Original Article

Risk Assessment and Roles of Stakeholders for Frame Scaffolding Procedures in Construction Projects

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ABSTRACT : *Scaffolding accidents occur every year on construction sites in Malaysia, and most of these accidents result in fatalities or end with severe injury. Department of Occupational Safety and Health (DOSH) declared that between 2012 and 2020, 13 scaffolding-related fatalities were reported, and 8 cases were caused by the lack of Safe Operating Procedure (SOP). This study aims to recommend an improved SOP that prevents the collapse of the scaffolding system based on the risk assessment on the failure of the scaffolding structure. This study applied a qualitative design by conducting semi-structured interviews with selected parties that their daily work routine relates to scaffolding works. The data were analyzed using ATLAS.ti to detect network failures and factors related to the causes of scaffolding collapse. The result showed that one of the hazards of scaffolding collapse is caused by unstable structures, which are associated with Organization, Technical, Human, and Environment factors. Based on the 14 hazards caused by unstable structures, ten hazards were identified in the category of non-compliance with SOP. Therefore, an improved SOP with an emphasis on compliance with all requirements is recommended ensuring the safety of all riggers, workers, and project team members. In addition, five checklists are recommended, which include two relevant additional procedures obtained during the data collection.*

Keywords - *Construction, Defect Component, Frame Scaffolding, Risk Assessment, Safe Operating Procedure*

1.0 INTRODUCTION

Cases of scaffolding accidents at construction sites in Malaysia are most often published in local newspapers and are searchable through online mediums (Hamdan, 2015). According to Bozena Hola et al. (2017), 43% of scaffold accidents resulted in fatal results, and 23% ended with severe injury. As reported in The Star Online on 10th March 2018, a foreign worker died caused by falling scaffolding at the Jinjang MRT Project site (Online, 2018). Two months before, on 10th January 2018, one worker was injured at the Kajang construction site due to scaffolding collapsing. (Malaymail, 2018). Department of Occupational

Safety and Health (DOSH) has declared that there were 13 fatal cases from the year 2012-2020 related to scaffolding, and 8 cases were due to the absence of Safe Operating Procedure (SOP) (DOSH, 2020a). Besides investigating fatality cases, DOSH also takes legal action against companies that violate the acts and requirements. There were 11 prosecution cases on scaffolding offenses recorded for 2014-2020, and 2 cases were fined due to the failure to provide the SOP. According to DOSH (2008), a hazard is defined as a source or situation with the potential to harm which may cause injury or ill health to humans, damage to properties, damage to the environment, or any combination of these. Hazards do appear during the operational works of scaffolding and identifying the potential hazards is important as effective control measures during the construction process could be implemented to prevent losses (Herda Balqis Ismail, 2012). The operational works of scaffolding during the construction phase can be divided into three stages. It starts with the erection stage, operation stage and end with the dismantle stage. As stated in Building Operations and Works of Engineering Construction (BOWEC) Regulations, Regulation 74 and Clause 5.4.3 (1) of Construction Industry Standard (CIS) (CIDB, 2017), any erection, modification, and maintenance of scaffolding shall be done by qualified or competent scaffolders with direct supervision from a competent designated person who engaged by the contractor.

1.1 Operational Hazards for Scaffolding

A few studies (Hamdan, 2015; Herda Balqis Ismail, 2012; Salim Mkubwa Salim, Fairuz I. Romli, Jailani Besar, & Aminian, 2017) have found that potential for a fall is the common hazard for scaffolding. According to the study done by Herda Balqis Ismail (2012), there are seven types of potential fall hazards. There is a risk of falling while erecting or dismantling a scaffold, depending on the environmental conditions, such as stepping on other tools, falls due to limited area, falls due to material handling and equipment, and falls due to unstable structure. The potential hazards of falling from a scaffold occur due to numerous functions and applications of scaffolding during the erection, operation, and dismantling.

In another study done by Kim et al. (2016), accidents related to scaffolding or staging account for a large number of the causes of safety hazards. The study states that in 2009, there were 54 fatalities of falling from scaffolds and making it one of the leading causes of fatalities and injury cases. In addition to falling, other types of hazards such as objects falling from scaffolds, electrocution, and spatial conflicts with construction activities are also caused by improper planning and use of scaffolds. This is supported by Shou et al. (2015), where fall and item dropping are the common hazards while working on a scaffold. Another study conducted by Hsiao (2008) found five major categories for the most common causes of falls, known as hazards related to the scaffold usage during its operation. They are: (1) Scaffold tipping or failure of the structure such as insufficient anchoring into the walls, improper assembly of the scaffold, unsecured bracing, loading beyond designed capacity, and failure under the stress of scaffold components, (2) breaking of planks, gapping, and slipping which caused by heavy loads, physical damage to the plank, misinformation about the type or rating of the plank, insufficient overhang of the bearers, unsecured planks, lateral movement of the planks and missing planks, (3) unguarded scaffold that contains a missing guardrail and insufficient cross bracing, (4) complicated access or transition to or from a scaffold, and(5) problems with scaffold erection and dismantling resulting from environmental conditions, scaffold unit weight, and handhold availability. It is shown that most of the studies listed above have found that falling is the most popular hazard during the operation of scaffolding works.

1.2 Factors of Scaffolding Collapsed

Several factors influence accidents in construction sites, and they vary from time to time, which is challenging to be identified. In some cases, the collapses were due to improper assembly, while some failed to support loads placed on it (Hamdan, 2015). According to Safe Operating Procedure (SOP), a proper erection must prevent collapse as the collapsed structure becomes hazardous. The falling objects may harm the people who work below the scaffolds. Lack of appropriate knowledge and skills of the responsible person who was assigned to look after the safety and health issue is the major cause identified (Norzalili Abu Bakar, 2008). Another study states that the main factors which contribute to scaffolding accidents are the lack of appropriate scaffold components, body movement while working on the scaffolding, inadequate capacities, and failure to comply with the usage of personal protective equipment (PPE) (Chi, Chang, & Ting, 2005; Hamdan, 2015; Herda Balqis

Ismail, 2012). For working at height, complying with PPE usage becomes very important as part of the Safe Operating Procedure (SOP). The study conducted by Hamdan (2015) concludes that scaffold accidents are categorized into four main elements: technical factors, environment, organization, and human. Technical aspects become the most common factors for scaffold accidents (Hamdan, 2015). It is supported by Anna Hola (2018), the most common technical factors in scaffolding accidents are the use of faulty components, uninformed modification of the structure, lack of barriers, and easily detectable structural errors. It is concluded that those technical factors are contradicted by SOP. The human element is in line with a study done by Soane (2016), as common reasons for collapses have been identified caused by human factors such as ignorance, lack of supervision and training, negligence, and corruption. Supervision during the work is part of the SOP required by Regulation 74 of BOWEC Regulations (DOSH, 2011). The environment factor is caused by weather, working surface, ground conditions, material handling, and falling objects. This is supported by Bozena Hola et al. (2017), where a strong wind gust causes the scaffolding structure's collapse. According to I. Szer (2018), the unfavorable environmental conditions that influence workers' behavior on scaffolding may also lead to untoward incidents.

Based on the operational hazards of the scaffold and the factors that cause the collapse of the scaffolding, this study was conducted to assess the risk of damage to the scaffold structure and propose improved Safe Operating Procedures (SOP) to prevent the collapse of the scaffold system.

2.0 METHOD

2.1 Data Collection

This study applied a qualitative design to explore risk assessments and stakeholder roles for frame scaffolding procedures in construction projects. A semi-structured interview was conducted with selected Project Managers, Safety Personnel, Scaffold Inspectors, Scaffold Riggers, and officers from the Department of Occupational Safety and Health Department (DOSH), whereby their daily work routine was related to the scaffolding works. This study involved 15 personnel with three project sites, as shown in Table 1, and Table 2 shows the questions sent to these five parties. As a result, operational hazards for scaffolding systems and factors that contribute to scaffolding collapse have been identified. In addition, a review of legal requirements, standards, guidelines, and a directive letter was issued to recommend an improved Safe Operating Procedure (SOP) to prevent the collapse of scaffolding. Those requirements such as Factory and Machinery Act (FMA) (BOWEC) Regulations, CIDB CIS 22:2017, and MS 1462 are mandatory requirements for scaffolding works in Malaysia. Other than that, guidelines and a directive letter from DOSH's Director-General serve as additional requirements for the scaffolding works.

Table 1 Informant Profile for Semi-Structured Interview

Organization/ Project Title	Informant	Designation / Role
Contractor of project: Cadangan Membina 120 Unit Rumah Teres 3 Tingkat	1	Project Manager
	2	Site Safety Supervisor
	3	Scaffold Inspector
	4	Scaffold Rigger
	5	Project Manager
	6	Site Safety Supervisor

Contractor of the project: Proposed Design and Build of Reinforced Concrete Open Sequential Batch Reactor (SBR) Sewerage Treatment Plant	7	Scaffold Inspector
	8	Scaffold Rigger
	9	Project Manager
Contractor of the project: Proposed Elevated Water Tank	10	Safety and Health Officer
	11	Scaffold Inspector
	12	Scaffold Rigger
DOSH Negeri Sembilan	13	Section Head of Construction Site Unit
DOSH Wilayah Persekutuan Kuala Lumpur & Putrajaya	14	Section Head of Construction Site Unit
	15	Officer of Investigation and Prosecution Unit

Table 2 Questions for Semi-Structured Interview

Personnel/ Party	Question
Project Manager	1) Why is scaffold SOP important?
	2) Who can erect, alter and dismantle the scaffold other than the scaffolder?
	3) How many times do incidents related to scaffolding occur during this project?
Safety and Health Officer/ Site Safety Supervisor	1) How many scaffolding incidents have been investigated?
	2) How do you ensure that the Scaffold Inspector is competent?
	3) How fast is the action taken after receiving any comments from the inspection?
Scaffold Inspector	1) Which legal requirements and standards do you refer to for scaffold works?
	2) What is your reference during the inspection?
	3) What are the most common issues when a scaffold is red-tagged?
Scaffold Rigger	1) What is your reference during erection, alteration, and dismantling works?
	2) What level of competency do you obtain from DOSH?
	3) How do you ensure that all materials used are in good condition?
DOSH Officer	1) Why did the scaffold accident keep occurring every year?
	2) What type of scaffold normally collapses or is involved in an accident?

3) How many scaffolders are currently registered with DOSH?

2.2 Data Analysis

ATLAS.ti is a tool used to visualize the connection for all findings gathered from interviews. The abbreviation ATLAS.ti stands for "Archiv für Technik, Lebenswelt und Alltagssprache" (Archive for Technology, the Life World and Everyday Language) and the extension "ti" stands for "text interpretation." (Susanne Friese, Jacks Soratto, & Pires, 2018). ATLAS.ti supports the researcher during the data analysis process, where texts are analyzed and interpreted using codes and annotations. This software also has a network-building feature, where it allows one to visually connect selected texts, memos, and codes using diagrams (Smit, 2002). Through ATLAS.ti, the researcher can perform process analysis at different study phases and validate the data collected through informant interviews to identify major and minor categories or themes. In addition, ATLAS.ti facilitates the code-recode method, which is a means to increase the credibility and reliability of the study (Mohamed Amin Embi, Chooi Kean Ang, & Yunus, 2016). Codes assist in organizing, structuring, and retrieving data, supporting the identification of a theme (Smit, 2002; Susanne Friese et al., 2018). After the coding process, the data are compared, and related events are grouped with the same conceptual label. The process of grouping the data is termed categorization. A phenomenon can represent a category, for example, a problem, an event, or an issue defined as important by the respondents or informants. It is related to its subcategories to form a more precise and wide-ranging explanation of the phenomena. Categories can also be found through relationships between where, how, when, why, and who (Smit, 2002). In general, capital letter codes such as ORGANIZATION, HUMAN, TECHNICAL, and ENVIRONMENT based on this research represent most categories whereby most are no longer coded. The idea is for the category label to be served as a title, and all data are distributed in the sub-codes of that category (Susanne Friese et al., 2018). The researcher can form network views among the codes and categories by using Network View and Family Manager functions. The files for each subject case can be saved as graphic files (Mohamed Amin Embi et al., 2016).

3.0 RESULTS

3.1 Network of Failure Factors by ATLAS.ti

Based on findings from the interview, there are 47 codes derived using the ATLAS. The software. All codes and categories are first recorded in the theme table. Four factors set as categories for the cause of scaffolding collapse are the organization, human, technical, and environment.

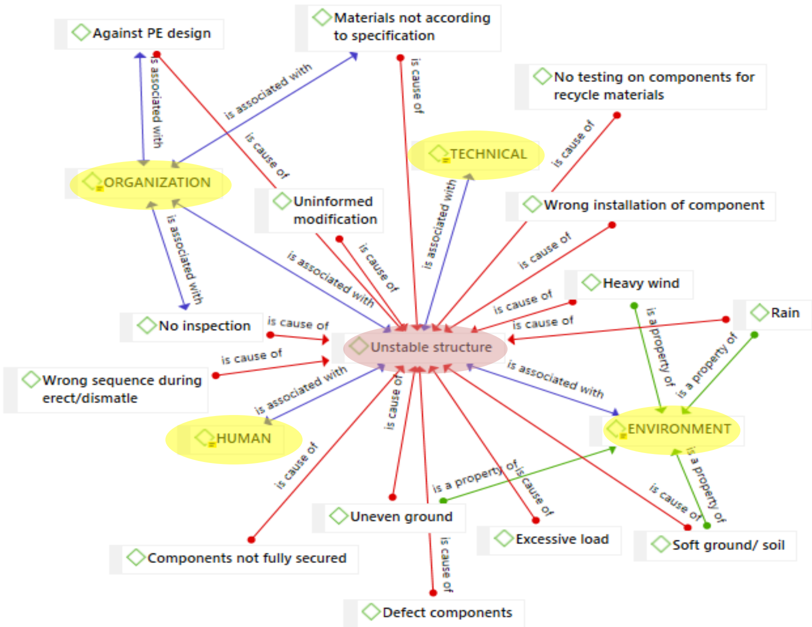

Figure 1 Failure Factors Which Associate with Unstable Structure

As shown in Fig. 1, four categories and factors are associated with unstable structure, while 14 codes or hazards cause unstable structure. Under environmental factors ' properties, there are four potential hazards: uneven ground, heavy winds, soft ground/soil, and rain. As for technical factors, the four potential hazards are failing to carry out a test for recycled components, non-sequential for the erection and dismantling process, installation of wrong components, and excessive load that causes unstable structure. Excessive load is attributed to organizational factors. It is due to less supervision and permits workers to carry out materials that exceed the permitted load. The other four hazards associated with organization factors are materials not according to specification, defect components, fails to carry out inspections, and against PE design. Other than appearing in the organization factor, against PE design is one of the hazards associated with human factors that cause the unstable structure. The other four hazards related to human factors are components not fully secured, the wrong sequence during erect or dismantle, incorrect component installation, and uninformed modification, which leads to an unstable structure.

3.1.1 Organization Factors

There are ten codes or hazards associated with organizational factors. The unstable structure is caused by the five hazards: against Professional Engineer (PE) design, excessive load, defective components, materials that do not meet specifications, and failure to perform the inspection. Against the PE design, which is also supported by several studies (Chi et al., 2005; Hamdan, 2015; Herda Balqis Ismail, 2012) caused by the urgency of works (Informant 5, 7) and the absence of PE during on-site installation, which sometimes the design does not apply to the site conditions (Informant 7, 11, 14). The unstable structure, which is caused by the excessive load (Informant 14) and defective components (Informant 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15) (Anna Hola, 2018; Hsiao, 2008) is due to less supervision during work. Less supervision that causes the collapse of scaffold structure is also found in several studies (Chi et al., 2005; Hamdan, 2015; Herda Balqis Ismail, 2012). In terms of technical factors, excessive load is caused by poor PE design due to the lack of scaffolding components installed (Informant

9). Materials that do not comply with specifications are using different sizes of components that do not fit each other (Informant 4, 10, 13) and using thinner components that do not comply with MS 1462. According to Informant 2, 6, 7, and 11, failure to inspect as required is also one of the causes of unstable structures (Błazik-Borowa & Szer, 2015; Hamdan, 2015; Hsiao, 2008; Soane, 2016). Another hazard related to organizational factors is inappropriate planning stated by Kim et al. in his study and violated the SOP and Regulation in another study (Amall Raihan Abdul Razak, 2017). In addition, incompetent scaffolders and workers' failure to comply with scaffolding rules are due to a lack of training, as mentioned in several studies. (Norzalili Abu Bakar, 2008; Soane, 2016).

3.1.2 Human Factor

Three codes or hazards are associated with human factors, while unstable structures cause five. Based on studies (Soane, 2016), corruption exists in scaffolding works, and it is associated with the human factor. Ignorance is another hazard that associated with human, and it happens due to low awareness of SOP compliance (Informant 3, 7, 9) and on the use of PPE (Informant 4, 7). Less awareness about PPE usage was also proven in several studies (Norzalili Abu Bakar, 2008; Soane, 2016). The unstable structure is also associated with human factors, where uninformed modification caused by humans is tremendously supported by 11 informants (Informant 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12) and in a few studies (Anna Hola, 2018; Błazik-Borowa & Szer, 2015; Hamdan, 2015). The other hazards that cause unstable structure are where components are not fully secured due to human negligence (Informant 1, 4, 10). This is supported by few studies (Hsiao, 2008; Soane, 2016). As admitted by Informant 3 in the study, against PE design is related to humans (Hsiao, 2008). As declared and supported in a study, falling objects are caused by human action (Shou et al., 2015).

3.1.3 Technical Factor

According to few studies, the technical factor contributes to the scaffolding accident during construction (Anna Hola, 2018; Hamdan, 2015). The unstable structure is the only code or hazard associated with technical factors. Operating work without SOP is part of the technical factor. Based on this study, two hazards that occur due to the absence of SOP is improper installation of the scaffold component (Informant 9, 15) and wrong sequence of erection and dismantling (Informant 1, 5, 6, 7, 9, 11, 14, 15) which lead to an unstable structure. Apart, the excessive load due to poor design by PE also caused an unstable structure whereby an accident occurs for this reason, as declared by informant 9. Besides, failure to conduct testing on the recycle component (Informant 11, 13) is also related to technical factors, leading to an unstable structure.

3.1.4 Environment Factor

There are three codes or hazards associated with environmental factors. Four of the hazards are rain (Informant 4, 5, 7, 8, 9, 11, 12, 13, 14, 15), soft ground or soil (Informant 1, 2, 3, 5, 8, 11), uneven ground (Informant 1, 3, 5, 8, 9, 10, 11, 13) and heavy winds (Informant 3, 8, 9, 10, 11, 14, 15). As described, environmental properties also cause unstable structures (Bozena Hola et al., 2017). According to Informant 1, 3, 4, 5, 11, and 13, working at height is associated with the environment, the main cause of falling from height is supported by several studies (Hamdan, 2015; Herda Balqis Ismail, 2012; Salim Mkubwa Salim et al., 2017). Slippery surfaces of rain and objects falling due to heavy winds are hazards reported by Informant 12. Poor housekeeping is also one of the hazards associated with the environment where it is found that components are scattered or hung up to others (Informant 13). In some situations, Hsiao stated in his study that the difficult access could be due to poor housekeeping.

4.0 DISCUSSION

From this study, the unstable structure was found as a hazard that led to a scaffolding accident. It relates to 15 hazards interrelated in four factors: Organization, Human, Technical, and Environment (Hamdan, 2015). One of the hazards that causes unstable structure is component defects. Based on this study, 93% of the informants (Anna Hola, 2018; Hsiao, 2008) supported by the research found that component defects are a common hazard of scaffold collapse. Defect components associated with the Organization factor are also one of the elements related to SOP compliance. Data (DOSH, 2020a, 2020b) showed fatality and prosecution cases related to SOP ignorance. The investigation outcome shows that some of the organizations were found operating their business totally without SOP while some were non-compliance with the developed SOP. It is strongly supported by DOSH officers, Informant 13, 14, and 15 during the interview session that scaffold accident is commonly due to violation of SOP and requirements. Therefore, all parties, especially those from the site, the project owner, the project management team, and the authorities, must develop a comprehensive SOP, implement the SOP at the best standard, and enforce the regulations related to the SOP for frame scaffold works.

4.1 Roles of Stakeholders

The project owner is generally known as the client in a project. The project owner refers to the person or group who provides financial resources for project delivery, approves project milestones and completion, is accountable for project investment, and obtains value from the operation of the facility delivered (J. Rodney Turner & ller, 2004). In the planning and design stage, the project owner is responsible for providing the design team with a site, project scope, and any required information needed to complete the project design. The project scope and requirements must be clearly communicated to the design team to ensure that the design meets the owner's goals, expected quality and is within the prescribed budget. Usually, the owner works closely with the design team to ensure that the desired design is achieved. To ensure the designers address safety aspects in their designs, the project owner must communicate with the designer during the design phase (Gambatese, 2000b). While, during the construction phase, the project owner's responsibilities are different from the planning and design phases. In the construction phase, the duties of the project owners included selecting qualified contractors, providing the necessary construction documents, coordinating the project team, and paying the contractor for the work completed. Conventionally, construction site safety has become the individual concern of contractors (Gambatese, 2000a) and the responsibility of safety personnel (Mohanad K. Buniya et al., 2020). Owners and other consultants did not play an active role in safety as to a great extent that there is no teamwork and cooperation in safety implementation. This makes the contractor's role become the primary employer in the job site and control the means and methods. (Gambatese, 2000a).

Conventionally, design professionals usually focus on the end user's safety for a product only and do not address the safety aspects in their project designs during the construction stage (Gambatese, 2000b). Although time flies, unfortunately, this culture continues to exist in several projects until now. The OSHA standard specifically includes requirements in which the services of professional engineers are mandatory for the analysis and design of temporary building structures such as scaffolding, shoring, and earth-retaining structures (T. Michael Toole, 2005). In Malaysia, the relevant laws and regulations may refer to the 1967 FMA, Article 28, and Article 75 of the BOWEC. During the interview, experiences were shared from informant nine, and an accident occurred in which the scaffolding collapsed due to the poor design by Professional Engineers. The design influences construction means and methods and directly affects the construction safety hazards that exist in the workplace. If designers are aware of the safety implications of their designs and pay attention to them, they can improve the inherent safety of construction projects. The designer's consideration of safety on the construction site can reduce accidents and related costs, such as redesign costs and operating costs for special procedures and protective equipment (Gambatese, 2000b). Communication between the designer and other project team members, such as project managers and security personnel, is also important because it can enhance safety during the design stage. Providing designers with information about how design affects workplace hazards will allow safety aspects to be included in the design process.

When enforcing any law, there must be a set of jurisdictions that will enable individuals or agencies to take action. Jurisdiction also gives rights to each person or agency by taking their authority according to the limits. Occupational Safety and Health (OSH) law in Malaysia is enforced by the Department of Occupational Safety and Health under the Ministry of Human Resources. Continual efforts are needed to improve the quality of administration and management of systems related to the implementation of OSH law, particularly the implementation in the BOWEC Regulations, Regulations 72-98, which focuses on scaffolding requirements for construction works. Any weaknesses and shortcomings of the laws need to be addressed. Thus, every action can be carried out professionally and prudently.

4.2 Improved Safe Operating Procedure

The enhanced SOP was generated from this study in the form of a checklist. Non-compliance in the checklist indicates the non-compliance to SOP, which must be rectified accordingly at the specified stage. Five checklists are drawn from this study, each of which includes requirements for frame scaffolding works in that particular stage. The main elements of the checklist are Requirements for Frame Scaffolding, Components Inspection (Checklist 1), Erection, Alteration and Dismantle of Scaffolding (Checklist 2), Operation on Frame Scaffolding (Checklist 3), Structure Inspection (Checklist 4), and Maintenance and Storage of Frame Scaffolding (Checklist 5).

The data gathered during the interview show that it is important to add several relevant procedures to enhance the existing SOP. Most of the additional procedures were proposed by an authorized representative, DOSH officers. The procedures concern continuing education and refresher program for scaffolders and the attendance requirements of a Professional Engineer (PE). Both requirements are added to checklist 2, which requires the latest date of scaffolding training participated by the designated person and. PE and to acknowledge the work performed on-site. As stated in the Guidelines on the Role and Responsibilities of Professional Engineers for Temporary Work during the construction stage (BEM, 2015), PE shall design and supervise Temporary Works according to the relevant standards, codes of practice, and good engineering practice, as stated in Section 5.0 (4). In addition, PE needs to be presented during the installation process to ensure the design meets with the on-site installation. This is to encounter any problems during the installation, such as the suitability of the design with actual conditions.

As shown in Fig. 2, the availability of design drawings and calculations that PE endorses is very important. This will be a reference at the site and is mandatory in CIS 22 Clause 5.3.3. When the scaffolding components and materials arrive on site, the components and materials will be received and recorded by a designated person appointed by the contractor. The designated person then inspects the components. As required in BOWEC 74(2), all materials used for scaffolding construction shall be inspected by the designated person before use. In CIS 22:2017 Clause 5.4.1, all scaffolding components and materials arrived at the construction site must be physically inspected, and the designated person must carry out proper marking. In other requirements, MS 1462-1, Clause 9. 3 states that the frame scaffolding components used at the site must be well inspected, and the conditions of the components should be recorded by qualified personnel or a competent scaffolder. PETW must approve this inspection.

In the case of damaged components, they will be discarded as required in CIS 22, Clause 5.4.1. If the result of the quality checking on random sampling complies with MS 1462-1, the components can be used for the erection of the structure at the site. Components that fail to meet the quality standard will be discarded. The inspection and maintenance of the scaffolding structure are carried out appropriately during the operation of the work by a designated person. This is to ensure that the structure is safe for the workers working on it. If any non-compliance with the procedures, the structure shall be altered, re-inspected by the designated person, and approved safe by PETW before being used. After completing the scaffolding work, the scaffolding structure can be dismantled. However, it is suggested that the structure be inspected before dismantling to ensure its stability. Upon completing the dismantling stages, all components shall be properly stored according to the procedure outlined in Checklist 5. It may be necessary to clean and dry the components before storage. Those components that are badly corroded, damaged, and cannot be repaired must be disposed of and adequately recorded.

5.0 CONCLUSION

Working on a frame scaffolding system for riggers or workers is a high-risk job, where most accidents cause fatality. From this study, there are 26 hazards found in scaffolding works. With a risk score of 25, the defective component ranked top among all other hazards. There are three risk levels of hazards. Ten hazards are at high risk, 12 are at medium risk, and four are at low risk. There were 12 hazards found during erection, 13 during operation, and 11 during the dismantling process. The unstable structure is considered one of the hazards that cause the scaffolding to collapse and is associated with four factors, Organization, Technical, Environment, and Human factors. A defective component is one of the hazards that cause an unstable structure and is one of the non-compliance with SOP. Therefore, an improved SOP is recommended for this study by emphasizing the compliance of all requirements to ensure the safety of all riggers, workers, and project team members. As an improved SOP, five checklists are recommended, including two relevant additional procedures obtained during data collection. It is hoped that the improved SOP can achieve the important goal of this study. The enhanced SOP will be a reference in construction to prevent the collapse of the scaffolding system and reduce the number of losses, injuries, and property damage.

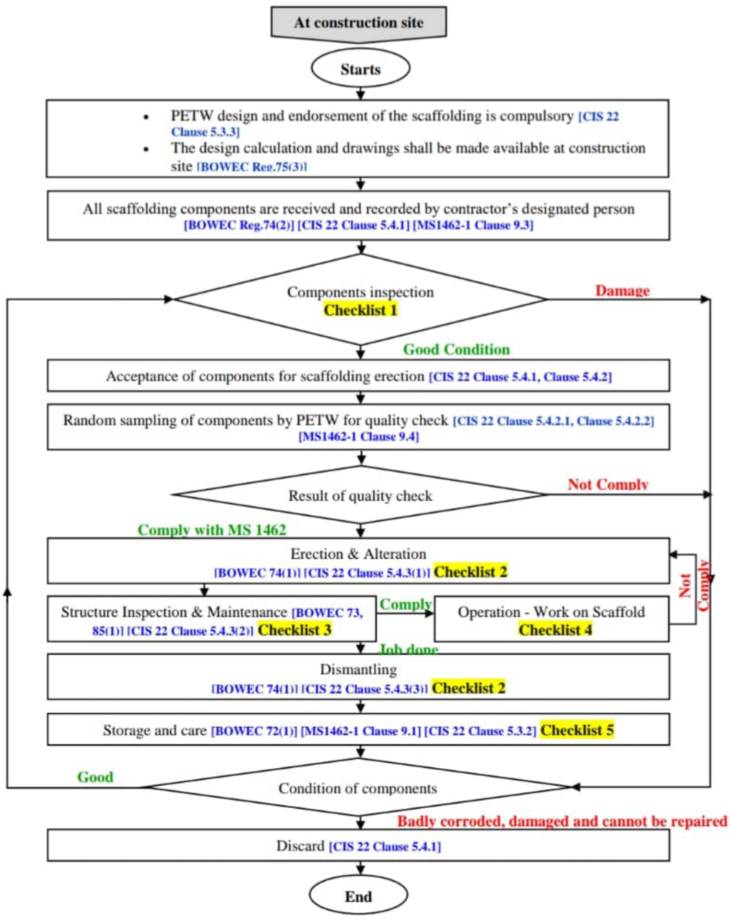

Figure 2 Process Flowchart for Scaffolding Works

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