Original Article

Construction Professionals' Perception of Construction Workers' Safety Attitudes and Behaviors on Construction Sites

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ABSTRACT: *The safety attitudes and behaviors of the construction workers play an important role in the occurrence of construction accidents on construction sites; however, the problem is that there is relatively limited research conducted locally regarding the perceptions of construction professionals regarding the safety attitudes and behaviors of construction workers on a construction site. This study aims to determine the perceptions of construction professionals regarding the critical safety attitudes and behaviors of construction workers on construction sites for the prevention of construction accidents as perceived by construction professionals. This study was conducted using a pilot survey and a self-administered questionnaire consisting of 97 respondents from consulting firms and construction sites located in Penang, Malaysia. Data analysis in this study was carried out using the Microsoft Excel Auto-filter Statistical Software (MEASAT) and the Relative Importance Index method. The findings of this study on the safety attitudes and behaviors of construction workers on construction sites revealed that positive communication must be two-way; that is, there must be elements of sending and receiving. Effective communication with the construction workers is essential. For example, they should help each other when they are working at height on a building or structure.*

Keywords: *Construction Professionals, Construction Safety, Construction Sites, Construction Workers, Safety Attitudes, Safety Behaviors*

1.0 INTRODUCTION

Construction is one of the most complex and dangerous activities in the world. Construction site work includes the construction of landed estates, low-rise and high-rise buildings, infrastructure, landscaping works, commercial buildings, repair work, oil and gas, refurbishment, and maintenance work. These studies include many hazardous tasks and conditions such as dust, excavation, noise, working at height, power tools, and equipment. In the construction industry, the risk of death is five times higher than in manufacturing, while the risk of serious injury is two and a half times higher (Sawacha, 1999). The most common accidents are falling from heights, falling objects, exposure to dangerous substances, and dust inhalation.

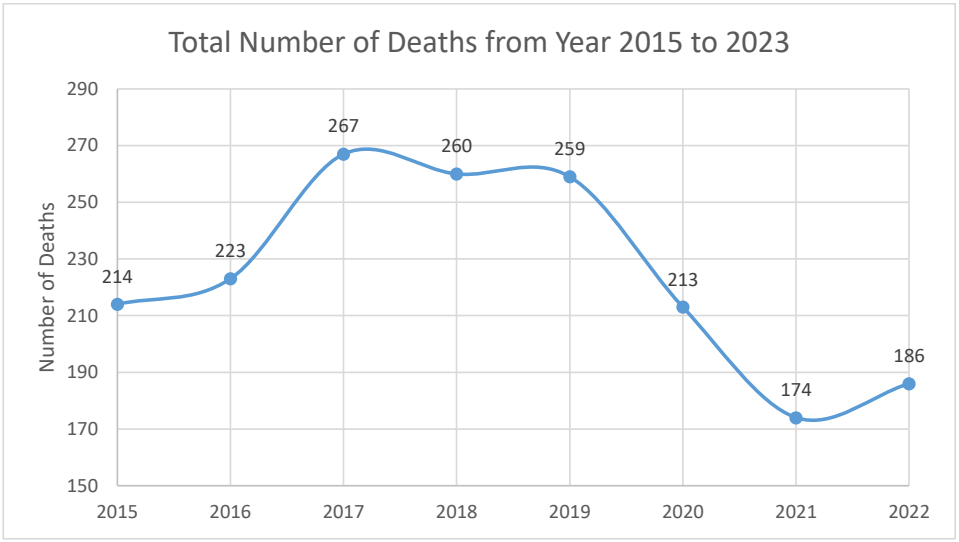

Figure 1 Total Number of Deaths from Year 2015 to Year 2022

Sources: Department of Occupational Safety and Health (DOSH)

As shown in Figure 1, the results change dramatically between 2015 and 2022. Starting in 2015, the number of deaths reached 214 and increased slightly to 223 in 2016. In 2017, the number of deaths increased continuously to 267, before falling slightly to 260 in 2018 and 259 in 2019. After one year, the number of deaths fell to 213 and continued to fall to 174 in 2021. In 2022, however, the number of deaths re-increased to 186.

Workplace accidents are a major public safety issue in many countries, usually involving situations beyond the control of other construction workers on site, especially the main contractors and subcontractors who are still not fully aware of safety rules and regulations. Combined with long working hours to speed up completion, accidents are common. Accidents slow down productivity and cause distress to workers and their families. Studies suggest that by assessing a department's safety attitudes and behaviors, it should be possible to predict the likely accident rates within the department and take proactive remedial action. It is also important for construction workers to be aware of how their safety attitudes and behaviors affect their safety performance on construction sites. Construction workers need to be aware of the rules and regulations enforced by the relevant authorities, and researchers need to focus on studying the possible insecurity factors and problems to better understand the safety situation of construction workers on construction sites. The research gap that this study aims to fill is to determine the perceptions of construction professionals on the critical attitudes and behaviors of construction workers at construction sites to prevent construction-related accidents in Malaysia.

Most researchers have studied the safety issues on construction sites but have not focused on the perceptions of construction professionals regarding the safety attitudes and behaviors of construction workers at construction sites. For example, Daniel Ndakuta Kolo (2019) studied the safety issues involving workers at building construction sites in Nigeria and focused on working conditions and unsafe work activities, but did not focus on the attitudes and behaviors of workers. Hassan and Rahim (2019) examined the relationship between supervisor safety, safety management practices, and safety compliance behaviors among employees in a medical laboratory. Nadhim et al. (2016) studied falls from height in the construction industry.

Yeong and Wahab (2016) investigated the mediating effect of safety culture on safety communication and human factor accidents in the workplace in Malaysia. A study conducted by Kaskutas et al. (2013) focused on fall prevention and safety communication training for foremen, which is a report on a piling project to improve residential construction safety.

In addition, Zin and Ismail (2012) studied the behavioral safety compliance factors of employers toward improving occupational safety and health in the construction industry. Loosemore and Malouf (2019) studied safety training and the formation of positive safety attitudes in the Australian construction industry.

Man et al. (2017) conducted a thematic study on the risk-taking behaviors of construction workers in Hong Kong. Goh et al. (2016) studied accident prevention practices on high-rise building construction sites. Guo et al. (2015) developed and tested an integrative model to predict safety behaviors in the construction industry. Seo et al. (2015) used structural equation modeling to analyze the safety behaviors of temporary construction workers. Thuan et al. (2015) examined the health and safety management practices of contractors in Vietnam. As can be seen from the above review of a sample of researchers who have conducted studies on various safety issues, most researchers have not considered the perceptions of construction professionals regarding the safety attitudes and behaviors of construction workers at construction sites. Therefore, this study was conducted to fill this gap in the existing literature. This is the rationale and justification for conducting this research, and the findings are presented in Section 5. The research questions and objectives were as follows:

Research Questions

1. What are the critical attitudes of construction workers on construction sites toward accident prevention as perceived by construction professionals?

2. What are the critical behaviors of construction workers on construction sites to avoid accidents as perceived by construction professionals?

Research Objectives

1. To determine the critical attitudes of construction workers on construction sites to avoid accidents as perceived by construction professionals.

2. To determine the critical behaviors of construction workers on a construction site to avoid accidents as perceived by construction professionals.

Why was Penang chosen as the research area? The purpose and rationale for conducting research on the perceptions of construction professionals of the safety attitudes and behaviors of construction workers at construction sites in Penang, Malaysia are as follows:

1. The construction industry in Penang contributes significantly to the economic growth and reputation of the region. Research into safety attitudes and behaviors can help to improve the reputation and competitiveness of an industry. By promoting a strong safety culture and demonstrating a commitment to worker welfare, construction professionals in Penang can attract investment, clients, and skilled workers. This study provides evidence-based recommendations to improve safety practices and position Penang's construction industry as a leader in safety excellence.

2. Conducting research in Penang could contribute to ongoing efforts to improve occupational safety in the construction industry. By understanding the perceptions of construction professionals such as project managers, engineers, and supervisors, researchers can identify specific areas of concern and explore strategies to improve safety attitudes and behaviors. This study can inform the development of targeted training programs, policies, and interventions to address the unique challenges faced by construction professionals in Penang. Accidents that occur on construction sites are caused either by the negligence of construction companies or by the workers themselves, which affects construction operations. The death of a construction worker who fell from a height in Penang in 2016 was caused by the failure of his company to provide safe working conditions and an adequate supply of personal protective equipment (PPE) to workers (Wahab, 2017).

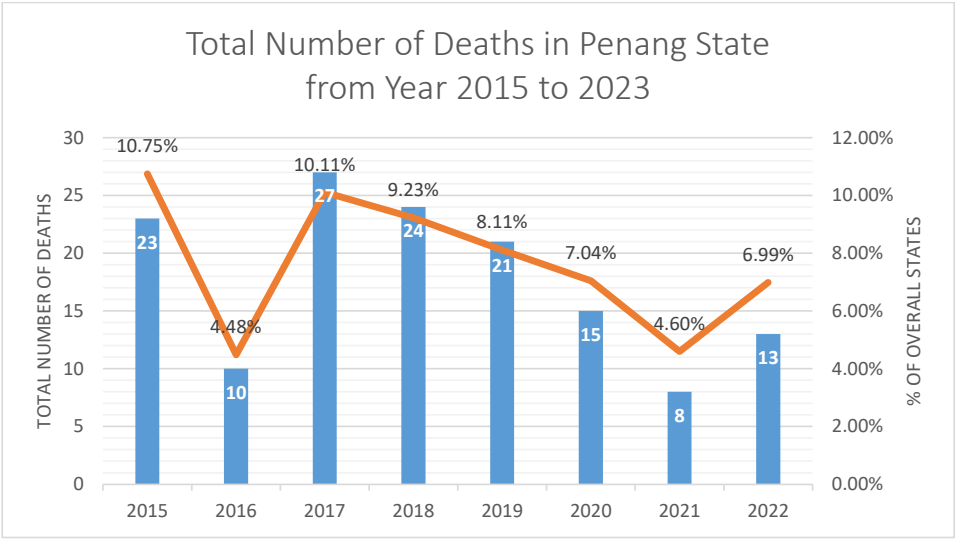

Figure 2 Total Number of Deaths in Penang State from Year 2015 to Year 2022

Sources: Department of Occupational Safety and Health (DOSH)

Referring to Figure 2, the number of deaths in Penang State in 2015 was 23, which was 10.75% of the number of deaths in Malaysia. In the year 2016, this number dropped to 10, and the percentage dropped to 4.48%. However, in 2017, this number increased again to 27, which is 10.11% of that in Malaysia. From 2017 to 2021, the number of deaths and the overall percentage dropped continuously. In 2018, 2019, and 2020, the numbers were 24, 21, and 15, respectively. These values are 9.23%, 8.11%, and 7.04%, respectively. In 2021, the number of deaths was the lowest (8), corresponding to approximately 4.60% of the deaths in the countries. However, in 2022, the number of deaths increased again to 13, representing 6.99% of the country as a whole.

In summary, conducting research on the perceptions of construction professionals on safety attitudes and behaviors in Penang, Malaysia can support the improvement of occupational safety, enhance regulatory compliance, improve the reputation and competitiveness of the industry, foster collaboration among stakeholders, and promote knowledge transfer and best practices.

2.0 LITERATURE REVIEW

A construction site accident can be defined as a risk in the construction industry. It is an undesirable, unplanned, and unexpected event. Hinze (1997) mentions that an accident may not injure the worker on the site, but it may cause damage to equipment, plant, and machinery, as well as to the persons who caused the accidents. Every possible cause of an accident must be considered. Attitudes can generally be defined as the regular feelings, perceptions, thoughts, and tendencies of an individual to perform or act on certain aspects of the environment (Secord and Backman, 1969). Attitude is a psychological attribute that starts in the mind.

Therefore, safety attitudes in the construction industry can be explained by the tendency of construction workers or the workforce to think, feel, or act with certain stated goals toward their safety performance. To recognize the importance of safety attitudes in improving safety performance in the workplace, Lingard and Rowlinson (2005) explained attitude as the intention to respond positively or negatively to objects and people in the environment. Furthermore, a construction workforce's safety attitude should not be determined as if they are safe in the workplace, but should comply with appropriate safety standards, laws, rules, and instructions when required, as attitudes and behaviors are interrelated.

If an individual's attitudes are psychological, then behaviors must be physical. Lingard and Rowlinson (1997) described safety behavior as a behavioral element of a "basic safety infrastructure." Krause (1997), similar to Chen and Fu (2006), recommends that attitude determines behavior. This means that if a construction worker had good safety attitudes, this will lead to good safety behaviors. As a result, their safety performance will improve. Krause (1997) also explained that behavior has a "counter effect" on attitude. For example, improving safety behaviors on a construction site can improve the positive attitudes of the persons involved. In the construction industry, professionals and experts contribute to safety performance. Improvements in safety performance on construction sites can be achieved if all those involved in the construction industry have a positive attitude toward safety.

2.1 Theory of Safety Attitudes

Attitudes can generally be defined as the regular feelings, perceptions, thoughts, and tendencies of an individual to perform or act on certain aspects of the environment (Secord and Backman, 1969). In theory, attitude is a psychological attribute in which everything about a person's behavior comes from the mind. Therefore, safety attitudes in the construction industry can be explained as the tendency of construction workers or the workforce to think, feel, or act in relation to certain stated goals for their safety performance. To recognize the importance of safety attitudes in improving safety performance in the workplace, Lingard and Rowlinson (2005) explained attitude as the tendency to react positively or negatively to objects and people in the environment. Safety attitudes of construction workers can be identified from multiple perspectives.

Siu et al. (2003) used the Safety Attitudes Questionnaire (SAQ) which was proposed by Donald and Canter (1993) to examine the relationships between age, attitude, and safety performance. It was found that older construction workers were more likely to have positive attitudes than younger construction workers. Curtis Breslin et al. (2007) found that young construction workers are employed in various occupations, including construction, that are perceived as potential safety hazards due to the lack of control over the ability to improve or change working conditions. Although work to establish safe attitudes is essential, it remains inadequate. Sound theoretical explanations and effective training to change attitudes need to be given widespread attention.

The concept of safety attitudes is an important aspect of creating a safe working environment. According to Triandis (1980) and Eagly and Chaiken (1993), in order to improve safety attitudes through training, it is essential to understand the three main components of this concept: emotions, cognition, and behavior. The main purpose of identifying the elements of critical attitudes of construction workers is to understand their attitudes toward safety, thereby helping the government and employers review their safety regulations, laws, and investments in safety solutions. The safety attitudes of construction workers consist of general feelings or emotions, safety awareness, the way they communicate, their thinking about contingencies, and their ability to observe their working environment.

2.2 Critical Attitudes of Construction Workers to Avoid Accidents

The purpose of identifying the elements of construction workers' critical attitudes is to understand their attitudes toward safety, thereby providing employers with information to check their construction workers' compliance with safety laws and regulations. The safety attitudes of construction workers consist of general feelings or emotions, safety awareness, ways of communicating, thinking about unforeseen circumstances, and the ability to observe the work environment.

2.2.1 Perform Tasks Carefully and Cautiously

Nadhim et al. (2016) emphasized that the carelessness of construction workers is one of the reasons why they fall from heights, causing permanent disability or even death. Therefore, construction workers must always be careful in the workplace to ensure that there are no accidents on construction sites. Lubega et al. (2000) noted that accidents on construction sites are due to worker negligence and carelessness.

2.2.2 Think of the Consequences and Avoid Taking Risks

Bellamy et al. (2008) mentioned that conducting a study on risk-taking considers the possibility of reducing or managing the consequences of an unsafe act that may compromise safety through ongoing exposure to the surrounding environment. Most participants agreed that risks have the potential to cause injury or death, and some participants responded that some examples of risks include working at height or working in a place that is unsafe or dangerous.

Risk-taking attitudes are hazardous at construction sites and there is a high probability of injury leading to death. Fang et al. (2006) found that older and married construction workers did not take risks while working on construction sites, but were safer. Iacuone (2005) described how construction workers' views on Occupational Safety and Health (OSH) are influenced by different hegemonic masculinities in the construction industry.

2.2.3 Maintaining Positive Emotions and Thinking

Feelings and thoughts are often associated with one or more specific events and are strong enough to disrupt thought processes. Emotions, however, are general feelings or states that are often not identifiable by specific stimuli and are not strong enough to interrupt the ongoing thought process. Allowing negative emotions and thinking to affect one's overall attitude or work mood can have many negative consequences. Therefore, high emotional quotients (EQ) and good emotional management are important characteristics of organizational life. It is essential to create publicly visible and ideal emotional displays as part of the job.

2.2.4 Positive Communication

In the construction industry, construction work requires a high level of communication between all construction and management personnel. Communication is a way for people to express ideas and feelings, and to transfer knowledge and information between individuals (Cigularov et al., 2010). Good communication is important for improving teamwork and better ways of working methods. Poor communication can lead to misunderstandings between colleagues and delays in construction projects. Yeong and Wahab (2016) noted that safety communication is the main factor that has a significant impact on accidents at construction sites. The extent to which communication can influence the safety behavior of construction workers in the workplace has been studied by several researchers. Kaskutas et al. (2013) found that safety communication is a factor that predicts the safety behavior of construction workers in the workplace. Geller (2005) stated that an organization's safety attitude is affected by how safety is discussed and communicated. A positive attitude toward effective communication can influence the safety behavior of employees working on construction sites (Michael et al., 2006).

2.2.5 Keeping a Low Profile

Individual factors play an important role in the occurrence of construction accidents. The main cause of construction accidents is attitude. Therefore, the cause of accidents on site is the construction worker himself, which includes demographics, personal experience, mentality, physical health, and well-being, especially personal assurance, confidence, and reaction. One solution to preventing accidents on construction sites is to keep a low profile while working on the site. Self-assurance, also known as overconfidence, can be described as a belief in one's ability to succeed. Achieving a healthy balance of confidence is challenging. Although confidence is seen as a positive attribute, overconfidence can lead to arrogance and cause more harm to individuals. Kolo (2015) found that overconfidence was the second most common cause of accidents among construction workers.

2.3 Theory of Safety Behaviors

Attitudes and behaviors are linked. If an individual's attitudes are psychological, then behaviors must be physical. Lingard and Rowlinson (1997) described safety behavior as a behavioral element of the "basic safety infrastructure." An individual's attitude determines their behavior. This means that, in theory, a construction worker with a good safety attitude is more likely to exhibit good safety behaviors. As a result, their safety performance will improve. Krause (1997) also explained that behaviors have a "counter effect" on attitude. For example, improving safety behaviors on a construction site can improve the positive attitudes of the workers involved. Ajzen (1994) postulated a theory of planned behavior that illustrates how human behavior is normally influenced by norms and beliefs, control beliefs, and self-efficacy in perceived behavioral control and action. Glendon and Mckenna (1995) emphasized that attitude formation is very important, especially for the construction worker who is performing a construction task. Lingard and Yesilyurt (2003) found that first aid training changed construction workers' safety attitudes and behaviors in the construction workplace by making them more concerned about the implications of safety in their behavior when injuries occur. In the construction industry, where construction professionals and experts contribute to safety performance, improvements in safety performance can be achieved if all parties have positive attitudes toward and promote safety.

2.4 Critical Behaviors of Construction Workers to Avoid Accidents

Vijayakumar (2007) defined behavior as a psychological action that can be observed and measured. According to Daniels (2005), Krause described safety behavior as a methodology applied to behavior analysis to achieve continuous improvement in safety performance. Safety behaviors explain the behavior of construction workers in relation to safety practices and activities, such as safety compliance and safety training courses, which explain the core activities performed by construction workers in accordance with occupational safety and health requirements and good practices to prevent workplace accidents (Mahmood, 2010). Glendon and Litherland (2001) conducted a study that used observational sampling of key behavioral inventories to measure safety performance. Safety behavior was randomly sampled to appraise the proportion of unsafe work practices, in particular non-compliance with Safety Operating Procedures (SOPs) and PPE practices. Johnson (2007) mentioned that safety behavior is the most important element in reducing workplace injuries and indirectly influences the consequences of an accident before it occurs.

2.4.1 Following the Correct Working Procedure and Method

Construction site accidents are caused by several factors. Incorrect working procedures or methods are often used on construction sites, which can lead to undesirable events. It is therefore essential that a method statement is submitted to the Superintending Officer and that the approved safety method is followed. A method statement is a step-by-step statement or method that describes a particular activity or operation. The method of presentation may be in the form of a flowchart or written step-by-step instructions. The presentation of the method statement covers all aspects of the activity, including its scope, responsibilities, prerequisites, methods of performing work or activities, testing or verification, and reference documents, especially safety and health requirements or risk-based assessments. There are many variations of the term method statement, including work procedures, work instructions, work method statements, routines, standard operating

procedures, method statements, safety declarations, and safe work practices. However, the main purpose of the method statement is to detail the complete process of the activity in a simple, step-by-step manner that the new engineer or construction worker can easily understand and perform. In some industries, the term "safe method statement" is also used. Although it is now an integral part of every method statement, it is still used to consider and focus on health and safety requirements.

2.4.2 Wearing of PPE

The approval of PPE is one of the needs and requirements of the Factories and Machinery Act 1967, the Occupational Health and Safety Act 1994, and the regulations thereunder. This legislation may be referred to as Legislation on PPE. The Regulations prescribe seven types of PPE which must be approved by the Chief Inspector of Factories and Machinery and the Director General of the Department of Occupational Safety and Health:

a. Head protection
b. Foot protection
c. Hearing protection
d. Eye protection (chemical hazard)
e. Hands protection (chemical hazard)
f. Body protection (safety harnesses, lifelines, and all devices for lifeline attachment)
g. Body protection (chemical hazard)
h. Respiratory protection (chemical hazard)

This applies to all PPE products used in the workplace, including both imported and locally manufactured PPE products. To be approved, all PPE must have a full-type test report and product certification license from the independent Inspecting/Certification Body appointed by Department of Occupational Safety and Health (DOSH), which is SIRIM QAS International Sdn. Bhd. (DOSH, 2023).

To ensure the best possible protection for construction workers in the workplace, the cooperative efforts of both employers and construction workers will help to implement and maintain a safe and healthy working environment (Rahim, 2008).

2.4.3 Compliance of Construction Workers

Accidents can occur anytime and anywhere in the world. Most construction accidents occur on construction sites, where people are more susceptible to various hazards, in particular, heavy machinery and work at heights (Zakaria, 2010). Human error, carelessness, equipment failure, dangerous behavior, and unsafe working conditions are common causes of workplace injuries and fatalities. However, it is difficult to predict accidents on construction sites. However, it is possible to minimize potential workplace hazards on the construction site. The best approach is to ensure that all construction workers on the site comply with the DOSH safety rules and regulations. Construction site personnel must ensure that construction workers and safety and health representatives are consulted, informed, and well-trained in all aspects of occupational safety and health, including contingency arrangements associated with their work, and ensure their participation.

2.4.4 Proper Housekeeping

Keeping a site clean and tidy can help reduce the risk of injuries and accidents caused by debris and obstacles. This practice is called housekeeping (Lingard and Rowlinson, 1994). In addition, it is essential to prevent accidents and injuries at the scene (Lingard and Rowlinson, 1994). This recognition is reflected by the empirical findings of Haslam et al. (2005). In this study, it was observed that among 100 construction accidents studied in the United Kingdom, workplace factors, especially site layout and space availability, had poor housekeeping practices, accounting for approximately 49% of the accidents. Problems identified included hazards or shapes of objects that could cause slips and trips. Uneven surfaces,

debris, and muddy environments were also identified. Haslam et al (2005) noted that these problems occur when the walkway is uneven and poorly maintained, and said: "From the point of view of people familiar with safety in many other industries, the harsh conditions found in buildings seem to indicate a weak safety and risk management culture in the industry."

2.4.5 Accessing Heights and Working Platform in a Correct Way

Working at height on a building or structure under construction is one of the leading causes of death and serious injuries in Malaysia, and comprises approximately one-third of fatal injuries to construction workers. Working at a height is any operation that could cause a person or construction worker to fall from a high position on a building or structure and cause personal injury to the person or construction worker (Goh, 2017). This includes working on ladders or flat roofs, falling from fragile surfaces, or even falling into openings or holes in the floor. Aerial work occurs in various industries, and each work environment has many hazards. However, a common cause of accidents is the failure to take adequate precautions while working at height. This is because workers sometimes fail to plan properly and underestimate the risks involved when working at height. They either did not protect themselves by using PPE or may have used PPE in an inappropriate manner.

In summary, the views of construction professionals on the safety attitudes and behaviors of construction workers significantly impact safety performance on construction sites. Constructive attitudes and adherence to safe behaviors contribute to safer working environments, whereas unfavorable attitudes and risky behaviors increase the likelihood of accidents and injuries. By understanding and addressing the factors influencing safety attitudes and behaviors, construction professionals can implement strategies that promote a safety-conscious culture and improve the overall safety performance of workers.

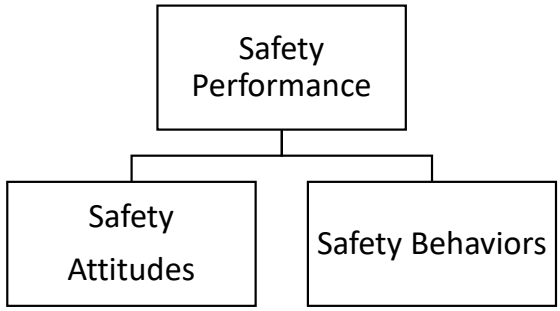

Figure 3 Conceptual Relationship between Safety Attitudes, Safety Behaviors, and Safety Performance

Based on the above safety attitudes and behaviors, construction workers' attitudes play a crucial role in shaping their safety performance on construction sites. Positive safety attitudes, such as performing tasks carefully and cautiously, thinking of the consequences and avoiding taking risks, maintaining positive emotions and thinking, positive communication, and keeping a low profile, will contribute to a safer work environment. When workers have a safety-conscious mindset, they are more likely to take proactive measures to identify and mitigate potential hazards, report unsafe conditions, and adhere to established safety procedures. Conversely, negative attitudes such as complacency, risk-taking behavior, or a lack of belief in the effectiveness of safety measures can lead to unsafe practices and increase the likelihood of accidents and injuries. Therefore, understanding the perceptions of construction professionals regarding worker attitudes is crucial for developing strategies to foster positive safety attitudes and improve safety performance.

The behaviors exhibited by construction workers significantly impact their safety performance. Safe behaviors include consistently following safety guidelines, using PPE correctly, practicing effective communication regarding safety concerns, participating in safety training programs, and promptly reporting incidents or near-miss events. Workers who

demonstrate these behaviors create a culture of safety and contribute to reducing accidents and injuries. However, unsafe behaviors such as taking shortcuts, disregarding safety protocols, engaging in distractions, and failing to communicate hazards pose significant risks to worker safety. Identifying behaviors that affect safety performance is essential for implementing targeted interventions and promoting a safety-focused work environment.

The perceptions of construction professionals regarding the safety attitudes and behaviors of construction workers are critical to understanding and improving the safety performance at construction sites. Positive safety attitudes, including the recognition of the importance of safety and commitment to following protocols, foster a safer work environment. Similarly, safe behaviors, such as adhering to safety guidelines, using PPE correctly, and reporting incidents, contribute to reducing accidents and injuries. Conversely, negative attitudes and unsafe behaviors increase the likelihood of accidents and injuries, posing risks to worker safety. To enhance safety performance, it is essential to cultivate positive safety attitudes and promote safe behaviors among construction workers. This can be achieved through targeted interventions, training programs, and the establishment of a strong safety culture within construction organizations.

3.0 METHOD

Quantitative research consists of empirical and statistical studies (Newman and Benz, 1998) in which data collected can be analyzed numerically and interpreted in tabular, graphical, and statistical forms. However, this method is often used to process large amounts of data and is important for obtaining highly reliable results. The data collected in this manner must be valid and reliable for analysis to generate new insights into this research area.

Quantitative research is typically conducted by distributing closed-ended questionnaires to respondents by hand or email. A written survey can clearly illustrate the expected relationship, describe future hypotheses, and explain why it is useful for the research. Researchers deductively use the literature in a particular model as a framework for investigating the need for research or the speculation of research outcomes. The way to determine hypotheses that fulfill the requirements of intelligence research is through the literature. To obtain quantitative data for this study, a set of related questions was carefully prepared and distributed to construction professionals and experts in the Malaysian construction industry, especially in Penang, Malaysia.

Data collection is the key to this research process. Using a survey method to collect data is one strategy for obtaining knowledge of certain aspects of the perceptions of a phenomenon (Taylor et al., 2016). The purpose of the survey was to highlight the safety factors that influence the understanding of certain situations. It operates for three main purposes: descriptive, interpretive, and conceptual. Researchers must pay attention to obtaining accurate data from respondents to achieve their research goals and objectives. After the research questions and objectives have been identified and the study design determined, the data collection process begins (Kothari, 2004). According to Kothari (2004), there are two types of data: primary and auxiliary. For the first time, the primary data were collected directly from the respondents, whereas the secondary data were the data that had been collected, analyzed, and statistically processed in previous studies.

In this study, a quantitative research method was adopted and used as a tool for data collection; therefore, the main element of the primary data was through the distribution of survey questionnaires. The wording of the questionnaire was simplified for clarity. If there are subjective issues, there should be enough space in the questionnaire to prevent respondents from restricting their opinions. The questionnaire should include the intent of the questionnaire, and the definitions of unfamiliar terms should be provided in explanatory notes to avoid respondents misunderstanding the questions. The questionnaire for this study comprises three sections: A, B, and C. Section A is about the respondent's profile, which includes the company, position of respondents, duration of time the respondent has worked in the construction field, the number of projects that the respondent was involved in, and the size of the projects the respondent was involved in. Section B concerns the perception of critical attitudes and behaviors of construction workers to avoid accidents at construction sites. A Likert scale was used in the questionnaire for respondents' critical ratings based on their perceptions. It ranges from "1" for the "least critical" to "5" for the "most critical" attitudes of construction workers toward safety to avoid accidents at the construction site. Section C solicited respondents' perceptions of construction workers' critical behaviors regarding their safety to avoid accidents at construction sites.

This pilot study played an important role in the methodology used in the present study. The trial questionnaire was used for the pilot survey before the full-scale data solicitation from the respondents. The questionnaire was completed before distribution. Chua (2016) stated that a pilot survey is a small-scale preliminary survey to test the possibility of a well-prepared questionnaire before conducting the final survey. Approximately 30 sets of trial questionnaires were distributed and collected for the pilot survey to determine their reliability and validity. The main reason for conducting the pilot survey was to check the wording, terminology, and appropriateness of the questionnaire to ensure that the correct meaning of the questionnaire was communicated to target respondents to avoid any misunderstanding of the questionnaire (Kumar et al., 2012). In addition, the pilot survey can be used to monitor the order of questions and ensure that questions are asked appropriately so that respondents can answer them properly. The pilot survey can also help determine whether other questions need to be listed as proprietary data in the questionnaire. The results of this preliminary study are important and should be considered when formulating a questionnaire for full-scale surveys. Trial questionnaires were printed and distributed to construction professionals and consultants in the selected research area in Penang, Malaysia (Figure 2). Targeted respondents included project architects, project engineers, project quantity surveyors, safety and health officers, site safety supervisors, project managers, project directors, and site supervisors. The respondents were required to complete questionnaires and provide their comments, if any. As previously mentioned, 30 sets of trial questionnaires were printed and distributed to solicit responses from respondents during the pilot survey.

The research area included construction professionals working at consultant companies and construction sites in Penang, Malaysia. The respondents included construction professionals and consultants such as project architects, project engineers, project quantity surveyors, safety and health officers, site safety supervisors, construction project managers, project directors, and site supervisors.

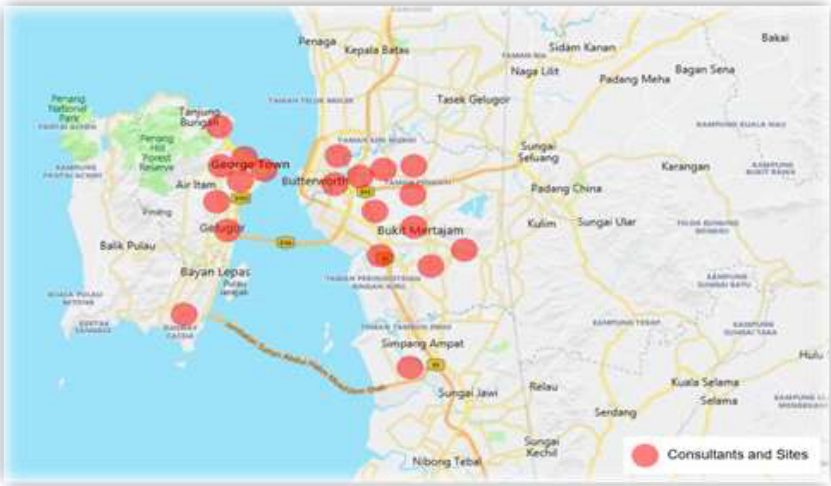

Figure 4 Consultant Companies and Construction Sites in Penang, Malaysia

Statistics from the DOSH show that there were 275 work-related accidents, of which 72 accidents resulted in death, 13 in permanent disability, and 13 in non-permanent disability (DOSH, 2023). In this study, approximately 130 respondents (50%) were taken as the sample size. A total of 130 sets of questionnaires were distributed, with the aim of receiving at least 80% of the distributed questionnaires. To ensure a good collection of the answered questionnaires, the questionnaires were delivered by hand and mail.

Table 1 Results of the Pilot Survey

Construction Professionals	Unsatisfied	Satisfied	Very Satisfied	Commented	Total
Project Architects	-	2	-	-	2
Project Engineers	-	4	2	2	6
Project Quantity Surveyors	-	4	2	2	6
Safety and Health Officers (SHO)	-	1	-	1	1
Site Safety Supervisors (SSS)	-	2	-	-	2
Project Managers	-	2	-	-	2
Project Directors	-	2	-	-	2
Site Supervisors	-	-	3	-	3
Total (Nos.)	0 (0%)	17 (71%)	7 (29%)	5 (21%)	24 (100%)

Table 1 shows the Relative Importance Index (RII), which was adopted to determine the relative importance of relativity toward the safety attitudes and behaviors of construction workers, as perceived by construction professionals (Doloi et al., 2012). The RII formula given by Tam et al. (2006) is as follows:

$$RII = \frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$$

$$(0 \leq \text{RII} \leq 1)$$

where N is the total number of respondents and 5 is the highest weighted score (5,4,3,2,1),

n_1= number of respondents (most critical)

n_2= number of respondents (more critical)

n_3= number of respondents (critical)

n_4= number of respondents (less critical)

n_5= number of respondents (least critical).

4.0 RESULTS AND DISCUSSION

Table 2 Respondents' Profile

Demographic	Frequency (n)	Percentage (%)
Position		
Project Architect	5	5.16%
Project Engineer	13	13.40%
Project Quantity Surveyor	33	34.02%
Safety and Health Officer (SHO)	4	4.12%
Site Safety Supervisor (SSS)	11	11.34%
Project Manager	13	13.40%
Project Director	7	7.22%
Site Supervisor	11	11.34%
Total	97	100%
How long have you been working in the construction field?		
1 – 5 years	13	13.40%
6 – 10 years	27	27.84%
11 – 20 years	24	24.74%
More than 20 years	33	34.02%
Total	97	100%
How many projects have you been involved in so far?		
1 – 5 projects	13	13.40%
6 – 10 projects	29	29.90%
11 – 15 projects	33	34.02%
More than 15 projects	22	22.68%
Total	97	100%
What is the type of project that you are currently involved with?		
Commercial Projects	27	27.84%
Residential Projects	26	26.80%
Mixed Development Projects	9	9.28%
Infrastructure Projects	35	36.08%
Total	97	100%
What is the size of the projects that you are currently involved with?		
Less than 10 million	18	18.56%
10 million – 50 million	28	28.87%
50 million – 100 million	40	41.24%
100 million – 500 million	11	11.34%
500 million – 1 billion	-	-
More than 1 billion	-	-
Total	97	100%
Have you ever heard of the safety attitudes and safety behaviors of construction workers?		
Yes	84	86.60%
No	13	13.40%
Total	97	100%
When you handle projects do you practice safety attitudes and safety behaviors?		
Yes	64	65.98%
No	33	34.02%
Total	97	100%

Table 2 shows the profiles of the respondents who participated in the pilot and final surveys and their experiences and practices in handling construction projects.

Table 3 Ranking of Critical Attitudes of Construction Workers

1 = Least Critical; 2 = Less Critical; 3 = neutral; 4 = More Critical; and 5 = Most Critical.

Critical Attitudes	Level of Criticality					Relative Importance / Comparative Significance	
	n_{1-5}	n5	n4	n3	n2	n1	
	Likert Scale	1	2	3	4	5	
	Frequency (n)					RII	Rank
Performs Tasks Carefully and Cautiously		2	15	26	33	21	0.72	2
Thinks of Consequences and Does Not Take Risk		4	18	27	34	14	0.67	5
Maintains Positive Emotions and Thinking		2	15	33	30	17	0.69	4
Positive Communication		2	16	22	33	24	0.73	1
Keeps a Low Profile		2	16	27	33	19	0.71	3

Table 4 Critical Attitudes of Construction Workers

Critical Attitudes	Relative Importance Index (RII)	Order of Criticality (Rank)
Positive communication	0.73	1
Performs the tasks carefully and cautiously	0.72	2
Keeps a low profile	0.71	3
Maintains positive emotion and thinking	0.69	4
Thinks of the consequences and avoid taking risks	0.67	5

Table 3 shows the most and least critical attitudes of the construction workers toward site safety. Based on Table 4, this study shows that positive communication (RII 0.7258) between construction workers is the most critical attitude for minimizing the occurrence of accidents on site. Positive communication must be two-way, which means that there must be elements of sending and receiving. SHO and SSS must always be vigilant when on site. If an accident occurs on a construction site, the construction workers must immediately inform the safety personnel. If safety personnel have predicted any actions that could harm construction workers, they must take preventive measures to prevent undesirable events from occurring.

Table 5 Ranking of Critical Behaviors of Construction Workers

1 = Least Critical; 2 = Less Critical; 3 = neutral; 4 = More Critical; and 5 = Most Critical.

Critical Behaviors	Level of Criticality					Relative Importance / Comparative Significance	
	n_{1-5}	n5	n4	n3	n2	n1	
	Likert Scale	1	2	3	4	5	
		Frequency (n)					RII	Rank
Follows Correct Working Procedure and Method		-	11	24	44	18	0.74	3
Wears Personal Protective Equipment (PPE)		2	7	31	45	12	0.72	5
Compliance of Construction Workers		-	11	28	37	21	0.74	4
Proper Housekeeping		-	7	29	33	28	0.77	2
Access to Heights and Working Platforms in a Correct Way		-	6	27	36	28	0.78	1

Table 6 Critical Behaviors of Construction Workers

Critical Behaviors	Relative Importance Index (RII)	Order of Criticality (Rank)
Access to Heights and Working Platforms in a Correct Way	0.78	1
Proper Housekeeping	0.77	2
Following The Correct Working Procedures and Methods	0.74	3
Compliance of Construction Workers with Safety Rules and Regulations	0.74	4
Wearing Personal Protective Equipment (PPE)	0.72	5

4.1 Critical Attitudes of Construction Workers

Based on Table 4, this study shows that positive communication (RII 0.7258) between construction workers is the most critical attitude to minimize the occurrence of accidents on site. Positive communication must be two-way, which means that there must be elements of sending and receiving. SHO and SSS must always be vigilant when on site. If an accident occurs on a construction site, construction workers must immediately inform safety personnel. If safety personnel can predict actions that could harm construction workers, they must take preventive measures to prevent undesirable events from occurring.

4.2 Critical Behaviors of Construction Workers

According to Table 6, correct access to heights and working platforms, with a relative importance index value of 0.7773, is the most critical behavior of construction workers in minimizing and preventing the occurrence of accidents. It is also the most dangerous action compared to other critical safety behaviors, which is why it is considered the most critical behavior of construction workers on construction sites.

4.3 Critical Attitudes that Affect Critical Behaviors

Effective communication with construction workers is therefore essential. For example, if construction workers want to reach the height of a building structure, they should help each other to observe the surroundings and inform each other if one of them sees an action that could be harmful to the other. In addition, construction workers should practice good housekeeping on the construction sites. To minimize the likelihood of injury, workers must be very careful and cautious in performing housekeeping. Being cautious means that construction workers must follow correct working procedures and

methods and adhere to good safety practices, norms, laws, and regulations. Construction workers must maintain a positive attitude when performing their tasks and adhere to safety legislation, especially the Occupational Safety and Health Act of 1994 (as amended in 2020) and the safety rules and regulations published and enforced by DOSH.

Good housekeeping makes it easier for the site or project manager to manage safety and minimizes the risk of accidents. However, careful construction workers may be less likely to have accidents than other workers who are careless in their construction activities. The health and safety manager should always remind the construction workers to adhere to safety procedures and provide adequate advice to their workers, and the construction workers should consider the consequences and risks when performing their jobs. No construction worker should ignore the use of PPE. This study provides insights for construction professionals, especially site managers, health and safety representatives, site safety supervisors, and consultants, in planning the safety of construction workers on construction sites. Proper planning of safety measures for construction work will minimize the occurrence of accidents on construction sites.

5.0 CONCLUSION

This study reveals the most and least critical attitudes of construction workers toward safety on site. First, this study shows that communication among construction workers is the most critical attitude toward safety in order to minimize the occurrence of accidents on site. Critically, communication must be two-way, which means that there must be elements of both sending and receiving. In general, one person must provide the correct instructions or orders. Subsequently, another person who is given the instruction or order must receive and acknowledge it to create clear communication. Therefore, safety professionals, such as SHO and SSS, must always be on duty on construction sites and put effort into observation. When accidents occur on site, construction workers must immediately inform safety personnel to prevent and minimize risks and damage. However, safety personnel predict actions that may harm construction workers. Safety personnel must implement preventive measures to prevent unwanted events. Communication is therefore the most critical safety attitude. The study also identified the most and least critical behaviors of the construction workers in terms of safety on site, with "Access to Heights and Working Platforms in Correct Way" being identified as the most critical behavior of construction workers in terms of minimizing and preventing accidents. In terms of the likelihood of accidents occurring, if the construction workers did not follow the correct and appropriate way to access heights, working platforms had the highest likelihood of accidents, as it is the most dangerous behavior compared to other safety behaviors. Hence, it is also the most hazardous action compared to other safety behaviors. This is why it is the most critical behavior of the workers on the site compared to other critical behaviors, as mentioned above. High-frequency communication is therefore essential for teams. For example, if team members are going to access a height, they should help each other observe the surroundings and inform each other if one of them spots a hazard that could be harmful to another. Additionally, construction workers need to do their housekeeping before leaving the construction sites.

To minimize the likelihood of injury, workers must be very careful and cautious when performing housekeeping tasks. Good housekeeping makes it easier for site or project managers to perform their management duties more easily, thereby minimizing the risk of accidents will be minimized. However, construction workers who keep a low profile are less likely to have accidents than other workers who are more likely to show off. To maintain a low profile, construction workers must follow the correct work procedures and methods; that is, they must follow the method statement prepared by the construction project manager or site supervisor. Construction workers must maintain positive emotions while performing their duties by following the safety rules and regulations published by DOSH, particularly the Occupational Safety and Health Act of 1994. In addition to OSHA 1994, safety and health plans should be prepared by the SHO so that construction workers can comply with safety measures. SHO should always remind construction workers of safety precautions and provide adequate counseling to their workers.

This study has some limitations. One limitation is the sample size of the study, which may not have captured the diversity and range of perspectives among construction professionals. Future studies should aim for larger and more diverse samples to ensure the representativeness and generalizability of the findings. Data collected through self-report measures may be subject to biases such as social desirability or recall bias. Future studies could consider incorporating multiple data collection methods, such as direct observation or interviews, to complement self-report measures and provide a more comprehensive understanding of safety attitudes and behaviors. Many studies on the perceptions of construction

professionals have relied on cross-sectional designs, which limit their ability to establish causal relationships or capture changes over time. Longitudinal studies or experimental designs could be used in future research to examine the temporal dynamics of safety attitudes and behaviors, and to assess the effectiveness of interventions or training programs. Some studies have focused on specific construction sites or geographical locations, which limits the generalizability of the findings. Future studies should aim to include multiple sites or locations to capture variations in safety attitudes and behaviors across different contexts.

In addition to these limitations, there are some recommendations for future research. Future studies should adopt mixed methods approach, combining quantitative and qualitative methods. This would provide a more comprehensive understanding of the factors influencing safety attitudes and behaviors and allow for a deeper exploration of the underlying reasons for the perceptions of construction professionals. Conducting comparative studies between different regions or countries could provide insights into the influence of cultural, regulatory, and organizational factors on safety attitudes and behaviors. Comparisons can also be made between different types of construction projects (e.g., residential vs. commercial) or different roles within the construction industry (e.g., project managers vs. site supervisors). Future studies should place more emphasis on exploring the organizational factors that shape safety attitudes and behaviors, such as leadership styles, organizational culture, and safety management practices. This would provide valuable insights for the development of interventions and strategies aimed at improving safety at the organizational level. It is essential to investigate the long-term effects of safety interventions and programs on the attitudes and behaviors of construction professionals. Future research should investigate the sustainability and durability of changes in safety attitudes and behaviors over time to assess the long-term impact of interventions. Including multiple stakeholders, including workers, subcontractors, clients, and regulators, in future studies will provide a more complete understanding of the dynamics and interactions that influence safety attitudes and behaviors. This can help identify areas of alignment or potential conflict, and inform strategies for improving safety practices through collaborative efforts. By addressing these limitations and making recommendations for future studies, researchers can improve the rigor, depth, and applicability of findings related to construction professionals' perceptions of the safety attitudes and behaviors of construction workers on construction sites.

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