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An Investigation on The Cause of Incidents Related to Scaffolding for Industrial Structure at Construction Company Located in Johor

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Abstract: Scaffolding can be considered as one of the main contributions of accident in construction area. This research has been conducted to determine the causes of incidents involving scaffolding erection at construction company located in Johor. The objective for this study was to investigate the causes of incidents involving scaffolding erection at construction sites, to measure the level of knowledge, attitude and practice by using scaffolding awareness among workers that were working at construction sites and the last objective was to propose control measure on several steps of improvement in complying with scaffolding erection at construction sites. In order to investigate the causes of incidents involving scaffolding at construction site, the data collected by referring project monthly report that focused on non-compliance and findings involving scaffolding at construction sites. In addition, to measure level of knowledge, attitude and practice, a survey questionnaire was constructed and total of 52 respondents were collected. It was found that level of knowledge, attitude and practice of employers and employees involving scaffolding awareness were high. Furthermore, to check either this knowledge, attitude and practice have a good relationship between scaffolding awareness, a hypothesis testing was conducted to determine whether a statistical association exists between two variables. It was figure out that there is significant correlation of knowledge and practices toward scaffolding awareness. Based on the result, some control measure on several steps of improvement in complying with scaffolding erection was proposed. This study could become the reference model for future investigation on the scaffolding activity at construction site or even other industries.

Keywords: Scaffolding, Incidents, Knowledge, Attitude and Practice (KAP)

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1. Introduction

Construction sites have a reputation for being accident-prone locations. As a result, there were numerous types of incidents that result in fatalities at building sites. There were two main factors that could lead to accidents at construction site. Among the factors were unsafe condition or unsafe acts. An unsafe condition refers to a situation at a construction site that could bring harm to the employees until it could cause an accident. While for unsafe acts, it refers to individual's actions that could be dangerous while at the construction site. Assessment of an accident at the construction site should take into account these two factors because they were interconnected with each other.

Scaffolding accidents occurred every year on construction sites in Malaysia, and most of these accidents result in fatalities or end with severe injury. According to the Department of Occupational Safety and Health (DOSH) declared that between 2012 and 2020, 22 scaffolding related fatalities were reported.

Scaffolding was a temporary structure or platform constructed for the purpose of support, loading, access, protection and storage reaching heights above arms' reach for the purpose of building construction, maintenance or repair. (Piping, 2008) Scaffolds were erected in accordance with the conditions of the structure and the condition of the area. For places which were not very high and the type of work was light, the types of scaffolds commonly used will be either trestle scaffold or ladder scaffold in the absence of the steel frame scaffold. As for more heavy duty works, the types of scaffolds used would be of different material such as aluminium, steel pipes and modular steel frame type.

Scaffolding allowed workers to do their job at elevated heights but if not properly erected and trained, those who work on scaffolding system are at risk for falls or falling which could cause serious or even fatal injuries. (Occupational Safety Training , 2019)

Based on fatality accident recorded by DOSH, the most common cause of accident was due to scaffold installation was not according to specification by professional engineer (PE), unsafe scaffold used and no safe working procedure and method statement with regards to the supervision of construction and stability support. All of these accident lead to fatality. (Department of Occupational Safety and Health, Modified date: 2022)

In addition, according to the incident and accident report at construction company located in Johor, it was an accident happened involving the scaffolding structure was collapsed. The accident was also linked to the non-compliance of scaffolding erection at site since scaffolding activity was the second highest after housekeeping which means that scaffolding erection always not complied with standard requirement at site.

1.1 Types of scaffolding

In the construction industry many types of scaffolds were erected in accordance with the needs of a specific activity. The common types of scaffolds were prefabricated scaffolds, tube and coupler scaffolds. For prefabricated scaffolds, it often divided into the three categories which were modular systems that consist of individual standard, ledgers, transoms, braces and other members.

Other than that, frame systems were also type of scaffolds, that consisted of fabricated walk-through frame units that usually incorporating a pair of standards and transom that was connected longitudinally with other members such as scissor braces. Last for prefabricated scaffold was tower frame systems that was incorporating fabricated frame units for use in single bay tower scaffolds. For tube and coupler scaffold, it was a scaffold of which the standards ledgers, braces and ties are circular tubes that were joined together by means of purpose designed couplers. (Occupational Safety and Health Administration, 2002 (Revised))

2. Materials and Methods

This study was conducted with a series of actions that must be followed in order to complete, achieved the research objectives and conduct the research effectively.

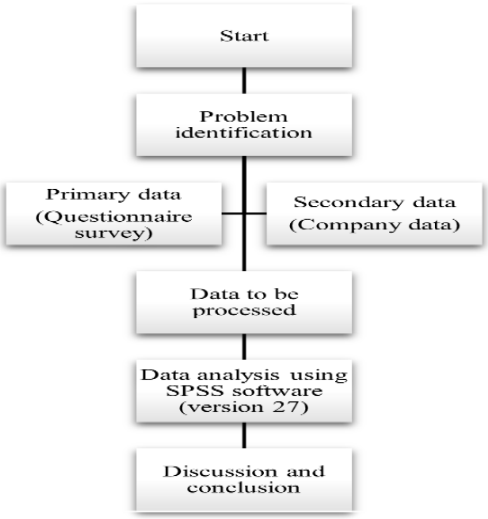

Figure 1: Flowchart of methodology

2.1 Data collection

There were two types of data collection which were primary data and secondary data. The primary data involves was a quantitative method. Quantitative method was being applied in this study which distributing the questionnaire survey to workers that were working at construction sites. The outcome for this questionnaire survey was able to know the level of scaffolding awareness through knowledge, attitude and practice and got to propose control measure on several steps of improvement in complying scaffold erection at construction sites.

The questionnaire consisted of three section which were section A, B and C. Section A was demographic background. This section was to collect information of the respondent's background. General information on participants was collected to make sure a fair representation of the respondents. Section B was level of knowledge, attitude and practice of workers about scaffolding awareness. This section was mainly to measure the knowledge, attitude and practice of the different position which include project team, safety team and general worker about the scaffolding awareness at site. Section C was control measure for the improvement of scaffolding activity at construction sites. This section was mainly to examine the idea of control measure from respondents to make an improvement of scaffolding at site.

For section B, the questionnaire was based on the Likert Scale, where respondents could make a choice for each question to answered from scale of one (1) up to the scale of five (5).

Table 1: Ranking score in Likert Scale

Scale	Description
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

Data collection which covers online and offline questionnaire were used. Online questionnaire was used as a fast and easy approach to be used by respondents. In addition, respondents might easily answer the questionnaire survey at any time either on smart phone, computer or laptop. However, the use of an online questionnaire also had some disadvantages. Among the disadvantages were general workers did not answer the questionnaire given because they did not know on how to answer the google form and click the link given. So, the offline data collection was also used to make sure the general workers participate for answering the questionnaire survey.

For secondary data, the researcher referred to the project monthly report from construction company. It was focus on health, safety and environment (HSE) non-compliance report involving scaffolding at construction company located in Johor. The outcome of this secondary data was able to know the causes of non-compliances or findings involving scaffolding at construction sites.

2.2 Data analysis

All the data received was analyze by using Statistical Package for Social Science (SPSS) software version 27. Analysis of the data comprises or 3 parts:

1. Demography
   The data comprising the demographic information of the respondents was analyzed using descriptive statistics and presented using frequency distribution and percentages.
2. Level of knowledge, attitude and practice of scaffolding awareness
   In order to interpret the level of knowledge, attitude and practice of scaffolding awareness among the respondents, a 3-level scale based on the mean score was used.

Table 2: The mean score

Range	Level
3.67 – 5.00	High (H)
2.33 – 3.66	Moderate (M)
1.00 – 2.32	Low (L)

3. Proposed control measure on several steps of improvement in complying scaffold erection at construction sites.
   To improve the scaffolding erection at construction sites, the researcher distributed the questionnaire survey about control measure that must be propose on several steps of improvement in complying scaffolding erection at construction sites.

3. Results and Discussion

3.1 Incident analysis

According to the figure 2 below, the graph shows the pareto analysis with 80/20 rules principle. The 80/20 rule showed that roughly the 80% of the effects come from the 20% of the cause. Thus, there were four causes need to be focused on to have greatest potential of improvements in terms of incident reduction are insufficient material for scaffolding erection, scaffolding erected was not according to the standard requirements, scaffolding without safe access and egress and scaffolding without safe working platform.

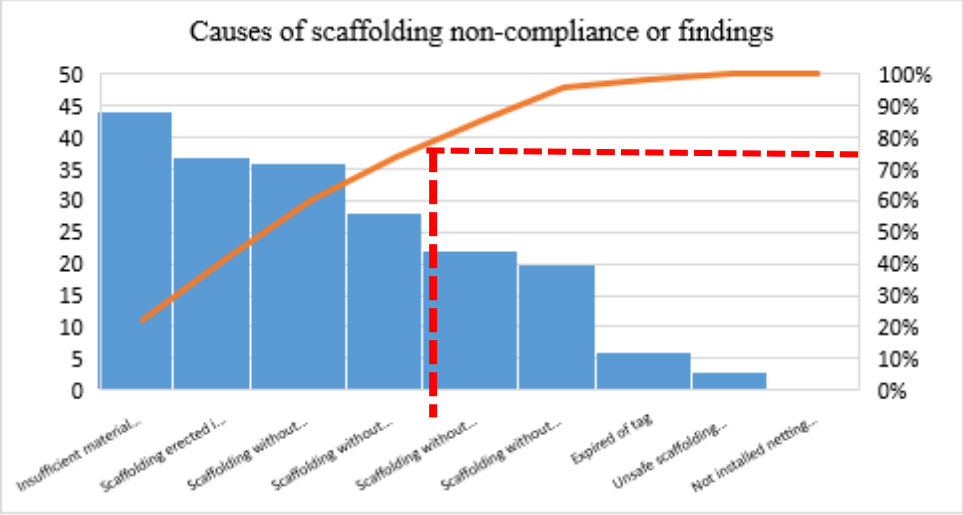

Figure 2: Causes of scaffolding non-compliance and findings

3.2 Demography

Table 3 below displayed the frequency and percentage distribution of respondents by characteristic which were age, position, education level and working experience using scaffolding. The demographic analysis by respondents' age displayed that, majority of the respondents' age were between 19 to 29 years old with percentage of 48.1 percent. Second highest of the respondents' age was between 30 to 39 years old with 28.8 percent and then followed by the age of 40 to 49 years old with 21.2 percent.

In addition, the demographic analysis by respondents' position showed that, majority of the respondents were general workers with 38.5 percent, which also means that 20 general workers were participates for answering this questionnaire survey. The second highest was others position with 17.3 percent and then followed by the position of project or site engineer with 13.5 percent. In addition, for respondents' position of safety and health officer, the percentage was 11.5 percent and then followed by site safety supervisor with 9.6 percent. The respondents' position of site supervisor was 7.7 percent and the lowest ratio of the representative was scaffolder supervisor with 1.9 percent since there was only one scaffolder supervisor for this construction project located in Johor.

The highest education level based on table 3, majority of the respondents have others of education level with 42.3 percent since there were general workers that participates in the survey. Second highest was diploma holder with 23.1 percent and then followed by degree holder with 21.2 percent. Besides, for education level of certificate, there was 5.8 percent of representatives, which means 3 persons that have certificate and then the lowest ratio of the representatives were SPM or STPM with 3.8 percent (2 persons) same goes to Master holder which also means that only 2 persons that have Master holder for their education level.

One of the most valuable parts of this demographic analysis was the working experience of the representatives when using scaffolding at the construction site. It would seem, the most of the representatives had working experience using scaffolding within less than 5 years. A total of 35 persons were categorized into that group. It was followed by representatives with a range of 6 to 10 years of working experience using scaffolding which were 21.2 percent, and representatives with an experience of more than 20 years was 5.8 percent. Besides, there was the least number of representatives that working experience within range of 11 to 15 years with 3.8 percent. This demographic indicated that this survey consisted of inexperienced until extensive experience of employers and employees at the construction site.

Table 3: Characteristic of respondents

Characteristic	Frequency	Percent (%)
Age		
19 – 29 years old	25	48.1
30 – 39 years old	15	28.8
40 – 49 years old	11	21.2
50 years old and above	1	1.9
Position		
Project or site engineer	7	13.5
Safety and health officer	6	11.5
Site safety supervisor	5	9.6
Scaffolder supervisor	1	1.9
Site supervisor	4	7.7
General worker	20	38.5
Others	9	17.3
Education level		
SPM/STPM	2	3.8
Certificate	3	5.8

Diploma	12	23.1
Degree	11	21.2
Master	2	3.8
Others	22	42.3
Working experience using scaffolding		
Less than 5 years	36	69.2
6 – 10 years	11	21.2
11 – 15 years	2	3.8
16 – 20 years	0	0
More than 20 years	3	5.8

3.3 Reliability analysis

Referring to table 4, the questionnaire developed was reliable and consistent because of the value of Cronbach's Alpha; 0.932 which was more than 0.90 and the level of reliability was very good. This indicated that the respondents understand the questionnaire survey and it was reliable to this study.

Table 4: Reliability analysis

Cronbach's Alpha	N of Items
0.932	15

Based on the above table, the reliability value for each variable was high which the value was within 0.90 to 1.0. As per displayed at table 5, the Cronbach's Alpha for each variable were 0.80 0 above and the level of reliability was good. This indicated that the respondents understand the questionnaire survey and it was reliable to this study.

Table 5: Reliability for each variable

Variables	Cronbach's Alpha	No. of item
Knowledge	0.865	5
Attitude	0.810	5
Practice	0.864	5

3.4 Level of knowledge, attitude and practice for scaffolding awareness among employers and employees at construction sites

Table 6 showed, the entire items of knowledge obtained high scores which showed that the respondents have a high level of knowledge for scaffolding awareness at construction sites. In detail, lots of respondents were exposed to the knowledge of scaffolding erection must be supervised by a competent scaffolder during an erection.

Table 6: Level of knowledge for scaffolding awareness

Knowledge	N	Mean value	Standard Deviation	Interpretation
Scaffolding must be erected according to the design and drawing by competent scaffolder or Professional Engineer	52	3.98	1.000	High
Scaffolding must be approved by a competent scaffolder before doing an erection	52	4.06	0.998	High

Scaffolding erection must be supervised by a competent scaffolder	52	4.13	1.030	High
Scaffolding must be inspected by a competent person after 7 days, after modifications are done and after bad weather	52	3.96	0.969	High
Scaffold cannot be installed, opened or modified if the worker does not have a scaffold competency certificate	52	3.94	1.056	High

Table 7 displayed the mean value and standard deviation for the item under attitude. It was clearly shown that the entire items of attitude obtain high scores which showed that the respondents have high level of attitude involving scaffolding awareness. In detailed, numerous of respondents have a great attitude when they followed the instruction and rules, that workers who worked on scaffold must be wearing body harness and hook at the anchor point.

Table 7: Level of attitude for scaffolding awareness

Attitude	N	Mean value	Standard Deviation	Interpretation
Nobody can work on scaffold during red tag inspection of scaffold	52	3.87	1.284	High
Do not alter the scaffold in any way that could affect the safety.	52	4.04	1.120	High
Worker who works on scaffold must wear body harness and hook at the anchor point	52	4.08	1.045	High
Make sure to stay on the platform while work is being done	52	3.98	1.057	High
Ensure cleanliness, free of obstruction on access, platform or stairs	52	4.02	1.213	High

Table 8 showed the mean value and standard deviation for the item under practice. It was clearly shown that the entire items of practice obtain high scores which showed that the respondents have high level of practice involving scaffolding awareness. In detailed, the respondents always practice to check scaffolding material and ensure there was no damage of the materials or components before erection.

Table 8: Level of practice for scaffolding awareness

Practice	N	Mean value	Standard Deviation	Interpretation
Working platform should be provided with guard rails and toe boards	52	3.92	1.202	High
Check scaffolding material and make sure there is no damage of the materials or components before erection	52	4.19	0.886	High
Heavy materials and loose materials must not be stored on the scaffold overnight.	52	3.96	1.066	High
Need to know the maximum load that the scaffolds can safely support before work	52	3.81	1.103	High

Install barricade and signage at the open area during scaffold erection and dismantle	52	4.15	0.916	High

4. Correlation analysis

A bivariate correlation analyze was conducted to determine whether a statistical association exists between two variables and the direction of the relationship. When the value of the correlation coefficient lied around ± 1, then it was stated to be a perfect degree of association between the two variables. As the correlation coefficient value goes towards 0, the relationship between the two variables would be weaker.

Since the research data was normally distributed was correlate with not normally data distributed, a spearman correlation coefficient was used. Spearman correlation refers to as spearman rank correlation or Spearman's rho. It was typically denoted either with Spearman's rho measure the strength of association between two variables. (Statistic Solutions, 2021) Table 9 below showed the Spearman's rho value for the level of correlation between two variables.

Table 9: Extent level of correlation

Spearman value (+ or -)	Interpretation of degree of correlation
0.00 – 019	Very weak
0.20 – 039	Weak
0.40 – 059	Moderate
0.60 – 0.79	Strong
0.80 – 1.00	Very strong

Table 10 depicted the results of the hypothesis test. There were only two hypotheses have a positive significant relationship and the hypotheses were accepted because the significance of tailed values were less than 0.05. Based on the results, hypotheses required by the researcher which were knowledge and practice have positive relationship with scaffolding awareness while the attitude hypotheses were rejected. As proven, that, only knowledge and practice were supported.

Table 10: Result of hypotheses testing

	Hypothesis	Correlation coefficient	Significance (2-tailed)	Hypothesis accepted or rejected
H_1	There is significant correlation of knowledge toward scaffolding awareness.	0.302	0.029	Hypothesis accepted
H_2	There is no significant correlation of attitude toward scaffolding awareness.	0.230	0.101	Hypothesis rejected
H_3	There is significant correlation of practices toward scaffolding awareness	0.310	0.025	Hypothesis accepted

5. Recommendation

Findings from this research could help the construction company to know in detailed about causes of non-compliances and findings involving scaffolding at construction sites. To avoid from an incident occurred involving scaffolding, the scaffolding inspector and safety, health officer need to be stricter in handling the scaffolding erection process in which, issue an alert or penalty towards the subcontractors for negligence when erecting the scaffolding at construction sites.

In addition, all of the data analysis about level of knowledge, attitude and practice has an important practical implication for the management to make an improvement on every aspect of scaffolding awareness between workers at construction sites. Level of knowledge, attitude and practice could be upgrade and level up when the management provide a good training, campaign. and competency courses involving the scaffolding process at sites.

To improve the scaffolding erection at construction sites, the highest control measure that the respondents choose was assigning designated scaffolding team for scaffolding erection, modification, dismantle, maintenance, lifeline distribution work and record. By assigning the designated scaffolding team, the scaffolding used at site could be control and managed by the scaffolding team only.

In addition, scaffolding drawing and calculation must be provided before erecting process to make sure the erecting process followed the standard requirement at site. When this company practiced as per mentioned in control measure, this company could ensure the erection and dismantling of scaffolding in a good and safest way.

Last but not least, the management team must provide sufficient scaffolding material for use at site to make sure there was no non-compliance or finding about insufficient material for scaffolding erection at site. Lastly, the respondents agreed to propose the control measure by giving suitable training for workers working on scaffolds, how to use and way to hook body harness when working at height.

5. Conclusion

In conclusion, this research study could be considered has been successfully conducted by the researcher and achieved the objectives of the research study. Through this finding of the study, it has clearly seen that non-compliances and findings involving scaffolding still high for this construction company and if employers and employees either from main contractor or subcontractor do not pay attention to this finding, it would lead to incident occur at the construction sites.

The findings of this study will provide a knowledge and awareness on the causes of incidents related to scaffolding for industrial structure at construction company located in Johor. The study participants were employers and employees that working at construction sites, so their perception was useful in determining the level of knowledge, attitude and practice of scaffolding awareness. Measuring the level of knowledge, attitude and practice were important before suggesting and carrying out preventive measures. Based on the findings, it was found that level of knowledge, attitude and practice of scaffolding awareness between workers were high and outstanding, so that they could identify and propose control measure on several steps of improvement in complying scaffolding erection at construction sites.

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References

[1] Department of Occupational Safety and Health. (Modified date: 2022, Modified date: June 16). *Fatal Accident Case*. Retrieved from Free Statistics of Official Website DOSH Ministry of Human Resources: http://www.dosh.gov.my/index.php/fatal-accident-case-1

[2] Occupational Safety and Health Administration. (2002 (Revised)). *Home | Occupational Safety and Health Administration*. Retrieved from A Guide to Scaffold Use in the Construction Industry: https://www.osha.gov/sites/default/files/publications/osha3150.pdf

[3] Occupational Safety Training . (2019, May 19). *Monthly Archive: May 2019*. Retrieved from Safety Matters Weekly: http://safetymattersweekly.com/2019/05/

[4] Piping, E. t. (2008). *Safety - What is a scaffold, scaffolding and scaffolding work?* Retrieved from Goal Zero: https://www.wermac.org/safety/safety_what_is_scaffolding.html

[5] Statistic Solutions. (2021, August 03). *Conduct and Interpret a Spearman Rank Correlation*. Retrieved from Directory od Statistical Analyses: https://www.statisticssolutions.com/free-resources/directory-of-statistical-analyses/spearman-rank-correlation/