A Study on Potential Physical Hazards at Construction Sites

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ABSTRACT

Statistics have shown that the number of fatality and permanent disablement cases due to accident at construction sites in Malaysia is one of the highest in comparison to other sectors. Therefore, there is an urgent need to mitigate this problem. In general, there are three basic steps that should be taken to ensure the safe and conducive working conditions: identifying the hazard, assessing the risk and controlling the risk. The implementation of effective hazards control methods may require different approaches due to changing working environment at the construction sites. This project is intended to identify and highlight the common hazards at construction sites today. The data collection was carried out through site investigation using a checklist forms and interview in construction. The study determines fourteen (14) types of work at building construction sites and their common hazards. The works include wood carpenter, bar bender, excavation work, boring rig, hacking and drill, crane work, roof work, bricks installation, scaffolding, electric welding, general activity, mechanical lifting, concreting and electrical equipment usage. The study was conducted at a building construction site and the results showed that the most common hazards for the project around the study area are associated with protective clothing, manual handling and roof work.

Keywords: *Physical Hazards, Construction Sites, Hazard Control, Work Safety, Safety Assessment*

Introduction

The construction industry is currently being recognized as a major economic force in Malaysia [1]. It is also one of the most hazardous industries [2, 3].

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Based on the report by Social Security Organization (SOCSO) in 2000, the fatality rate for construction industry in Malaysia is more than three times of other workplaces. In conjunction to this, compensation paid out by SOCSO for industrial accidents and diseases accounted for almost RM650 million [4]. As the hidden or indirect cost of an accident is about eight (8) to thirty three (33) times more than direct costs, the total cost of an accident can run into billions of ringgit [5].

In the field of occupational safety and health, Malaysia is now moving away from the traditional approach that believes all occupational hazards can be effectively controlled through a detailed regulation [3]. On 25th February 1994, Occupational Safety and Health Act 1994 (OSHA) came into force to provide protection on the safety and health for work activities in all economic sectors including public services and statutory authorities, with the exception of those subjected to Merchant Shipping Ordinance and the armed forces [6]. Under Section 15 (1) and (2) of OSHA 1994, employers have a responsibility to ensure, as far as practicable, that employees are not exposed to any hazard at the workplace [6]. Though there has been marked reduction in the number of industrial accidents and the rate of accidents per 1,000 workers since the introduction of OSHA 1994, there has not been a credible improvement over the last five years. The rate per 1,000 workers has been at a plateau of 9.5 to 10.5 persons in non-developed nations while for developed nations, it is three to four persons per 1,000 workers [4]. Though the regulation on occupational safety and health in Malaysia is quite comprehensive, the level of awareness and practicability of the regulation within the society of construction industry are generally lower than what is supposed to come into force.

From Table 1, among the formal industries, construction industry has the most number of deaths so far this year as of April 2017 in Malaysia. It should be noted that the figures given only cover those cases investigated by DOSH. There is a popular belief that the construction sites are supposed to be unsafe and the risks that the workers are subjected to are common and at their choosing [7]. Accidents that can happen at the construction sites may cause long term physical injuries or health illness. The term hazard in this research study is defined as anything that can cause harm such as scaffold, excavation, roof work, working from ladders, etc.

This work is intended to study the potential hazards in a building construction site and devise some precautionary plan to reduce the hazards' risk. Picture of the construction site chosen for this study is depicted in Figure 1. This site has been chosen as the sample case study in this research primary due to its easily accessible location. The site is also attached to current office building, which eases the process of making observation with regards to the safety pre-cautions taken within interested construction areas (apart from observations made during on-site visits). Furthermore, access to

this site is made possible since one of the researchers is also the staff of the company.

Table 1: Statistics of number of industrial de aths by Department of Occupational Safety and Health, Ministry of Human Resources, Malaysia

Sector	**Jan**	**Feb**	**March**	**April**	**Total**
Manufacturing	2	5	2	3	12
Mining and quarrying	0	0	0	0	0
Construction	1	6	5	3	15
Agriculture, forestry, logging and fishery	2	0	1	1	4
Utility	1	1	0	2	4
Transport, storage and communication	2	1	1	0	4
Wholesale and retail trade	0	0	0	1	1
Hotel and Restaurants	0	0	0	1	1
Financial, Insurance, Real estate and business services	0	1	1	0	2
Public services and statutory bodies	2	0	1	1	4
No information	6	5	9	3	23
Total	16	19	20	15	70

Figure 1: Construction site for this study

Several visits are made to the construction site within six weeks' time. The main interest of the visits is to identify potential physical hazards, assess the risk of these hazards and identify measures that can be taken to control the risk. The findings from this on-site observation may help to give some

insights on the common hazards faced by the construction workers and how they and their employers can act together to significantly reduce the risks. Construction industry as an engineering system can accommodate changes either statically or dynamically [8].

Environmental, Safety and Health (ESH)

ESH has continued to gain recognition as an important issue in Malaysia and this has been reflected by its significant progress in recent years through the published studies. Current ESH trends are moving away from compensatory approach and leaning more towards prevention practices and promotion of occupational health and safety with emphasis on holistic workplace programs and strategies. Many companies have already made an effort to inculcate the safety culture among their employees for the implementation of safety and health with the specific concept to achieve the safety standards.

Occupational Safety and Health (OSH) Indicators

OSH issues have received increased attention nowadays and are considered as highly important in Malaysian Industrial Relations. In operational analysis report of the OSH Regulations (2000), it has been found that 80 percent of workplace investigated failed to adhere fully to the enforced regulations [3]. The mass media are also continuously reporting various workplace accidents that result in deaths.

As developing nation, improvements to its workers' safety and health issues should go hand in hand with Malaysia economic booming. With the increased number of industries, Malaysia is now facing greater challenges to effectively monitor the enforcement of the OSH requirements. Among the Southeast Asian countries, Malaysia is ranked third for the least accident rate (14000 cases) and fatality rate (18.3).

Research Methodology and Procedures

The data collected in this study can be categorized into two classifications: primary and secondary data. Primary data covers those collected from on-site inspection, interviews with construction workers and staff and also checklist forms. On the other hand, the secondary data refers to the information gained from references of articles, journals, books and internet. The gathered data is then subjected to the quantitative and qualitative analysis for the study.

Primary Data

Data that has been collected during the visit to the construction site consists of two sources: interviews and checklist. Interviews are conducted with a few personnel from the construction company and also the company for which the building is being built for. This is necessary to get a broader perspective

on the subject matter from the workers' viewpoint. Such information is useful in assisting the determination of the potential hazards in the construction site. The interviews are conducted in an informal manner in order to get 'genuine' and sincere feedbacks. On the other hand, the checklist form identifies some of hazards most commonly found on construction sites. From the observation made during the site visits, the checklist is completed based on the hazards found.

Secondary Data

Secondary data is used primarily to enhance the understanding of the subject matter and provide an insight to possible recommendations. These data were obtained both internally and externally. Relevant writing materials on hazards are obtained internally from the companies while the external sources for the secondary data include journals, news articles, research papers, etc.

Hazard Identification, Risk Assessment & Risk Control (HIRARC)

Nowadays, HIRARC has grown to be an essential element to the practice of planning, management and operation of a business as basic risk management. This method implements risk assessment at the workplace and it has been reported to be positive in changing the working place safety issues. The main purposes of HIRARC are to identify all the factors that might cause harm to employees and others (the hazards), consider what are the chances the harm can actually be falling anyone in the circumstances of a particular case and the possible severity that could come from it (risks), and enable employers to plan, introduce and monitor preventive measures to ensure that the risks are adequately controlled at all times. Figure 2 depicts the steps of the HIRARC process.

As widely used in many management studies, the risk can be defined as the product of its likelihood to occur and the measure of its severity [5]. The assessment of risk likelihood is often based on the worker's experiences, analysis or measurement whereas the severity assessment is based upon the level of impact to individual health, environment or property. Table 2, Table 3 and Table 4 show risk assessment, likelihood and severity, respectively.

Table 2: Risk assessment

Likelihood / **Severity**	**1** **Very Unlikely**	**2** **Unlikely**	**3** **Likely**	**4** **Very likely**
First Aid (1)	L	L	M	M
Minor Injury (2)	L	M	M	H
Major Injury (3)	M	M	H	H
Fatality (4)	M	H	H	H

*Note: L = Low, M = Medium, H = High

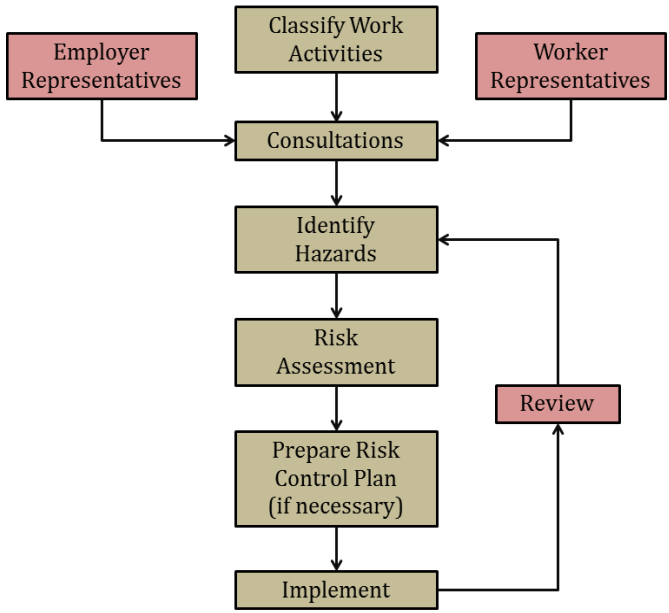

Figure 2: Flowchart of HIRARC process [4]

Table 3: Likelihood table

Assessing Likelihood	Rating
Highly Unlikely, Probably Never Will, Yearly	1
Unlikely, Rarely, 6 months	2
Likely, Occasionally, Monthly	3
Very Likely, Frequently, Daily	4

Table 4: Severity rating

Severity (Injury/Accident/Illness)	Description	Rating
First Aid Injury/Illness	Minor injury or illness requiring first aid only, no loss of work time.	1
Minor Injury/Minor Illness/No Lost Time Injury	Moderate injury or illness requiring casualty treatment	2
Major Injury/Major Illness/ Permanent Disability/Lost Time Injury	Serious bodily injury or serious work caused illness	3
Fatality	Death	4

Data Analysis and Findings

Overall, there are 14 different identified work activities with 23 hazards at the construction site for this study. Some of these work activities have several hazards that can cause injury to the workers and at the same time damage the operated machines [5, 13, 14]. Several pictures around the construction site that highlight some of the potential hazards found are shown in Figure 3. For instance, since the work area was not guarded during the bricks installation work, the bricks might fall on the person below or on the cement machine and cause damages. Table 5 tabulates the summary of HIRARC at the chosen construction site for this study. Based on the results, the work activities with a high risk hazards result are further discussed as follow.

Roof Work

Roof work has been identified as one of the work activities that lead to main hazards in construction sites with risk score of 16. In this work activity, the potential common hazards are slipping and falling. The safety harness is very important for this type of job. Furthermore, when dealing with roof works, precaution should be made to clear out other people from the areas below the roof works and other additional precautions to stop debris from falling onto. The overall rank for these groups of hazards is three, which indicates they are rather satisfactory.

Scaffolding

Scaffolding has also been identified among the work activities that may lead to hazards at the construction sites with risk score of 12. The most common hazard on scaffolding is the potential for falling. Items that require attention are the inspection of the scaffold to ensure cross bracing not missing from the base of the scaffold, additional precaution condition (i.e. intermediate guard rails) is properly equipped and barrier or warning notices should be available or sufficient to warn people from using the incomplete scaffold.

Electrical Equipment Usage

Electrical hazard has been identified to be a high risk in the construction sites with score of 8. Among the activities involved are electric welding and any other tasks associated with the power access. A dangerous condition such as direct contact or equipment failure can consequently result in electric shocks or electrocution, arc-flash burn, thermal burn and blast.

Crane Lifting

Mobile crane lifting is identified as a high risk in construction sites with the score of 12. Inspections for cranes in regular intervals should be performed.

The intervals in turn are dependent upon the nature of the critical components of the crane and the degree of their exposure to wear and deterioration.

(a) Scaffolds are not properly stored

(b) Crane works without proper safety equipment

(c) Working without safety equipment

(d) Not a proper fence

Figure 3: Potential hazards observed at the construction site

Excavation

Excavation is identified to be a medium risk in construction sites with a score of 6. The excavation has already completed at the time of survey. From the interview, the hazards in association with excavation that are identified to be the most significant for infrastructure works at sites include the availability of stop block or signage to prevent or warn tipping vehicle from falling in and also the adequacy of guard rail to prevent people from falling in.

Summary of Accident Report

Based on the records provided by the construction company, 100 accidents have been reported at the construction site. The distribution of the accidents is shown in Figure 4. It can be implied that the reported accidents are in good agreement with the observations made in this study regarding the potential hazards.

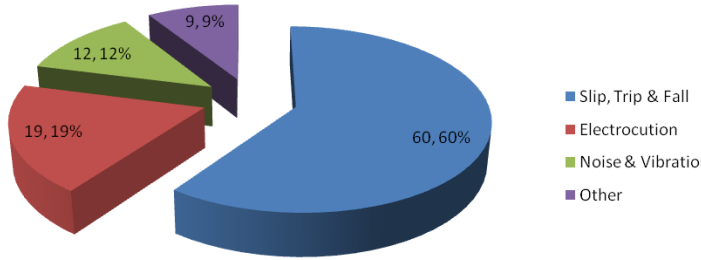

Figure 4: Common physical hazards based on the accident reports

Conclusion

In this case study, it can be summarized that common physical hazards at the building construction sites are slip, trip and fall, electrocution, noise and vibration. In some other cases, they are due to falling debris, nails, and sharp item. Continuous review by construction companies for safety improvement purposes are required. Nevertheless, the role of individual employee is also equally crucial in reducing the potential injury at the workplace, which a recommended scope for future study.

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Table 5: HIRARC results summary

No	Work Activity	Hazard	Which can cause / Effect	A Severity	B Probability	Risk Rank	Action for control
1	Wood carpenter	Unguarded cutter	Wood hurled into the body / Cuts and bruises	2	2	4	1. Engineering control -make sure the guard on the cutter blade in good condition 2. Administrative control -teach the workers a safe working methods 3. PPE, safety glove, shoes, safety glasses and safety helmet
		Not suitable cutter	Broken cutter / Seriously injured	3	2	6	Make sure the blade is in good condition before starting work
2	Bar Bender	Unguarded machine	Hand caught in machine / Broken bone or Cuts	3	2	6	Be sure employees do the work carefully and the chief give the instruction or safe procedure of work
3	Excavation Work	Unstable land	Landslide / Injuries to nearby employees	3	2	6	1. Excavator driver must ensure that workers do not approach the machines near the excavation work done. 2. Follow the safety procedure (operator and nearby workers)

No	Work Activity	Hazard	Which can cause / Effect	A Severity	B Probability	Risk Rank	Action for control
4	Boring Rig	Unguarded hole	Fell into the hole or Struck by rig / Death and drowning	4	2	8	1. Excavator driver must ensure that workers do not approach the machines near the excavation work done. 2. Follow the safety procedure (operator and nearby workers)
5	Crane Work	Hanging object	Material falls on the employee / Death / Seriously injured	4	3	12	1. Give safety briefing and how to handle the materials to employees. 2. Ensure employees are trained crane operator
6	Hacking and Drill	Splash of the debris	Small objects hurled in the direction of the body / Cuts and bruises	2	2	4	1. Always use standard operation procedure (SOP) 2. Create barriers 3. Put on safety helmet, safety glove, safety glasses and safety shoes.
7	Roof work	Working at high place	Fall of person / Death / Seriously injured	4	4	16	1. Follow the working at height regulations. 2. Hand railing 3. Safety harness 4. Warning sign

No	Work Activity	Hazard	Which can cause / Effect	A Severity	B Probability	Risk Rank	Action for control
							5. Monitoring by safety supervisor
		Slippery work place	Slip of person / Death / Seriously injured	4	3	12	Make sure the area around the work place is clean and safe before starting work
8	Bricks installation	Unguarded work area	Material falls on the employee / Seriously injured / Minor injuries	4	2	8	1. Keep clean 2. Placing warning sign at the bottom of the work place. 3. Placing barriers in the work area (teo board) 4. PPE
			Material falls on the machine / Damage on the machine	3	2	6	1. Do not put the machine under the work area 2. Cover the machine under the work area
9	Scaffolding	Working at high place	Fall of person / Death / Seriously injured	4	3	12	1. Follow the working at height regulations. 2. Hand railing 3. Safety harness 4. Warning sign 5. Monitoring by safety supervisor 6. Body harness for working more than 3 meters.

No	Work Activity	Hazard	Which can cause / Effect	A Severity	B Probability	Risk Rank	Action for control
		Slippery work place	Slip of person /Death / Seriously injured	4	3	12	1. Make sure the area around the work place is safe before starting work 2. Hand railing 3. Body harness for working more than 3 meters
		Incompetent scaffolds	Collapse scaffolds / Death / Seriously injured	4	2	8	1. Scaffolding design by qualified person. 2. Warning sign 3. Scaffold tag must be present to ensure that the scaffold has been inspected and are safe to use
		Unguarded work area	Falling objects / Death / Seriously injured	3	2	6	1. Safety net 2. Keep the work equipment carefully so that it do not falls 3. Warning sign (Warning : falling object)
10	Electric Welding	Wet work area	Electric shock / Death / Seriously injured / Minor	4	2	8	1. Ensure the work area is dry 2. Use a good condition equipment

No	Work Activity	Hazard	Which can cause / Effect	A Severity	B Probability	Risk Rank	Action for control
			injuries				3. Use leather glove 4. Pair work
		Confine space	Sparks or Fire / Death / Seriously injured / Minor injuries	4	2	8	1. Using a face mask during work 2. Wear glove 3. Put a fire extinguisher near the work area 4. Pair work
11	General activity	Not wearing PPE	Death / Seriously injured / Minor injuries	4	2	8	1. Daily monitoring by safety supervisor 2. Penalty system is used
		Unsafe Condition	Death / Seriously injured / Minor injuries	4	2	8	Daily monitoring by safety supervisor
		Unsafe Act	Death / Seriously injured / Minor injuries	4	3	12	1. Daily monitoring by safety supervisor 2. Penalty system is used
12	Mechanical lifting	Incompetent cable	Cable break / Death / Seriously injured	4	2	8	1. Ensure that the machine has a valid PMA 2. Operate by competent person 3. Periodic inspections by the crane operator
		Operate on	Crane	4	2	8	1. Ensure that the machine has a

No	Work Activity	Hazard	Which can cause / Effect	A Severity	B Probability	Risk Rank	Action for control
		soft soil base	overturned / Death / Seriously injured				valid PMA 2. Ensuring a strong base of crane / put the metal plate if necessary 3. Periodic inspections by the crane operator
13	Concreting	Wet cement	Burns on the skin / Minor injuries	3	1	3	1. Ensure that workers follow site supervisor direction 2. Monitoring by site supervisor 3. Awareness about danger and effect of wet cement to the body 4. PPE
14	Electrical equipment usage	Wet work area	Short circuit / Electric shock / Death / Seriously injured / Minor injuries	4	2	8	1. Ensure the work area is dry 2. Ensure the wire does not reach the floor 3. Monitoring by supervisor 4. Penalty system is used