

## **Accidents in Construction Sites: A Study on the Causes and Preventive Approaches to Mitigate Accident Rate**

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### **Abstract**

Accidents occur at construction sites are due to the faults of either the construction companies or the workers themselves (Wahab, 2017). It is disheartening that the victims suffer injuries, death, loss or damage of properties. At the same time, construction accidents also has the cost and time implication on the projects. These can cause cost overrun and delay in completion of projects (Asanka and Ranasinghe, 2015). The purposes of this study are to obtain the feedback from the respondents in Klang district, Selangor on the causes of construction accidents, identifying the more prevalent types of accidents occurring at the sites and suggesting preventive actions to mitigate accident rate at the sites. The targeted respondents are professionals in CIDB registered construction companies under category G7. This study will focus on the construction accidents caused by human errors which can be prevented. Construction accidents caused by natural disasters are unpredictable and at best, the contractor can only make resolution to minimise damages and injuries (Perecmen, 2018).

### **Key Words**

Construction accidents, mitigating approaches, health and safety at sites

### **Introduction**

According to Idris (2017), the construction sector in Malaysia encounters higher accident risk compared to other sectors. The accidents in construction sites not only cause fatality of workers, but also have great impact on construction companies. CIDB (2018) identifies 6 common types of accidents occurring in construction sites in Malaysia from 2015 to 2017 and these are fall from a height or falling into dangerous location (38 cases), struck and hit by object (32 cases), pinned by building materials or machinery (16 cases), electrocution (6 cases), buried under collapsed holes (5 cases) and poisonous gas (2 cases) (Wahab, 2017).

However, accident rate can be mitigated or controlled through proper approaches such as enforcing safety measures by construction companies, establishing safety management system and complying to the Occupational Safety and Health Act 1994 (OSHA1994) at the construction sites (Idris, 2017). As such, this paper explores the causes of accidents at the sites and intends to propose preventive approaches to minimize the risk of accident in construction sites, which would be beneficial to the industry at large.

The aim of this research is to investigate the causes of accidents and propose preventive approaches to resolve high accident rates at construction sites. Three objectives have been established to achieve the aim of this research: to identify the causes of accidents occurring in construction sites, to evaluate the impact on the construction companies involved and to propose preventive approaches to mitigate the accident rate in construction sites.

Literature review has been explored on various opinions and findings of other researchers on the causes of accidents, impacts of accidents on projects, process of compensations due to accidents and strategies to prevent accidents in construction sites.

Perecman (2018) attributes the two major classifications of causes of construction accidents as natural disasters and faults of human. Natural disasters such as thunderstorms, floods, earthquakes and strong winds can lead to accidents for example the collapse of a construction crane that killed 107 people at Mecca's Grand Mosque (NST, 2015) due to strong wind. The accidents caused by natural disasters on construction sites are unpredictable, and the construction companies can only make some resolutions or plan strategies to minimize the damage of accidents. On the other hand, Goetsch (2003) opines that most of the accidents occur are caused by the faults of human and the following are the common types of human faults resulting in construction accidents:

- |                                |                                    |
|--------------------------------|------------------------------------|
| Failure to enforce procedures  | Inadequate training                |
| Inadequate facilities          | Inadequate coordination            |
| Failure to recognize hazard    | Unclear operational procedures     |
| Failure to motivate            | Inadequate warnings                |
| Poor design or selection       | Inadequate supply                  |
| Poor maintenance               | Lack of comprehension              |
| Inadequate instructions        | Low morale                         |
| Poor attitude                  | Inadequate supervisory proficiency |
| Inadequate planning and layout | Poor worker placement              |
| Failure to enforce safety      |                                    |

Accidents which occur at the construction sites are either caused by negligence of construction companies or workers themselves, which will affect the construction operation. A construction worker died falling from height in Penang in 2016 was caused by the failure of his company to provide safe working conditions and adequate supply of personal protective equipment (PPE) to the workers (Wahab, 2017). Two fatal casualties were hit by a crane in Sarawak in 2017 because the construction company did not comply with OSHA 1994 for lifting works. The accidents could have been avoided had the construction companies been careful in the management and supervision of their duties by complying with the OSHA 1994 during the construction process (Borneo Post, 2017). It is obvious that strict adherence to OSHA 1994 is a must for safety precaution at the sites (Wahab, 2017).

In their study, Asanka and Ranasinghe (2015) conclude that the consequences of accidents occurring at the sites not only delay project completion and cost overrun but also very often ruin the reputation of construction companies involved. The impacts of accidents can also cause uncompetitive tenders of companies involved, dissatisfaction among stakeholders, companies' financial losses due to property damages and removing cost, compensation and penalties from authorities (Hamid et al, 2014). Besides that, Chong and Low

(2014) even imply that large number of accidents at the sites may bring about the economic slow down.

Both the employees and employers have the obligations to avoid accidents from occurring at the sites. From literature review, the approaches adopted for mitigating accident rate include provision of fall protection by employers for their workers Jones (2016), provision of safety training for workers (Bakri et al, 2015), effective communication between construction parties (Riddel, 2016), holding frequent safety meetings on site , keeping workspaces clean (Perecman, 2018), regular maintenance of equipment and tools (IHA, 2018), establishing proper safety planning (Simmonds, 2015) and effective safety supervision on site (Perecman, 2018) using equipment in the manner as prescribed (IHA, 2018) and following OSHA guidelines and report any dangerous working conditions (OSHA, 2015). Besides that, progressive technologies such as 7D Building Information Modelling which include data of safety line (Simmonds, 2015) , site sensors , self-driving trucks and heavy equipment (Jones, 2016) will enhance the safety condition and control at construction sites.

### Methodology

This research employs the quantitative method by sending structured questionnaire randomly to professionals in construction industry as targeted respondents. The respondents have been given one month to reply and the data collected are then analysed and results are presented in simple descriptive statistics.

The questionnaire is designed via open online surveys tools known as the Google Form and the results collected are saved in Google Drive Data Storage and are divided into 4 parts to correspond to the objectives of the study: Section A relates to the background of respondents; Section B is to identify the main causes, major types of accidents and the impact on construction companies; Section C covers the opinions of the construction personnel towards the importance of mitigating accident rate in construction sites and Section D is to obtain the recommendations and suggestions from the construction personnel on preventive measures.

The data collected are then analysed and recorded in frequency distribution analysis chart and pie chart for discussion. Besides that, mean score analysis has been used for comparison in the data analysis. The data collected from the respondents based on their opinion were analysed according to the order of ranking, which were derived from the average index to analysis for each answer from choices of the respondents. T test analysis are then made to confirm whether the results are significant or not significant.

$$\text{Mean} = \frac{\sum_{i=1}^5 (\text{Weight of ranked position}_i \times \text{Frequency of response}_i)}{\sum_{i=1}^5 \text{Frequency of response}_i}$$

The category of Likert Scale is divided into five specific weightages as indicated in Table 1 below.

Likert Scale	Average Index	Weightage
Strongly Disagree	1.0≤Mean<1.5	1
Disagree	1.5≤Mean<2.5	2
Neutral	2.5≤Mean<3.5	3
Agree	3.5≤Mean<4.5	4
Strongly Agree	4.5≤Mean≤5.0	5

Table 1 : Category for Average Index (Majid and McCaffer, 1997).

## Results and Discussion

The sample frame for this research are the building construction companies registered with CIDB under the category grade G7 in the district of Klang, Selangor. There are a total of 205 registered grade G7 building contractors (B4) in this district. Grade 7 construction companies are those which can undertake projects exceeding RM 10 million and without limit to the value of projects (CIDB, 2018). 100 sets of questionnaire have been sent out but only 33 (33 %) responded within the period of one month. In order to avoid biasness, random sampling has been adopted in picking the respondents. For the confident level of 90% and confident interval of 10%, the minimum sample size required is 51. Although the completed response is only 33, this figure is not too far from the 51 sample required.

### 5.1 Background of respondent

This study only selects personnel at professional level in construction companies as shown in Figure 1. The accuracy of the survey depends on the level of their working experiences as shown in Figure 2. Figure 3 shows the types of project the companies have handled before and Figure 4 the causes of accidents on sites. The common types of accidents occurring on sites identified in Figure 5 will influence the opinions of respondents toward preventive approaches to mitigate the accident rate in construction site are shown in Figure 8.

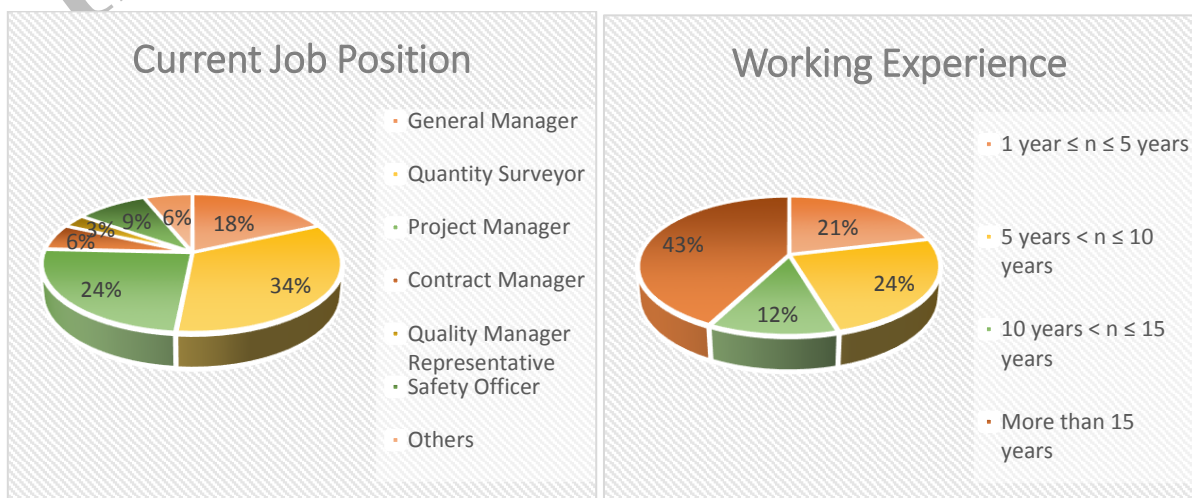


Figure 1 : Respondents' current job positions.

Figure 2 : Working experiences of respondents.

Figure 1 indicates that the major 5 professions of the respondents are Quantity Surveyors (34%), Project Managers (24%), General Manager (18%), Safety Officers (9%) and Contracts Manager (6%). The majority, 43%, of the respondents have more than 15 years of experience whilst 21% of the respondents have less than 5 years working experience (Figure 2). This indicates that generally the respondents are very experienced in the industry which provides high accuracy of opinion.

Figure 3 shows that 85% (28 of 33) of the respondents have experience in residential projects, 52% (17 of 33) in commercial projects and 52% (17 of 33) in industrial projects. Besides that, 27% (9 of 33) of the building contractors have also experience in infrastructure project.

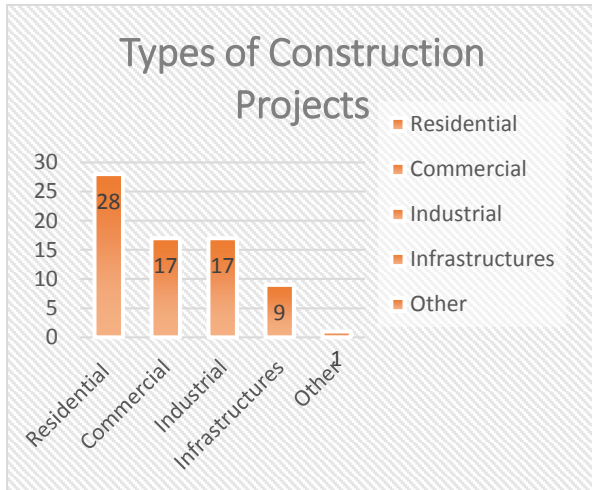


Figure 3: Types of construction projects undertaken by respondents.

### 5.2 General Awareness of Accidents in Construction Industry

The objective of the awareness survey is to understand the degree of awareness of the industry towards the seriousness of accidents in construction sites in comparison to other industries. This Section comprises of 8 questions for respondents to answer their opinion in the 5-point Likert Scale of strongly agree, agree, neutral, disagree and strongly disagree in each question. Table 2 shows that except for Question 5 (mean score 3.12), which is “Neutral” according to the classification of Likert Scale, all the other Questions 1 to 8 have the mean score of exceeding 3.50 but not exceeding 4.50, referred as “agree” by the respondents. The values have been confirmed by T test analysis with mean population of 3.5 giving the results that Questions 1, 2, 3, 4, 6, 7 and 8 as significant for 90% confident level. The test values show the population means are above 3.5 (Table 2 below). Therefore, it can be considered that respondents agree to higher accident rate in construction industry than other industries; accidents affects project operation; accidents in construction sites damage public properties; ignorance of safety and health will lead to higher accident rates; accidents will affect the reputation of construction companies; taking proactive actions to prevent accidents will benefit the construction companies; and finally implementing OSHA 1994 is the best method of reducing accidents on sites. However the Test value indicates that Questions 5 the population mean value is below 3.5 implying that the respondents do not believe that accidents at the sites will slow down the economy of the country contrary to the findings of Chong and Low (2014).

$H_0: \mu \leq 3.5$  ;  $H_1: \mu > 3.5$

Question	Mean	Rating Scale	Standard Deviation	Test Statistic Value, t	P-Value (right-tailed)	Accept or reject $H_0$ at 90% c. l.
1) The accident rate is higher in construction industry than other industries.	4.09	Agree	0.9139	3.714	0.001	Reject $H_0$ , Accept $H_1$

2) The construction accidents will affect the project operation.	4.48	Agree	0.7954	7.113	0.000	Reject H <sub>0</sub> , Accept H <sub>1</sub>
3) Construction accidents will damage public properties.	3.79	Agree	0.8929	1.852	0.037	Reject H <sub>0</sub> , Accept H <sub>1</sub>
4) Ignorance of the safety and health in construction sites will lead to higher accident rate.	4.12	Agree	0.7398	4.824	0.000	Reject H <sub>0</sub> , Accept H <sub>1</sub>
5) High construction accident rate will cause economic slow down.	3.12	Neutral	0.8200	-2.654	0.006 * Left-tier test	Significant that population mean is <3.5
6) High accident rate at construction sites will affect the reputations of construction companies.	4.18	Agree	0.8461	4.629	0.000	Reject H <sub>0</sub> , Accept H <sub>1</sub>
7) Taking proactive actions to prevent accidents in construction sites will benefit the construction companies.	4.21	Agree	0.9273	4.412	0.000	Reject H <sub>0</sub> , Accept H <sub>1</sub>

8) OSHA 1994 is a best way to control the accident rate on construction sites.	3.85	Agree	0.8975	2.955	0.004	Reject H <sub>0</sub> , Accept H <sub>1</sub>
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Table 2: The degree of awareness of the respondents towards accidents in construction sites

**5.3 Causes, Types and Impact of Accidents**

The purposes of this Section is to assess the main causes of accidents at the construction sites in district of Klang, Selangor. The results from Appendix I are illustrated in Figure 4 which shows the mean score of each cause of accident occurred on construction sites. Failure to enforce safety measures (mean score 4.27), inadequate training of workers (mean score 4.24) and negligence of contractor (mean score 4.18) are the three most common causes of accidents at the site, which are classified as “agree” according to Table 1. The values are significant from the results tested in Appendix I. The study explores the root causes in order to provide effective strategy to resolve the accident problem.

Figure 5 indicates that the respondents identify fall (mean score 4.27), hit by objects (mean score 4.24), and machinery & equipment error (mean score 4.18) as the three most common types of accidents occurring at the sites in district of Klang.

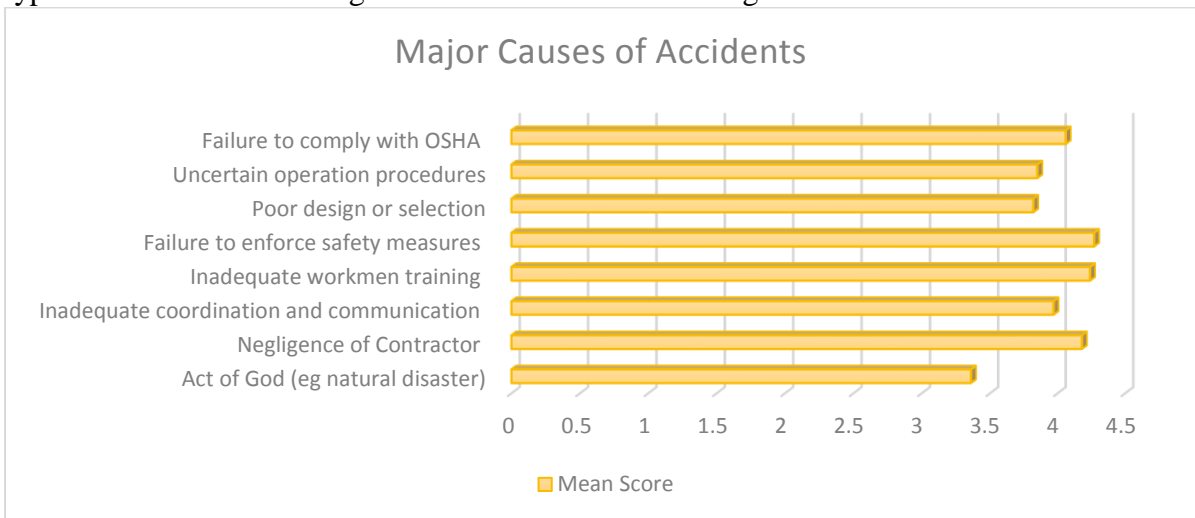


Figure 4 : Opinions of respondents on major causes of accidents at sites

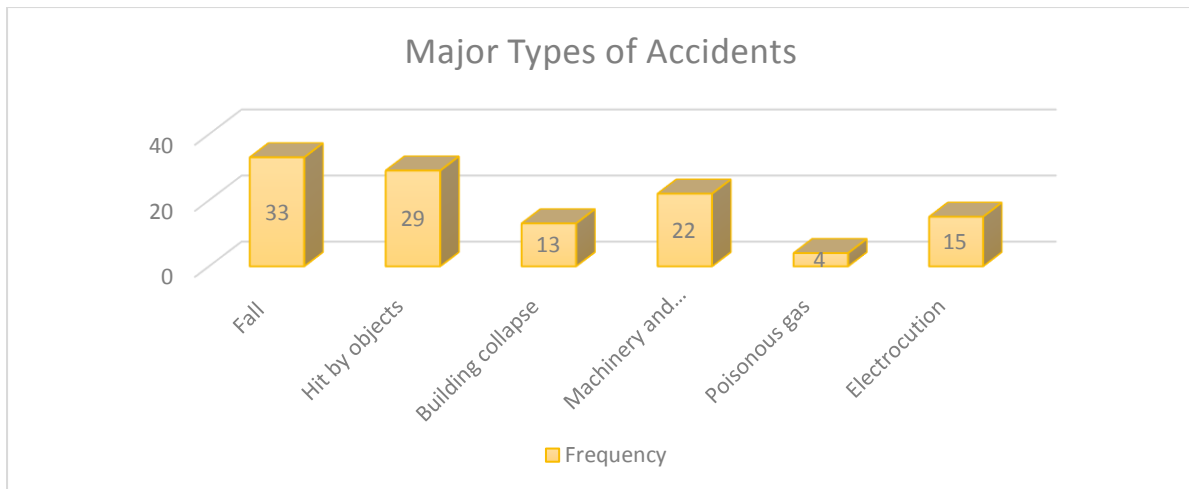


Figure 5 : Common types accidents at construction sites

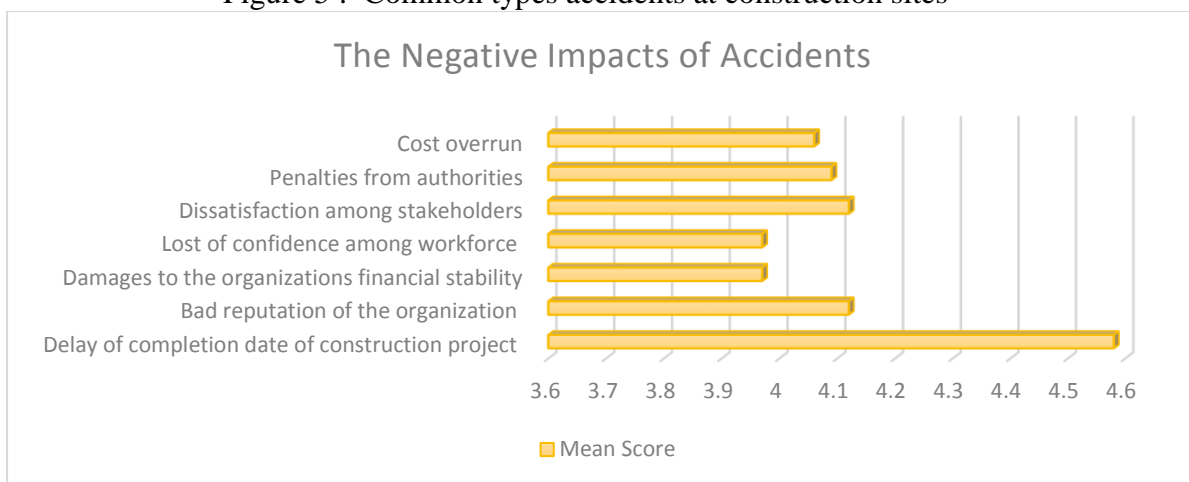


Figure 6 : Negative impact of accidents to the construction companies.

From Figure 6 above, delay of completion date of construction project (mean score 4.58), bad reputation of the organization (mean score 4.12) and dissatisfaction among stakeholders (mean score 4.12) are the most crucial impacts affecting the construction organization. Delay in completion of project, bad reputation and dissatisfaction among stakeholders are classified as “agree” among the respondents. Delay of completion date of construction project has not been classified as “strongly agree” as the T test result for this question is not significant (Refer to Appendix II-P1 & Appendix II-P2). In view of these, construction companies should be wary of the damages they will incur for not putting sufficient effort on safety and health issues in their projects.



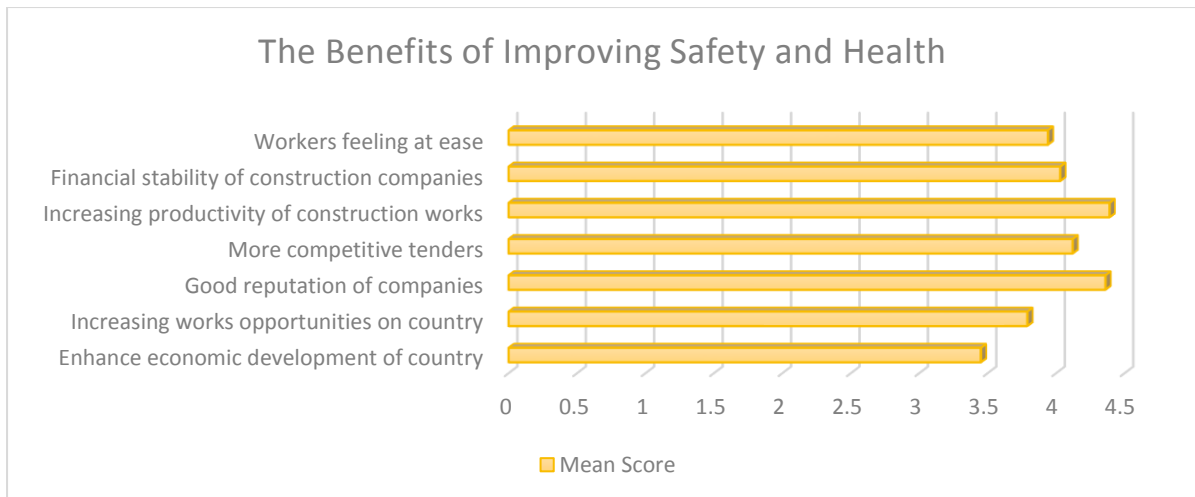


Figure 7 : Benefits of improving safety and health at construction sites

Figure 7 (refer to Appendix III) above shows the feedback of the respondents on the benefits of improving safety and health at the sites. These 3 top ranking include increasing productivity of construction works (mean score of 4.39), enhancing the reputation of construction companies (mean score 4.36) and more competitive tender prices (mean score 4.12). The mean scores are under the category of “agree” by the respondents are significant from the results. These advantages should be promoted by the construction companies through increased reinforcement on safety on the construction sites.

#### 5.4 Preventive Measures to Mitigate Construction Accident Rate

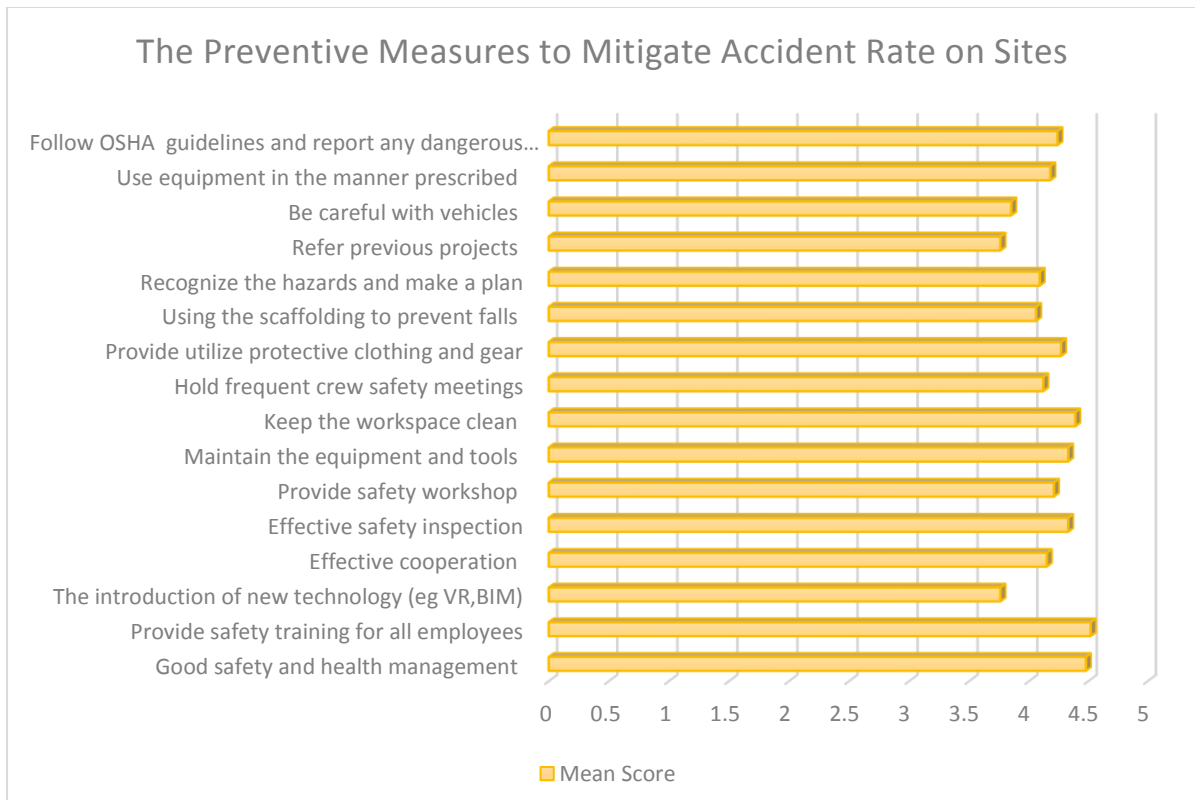


Figure 8 : Opinion of respondent on the effectiveness of the mitigating measures of accidents on sites

From Figure 8 above, the providing safety training for all employees (mean score 4.52), good safety and health management (mean score 4.48), keeping the workspace clean (mean score 4.39), effective safety inspection (mean score 4.33) and maintaining the equipment and tools (mean score 4.33 ) are the most effective strategies to improve the safety and health by mitigating the accident rate on construction sites. These mitigating measures are term “ agree” by the respondents as the results are significant. Providing safety training for all employees (mean score 4.52) cannot be considered as “strongly agree” as the test for population mean of 4.5 is not significant (Appendix IV).

### ***Comments and Recommendations of Respondents***

These are open ended questions and the objective is to further extract any other opinions and recommendations from the respondents .There are 2 questions in this section. Question 1 requires the respondents to state any accidents that occurred in their current construction sites still in progress and provide any related causes for these accidents. In Question 2, the respondents are asked to provide any other preventive measures to mitigate accident rate not listed in the questionnaire.

Some feedback on the accidents that occur on the current project sites are fall from height, hit by objects and trench collapse.Certain respondents comment that these are due to either the employees’ negligence or employers’ lack of safety control. Feedback from the comments also blame the loss of productivity due to the loss of confidence and dissatisfaction of the workers. Suggestions on other mitigating actions not mention in the questionnaire are daily safety briefing to workers before the work begins and regular site visits conducted by the higher management will surely keep the site personnels on their toes not only on the safety and health of the site but also on work progress, site control of materials, labour and equipments.

### **Conclusion**

Conclusion has been established from investigating the causes of accidents and proposing mitigating approaches to resolve high accident rates at construction sites.The researchers feel imperative to conclude through the three objectives mentioned in the sub-section 2.0 above.

#### ***Objective 1: To identify the causes of accidents occurring in construction sites***

The most common types of accidents occurring at the sites in the district of Klang, Selangor, are fall from height, hit by objects and machinery and equipment error.The major causes of these accidents are failure to enforce safety measures, inadequate training of workers and negligence of contractor. Comments from the respondents attribute the causes to either employees’ negligence or employers’ s faults. The faults of contractor refers to lax implementation of safety control at their project sites and failure to provide personal protective equipment (PPE) to workers.

#### ***Objective 2: To evaluate the impacts of the accidents in construction industry.***

Findings of the research show that the greatest impact of accidents is delay of completion of construction projects. Delay in completion itself causes cost overrun and loss of profit due to liquidate and ascertained damages, and other expenditure incurred due to accidents. Some respondents (from open ended questions) believe that high accident risk results in workers’ loss of confidence and low productivity. Besides that, construction companies which are synonymous with high accidents tendency have bad reputations creating dissatisfaction among stakeholders, and consequently become unattractive in their tendering.

**Objective 3 :To propose preventive approaches to mitigate accident rate at construction sites.**

Construction companies must not only provide safety training for all the staff , but these trainings must be adequately and progressively provided to increase the workers' knowledge of safety, technicality of work procedure and machinery usage, and create familiarity to the work environment. Besides that, construction companies should establish good safety and health management, ensure clean workspace, conduct safety inspection regularly, maintain their equipment and tool properly. Other recommendations (stated in open ended questions) proposed by the respondents are daily safety briefing before the work begin and regular site visits by higher management can ensure site personnel to be more vigilant not only on safety measures but other site control issues such as work progress, material wastage, labour coordination and timely deployment of machinery and equipments. These are essential strategies to mitigate accident rate in construction sites.

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