



# Perspectives of Contributing Factors and Prevention Measures of Struck-by Accidents in from Experienced Safety Personnel

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**Abstract:** Malaysia's construction industry has been long characterized as risky, as evidenced by its poor health and safety performance. The statistics on fatal accidents recorded by the Department of Safety and Health Malaysia (DOSH) present that struck by accident in the Malaysian construction industry have the highest number of deaths and were one of the critical contributor. Therefore, this study was done to find the main contributing factor to the struck by accidents and its preventive measures. The questionnaire was distributed to the respondents, who were experienced safety personnel in construction industry with at least 10 years' experience in handling safety and health at the workplace. From the questionnaire survey, the most significant contributing factor to struck-by accidents is careless behaviour, and the main perceived prevention measure for struck-by accident is job hazard analysis or job safety analysis briefing to workers before starting job. The outcome of the study could provide awareness on struck-by accidents and reduce the risk of struck-by accident by objects in the construction industry in Malaysia.

**Keywords:** Struck-by accident, preventive measure, contributing factor, construction, Malaysia

## 1. Introduction

Malaysia's construction industry contributes significantly to the development and growth of the country's domestic economy, resulting in increased demand for construction services (Alaloul et al., 2021). However, the industry has earned the reputation of being a highly hazardous industry due to its high rates of accidents and fatalities (Koh et al., 2021). According to Abdul Hamid et al. (2018), accident rates in the Malaysian construction sector are too high year after year. In addition, out of 148 total accidents reported to the Department of Occupational Safety and Health (DOSH) in 2022 (until November), 40% of them involved fatalities (DOSH, 2022). This industry also made the highest contribution to the number of fatalities out of the total 186 number of deaths recorded in all industries. The most recent figures produced by the Department of Occupational Safety and Health (DOSH) reveal that fourteen (14) out of forty-three (43) fatality cases were attributed to the construction industry (until April 2023) (DOSH, 2023a). This disproportionally high rate of accidents and fatalities has caused concern among industry players and the government.

Major causes of accidents are related to various factors such as the nature of the industry, human behaviour, difficult work-site conditions and poor safety management and culture. This has resulted in unsafe work methods, equipment and procedures and has made occupational safety and health (OSH) management an important element in the construction industry. There are also many types of construction accidents such as trips and falls, struck-by object, trapped by something collapsing or overturning, cave-ins, electrical shock, fire and explosion, and others. Understanding the causes of these accidents and the prevention strategies of construction accidents should be a top priority, as worker safety can impede development and cause businesses to incur astronomical losses.

Many research had been undertaken previously to evaluate the causes and preventive measures of building accidents. The majority of earlier studies concentrated on the general factors that led to building accidents. For instance, Abdul Halim et al.'s (2018) research study from 2020 looked at 145 fatalities that were investigated by DOSH over a five-year period (2013–2018) to determine the main factors that led to incidents involving management, the worksite, and people. Zhang et al. (2020), Hamid et al. (2019) and Othman et al. (2018) are more research that discuss the causes of construction accidents. Nonetheless, there have been examinations into the causes of specific types of accidents. Halabi et al. (2022), Rafindadi et al. (2022), Zermame (2020), Chi et al. (2014), and Muhammad Zaini et al. (2020) investigated fall from height accidents; and Blazik-Borowa (2015), Abas et al. (2020a) and Ohdo et al. (2011) investigated scaffold accidents; and Fass et al., (2017) and Abas et al. (2020a) focused on the contributing factors of the struck-by accident.

Because there has been less research in this sector, the current study is focusing on struck-by accidents. It should be noted that victims of struck-by-object accidents are not confined to construction workers; they may also involve members of the general public (Goh et al., 2016). Even though earlier research has explored the causes of struck-by accidents throughout Malaysia (Abas et al., 2020a), the scope of this study is limited to the Johor construction industry. Yap et al. (2022) further investigated the preventive measures of struck-by accidents, but the study also limits to Johor construction industry only. The current study suggests that obtaining the causes and preventative measures of struck-by accidents from experienced safety workers is essential, as they can be regarded as experts in the field and their results will be more reliable and robust. Therefore, this study is conducted to find the major contributing factors to struck-by accident at construction site and their preventive measures.

## 2. Types of Construction Accidents

The sources of accidents and diseases in Malaysia are provided by two organizations: the Social Security Organization (SOCSO) and the Department of Health (DOSH). During the construction process, there are numerous occupational dangers. Cham (2011) discovered in his research that the top five causes of construction accidents from 2005 to 2009, according to SOCSO statistics, are 1) stepping on/striking against or struck by objects; 2) falls; 3) other types of accidents; 4) caught in between objects; and 5) over-exertion or strenuous movements. Table 1 shows the situation of the accident types.

**Table 1 – Causes of accident and its description (Adopted from Abas, 2015)**

Causes of accident	Description
Stepping on/ striking against or struck by objects	Happens when moving construction equipment strikes or step on the workers.
Falls	Categorized under 11 groups, which are falls from stairs or steps; falls through existing floor openings; falls from ladders; falls through roof surfaces; falls from roof edges; falls from scaffold/staging; falls from building girders or other structural steel; falls whiles jumping to a lower level; falls from floors, docks or ground level; and other non-classified falls to lower level (The US Department of Labor, 2003).
Other types of accidents	Consist of structure collapse, electrocution, fire, drowning, explosion and <u>toxification</u> .
Caught in between objects	Usually relating to something/somebody was buried inside the hole or trench.
Over-exertion or strenuous movements	Ergonomic related injury due to great effort and energy for the movements, especially occurs during compact work program and delay in project schedule.

### 2.1 Struck-by Accident

Struck-by injuries are caused by the affected individual coming into contact with or being struck by an object or piece of equipment. Struck-by accidents are mostly caused by vehicles, falling or flying objects and constructing masonry walls. Some examples of struck-by fatal accidents happened in construction site in Malaysia, particularly in Johor are below (DOSH, 2023b):

- i) In September 2022, a worker was installing a variable frequency drive (VFD) switchboards when suddenly a 2000kg VFD switchboard struck him. The worker died. After investigation, it was found that there is no risk assessment (HIRARC) carried out for the work activities related to the installation of switchboard. In addition, the safe working procedure for the particular activities was also not available.
- ii) In June 2022, a construction worker was killed when a 4-meter-high wooden block fell on him as he was resting at an unspecified place. Employers and employees were found to be in violation of Safe Operating Procedure (SOP) and HIRARC work. Furthermore, there was no supervision during the labor process, and the victim was resting in an improper location.
- iii) In 2018, A construction worker was killed after being struck by falling bricks while cleaning. The brick was said from the building's level 18.

Table 2 shows the fatality rate in Johor construction industry reported to DOSH from 2019-2023 (as of May 2023) related to struck-by accidents. 'Falls of persons' is undoubtedly the type of accident which causes the highest fatality rate compared to other types of accident. The second highest rate of occurrence of fatal accidents recorded in Johor was due to struck-by objects. It is to be noted that some figures related to other types of accident was not listed in the table. Moreover, from the analysis of the types of materials involved for fatal struck-by accidents cases revealed that the most frequent materials involved include brick (17%), machine (14%), concrete structure 910%), vehicle (10%) and mobile crane (10%).

**Table 2 - Number of construction fatalities based on accident causes in Johor state from the year 2019 – May 2023 (DOSH, 2023a)**

Type of accident	Number of deaths recorded
Electrical shock	4
Falls of persons	37
Struck-by	18
Caught in or between objects	1

## 2.2 Causes and Preventive Measures of Struck-By Accidents

Some of the causes of struck-by accidents include misjudgement of hazard situation (Suraji, 2001); inappropriate procedure for handling materials (Yap et al., 2022); improper operation (Cheng, 2010); malfunction of procedure for securing operation or warning of hazardous situation (Yap et al., 2022); insufficient housekeeping (AbouRizk, 2010); insufficient written work practices (Connolly & Crowell, 2005); lack of engineering controls (Russell, 2003); failure to identify unsafe conditions (Dong et al., 2017); poor planning for site mobilization or site preparation (Edison, 2021); lack of attention to one's task (Tengan, 2021); inadequate training (Goh et al., 2016); poor communication between workers and supervisors (Dainty et al., 2006); and careless behaviour (Yates, 2020).

Meanwhile, the preventive measures for struck-by accidents are the use of personal protective equipment (PPE); proper use of tool tethering system; regular training (Abdul Halim et al., 2019); use of warning sign and barricades; equipment inspection (Dong, 2017); securing the loads; comply with manufacturer's specification; good housekeeping; and proper demolition procedures (Hinze et al., 2005).

## 3. Methods

This study entailed gathering extensive data for the causes of struck-by accidents and associated prevention measures from experienced safety personnel working on Johor building sites. Participants included a safety and health officer (SHO), a site safety supervisor (SSS), a safety manager, and others with safety and health responsibilities. The response was chosen from among individuals with more than ten years of expertise managing safety and health on building sites. The information was gathered using a questionnaire survey form administered both online and in person. The questionnaire was delivered to just 100 randomly selected respondents, and 54 (54% response rate) returned the form. This number, however, is considered adequate because the respondents were purposefully chosen from those who have 10 years' experience only.

The questionnaire consists of 3 parts, which are; Part 1: Background of respondent; Part 2: Respondent's level of agreement on the contributing factors of struck-by accident in construction listed are significant or not; and Part 3: Respondent's level of agreement whether the listed preventive measures of struck-by accident in construction are significant or not. The respondents were required to rate the level of agreement of the factors and preventive measures of struck-by accidents in construction, in the range of 1 (strongly disagree) to 5 (strongly agree). Two academicians and one safety personnel with more than ten years of expertise in respective fields validated the questionnaire. Before

releasing the actual questionnaire to respondents, several adjustments were made based on expert panel recommendations.

The researcher used Cronbach's Alpha to assess questionnaire reliability and item consolidation. The factor of struck-by accident in Malaysia has a Cronbach's alpha of 0.811, while the preventive measures is 0.904. This demonstrates that the questionnaire is relevant (Gliem & Gliem, 2003). The returned questionnaires were analysed using Average Index (AI) analysis by using the following formula:

$$Average\ Index\ (AI) = \frac{\sum(a_i \cdot n_i)}{\sum Xi} \tag{1}$$

where xi = the number of respondents that agreeing with a choice; a<sub>i</sub>= score at i (Likert scale); and I = 1, 2, 3, 4, 5. The findings were then classified by modifying the AI range value suggested by Majid and McCaffer (1997), which was based on the following range.: 1.00 ≤ AI < 1.50 very insignificant); 1.50 ≤ AI < 2.50 (insignificant); 2.50 ≤ AI < 3.50 (moderately significant); 3.50 ≤ AI < 4.50 (significant); and 4.50 ≤ AI < 5.00 (very significant).

Furthermore, in this study, the Relative Importance Index (RII) was utilized to rank the contributing elements and preventive strategies to struck by objects incidents in terms of their relative importance [5]. Each criterion's RII was determined using the formula described below.

$$RII = \frac{\sum W}{(A \cdot N)} \tag{2}$$

where RII = Relative Importance Index; W = Weighting given to each factor by respondents that was ranging from 1 to 5, A = Highest weight and N = the total number of respondents (Abdelhamid & Everett, 2000).

## 4. Results and Discussion

### 4.1 Background of Respondents

Out of 54 total respondents of the study, 46% of them were site safety supervisors, 32% were safety and health officers, 9% were safety managers and 13% were holding other positions related to safety and health. All of them had more than 10 years of experience, with 13% of them had more than 15 years of working experience.

### 4.2 Contributing Factor of Struck-by Accident

Table 3 depicts the respondents' perceptions of the factors that contribute to struck-by accidents. The Relative Importance Index (RII) ranking is used to identify the key contributing elements to struck-by accidents.

**Table 3 - Summary of respondents' perception and AI of Contributing Factors of Struck-by Accidents**

No.	Contributing factor of struck-by accident in construction	AI	Level of agreement	RII	Ranking based on RII
1.	Misjudgement of hazard situation	4.22	Significant	0.844	7
2.	Procedure for handling materials not suitable for the task	4.04	Significant	0.807	10
3.	Inappropriate operational for task for instance not having CIDB card for personnel work focusing in civil infrastructure	3.93	Significant	0.785	12
4.	Malfunction of procedure for securing operation or warning of hazardous situation. For example, no proper barricade of the working area or signage mentioning "man working above"	4.20	Significant	0.841	8
5.	Poor and improper housekeeping of scheduled waste and domestic waste	4.02	Significant	0.804	11
6.	Insufficient or lack of written work practices	3.74	Significant	0.748	13
7.	Insufficient or lack of engineering controls	4.20	Significant	0.841	8
8.	Failure to identify unsafe conditions	4.41	Significant	0.881	5
9.	Poor planning for site mobilization or site preparation	4.48	Significant	0.896	3
10.	Lack of attention to one's task	4.31	Significant	0.863	6
11.	Inadequate training (lack of training)	4.48	Significant	0.896	3
12.	Poor communication between workers and supervisors	4.54	Very Significant	0.904	2
13.	Careless behaviour. For example, the worker's carelessness or personal faults which lead them to pay insufficient attention to the task	4.57	Very Significant	0.915	1

The result of AI analysis shows that, the highest contributing factor of fatal struck-by accident at construction site is due to worker's careless behaviour, with the AI value of 4.57 (RII = 0.915). It is followed by the factor of 'poor communication between workers and supervisors' (AI = 4.54, RII = 0.904), and 'inadequate training' and 'poor planning for site mobilization or site preparation' (with both AI = 4.48, RII = 0.896).

The finding was in the agreement with the author such as Goh et al. (2016), Cheng et al. (2010), Chi et al. (2005) as their studies agreed that careless behaviour was the most significant contributing factor to struck-by accident and no contradicts. According to Zulkeflee et al. (2020), the primary factor contributing to accidents at construction sites is the attitude and behaviour of the workers, who are unwilling to follow safety regulations out of laziness and stubbornness. Failure to follow safety guidelines and safety practices is frequently attributed to a number of factors, including being lethargic, difficult, and tasty. Accidents result from employee attitudes and behaviours that frequently disregard safety regulations. As a result, efforts to lower accidents and incidents are ineffective. As a conclusion, the workers must always caution in construction to prevent the worker's carelessness or personal fault.

Poor communication is also perceived as a very significant factor of struck-by accidents. Even though the importance of good communication factor in construction project has been highlighted by many authors (such as Johnson et al., 2016 and Olanrewaju et al., 2017), it is found that this factor had been a source of problem in almost all construction projects (Abas et al., 2020b). Numerous factors, such as work stress, high employee and employee attitudes, misinterpretations of high command, poor employee communication skills, fear of staff talking, misinterpretations of body language and hand signals between supervisors and employees, can lead to communication issues on the job site. Example of fatal accident case related to this type of accident is when a mobile crane in a reversing state has collided with a car that was parked at a construction site in Sarawak (February 2021). The accident caused damage to the car and the driver of the car was injured and died at the scene (DOSH, 2023b).

Next, it appears that lack of training seems to be also perceived as the very significant factor of struck-by accident. Many authors have cited this factor as the main cause of accident such as (Al-Khaburi & Amoudi, 2018; Othman et al., 2018; Abukhashabah et al., 2020). This is due to the fact that untrained personnel are more prone to injury. This occurs when personnel lack the necessary knowledge and abilities to utilize equipment and supplies properly. The problem might be devastating in workplaces with heavy machinery and dangerous materials. Therefore, having rigorous health and safety training helps to mitigate the risks that could lead to accidents, and the entire workers will be aware of the hazards and risks while working.

### 4.3 Preventive Measures to Struck-by Accidents

Table 4 shows the respondents' perception towards the preventive practice to struck-by objects accidents.

**Table 4 - Summary of respondents' perception and AI of preventive measures of struck-by accidents**

No.	Preventive measures for struck-by accident in construction	Mean Index	Level of agreement	RII	Ranking based on RII
1	Use of Personal Protective Equipment (PPE)	4.52	Very significant	0.904	6
2	Proper use of tool tethering system	4.46	Very significant	0.893	8
3	Regular training	4.52	Very significant	0.904	6
4	Use of warning signs and barricades	4.56	Very significant	0.911	5
5	Equipment inspection	4.65	Very significant	0.930	3
6	Use of falling objects protective structures on equipment	4.24	Significant	0.848	13
7	Securing the loads	4.30	Significant	0.859	12
8	Comply with manufacturer's specification	4.30	Significant	0.859	12
9	Good housekeeping	4.37	Significant	0.874	11
10	Proper demolition procedures	4.39	Significant	0.878	10
11	The importance of safety training in the construction industry	4.43	Significant	0.885	9
12	Proper planning before starting job	4.61	Very significant	0.922	4
13	Provide training to all workers	4.76	Very significant	0.952	2

14	Brief Job Hazard Analysis (JHA) or Job Safety Analysis (JSA) to workers before starting job	4.78	Very significant	0.956	1
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Most of the perceived effective prevention measure for struck-by accident is 'brief job hazards analysis or job safety analysis to worker before starting job'. It has the highest mean index of 4.78 and RII value of 0.956. The second effective preventive is 'providing the training to all workers' with the mean index of 4.76 (RII value of 0.952), followed by 'equipment inspection' with the mean index of 4.65 and the value of RII is 0.930.

According to the analysis, the finding shares the agreement with the authors such as Yap et al. (2022) and Benny & Jaishree (2017) where providing adequate training to all workers is the significant preventive measures to accident. Additionally, the respondents seemed to perceive that undertaking brief JHA or JSA before commencing the work is very significant to prevent struck-by accident. JSA is a systematic technique that divides each job/task into major training sequences, identifies safety features of each job/task step, and teaches the employee on how to avoid potential safety dangers. JSA can maintain consistent and safe work practices, prevent injuries by educating employees on how to complete tasks with the least chance of injury, and give training documentation on the employee's understanding of the necessary job safety criteria. According to Albrechtsen et al. (2019), although hazard control can be accomplished using methods other than JSA, the method has additional advantages in terms of safety and production.

With regards to training, it is essential that every worker must be appropriately qualified and practically trained for every duty that is assigned to them. Furthermore, continuous on-the-job training concerning workplace safety and occupational dangers should be part of every worker's armament (Albrechtsen et al., 2019). Next, Goh et al. (2016) postulated that inspection of safety at construction site is essential to ensure the effectiveness of accidents prevention methods during project operation. Auld et al. (2001) in their study found that though on-site safety inspections had no influence on the risk of accident and injury, but they do have a favourable effect on the number of work-related fatalities. Safety inspection is considered as the primary instrument for maintaining a safe working environment and monitoring harmful practices at the workplace and further can affect the safety performance in construction project. Accidents and injuries can be avoided by performing regular maintenance and inspections on construction equipment and machinery. Therefore, employers should develop a maintenance schedule for equipment and train employees to identify any problems and report them quickly.

## 5. Conclusion

This study looked into experienced safety personnel's perspectives of the elements that contribute to and prevent struck-by accidents on construction sites. According to the findings, respondents regarded all of the elements listed as significant causes of struck-by incidents on construction sites. Two factors were deemed very significant, which are poor communication between workers and supervisors, and careless behaviour of the worker. Meanwhile, the most significant preventive measures of struck-by accident is providing brief Job Hazard Analysis (JHA) or Job Safety Analysis (JSA) to workers before starting job.

Some limitations were noted in this study. Firstly, the population of the respondents were limited to those who have more than 10 years' experience in handling safety and health at construction site only. Similar study can be conducted by involving different categories of respondent such as engineering, managerial staff, architect or consultant. Their opinions can also serve as references in helping to make this study successful. Next, the focus of the study was only in the state of Johor only. Future study is sought to cover all states in Malaysia. It is hoped that the outcome of the study could provide awareness on struck-by accidents and reduce the risk of struck-by accident by objects in the construction industry in Malaysia

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