to put preventive measures in place when it comes to handling safety issues at high rise building construction sites. Furthermore, with the industrial revolution 4.0 in this era, the safety performance can be enhance using new method to improve productivity of organization safety and health in construction site. Consequently, investing in new technology would improve construction sites' ability to maintain worker health.

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