Investigating the safety cognition of construction personnel based on safety education

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Abstract. Competency in safety is important for construction personnel and it is compulsory for all construction personnel in Malaysia to attend safety training/courses. A literature review of the recommended safety module revealed gaps in evaluating the effectiveness of safety cognition among construction personnel. Therefore, this paper investigates the safety cognition based on safety education. A structured, self-administered questionnaire was designed and used to assess the level of safety cognition in safety education. The results show the safety cognition of construction personnel is still at a moderate level and there is a difference level of safety cognition among construction personnel on Occupational Safety module.

1. Introduction
Safety in construction sites is of utmost importance which makes it fundamental to distinguish the competency level, training and knowledge among Malaysian’s construction personnel. This is necessary because incompetency and inadequacy in these areas among construction personnel may increase the risk factors in the occurrences of accidents, incidents, injuries, fatalities and loss of properties on construction sites [1-4]. It is worthy to mention that there are a total of 763 cases of construction accidents filed in Malaysia between 2007 to 2012 and 422 or a concerning 55% of the number involved fatality accidents as recorded by the Department of Occupational Safety and Health Malaysia, Ministry of Human Resources [5]. Therefore, this whopping figure further fortifies the requirement for construction personnel to have adequate safety cognition in construction safety. Safety cognition and the level position of construction personnel are interrelated behavioural displays which affect any form of incidents in construction. Realizing the importance of safety in the construction industry, the National Institute of Occupational Safety and Health (NIOSH) conducts safety education to deliver the necessary knowledge of construction personnel. Upon getting the necessary safety education, construction personnel are expected to have more in-depth knowledge on safety which should be demonstrated in their daily practices at work. This in turn should improve their abilities to identify any possible risks and hazards connected to the workplace.

The sample of the study consisted of 150 construction personnel at various positions such as the Site Safety Supervisor, Safety Health Officer and Safety Health Manager who had participated in...
safety education. The study uses Snowball-sampling to obtain representative samples. In order to obtain a comprehensive set of data, this study uses quantitative approaches. This method includes surveys with two sets of questionnaires that are self-designed by researchers in the form of an objective questionnaire closed-ended questions with 3 multiple choice options.

1.1. Safety Education for Construction Personnel
Implementing safety education among construction personnel is an important element in promoting a safe working environment. Safety training and education are two important topics in general construction safety. Safety education is a learning process through which construction personnel acquire knowledge, information, cognitive capacities and the transfer of norms, values and modes of behavior. While safety training is a technique for developing human resources through the enhancement of the skills of workers and their ability to cope with workplace hazards. The significant index scores of construction safety risk factors in Australia and China found that “low levels of safety education/training” was the biggest differences scores at 0.22 with the China (0.46) and Australia (0.24) in general terms is a high risks for construction site workers [6]. Construction workers usually rely on the safety cognition of construction personnel to deliver the safety expertise he has learned in safety education. [7] in his study found that education was an essential element for those who hold positions in safety as they were able to create a healthy and safe environment in keeping with the safety knowledge and skills it received. It is without doubt that construction personnel need to have all the necessary knowledge for effective safety practices while getting the required and continuous safety education.

The execution of a safety modules in safety education was developed for construction personnel to foster a safety culture at construction site. The safety modules contain 4 major modules which comprises of OSH Management, OSH Legislation, Occupational Safety and Occupational Health. OSH Management module in which participants are required to acquire an understanding of the application of OSH management system while OSH Legislation module provides specific legal requirements on major considerations of construction safety and health. However, Occupational Health and Industrial Hygiene module, specifically aims for participants to control an environmental factors in the workplace that may cause sickness, impaired health or discomfort will affect to the workers. Meanwhile the Occupational Safety module is to create a safer workplace by providing workers with the knowledge and tools to enable them to realise the fortunes and to exercise safely. By attending this safety education, construction personnel will become a competent person. Therefore, this study aims to investigate the safety cognition of construction personnel based on safety education.

2. Methodology

2.1. Selection of construction personnel
The study uses snowball-sampling to obtain representative samples which involved 150 construction personnel. The participants are Safety Health Officer, Safety Health Managers and Site Safety Supervisors who are of technical background with extensive working experience in construction and are equipped with safety knowledge.

2.2. Questionnaire
A questionnaire-based survey was carried out in this study comprising of 3 major parts. These parts include the following: Part 1 requires the participants to provide their demographic information; Part 2 evaluate the safety cognition of participants towards construction accident; and Part 3 attempts to collect information on the safety cognition of participants in minimising construction accident.

The questions for Part 2 and Part 3 were developed based on a multiple questions because it is the most common and widely used assessment tool for the measurement of knowledge, ability and complex learning outcomes [8,9] and extensively used [10]. Safety modules provided by NIOSH were used as a reference to develop the multiple choice questions. The questionnaire contained 50 close
ended questions which include 4 major modules namely OSH Management, OSH Legislation, Occupational Health and Occupational Safety.

Part 2 involves some theory questions to seek the safety cognition of construction personnel towards construction accidents through 14 close-ended questions with two possible answers ‘true’ and ‘false’. For each right answer, one (1) point was awarded. Part 3 attempts to assess the level of safety cognition among the construction personnel through 36 close-ended questions regarding practical work in minimising construction accident. The construction personnel will also be required to organize their answers in the order of their preferences and their scores will be dictated by the preference that they have assigned in their answers. The setting of the individual’s acceptance level is referred to response criterion. The correct acceptance is referred to as a hit and will be analysed.

3. Analysis of data
The knowledge score for each participant in Part 2 and Part 3 were calculated by dividing the sum of correct answers by the total number of correct responses. Mean score was used to know the level of safety cognition among construction personnel on the content of safety modules. The Kruskal-Wallis test is a non-parametric test that compares three or more unpaired group and do not require data to be distributed normally. Because of that, to identify safety cognition gaps, Kruskal-Wallis was used to compare the percentage of correct replies to each question across the three types of construction personnel. Values with p < 0.05 were considered statistically significant.

4. Results
4.1. Sample characteristics
150 construction personnel participated in this study which comprising of 21% were Site Safety Supervisor, 69% Safety Health Officer, and 10% were Safety Health Manager. This figure is made up of 85% male and 15% female participants respectively. A majority of 50% participants were 26-35 years old while those between the ages of 36 to 45 years old were 23%, 16% of the participants were above 45 years old and 11% of the participants were below 25 years old. It is worthy to note that 60% of the participants had less than 5 years of work experience, with 31% of them had between six to fifteen years of work experience, and 9% had between sixteen to twenty five years of work experience. It is also worthy to note that majority of participants had attending the safety education from National Institute of Occupational Safety and Health (NIOSH) (68%), 5% of the participants from RANACO Education & Training Institute(RANACO), with 11% of them from Industrial Skills Enhancement Programme(INSEP), 4% from KLIA Training & Research Centre and 12% participant were from Melaka Industrial Skills Development and Entrepreneurship Centre(MISDEC).

4.2. Knowledge score within different construction personnel
Table 1 shows the descriptive statistics of the safety modules show the average competence level of safety cognition among construction personnel were at a moderate level of not exceeding mean score 3.66. The data analysis also showed that the highest average score was Occupational Safety module (mean = 3.49) and lowest score was Occupational Health module (mean = 2.72). While for the sub topic, the general area fencing (mean = 4.91) has the highest mean score followed by the indoor air quality (mean = 1.34) with the lowest mean score. The mean score between 1.00 and 2.33 shows the score for the variable sub-component or the variable's dimension is low, while for the mean score between 2.34 and 3.66, the mean score of the variable sub-component or the variable dimension is researched at the medium and the mean score of 3.67 to 5.00 shows a high mean score for the variable sub-component or the variable dimension studied.
Table 1. Descriptive statistics on the main topics and sub topics of the safety modules for construction personnel.

| Modules                                      | Mean Score | Competency Level |
|----------------------------------------------|------------|------------------|
| OSH Management                               | 3.07       |                  |
| Incident prevention                          | 2.43       | Moderate         |
| Risk Assessment                              | 4.22       | High             |
| Emergency response preparedness & recovering planning | 1.43       | Low              |
| Incident investigation and corrective action  | 3.43       | Moderate         |
| Auditing                                     | 4.63       | High             |
| Management Review                            | 2.28       | Low              |
| OSH Legislation                              | 2.80       |                  |
| Introduction to OSH Legislation              | 2.63       | Moderate         |
| OSH Act and its Regulations (DOSH)           | 3.67       | High             |
| Regulations on Health in the FMA 1967        | 1.44       | Low              |
| Regulations on Safety in the FMA 1967        | 4.12       | High             |
| Employment Act 1955 and SOCSO Act 1969       | 3.27       | Moderate         |
| Introduction & overview of other related, legislation & codes | 1.65   | Low              |
| Occupational Health                         | 2.72       |                  |
| Overview of occupational health              | 2.78       | Moderate         |
| Basic principles of industrial hygiene       | 2.57       | Moderate         |
| Classification of chemicals, packaging & labelling | 2.09       | Low              |
| Chemical hazard management                   | 4.10       | High             |
| Ventilation                                  | 2.53       | Moderate         |
| Indoor air quality                           | 1.34       | Low              |
| Mental workload & shift work                 | 3.66       | Moderate         |
| Occupational Safety                         | 3.49       |                  |
| Housekeeping and physical arrangement        | 1.88       | Low              |
| Machinery hazard                             | 4.44       | High             |
| Safe guarding of machinery                   | 4.07       | High             |
| Safe machine operation                       | 4.88       | High             |
| Safe of hand tools and portable power tools  | 4.12       | High             |
| Maintenance of machine guard & tools         | 4.61       | High             |
| General area fencing                         | 4.91       | High             |
| Transport safety                             | 2.55       | Moderate         |
| Manual handling                              | 4.87       | High             |
| Mechanical handling                          | 4.57       | High             |
| Pressurised equipment                        | 1.38       | Low              |
| Construction safety                          | 2.82       | Moderate         |
| Fire safety                                  | 2.15       | Low              |
| Office safety                                | 2.31       | Low              |
| Confined space                               | 2.82       | Moderate         |

4.3. Identifying knowledge gaps

In order to test the difference in safety cognition among construction personnel on the content of the safety modules, Kruskal-Wallis test analysis has also been used. The value of $p < 0.05$ is set as the confidence level in determining the likelihood of differences in safety cognition among construction personnel.
Kruskal-Wallis test analysis in Table 2 shows the total difference level in safety cognition among construction personnel based on safety modules. The findings showed that there was no significant difference level in safety cognition among construction personnel against safety modules, \( p > 0.05 \) with \( p = .175 \). Analysis data discussions are as follows: -

4.3.1. OSH management. Kruskal Wallis test analysis for OSH Management Module shows that there is no significant difference level in safety cognition among the construction personnel for OSH Management module. It can be seen through the value of Kruskal Wallis statistical test (Chi-Square) is .28 with a significant level at .868 \( (p > 0.05) \). Higher mean score was obtained from Site Safety Supervisor's knowledge of 77.44 compared with two other positions namely Safety Health Officer and Safety Health Manager which recorded their mean score was 75.68 and 70.27.

4.3.2. OSH legislation. Results obtained in identifying safety cognition gaps among construction personnel have generally revealed that there is no significant difference level for the OSH Legislation module. It can be seen through the value of Kruskal Wallis statistical test (Chi-Square) is 5.40 with a significant level at .067 \( (p > 0.05) \). Meanwhile, safety cognition of Site Supervisor recorded a higher mean score of 89.35 compared with two other positions namely Safety Health Officer and Safety Health Manager which recorded their mean score of 70.14 and 84.03.

4.3.3. Occupational health. Safety cognition of Site Safety Supervisor stated a higher mean score of 78.35 while Safety Health Officer and Safety Health Manager which recorded their mean score was 75.75 and 67.83. The Kruskal-Wallis analysis test against the Occupational Health module shows the value of Kruskal-Wallis statistical test (Chi-Square) is .610 with a significant level at .737 \( (p > 0.05) \). This result means that there is no significant difference level in safety cognition among construction personnel.

4.3.4. Occupational safety. Safety Health Officer recorded a higher mean score of 80.16 compared with Site Safety Supervisor of 71.77 and Safety Health Manager of 50.90. However, the data found in the analysis of Occupational Safety module shows that there is a significant difference level in safety cognition among construction personnel. It was identified that the value of Kruskal-Wallis statistical test (Chi-Square) is 6.26 with a significant level at .044 \( (p < 0.05) \).

| Table 2. The difference in the safety cognition among construction personnel based on safety modules. |
|---------------------------------|-----------------|-----|-----------------|-----|-----|-----|-----|
| Modules                        | Position        | N   | Mean Rank | Value of Kruskal-Wallis | df  | p   | Total Mean |
| OSH Management                 | Site Safety Supervisor | 31  | 77.44     | .28            | 2   | .868 |            |
|                                | Safety Health Officer    | 104 | 75.68     |                |     |     |            |
|                                | Safety Health Manager   | 15  | 70.27     |                |     |     |            |
| OSH Legislation                | Site Safety Supervisor | 31  | 89.35     | 5.40           | 2   | .067 |            |
|                                | Safety Health Officer    | 104 | 70.14     |                |     |     |            |
|                                | Safety Health Manager   | 15  | 84.03     |                |     |     |            |
| Occupational Safety           | Site Safety Supervisor | 31  | 78.35     | .610           | 2   | .737 |            |
|                                | Safety Health Officer    | 104 | 75.75     |                |     |     |            |
|                                | Safety Health Manager   | 15  | 67.83     |                |     |     |            |
| Occupational Health           | Site Safety Supervisor | 31  | 71.77     | 6.26           | 2   | .044 |            |
|                                | Safety Health Officer    | 104 | 80.16     |                |     |     |            |
|                                | Safety Health Manager   | 15  | 50.90     |                |     |     |            |

Notes: Significant at \( p < 0.05 \) is set as a difference level in safety cognition.
5. Discussion
This survey provides significantly important information regarding the safety cognition of construction personnel in the construction industry holding different portfolios such as Site Safety Supervisor, Safety Health Officer and Safety Health Manager based on safety education. It is generally assumed that by acquiring safety knowledge, construction personnel can enhance their skills and gain more positive attitude while increasing their safety cognition level in performing their jobs. Construction personnel with high cognitive efficiency can support employees in yielding high quantity of work by appropriately addressing safety related issues.

The descriptive statistics used in this study are aimed to know the level of safety cognition among construction personnel through mean score. Results gathered on the responses among construction personnel showed that many of the construction personnel who participated in the study have moderate knowledge of employees’ safety. They need to go through the refreshing safety courses to ensure that their knowledge in dealing with safety at the construction site can be effectively addressed. The results of this study are in line with the study conducted by [11,12] which found that the safety cognition of construction personnel in terms of awareness and behavior is still moderate.

The inference statistics used in this study are aimed to investigate the safety cognition based on safety education among construction personnel through Kruskal-Wallis test. If significant value is less than 0.05, it means construction personnel have a difference level in safety cognition with the content of safety modules. Occupational Safety modules showed a difference in safety cognition among construction personnel on Occupational Safety modules $p < 0.05$. The results of this study are not consistent with the findings of the study by [12] found that the level of safety cognition among construction personnel in Occupational Safety such as reporting unsafe situations in the workplace without doing any action is at a moderate high (mean = 3.96), ensuring competent workers are eligible to perform work (mean = 4.15), perform work according to a safe procedure (mean = 4.02) and able to identify hazard at work (mean = 3.92).

Meanwhile results gathered on the responses from identifying the level safety cognition gaps in OSH Management, OSH Legislation and Occupational Health found that mean score of Site Safety Supervisor knowledge level was high. This demonstrates that Site Safety Supervisor plays the most important role in safety at the site. Hence they need to have a good level of safety cognition. This coincides with a study by [13] found that Site Safety Supervisors are more likely to have a significant impact upon safety, compared to top Managers and Safety Managers.

6. Conclusion
This study concludes that the safety cognition of construction personnel based on safety education are at moderate level. However there is a difference in safety cognition among construction personnel on Occupational Safety module. The results are contradicting to the literature, that the safety cognition of construction personnel are at moderate high in practice safety measures.

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