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# Safety Personnel's Perceptions on the Significant Factors that Affect Construction Projects Safety Performance

**Nor Haslinda Abas[1*], Nurhalimah Yusuf[2], Muhamad Hanafi Rahmat[1], Tong Yean Ghing[1]**

[1]Jamilus Research Centre, Faculty of Civil Engineering and Built Environment,
Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, MALAYSIA

[2]Site Office Saloma Link,
Level 1, Lot 2400, Jalan Raja Muda Musa, 50300 Kuala Lumpur, MALAYSIA

*Corresponding Author

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**Abstract:** The Malaysian construction industry has been long categorized as one of the riskiest industries due to the high number of accidents that happened at construction sites. The poor safety performance in the construction industry has caused several drawbacks and failures in the aspects of project performance, cost, project completion time, and productivity. One of the reasons that led to this situation is due to the inadequate awareness of the project safety performance factors. Therefore, this study aims to investigate the significant factors affecting the safety performance of construction projects, based on the perceptions of safety personnel. Fifty-six (56) questionnaires were distributed among construction safety personnel who are working at construction sites in Kuala Lumpur through email and face-to-face methods. The percentage of the returned questionnaire was 100%. The questionnaire was analyzed using the Average Index (AI) analysis to attain the significant factors that affect the safety performance of construction projects. The findings revealed that among significant factors that affect safety performance on the construction project through project level and organization level were safety training, safety rules and safety induction, and performance monitoring. The outcomes of the study could assist relevant parties especially contractors to avoid accidents occur and have a systematic improvement on safety performance indicators at the construction project.

**Keywords:** Construction industry, safety performance, safety perceptions, project level, organization level

## 1. Introduction

The construction industry is known as a 4-D industry (Dirty, Dangerous, Difficult and Death) that involved many hazardous activities that could result in injuries, illness and death to workers if poor safety management is implemented at the construction site [1]. In Malaysia, the high rate of accidents and fatality is proven by the statistic reported by the Department of Occupational Safety and Health (DOSH). In 2020 alone, the number of fatalities recorded in the construction industry was 66 out of 213 number of fatalities recorded in all industries, with the percentage of 31% [2], regardless of the smaller number of accidents happened in the construction industry if compared to other industries. Yakubu & Bakri [3] evaluated the safety and health performance on 2 construction sites in Kuala Lumpur and found that even though the potential hazards and risks were well-managed and documented at both sites, there were still several risky activities being neglected by the contractor. Improving occupational safety and health (OSH) performance

*Corresponding author: nhaslin@uthm.edu.my

in the construction industry is important because it symbolizes the excellence of the executed projects, and more importantly the protection of life for those (i.e. workers) who work in the field.

According to Haupt [4], occupational safety and health (OSH) legislation alone was not adequate to reduce the number of accidents. A range of initiatives had been adopted in many countries around the world to improve construction safety performance. One of the main concerns was safety management through organization policies and practices. For example in Hong Kong, the introduction of the Pay for Safety Scheme (PFSS) in 1996 to encourage the safety awareness by taking the contractor's pricing for safety items out from the area of the competitive building had improved the safety performance of the construction industry in terms of reduction of the number of accidents [5], [6]. Carter & Smith [7] integrated safety with construction schedules where all safety considerations could be included at the early stage of construction. According to Zou & Zhang [8] and Mohamed [9], safety awareness, knowledge and training were believed to effectively promote safety culture. Some researchers also investigated accident causes and analysis to avoid accidents from happening [10], [11]. Farooqi [12] suggested that employers need to provide training to employees and implement comprehensive safety programs that could improve safety performance continuously. Recently, the use of technological advancement such as Building Information Modelling (BIM) has been acknowledged as one of the ways to improve construction safety [13], [14].

For construction projects, the contractors need to measure their safety performance to ensure they are aware of their organization's safety well-being. Hinze & Gambatese [15] in their study concluded that the contractor's safety performance was consistently influenced in part by several factors. Moreover, the quality of the project was even more important because it had a direct bearing on the performance of the prime contractors on key elements of the work [16]. Safety performance can be measured through either traditional goal-setting or feedback method (known as a lagging indicator), or input-oriented predictive measurement (known as a leading indicator). Examples of lagging indicators commonly used while measuring safety performance are the number of accidents and near-misses, accident and incident rates, number of complaints, etc. In recent years, leading indicators had been highlighted as the method to evaluate the safety performance of the construction project [17]. Leading-indicator based safety performance measurement tools had been developed in other countries, such as Gunduz & Khader [18] who develop a safety performance index assessment tool by using a fuzzy structural equation model for construction sites. Another examples include 'Safety Meter' in Australia, which was based on leading indicators that aim to involve the workforce in the method of measurement and raise site safety awareness [19]; 'Site Safe' in New Zealand, which consists of 3 main measurement themes i.e. safety systems, safety behaviors and safety leadership [20]; and Safety Effectiveness Indicators (SEIs) [21].

In Malaysia, the Construction Industry Development Board (CIDB) has developed a safety performance tool named SHASSIC, which aims to measure the safety and health performance of the construction project, based on leading factors that underpin the tool. However, the indicators or factors in SHASSIC only cover organization-wise factors, such as safety policy and safety committee, with the lacking of project-wise indicators, such as the implementation of audit and safety personnel [22]. Abas et al. [22] studied the factors affecting safety performance pertinent to project levels. This study expands Abas et al.'s [22] work, by identifying the significant factors affecting safety performance in the construction project, pertinent to organization and project levels.

## 2. Safety Performance Factors

Safety performance of a construction project can be affected by several factors or indicators, whether in project level or organizational level [23]. The next sections describe the factors affecting the safety performance of construction projects, pertinent to these two categories.

### 2.1 Project Level

Project level is described as when thee owners had chosen to divide the work required to provide a facility and contract with several inter-firm organizations, and also related with historical factors such as economy, psychology, technical, procedure, organization and environmental work issues [24]. According to Wong et al. [25], the development of safety systems, safety procedures and practice could affect safety performance. This also included monitoring of safety compliance, the establishment of safety committees, communicating safety policies to safety site personnel, the involvement of safety officers and consultation between safety officers and site staff [25], [26].

Abas et al. [22] reviewed the factors affecting safety performance in construction projects related to the project level. Among the factors affecting construction project safety performance in project level were:
"implementation of safety inspection, implementation of safe system of work, implementation of safe plant & equipment, implementation of safe working environment, implementation of safety officer & supervisor, safety review for safety audit, safety review for site safety policy review, emergency plan & procedures, and safety training" [22].

## 2.2 Organization Level

The organization level is described as the top management actively involved in safety and a strong commitment to safety [24]. Ng et al [23] had identified and summarized the factors of safety performance factors on an organizational level as follows (Note that the summary of factors is supported by relevant literature):

i) Safety policy & safety management system - A policy is an administrative belief used in an organization that can be a sequence of actions and effective decisions [23]. Company safety policies and safety management systems following relevant legislation can positively affect construction safety performance [22], [27], [28]. The research found that the reduction of accidents would be accomplished when top management takes a dynamic approach with concern and through the dedication of safety and health improvement as well as maintaining good safety and health policy [27].
ii) Safety rules - Construction worker's safety attitudes are influenced by their understanding and realizing of risk, management, safety rules and the working procedure [29].
iii) Safety organization - Designers should take consideration of how the project components will be assembled and the way the construction task is undertaken. That is why designers must address the safety and health requirements into the design stage and before the commencement of the project [30]. In addition, when designers are aware of the consequences of the design decision it will improve safety performance. This could reduce the injuries and associated costs, and decrease redesign costs and operating costs for special procedures and protective equipment [31].
iv) Safety responsibility - According to Peyton & Rubio [32], safety responsibilities should be clearly defined as an effective safety program.
v) Selection of subcontractor - Toole et al. [33] argued that when it comes to safety responsibilities between engineers, general contractors and subcontractors there is no uniform agreement on-site safety responsibilities. Besides, to determine good company safety records the management accountability should consider the accidents along with productivity, quality and schedules of one's contractors company based on Stanford University.
vi) Safety induction & performance monitoring – Shannon et al. [25] in their study indicated that the provision of regular safety training was found to be a common feature of good safety performers [25]. Ng et al. [20] reviewed several literatures and found that safety trainings such as induction of new workers at the workplace and induction in safe working procedures are associated with good safety performance in construction companies (as noted in 25,32,33]. In addition, training and induction procedures were found to be haphazardly arranged and poorly organized in construction companies that were not performing as well as their counterparts [20].
vii) Safety audit – According to Shannon et al. [27], the completion of regular safety audits has generally been associated with construction companies that have lower injury rates and/or successful approaches to health and safety.
viii) Organizational safety policy review - effective safety program has outlined some of the basic elements which are periodic safety performance reviews must be undertaken (including accident statistics, report of injuries and results of safety inspections) [34], [35].
ix) Resources for training - Tsui & Gomez-Mejia [36], stated that one way to encourage employee safety is to involve all employees at various times in safety training. Merely sending safety memos is not enough but produce the newsletters, change the safety posters, continue to update bulletin boards and post the information in visible areas are recommended.
x) Organizational safety plan - The most factor affecting safety performance is an emergency or disaster of planning and preparation [37]. The emergency can be brought under control using the resources and procedures for the emergency response in place for the workplace [38].
xi) Legislation, codes & standards - In many countries, the procedure intended to prevent such accidents are usually mandated by the appropriate occupational safety authority [39]. For instance, Malaysia was prevailing regulations and legislation regarding safety and health at the workplace through OSHA of 1994. Many scholars and professionals within the construction industry identified that regulations and legislations by themselves are still not enough to bring about the desired goal to zero accidents and incidents on construction sites [3], [4].

From the above indicators, it could be seen that management commitment to safety induction and performance monitoring was the most cited factor that could affect the safety performance of construction projects. Safety induction was one of the important practices to be done by management because it prepared new employees and visitors' awareness about the hazards presented at the workplace, escape routes, emergency preparedness, etc. In this way, employees and visitors would be more careful and well-prepared, thus reducing injuries. Other than that, safety responsibility was also frequently cited in the literature as the safety performance factor for the construction project. Management commitment towards the safety responsibility of all personnel at the workplace could be enhanced through the implementation of safety culture at the workplace. Through promoting safety culture, everybody involved in the workplace would be more self-responsible towards the safety and health of themselves and others. This could further enhance safety performance at the workplace, particularly the construction site.

# 3. Methodology

## 3.1 Questionnaire Development and Procedure

This study involved collecting significant data for safety factors of construction projects among safety personnel who worked at construction sites in Kuala Lumpur. The data was collected through a questionnaire survey form which was done through the online platform (google survey) and self-administered. The participants were among project managers and safety personnel who were directly involved in the projects such as safety and health officer (SHO) and site safety supervisor (SSS). However, the outlook point by distributing the questionnaire to site representatives among engineers also needed to know their side views about safety. Due to time constraints, the questionnaire was distributed to only 100 selected respondents, and the number of the returned questionnaire was 56 (56% response rate).

The questions were closed-ended using a Likert scale to represent the respondent's degree of agreement about the factors. The questionnaire consisted of two parts: Part A was about respondent's background such as position, academic qualification and working experiences (in years); and Part B was the list of factors that affected the safety performance of construction projects pertinent to both projects and organization levels. In Part B, the respondents were required to rate the level of significance of the factors towards affecting the safety performance of construction projects, in the range of 1 (very insignificant) to 5 (very significant).

The questionnaire survey was validated by 5 panels of the expert who had more than 10 years of experience in the construction industry and currently in charge of safety. Several improvements have been made according to expert panels' suggestions before distributing the actual questionnaire to the respondents.

## 3.2 Measure for Data Analysis

The returned questionnaires were analyzed using Average Index (AI) analysis by using the following formula:

$$\mathrm{AI} = \frac{\sum(a_i.x_i)}{\sum x_i} \tag{1}$$

where $x_i$ = the number of respondents that agreeing with a choice; $a_i$ = score at i (Likert scale); and $i$ = 1, 2, 3, 4, 5. The results from AI were then categorized by adapting the AI range value proposed by Majid & McCaffer [40], based on the following range: $1.00 \leq \mathrm{AI} < 1.50$ (very insignificant); $1.50 \leq \mathrm{AI} < 2.50$ (insignificant); $2.50 \leq \mathrm{AI} < 3.50$ (slightly significant); $3.50 \leq \mathrm{AI} < 4.50$ (fairly significant); and $4.50 \leq \mathrm{AI} < 5.00$ (very significant).

# 4. Results and Discussions

## 4.1 Demographic of Respondents

Table 1 shows the background of respondents. Out of 56 returned questionnaires, most of the respondents were safety and health officers (55.36%), followed by site safety supervisors (23.2%) and safety managers (16.1%). Most of the respondents had work experiences between 6 to 10 years (48.21%), followed by 3-5 years (28.57%), while 19.64% of respondents had more than 10 years of working experience. From respondents' background analysis, it was believed that the information provided by them would be reliable because the respondents were among those who manage the construction at the site and half of the respondents had working experience in construction for more than 5 years. Their insights and opinions on the factors of safety performance indicators are essential in order to achieve the aim of the study.

**Table 1 - Background of respondents**

| Description | Number of respondents |
|---|---|
| *Job position* | |
| Safety and health officer (SHO) | 31 |
| Site safety supervisor (SSS) | 13 |
| Safety manager | 9 |
| Others (e.g. representing safety and health committee) | 3 |
| *Years of experience* | |
| Less than 3 years | 2 |
| Between 3 to 5 years | 16 |
| Between 6 to 10 years | 27 |
| More than 10 years | 11 |

## 4.2 Significant Factors of Safety Performance on Project Level

Table 1 presents the average index analysis of the significant safety performance factors of construction projects pertinent to the Project Level. It could be seen that all of the listed factors are categorized as fairly significant to very significant in affecting the safety performance of construction projects, where 7 out of the 9 factors are perceived as very significant. Safety training is perceived as the most significant factor, followed by the implementation of a safe working environment and implementation of safety officer and supervisor. The result is parallel with Abas et al. [22] study, in which safety training is the most cited factor that affects the safety performance of construction projects.

**Table 1 - Results of AI analysis and significance level of the factors (project level)**

| No. | Factors affecting safety performance on project level | Average index analysis | Significance level |
|---|---|---|---|
| 1 | Safety training | 4.66 | Very significant |
| 2 | Implementation of safe working environment | 4.59 | Very significant |
| 3 | Implementation of safety officer & supervisor | 4.59 | Very significant |
| 4 | Safety audit | 4.52 | Very significant |
| 5 | Implementation of safety inspection | 4.50 | Very significant |
| 6 | Implementation of plant & equipment | 4.50 | Very significant |
| 7 | Emergency plan & procedure | 4.50 | Very significant |
| 8 | Site safety policy review | 4.48 | Fairly significant |
| 9 | Implementation of safe system of work | 4.43 | Fairly significant |

Jaselskis et al. [41] proposed increased devoted time to safety training for the project safety representative etc. were essential on the project level stage. Despite raising awareness level on safety at the workplace, education and training can prevent the human error that may cause the accidents and to enable workers to perform a repetitive task with the needed skills [42]. Training helps to improve worker's skills and abilities to identify hazards, thus act as an effective tool to mitigate hazards [43].

The second most significant factor was the implementation of a safe working environment which is in agreement with Bakri et al.'s, [44] study, in which they highlighted that the most effective strategy to avoid the financial loss of the project was by providing a safe and healthy working environment. Meanwhile, the appointment of safety and health officer and safety supervisor can ensure a good safety performance of the project, which is in agreement with Hinze and Rabound [45] and Yung [29]. The appointment of full-time safety and health officers and project safety officers with the specific job site safety tours and inspections can be conducted to ensure better construction safety [29], [45].

Safety audits are also deemed significant to affect the safety performance of construction projects. Nikolaos [46] believed that safety audits such as safety inspections, an inspection of documents and interviews must be conducted on the construction project. Meanwhile, Kavianian & Wentz [47] agreed that conducting a comprehensive safety audit review of the company's safety program will determine the strength and weaknesses of a current safety program.

## 4.3 Significant Factors of Safety Performance on Organization Level

Table 2 presents the average index analysis of the factors affecting the safety performance of construction projects pertinent to the organizational level. Out of the twelve factors, ten factors were perceived as very significant, whereas the remaining factors were categorized as fairly significant. The factors reflected organization commitment; therefore, the results of the study have indicated respondents' agreement on organization commitment was significant to cultivate a positive OSH environment at the workplace, which was also postulated by Ng et al. [23].

**Table 2 - Results of AI analysis and significance level of the factors (organization level)**

| No. | Factors of safety performance on organization level | Average index analysis | Significance level |
|---|---|---|---|
| 1 | Safety rules | 4.68 | Very significant |
| 2 | Safety induction & performance monitoring | 4.61 | Very significant |
| 3 | Safety policy & Safety management system | 4.59 | Very significant |
| 4 | Safety organization | 4.59 | Very significant |
| 5 | Compliance with legislation, code and standards | 4.59 | Very significant |
| 6 | Safety audit and review | 4.57 | Very significant |
| 7 | Safety responsibility | 4.55 | Very significant |
| 8 | Resources for training | 4.55 | Very significant |
| 9 | Organizational safety policy review | 4.54 | Very significant |
| 10 | Organizational safety plan | 4.52 | Very significant |

| | | | |
|---|---|---|---|
| 11 | Safety and health training | 4.36 | Fairly significant |
| 12 | Selection of subcontractor | 4.34 | Fairly significant |

From Table 2, it could be seen that the safety rules factor is deemed as the most significant factor that affects the safety performance of construction projects, followed by safety policy and management system; safety organization; and compliance with legislation, code and standards. This is parallel with Teo et al.'s [28] findings that the reduction of the accident would be accomplished when top management takes dynamic attention and is dedicated to safety and health improvement as well as maintaining good safety rules and health policy [31] As stated earlier by Mohamed et al. [30], construction worker's safety attitudes were influenced by their understanding and realizing of risk, management, safety rules and the working procedure, which further could increase the safety performance of construction projects.

The next perceived very significant safety performance factor is the safety policy and safety management system. This finding supports the previous study by Ng et al. [23], Teo et al. [28], Yung [29], where they highlighted that the company's safety policies and management systems that were developed and implemented following relevant legislation, could positively affect the construction safety performance. Safety organization was also significant to affect construction safety performance through a sequence of actions and effective decisions taken by the organization [21].

The findings of this study indicate that compliance with legislation is also important to improve the safety performance of construction projects, but regulations and legislation alone are not enough to achieve the goal of zero accidents and incidents at construction sites [3], [4]. In Malaysia, the government has enacted the legislation related to OSH such as Occupational Safety and Health Act (OSHA) 1994 and Factory and Machinery Act (FMA) 1967, but the number of accident and fatalities are still high. Therefore, this study proposes that compliance of OSH legislation should be done concurrently with performing other measures to increase safety performance.

## 5. Conclusions

This study investigated the safety personnel's perceptions of the significant factors that affect the safety performance of construction projects pertinent to the project and organizational levels. The results from Average Index analysis yielded that respondents perceived all the factors listed as significant to affect the safety performance of construction projects. The most significant safety performance factor pertinent to the project level is training, whilst the development and implementation of safety rules are perceived as the most significant safety performance factor pertinent to the organizational level. It is hoped that the findings of this study can provide awareness to construction stakeholders on the factors that impact the safety performance of construction projects.

The researchers offer some recommendations for enhancing the safety performance of construction projects. First, the employer should effectively plan and conduct regular training because it can increase the level of awareness of workers about safety and improve the worker's skills. In addition, the organization must ensure that new employees are given a safety induction and training program. Other than that, the contractor should also obey safety legislations with full commitments. The client also can play an important role in selecting the contractor with good safety performance history, rather than selecting them based on the lowest bidder in terms of cost aspect. Besides, the client must ensure that the contractors know their responsibility to perform greatly in safety, for example appointing safety and health officer to ensure safety and health at the construction site. The contractor can also implement safety rewards or other types of behavior-based safety programs to enhance the safety culture in the workplace. It is also proposed for contractors to conduct risk assessment and analysis before commencing construction project to predict the hazard and risk involved so that relevant control measures can be planned and executed.

For future research, it is recommended that the number of respondents to be increased to at least 300 respondents so that the results will represent the population. The respondents also could be extended to other individuals with different job positions such as engineers, project managers, etc. Lastly, it is recommended that the study is extended to other states in Malaysia.

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