FACTORS CAUSING INCIDENTS IN A MEGA CONSTRUCTION PROJECT: A QUALITATIVE STUDY IN KLANG VALLEY

CHUAH CHONG KEN

MASTER OF SCIENCES
(OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT)
UNIVERSITI UTARA MALAYSIA
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CHUAH CHONG KEN

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Universiti Utara Malaysia

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ABSTRACT

Malaysia being one of the developing country, understands the role of construction as one of the important and productive sector towards economy. Despite the growth, construction industry is categorized as a highly dangerous working environment due to the increasing rates of accident and fatality rates year after year. The aim of this study is to identify root cause of incident in construction industry. This study utilize the qualitative study which focus on approach based on the Ishikawa 5M +1 E method which stresses on several components which are divided into man, management, method, machine, material and environment based on incident report from 2016 to 2018 obtained from a construction of a mega project in Klang Valley. A total of 73 incident reports were obtained and analysis done to identify information such as the activity carried out and time when incident occurs, category depending on extent of injury or damage, type of incident depending on unsafe act or unsafe condition and the root cause of incident to gain better understanding of the research topic. Results shows that the man factor are the most significant factor with method and environment factors also to be significant while the machine and material factors are slightly insignificant based on the data obtained. The study are very depended on the information obtained from the reports and some factors may be more significant compared to the other factors as this study are focus entirely on a mega project in Klang Valley. Thus, further research which involves a wider scale and obtaining data from the whole Malaysia is required to have a better picture of the actual scenario and root cause of the construction industry in Malaysia

ABSTRAK

Malaysia selaku salah sebuah negara membangun faham akan kepentingan industri pembinaan sebagai satu sektor yang penting dan produktif terhadap ekonomi negara. Di sebalik itu, industri pembinaan telah dikategorikan sebagai persekitaran bekerja yang amat berbahaya ekoran daripada peningkatan kadar kemalangan serta maut dari setahun ke setahun. Tujuan kajian ini dijalankan adalah untuk mengenalpasti punca kemalangan dalam industri pembinaan. Kajian ini merupakan kajian kualitative yang berfokuskan pada pendekatan yang berdasarkan pada kaedah 5M + 1E oleh Ishikawa yang menekankan konsep *Man, Management, Method, Machine, Material* dan *Environment* berdasarkan pada laporan kejadian dari 2016 sehingga 2018 yang diperolehi dari sebuah tapak pembinaan projek mega di Lembah Klang. Sejumlah 73 laporan kejadian telah diperolehi dan analisis untuk mengenal pasti maklumat seperti aktiviti yang dijalankan serta masa semasa kemalangan, kategori kejadian berpandukan pada tahap kecederaan serta kerosakan, jenis kejadian disebabkan oleh perbuatan atau keadaan tidak selamat dan punca kejadian untuk lebih memahami tajuk kajian. Keputusan kajian menunjukkan bahawa faktor *Man* adalah paling significant diikuti oleh faktor *Method* dan *Environment* yang juga significant manakala faktor *Machine* dan *Material* adalah kurang significant berdasarkan data yang diterima. Kajian ini amat bergantung kepada maklumat yang ditulis dalam laporan kejadian dan sesetengah faktor mungkin lebih significant berbanding faktor lain memandangkan kajian ini hanya bertumpukan sepenuhnya pada satu projek mega di Lembah Klang. Oleh itu, kajian masa depan yang melibatkan skala yang lebih besar serta mendapatkan data daripada seluruh Malaysia adalah diperlukan untuk mendapatkan gambaran yang lebih jelas tentang keadaan serta punca kejadian di industry pembinaan di Malaysia.

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I wish to dedicate my deepest gratitude to my supervisor Associate Professor Dr. Mohd Faizal Bin Mohd Isa for his supervision and assistance to me to complete this study.

I also would like to express my highest appreciation to my company who allows me to carry out this study by granting me access to the information and data needed for this project. However, it is with deep regret that I am not able to disclose the identity of the company due to confidentiality related to the data obtained for this study.

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LIST OF ABBREVIATIONS

DOSH	Department of Occupational Safety and Health
FMA 1967	Factory and Machinery Act 1967
LRT	Light Rail Transit
MRT	Mass Rail Transit
NADOPOD	Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease Regulations 2004
NIOSH	National Institute of Occupational Safety and Health
OSH	Occupational Safety and Health
OSHA 1994	Occupational Safety and Health Act 1994
SOCSO	Social Security Organization

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

This chapter comprises of the background of the study, problem statement, scope of study, research questions, objectives of the study and significance of the study.

1.1 BACKGROUND OF STUDY

The developing as well as the developed nations have realized and understand the significance of construction industry in socio-economic and sustainable development of a country. Dong, Entzel, Men, Chowdhury, and Schneider (2004) states that in the developed nations such as United States, construction labor is considered one of the most dangerous occupations and one of the high risk industry related to Occupational Safety and Health (OSH). It is a common practice that all workers are given basic safety induction prior to them working at the site in order to educate them to work safely (Health and Safety Executive UK, 2009) but despite that, the construction industry is also categorized as a highly dangerous working environment due to the continuous increasing rates of accident and fatality rates as reported year after year. According to the United States National Census of Fatal Occupational Injuries in 2011 (Bureau of Labor Statistics, 2012), a large number of people are killed because of construction accidents each year and in the year 2010 and 2011, there were 774 cases and 721 cases respectively of fatal occupational injuries among construction workers, a rate of almost two death per day. Statistics from the

European Union published in October 2012 also reported that in 2009, more than one in four (26.1 %) fatal accidents at work in the European nation took place within the construction sector, while the manufacturing sector is second highest (16.1 %). In Australia, the fatal accident rate in construction is nearly 6 workers in 100,000 which are more than twice the average of fatal accident rates when compared to other major sectors (Zou, 2011). From every accident that occurs, there are precursor of near miss incident leading to the actual accident. According to Heinrich (1959), 88 percent of accidents are due to the unsafe actions of an individual specifically an unsafe act while unsafe condition contributes to another 10 percent and a 2 percent attributed to unavoidable accidents or known as God's will. Lauver, Lester, and Le (2009) cited Heinrich's findings and summarize that there will be 1 major incident leading to permanent disability or fatality and 29 minor incidence leading to injuries from every 300 near miss incidents. In addition to that, one of the axiom of Heinrich Domino theories also pointed out the element of unsafe act as one of the causes of accident and injury and this theory and other relevant theories on accident causation will be elaborate further in the next chapter.

The risk factors leading to the data in the incident statistics may be due to the fact that construction often take place under extreme condition such as time constraint and excessive pressure from external which are not conducive for safety and health. Apart from that, workers in the construction sites have to face constant change in the nature of work, changes of safety practice from one organization to another and the mixture of skilled and unskilled workers (Misnan & Mohammed, 2007). According to Mbuvi, Kinyua, and Mugambi (2015), workplace factors that causes near misses which are not mitigated and

repeated near miss are important signs of a problem or a lacking indicator of the safety system at workplace. Failure to identify the actual root cause of near miss incident will eventually lead to accidents and near miss are often overlook and under reported as there was no injury or property damage involved. Phimister, Oktem, Kleindorfer, and Kunreuther (2003) mentioned that the possibility to reduce major incidents will increase when near misses can be reduced thus the factors leading to incident is important to be identified in the early stages during near miss before it is too late. The lack of an effective system to interrupt and prevent the precursors and contributory factors on construction sites is argued to be the critical deficiency of extent research and practice (Wu, Gibb, & Li, 2010). All these possible factors leading to incidents in construction industry will be further analyzed in this study.

1.2 **PROBLEM STATEMENT**

Malaysia being one of the developing country, understands the role of construction as one of the important and productive sector towards Malaysian economy (Khan, Liew, & Ghazali, 2014). Malaysia recognized the importance of the construction sector since its independence in 1957 where the industry was low-tech, labour intensive crafts-based industry and since then have developed to a one that has a capacity to deliver modernized and advanced buildings and infrastructure (Khan et al., 2014). Mega construction projects especially infrastructure projects in the past which has help develop Malaysia and its economy include the Klang Valley Light Rail Transit (LRT) project, Electric Train Service (ETS) connecting Padang Besar and Gemas and Sultan Abdul Halim Muadzam Shah

Bridge (Penang Second Bridge) and the on-going Klang Valley Mass Rapid Transit (MRT), East Coast Railway Link, Pan- Borneo Highway and upcoming High Speed Rail (HSR) connecting Kuala Lumpur and Singapore shows the massive growth and increasing importance of infrastructure construction projects towards Malaysia achieving the status of a develop nation.

Construction workers worldwide are easily susceptible to diseases, ill health, and injuries regardless of those working in develop or non-develop countries and based on Malaysia Social Security Organization (SOCSO) Annual Report 2016, the number of accidents in construction sector was 7338 cases compared to 6301 cases in 2015. In addition to that, SOCSO compensated to 7093 workers with cases of temporary disability and 1879 with permanent disability in 2016 while in 2015 temporary disability were 6250 and permanent disability was 1786 in the construction sector. Based on Figure 1.0 from Department of Occupational Safety and Health, there were 52 cases of fatality in the construction industry in 2018 up till June 2018 which is the highest recorded compared to other industries such as manufacturing, agriculture, mining and others in Malaysia (DOSH, 2018).

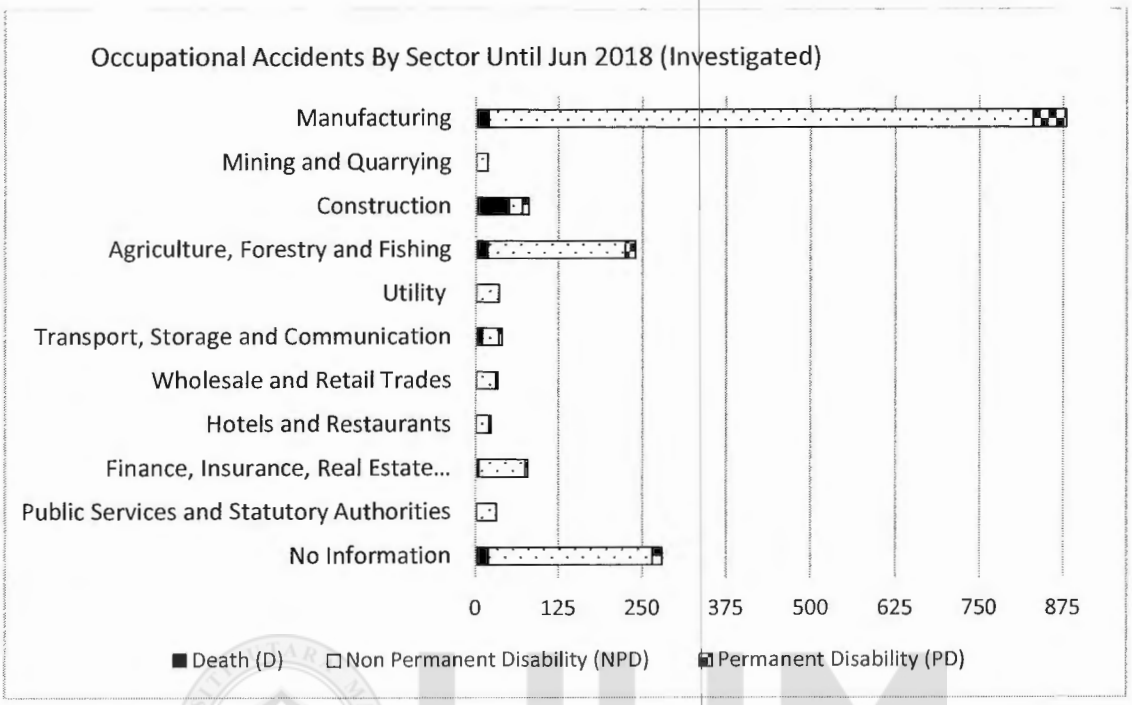

Figure 1.0
Occupational Accidents Statistics by Sector Until Jun 2018
Source: DOSH, 2018

In the past few years, there have been several cases of fatality in the construction industry particularly in the construction of mega project as reported in the newspaper which shocks the nation due to the fact that these mega projects are usually seen as more stringent in terms of safety and health compliance compared to smaller projects with insufficient or lack of safety compliances and budget. As these mega projects are carried out by well-known contractors thus it was assumed that there will be no unforeseen incidents happening especially when the project is carried out in the middle of the city. However, in June 2014, two near miss cases happened back to back within the gap of 2 days in MRT and LRT project respectively when construction materials fell onto public vehicles causing damage but in both cases, the victims were very lucky to escape death as the falling material severely damaged the car but barely hitting the victims clearly shows a weakness in the

implementation of safety at construction sites in these mega projects (The Star Online, 2014). Few months after the near miss incident, the first fatal incident occurred in MRT project. In August 2014, 3 Bangladeshi workers were killed in the MRT project (New Straits Times, 2014) when they were crush by a falling viaduct span in which they were working on top of and reports identified lack of supervision and failure to follow method statement as one of the major contributing factors to the incident. In February 2015, another Bangladeshi worker were killed when a rebar cage fell onto him during works and injuring another worker in MRT Semantan site (Malaymail, 2015). Few months after that in May 2015, another fatal incident struck the MRT project when a Bangladeshi worker was killed when he was trapped under the debris which fell onto him during dismantling works at the Tun Razak Exchange MRT site (Astro Awani, 2015). In February 2016, a local worker was crushed to death when the skylift he was riding on overshoot due to hydraulic failure of the machine in a MRT project site at Kota Damansara (The Star Online, 2016) while in October 2017, 2 workers were killed when an explosion occurs in the Bandar Malaysia MRT project site (New Straits Times, 2017). The most recent incident to happen in MRT project was just as recent as March 2018 when 1 worker was killed while the other suffer permanent disability (both were Malaysian) when a launching gantry in MRT Kepong site collapse during work (Malaysiakini, 2018). High profile incidents leading to fatality in MRT has led to the resignation of various top management personnel in MRT and further decrease of trust from the public as the rate of incidents happening one after the other made the public very worried in terms of their safety when they are in the vicinity of MRT sites (The Malaysian Reserve, 2017).

1.3 SIGNIFICANCE OF THE STUDY

The accident rate of construction industry remain high and safety problems on construction sites seem to be largely unresolved as the fatality and injury records in construction continue to plague the industry in Malaysia based on records from SOCSO and DOSH. The intent of the proposed study is to learn more about factors related to incidents in the construction industry and the main objective of identifying root cause of incident which is based on the Ishikawa 5M +1 E method which stresses on several components which are divided into man, management, method, machine, material and environment. The person who can give the most accurate information are those directly involved in the works at site thus this study aims at obtaining actual data (incident report) prepared from site personnel consisting of Project Managers, Engineers and Safety personnel who are hands on at the site and knows what happens best which are very useful in order to truly understand the level of OSH at the workplace in compliance to Occupational Safety and Health Act 1994 based on Malaysia context.

Since this mega project is still consider at an early stage with progress of less than overall 30% thus identifying important and high risk areas and further areas for improvement in terms of safety and health management are crucial to ensure safe working environment to everybody including the public who are in the vicinity of the construction area. The best way to identify these high risk area is to analyze data from incidents that has already happened in the project as different project have different setting including the risk factor thus information from internal is important to identify suitable mitigating measures to be carried out.

Based on a study by Coble, Hinze, and Haupt (2000) on 582 medical case injuries, lost of productivity and increase effort in administrative issues are related to accidents as part of the indirect cost. They further summarize that a worker will lose up to 3.7 hours of productive work on the day the worker is injured and a subsequent 8 hours of productivity for every day he is not back to work and in addition to that, the workers productivity may not be as optimum as what he did prior to the accident upon returning to work. Apart from the worker himself, the overall department will be affected due to lack of one worker and will obviously lead to lower productivity. Based on the table of summary of indirect cost by Coble et al. (2000) in Table 1.0, it was estimated that approximately 5.2 hours are spend by supervisors and managers to investigate the incident, prepare report and to constantly follow up on the treatment given to the injured worker so that the worker is able to return to work.

By identifying the possible risk factors and have mitigation plan in placed in order to prevent major incidents which can be very costly in terms of reputation, legal, financial and progress is an important aspect of safety and health management. Besides that, no foreign investor will want to invest in country with high risk construction accidents as it will lead to various additional cost and may even lead to delays of project completion thus further incurring financial loss. That is why it is important to identify the actual root cause of the incidents with the main objective to carry out immediate corrective action and long term preventive action not only for the sake of employee in complying to the local legislation but for the public and for the image of the nation in the eyes of foreign investor. In addition, as the construction activities begin to enter its optimum stages which involves

various high risk activities will certainly increase the risk of incidents if preventive measures are not well planned and implemented in the workplace.

Information from this study can also contribute to academic knowledge in terms of providing relevant information on factors that are significant in causing construction incident so that future researchers or academicians can focus on these factors and areas when proposing theories or models related to mitigating construction related incidents. In addition, the information can also help academicians on which significant factor to focus and stresses on when educating students on construction related topics in Malaysia.

Table 1.0
Summary of indirect cost related to medical case injuries

Affected parties	**Indirect Cost**
Victim (injured person)	3.7 hours of productive work on the accident day 8 hours of productivity for every day victim is not back to work
Department	12 hours lost due to lack of one worker (victim)
Surrounding workplace workers	5 hours of workers time wasted on temporary stopping work to idle and watch the accident
Damaged equipment, machine, materials	2 hours to repair damage items 2 hours to clean up and restore working area back to normal
Temporary worker to replace victim	0.06 hours of lost productivity (due to not being familiar with task or not as skilled as victim)
Supervisor and management	1.5 hours to carry out investigation 1.0 hours to complete accident report 2.7 hours to follow up on victim progress

Source: (Coble et al., 2000)

1.4 RESEARCH OBJECTIVE

As a summary, this research aims at describing the factors and information associated with construction incidents and specific aims are as below

1. To identify types of activity carried out during construction incident
2. To analyze information such as time when construction incident occurs
3. To categorize the incidents based on extent of injury or damage
4. To list the unsafe act or unsafe condition leading to construction incidents
5. To analyze the factors such as man, material, machine, method and environment factors causing construction incidents

1.5 RESEARCH QUESTION

Based on the research objectives, following are few of the research questions of the study which aims at answering questions related to types of activity during incident, time incident occurs, types and classification of incidents and factors leading to construction incidents. As the research progress, detailed analysis of the incident reports will be carried out in order to gain more in-depth understanding of factors leading to construction incidents and each questions or concern.

i) What are types of activity carried out when a construction incident happen?

ii) Is there any specific time when construction incident tends to occur?

iii) What is the category of incident based on injury or damage?

iv) What is the type of unsafe act or condition leading to construction incident?

v) What is the most common significant factor causing incidents? Which of the factors Man, Machine, Material, Method, Management, Environment is significant and what are the exact root cause?

1.6 SCOPE OF THE STUDY

The study is limited to a Mega Construction Project in Klang Valley only and the project is considered one of the largest transport infrastructure projects in Malaysia with target completion of 2021 and specific details of the project will not be disclose due to confidentiality purposes. The study follows a qualitative research approach, involving the analysis of existing incident report as the main method only because of the time constraints involved in data collection and in-depth analysis of the data.

1.7 KEY TERMS

1.7.1 Construction

Construction refers to the action of building something, typically a large structure. *(Source: Oxford English Dictionary)*

1.7.2 Incident

An incident is defined as an unplanned event that may or may not result in personal injury and property damage including near miss cases and is worthy of recording. *(Source: Occupational Safety and Health Administration under United States Department of Labour)*

1.7.3 Root Cause

Root cause can be defined as a factor that caused a nonconformance and should be permanently eliminated through process improvement. *(Source: American Society for Quality)*

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter begins by describing an introduction to the characteristics of the construction industry before discussing on the definition of accident/incident before further review of related theories and models developed by researchers in past studies. This chapter will also discuss on Malaysia OSH Legislation and accident reporting in the construction industry.

2.1 ACTIVITIES DURING A CONSTRUCTION PROJECT

A building is a place where people spend most of their time in either living or working and most buildings are considered unique as they differs in design and materials as an architect designs a building that meets the requirement and what is needed by the owner. The process of erecting a building according to specifications and requirements is called a construction. The usual procedure in constructing a building begins with the planning stage at the office in which building plans are drawn, materials calculated, planned and ordered and the duration and man-power needed is estimated and arranged, contracts given out to sub-contractors of various trades. Several of the task involve in construction works include alterations, fitting out, renovating, repairing, decorating, maintaining, demolishing, dismantling and assembling. (Health and Safety Authority Ireland, 2012). The construction work consisted of various activities requiring workers from all types of trades and usually

the work is given to sub-contractors and the number of trades usually differs in accordance to the type of building constructed. For example, when building a residential building in the Netherlands, more than 20 sub-contractors from at least 18 different companies will be hired to complete their respective working activities as shown in the Table 2.1. (Koningsveld & Van Der Molen, 1997).

Table 2.1
Common job activities and trade during a construction of a housing project in the Netherlands.

Job activity	Trade
Alignment	Carpenter
Earth moving	Machine driver
Piles	Rammer
Concrete work	Concreter
Making of window and door frames	Carpenters
Erection and dismantling of scaffold	Scaffolder
Installation of elevators	Elevator installers
Placing of window frames	Carpenter
Transport of bricks and mortar	General worker
Bricklaying	Bricklayer
Plasterwork at walls	Plasterer
Plaster painting of ceilings	Plastererpainter
Roofing	Roofer
Gutters	Plumber
Window panes	Glazier
Screeds	Screeder
Electricity works	Electrician
Tiles	Tiler
Water, sanitary and heating	Plumber
Painting	Painter
Kitchen	Carpenter
Pavements, terraces	Paviour
Management	Site manager
Supervision	Superintendent

(Source: Koningsveld & Van Der Molen, 1997)

In addition, some construction projects may involve the usage of heavy machineries such as lorry, trucks, mobile cranes, crawler cranes, forklift, excavator, backhoe, piling machine and others and all these machineries poses different risk and hazard to the workplace. Some construction projects requiring demolition activity may involve usage of explosive and special permits must be obtained based on local legislation. Large scale construction projects may further require larger machinery and equipment such as Launching Gantry for bridge construction, Tower Crane for high rise building construction and Drilling Rig for offshore construction.

Different activities at the construction project can lead to all kinds of Health and Safety issues as different trade brings with it different hazard and danger to workers. Different hazards are present between someone doing electricity works compared to someone doing roofing works as the former is exposed to electrical hazard which can lead to electrocution while the latter is exposed to working at height with risk of falling and suffering injuries. Due to the various trades that are present, it is very hard to implement a single safety program that suits all the trades thus presenting a very big challenge in implementing safety program in the construction industry. Some of the trades have their own hazard which is different from other trades and with the improvement of technology in construction industry, various pros and cons in terms of health and safety are constantly present.

As stated before, construction methods in different countries vary so does the method, materials, legislative requirement, weather, mentality of workers and working cultures thus making international comparisons of OSH among various construction

industry worldwide difficult and presents a challenge for a joint-management aimed at improving the level of OSH in the construction industry. In summary, a bigger construction project will pose bigger risk due to the various types of hazard present at the project compared to smaller construction project such as comparing a construction of a bridge across live traffic to a construction of a double-story house and thus risk analysis and safety measures are different from construction projects to projects.

2.2 DEFINITION OF ACCIDENT/INCIDENT

OHSAS 18001 define incident as "Work-related event(s) in which an injury or ill health (regardless of severity) or fatality occurred, or could have occurred." When injury or illness occurs due to an incident, the situation is term as an accident but when injury or illness does not occur but could have occur due to an incident, the situation is term as near-miss. Therefore, an incident can be either an accident or a near-miss. Accidents prevention is always a number 1 goal in workplace safety. When it comes to workplace accidents and injuries, the consequences of an accident can be severe to an organization and may even cause an organization to shut down. According to OSHA 1994 (NADOPOD), accident is defined as an occurrence arising out of or in connection with work which results in fatal injury or non-fatal injury. In the past, people thought of each accident as an isolated event. Organization often manage accident by emergency response and compensation. As more accident happens, individuals and organizations has trying to understand the causal relationship of accident, with the aim of managing accident systematically and effectively. Accident causation theory is being studied as an effort to predict accidents. However, none of the theory has been accepted universally.

Before we proceed to elaborate further, the term accident and incident must be explained further in order to better understand the concept of accident and incident. The US Occupational Safety and Health Administration define accident "as an unplanned event that results in personal injury or property damage" while incident is define as unplanned event that does not result in personal injury but may result in property damage or is worthy of recording". Accidents are consider undesirable and could have been avoided if the events leading up to the accident had been identified and actions taken upon them. All accidents are can be categorized as incident but not all incident can be categorized as accident because some incident such as near miss incident does not cause injury or property damage but under different circumstances, the near miss might have become an accident. A model propose by Bird devised this ratio into 1 fatal incident for every 600 minor incident by studying the cases reported to insurance company, which is somewhat biased and might not represent the true ratio of all incident in the workplace (Bird & Germain, 1996). This concept might also cause business operators to overlook hazards that have low risk but high severity. Empirical studies conducted by Bellamy et al. (2008) suggest that the ratio of accident pyramid is depended on the type and the risk of the activity.

2.3 ACCIDENT/INCIDENT RELATED THEORIES AND MODELS

By identifying the root causes of accidents through investigation techniques and theories can help to reduce construction accidents. As defined by Heinrich, Petersen, Roos, and Hazlett (1980), accident prevention refers to "*An integrated program, a series of coordinated activities, directed to the control of unsafe personal performance and unsafe*

mechanical conditions, and based on certain knowledge, attitudes, and abilities''. Abdelhamid and Everett (2000) describe accident prevention in terms of managing a loss in terms of how to prevent and control them from happening.

2.3.1 DOMINO THEORY

Accidents in workplace can be explained using Heinrich's Domino Theory of Accident Causation. In the "Domino Theory", a workplace injury or accident happens as a result of a complete step-by-step sequence of five factors that needs to be look into in order to prevent an accident from happening. According to Heinrich, these 5 dominoes metaphorically represent 5 factors which are Social Environment, Fault of Person, Unsafe Act, Injury and Accidents and every factor is highly dependent on the factor before it and each domino represents a factor in this theory as illustrated in Figure 2.1. (Heinrich, 1959).

The sequence of accident factors is as follows:

1. **Ancestry and Social Environment**

   A person could learn or obtain characteristics that can causes unsafe act and unsafe condition by inheritance or social environment.

2. **Worker's Fault**

   The characteristics or behaviour obtained or inherited by the worker may cause him/her to making wrong decision or action that leads to unsafe act and unsafe condition.

3. **Unsafe Act and Unsafe Condition**

   The unsafe act and unsafe condition caused by the worker's fault causes the accident at the workplace

4. **Accident**

   The accident caused by unsafe act and unsafe condition will lead to damage to the machinery and properties involved. It will also lead to injury or fatality of persons involved.

5. **Damage or Injury**

   The company will need to response to the damange and injury caused by accident.

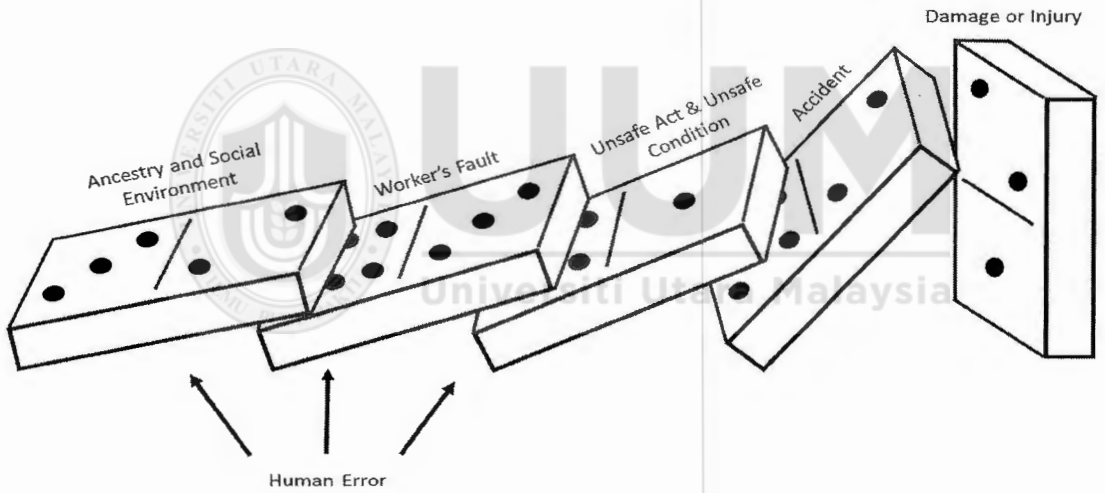

Figure 2.1
Domino Theory
Source: Heinrich, 1959

Just like in domino, the fall of one domino will cause the entire row of domino to fall thus the existence of any single factor can lead to a series of factors that can lead to workplace injury. Removing a key factor (such as an unsafe condition or an unsafe act) prevents the start of the chain reaction of domino falling thus resulting in the avoidance and prevention of workplace injury and accident.

According to Heinrich, the key domino to be removed is unsafe act & unsafe condition, which is the middle factor in the sequence. To remove the unsafe act & unsafe condition, Heinrich proposed the three "E" s corrective action sequence as below:

1. Engineering – Hazard was controlled by product design or process change.
2. Education – Staff is trained on safety procedures.
3. Enforcement – Ensure the rules and SOP on safety are followed by workers and management.

Thus by removing the second (fault of person) or third piece of Domino (unsafe acts or physical hazard factor) through implementation of safety program in the workplace is an example of removing away one domino of the series, which will prevent the accident from happening. An example of a worker lifting heavy loads by poor lifting technique *(fault of person)* and in addition without proper lifting gears *(unsafe acts)* can easily cause injuries such as being trampled by the heavy load or occurrence of back pain. The implementation of safety Program in which workers receive proper work training in their daily task which can lead to the removal of the risk factor "fault of person" and "unsafe acts" and eventually increase the level of Health and Safety in the workplac thus ultimately preventing injury and accident.

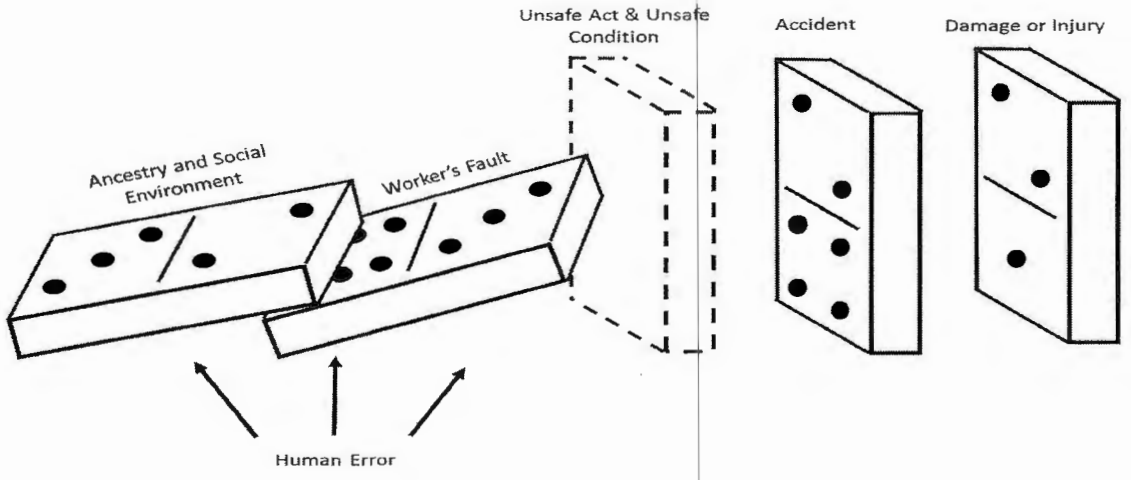

Figure 2.2
Domino Theory in which removing a single factor can prevent accident
Source: Heinrich, 1959

2.3.2 HUMAN FACTOR THEORY

The Human Factors Theory explains further on the domino theory posed by Heinrich and places the concept of human factor as the cause of accidents (Friend & Kohn, 2018). The 3 factors that causes human factors are defined broadly as below:

1. Overload

   The work task assigned is beyond the capability of the workers within the expected time frame in terms of physical and psychological factors, and external environmental factor. Overload may also be cause by:

   i. Environmental factors – noise, heat, dust etc.

   ii. Internal factors – Personal matters, emotional stress, worries etc.

   iii. Situational factors – Instruction not clear, lack of training etc.

2. Inappropriate response

Worker does not act desirably to maintain the safety of the workplace to contain the hazard. In some circumstances, if the staff is able to identify the hazard, s/he might be able to act in time to prevent the accident. However, the worker might have other consideration that might cause him to continue the operation without taking any action on the hazard. Either it is because to meet production deadline or increase output, or purely ignorant and negligence. The environment might not be complementing to the worker for him/her to perform. The worker should feedback this problem to the management, and it is the responsibility of the management to provide a suitable environment to the worker. The response in this situation consider inappropriate if the worker fails to inform the management on this problem, or the management fail to response appropriately to worker's feedback.

3. Inappropriate activities

Workers might be lack of training in safety and not able to judge, identify and acknowledge the hazard in the workplace. When misjudgement of hazard occurs, the worker might not be taking reasonable action to reduce the risk of their work. E.g. worker reluctance to wear PPE, worker modifying machine. This will cause the worker to be more prone to accident.

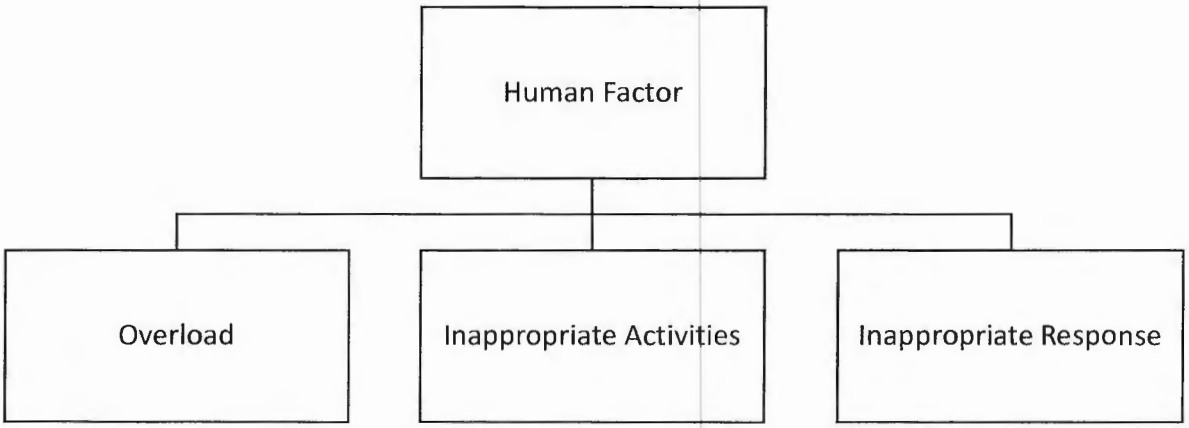

Figure 2.3
Human Factor Theory
Source: Friend and Kohn, 2018

2.3.3 INCIDENT THEORY

The incident theory by Petersen (1978) extends the human factors theory. This theory was also known as Petersen's accident/incident theory. The theory redefines some of the issues in newly introduced elements, namely ergonomic traps, the decision to err, and system failures. The decision to err is actually a concept derives on the "Superman Syndrome" in which Peterson explained, a person or the management may have the perception of "It won't happen to me" on an accident and thus choose to continue to work with the risk. He also put more emphasis on the management role in preventing system failures. A workplace should have system that are able to portray the hazards and the cause and effect to the management. They should also have system that strengthen the roles of management in preventing accident.

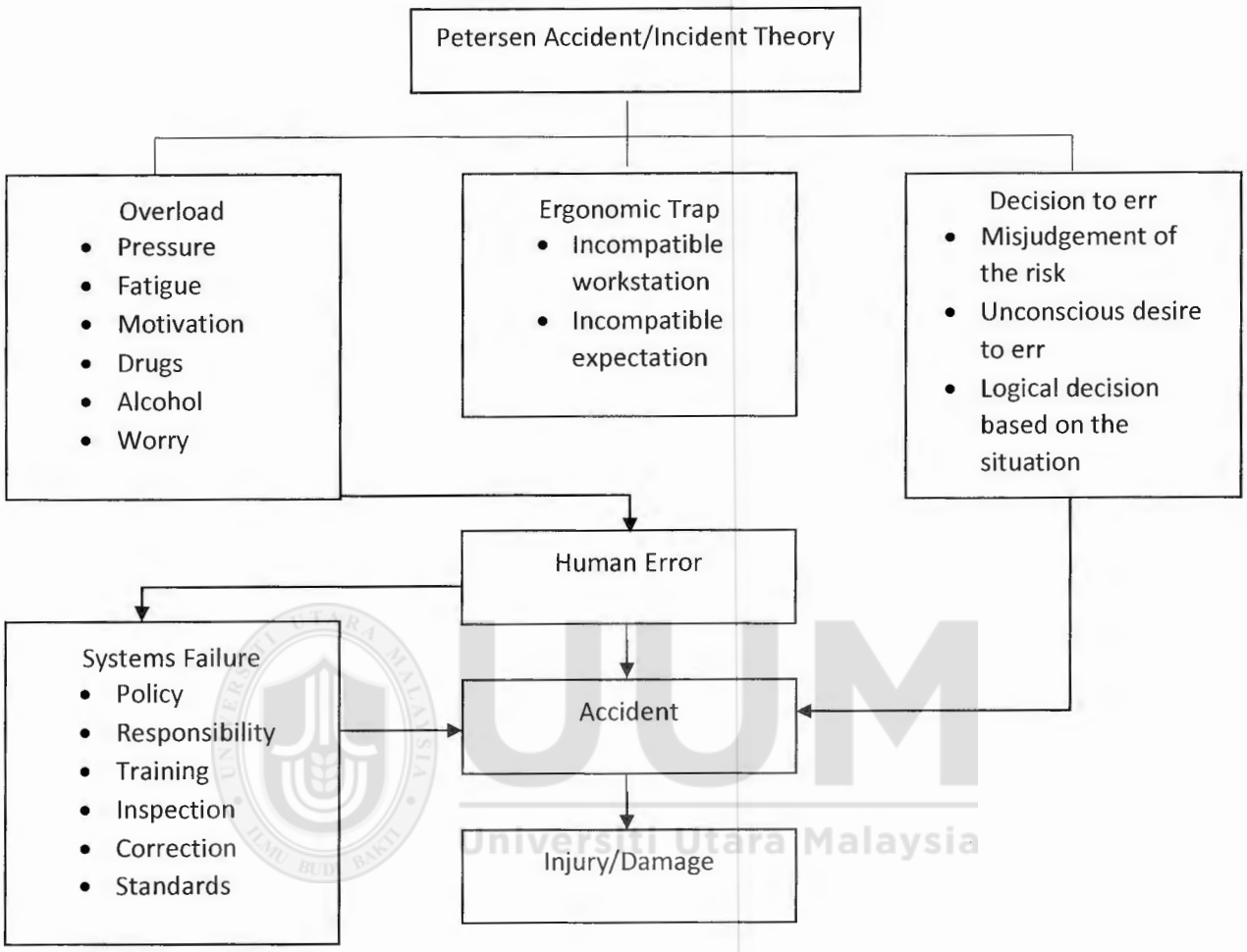

Figure 2.4
Accident/Incident Theory Model
Source: Petersen, 1978

2.3.4 MULTIPLE CAUSATION THEORY

The Multiple Causation Theory is derived from the Domino Theory which focuses on the various contributing factors and the combination of these factors that leads to an accident. According to this theory two major contributing factors that leads to an accident are categorize into behavioural also known as unsafe act and environmental also known as unsafe condition. However, under the unsafe act and unsafe condition, there are further sub-causes to them as shown in the figure 2.2 below by Stranks (2007). Examples of unsafe act includes factors related to workers such as poor attitude, lack of skills and knowledge and poor physical and mental fitness while examples of unsafe condition includes equipment without adequate guarding for hazardous parts and the poor condition of equipment through poor handling and storage which accumulates over time. Stranks (2007) also conclude that by identifying the various unsafe acts and unsafe conditions can reduce the possibility of accidents from happening.

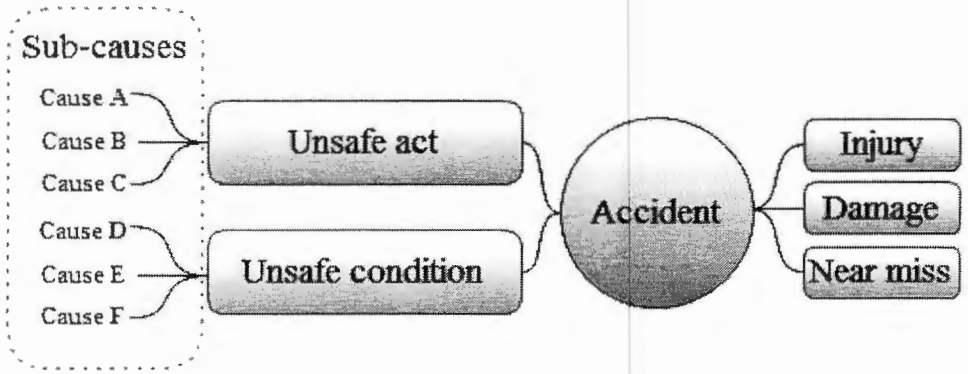

Figure 2.5
The multiple causation theory model
Source: Stranks, 2007

2.3.5 SWISS CHEESE MODEL

The Swiss Cheese model is an accident causation model in the form of a straight line proposed by Reason (2000). The model resembles a few pieces of randomly-holed Swiss Cheese arranged in a straight line with small distance between each piece (Figure 2.6). The few pieces of cheese represent the different levels of operations in a workplace while the various hole with various location on each cheese represents hazards or weaknesses in each level of operations which varies among operations thus the hole on the cheese differs among one piece to another. The portion of the cheese without hole is considered as organizational defence which prevents accidents from happening.

According to Kanki, Helmreich, and Anca (2010), organizational defence can be divided into hard and soft defences in which hard defences are safety system such as alarm system and engineering controls such as barriers and guarding while soft defences are very dependent upon human factors such as procedures that require constant training and supervision to ensure compliance. When holes in all of the cheese forms a straight clear path allowing an opportunity to pass through all the cheese without any barrier signifies an opportunity for accident to occurs (Awal & Hasegawa, 2017).

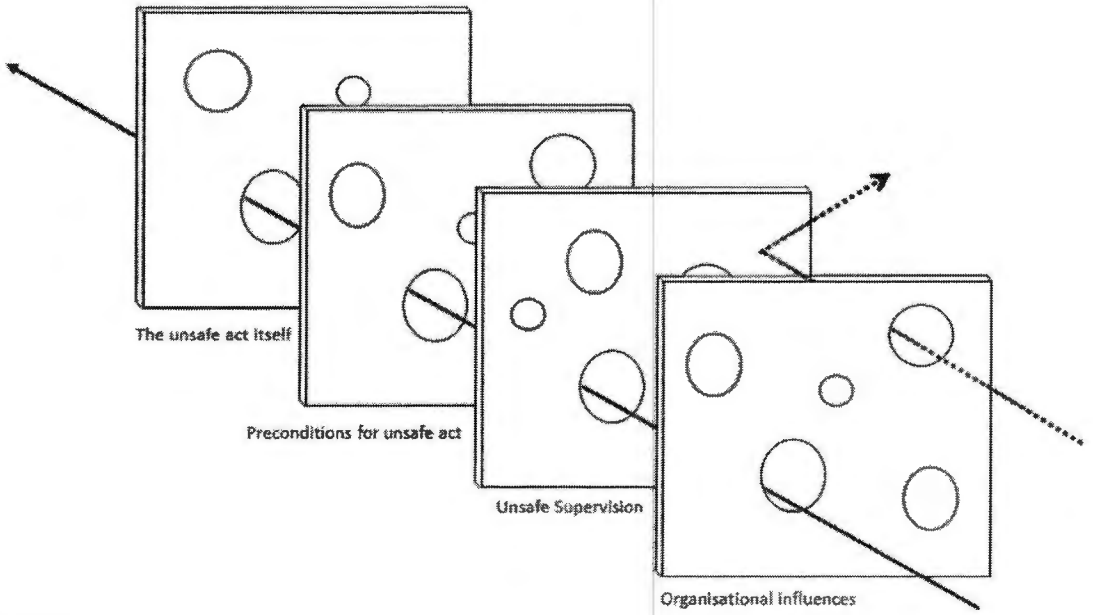

Figure 2.6
Reason's Swiss Cheese Model
Source: Reason, 2000

2.3.6 ISHIKAWA CAUSE AND EFFECT MODEL

The Ishikawa diagram also known as the cause and effect diagram is an interesting and well-known method to describe the chronology of an events leading to an accident (Górny, 2013). Fishbone diagram is use to undermine the possible causes of a problem by sorting all the possible causes into several fix classification scheme. The model which is introduced by Japanese scientist Ishikawa is based on the 5M + E method which are derived from the first letter of the factors in English which are Manpower, Methods, Machinery, Materials, Management and Environment. These 6 categories are as shown in the diagram in Figure 2.4 (Hola, Nowobilski, Szer, and Szer, 2017) and are taken into account as the main category of accident root cause. Each category contains further sub-factors that is related to the category for example under manpower, sub-factors include worker knowledge, worker skills, worker training and other manpower related factors that are possible factors leading to the particular accident while under materials. Septiawan and

Bekti (2016) conclude that the fishbone diagram is very helpful in determining the root cause of a problem using a structured approach and helping researcher in their studies by enabling the researcher to identify the specific and necessary areas where more focus should be put into and data should be obtained to achieve the goals of their studies.

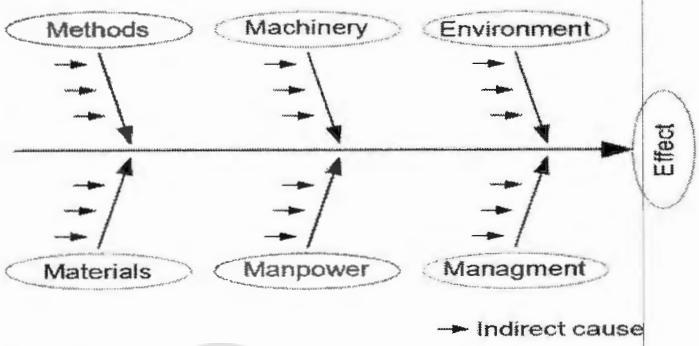

Figure 2.7
Ishikawa cause and effect model
Source: Hola et al. (2017)

2.3.7 SUMMARY OF THEORIES

The accident theories discussed were summarized in table 2.2.

Table 2.2
Summary of theories

Theories	Summary
Domino Theory	Workplace incident happens as a result of a complete step-by-step sequence of five factors in a domino effect. Removal of one factor can prevent the workplace incident
Human Factor Theory	Workplace incident happens due to overload, inappropriate response and inappropriate activities which are part of human factor
Incident Theory	Workplace incident happens due to overload, ergonomic trap and decision to err which is a further extension to the original human factor theory that leads to accident and injury.

Multiple Causation Theory	Workplace incident happens due to two major contributing factors which are categorize into behavioural also known as unsafe act and environmental also known as unsafe condition
Swiss Cheese Model	Workplace incident happens when a straight clear path pass through all the cheese without any barrier through the various hole on each cheese which represents hazards or weaknesses in each level of operations. Effective safety measures implemented will close the hole.
Ishikawa Cause and Effect Model	Workplace incident can be contributed to the following factors which are Manpower, Methods, Machinery, Materials, Management and Environment or combination of factors.

2.4 **OSH LEGISLATION IN MALAYSIA**

Different country has their different procedure in terms of obtaining permits and in Malaysia, several of the main laws that are involved in the construction sector includes Occupational Safety and Health Act 1994 (OSHA 1994) and Factory and Machinery Act 1967 (FMA 1967) both govern by DOSH under the Ministry of Human Resources. The Uniform Building By-laws 1984 is also taken into consideration when constructing a building in terms of approval, permits, structural requirements, construction requirements, space, ventilation, fire alarm and miscellaneous requirements as stated in the by-law. Other related legislations such as Environmental Quality Act 1974, Street, Drainage and Building Act 1974, Fire and Services Act 1988 are also used and referred when constructing a building.

The Malaysia Occupational Safety and Health Act 1994 (Act 514) was adapted from the British Occupational Safety and Health Act of 1970 with the primary objective to secure the safety, health and welfare of persons at work against hazard and risk at the workplace. Among the legal outline includes the requirement of companies to have safety and health policy, safety and health committee, safety and health officer, duties of employer and employees with respect to safety and health at the workplace. The act emphasized on the concept of self-regulation approach in which organizations establish their own safety programs based on the risk identified at their own workplace. As different industries poses different hazards and safety programs implemented at a construction site may not be 100% suitable to be implemented at a factory setting thus the phrase "as far as practicable" are taken into account in which the safety programs implemented must take into consideration the severity of the risk, the availability of mitigation measures and the cost involve. Thus the concept of self-regulation together with co-operation, consultation including involvement of employees and employers are the key concepts of the OSHA 1994 in order to improve the standards of safety and health in the workplace.

One of the long term goal of the OSHA 1994 is to create a safety culture among employees and employers in Malaysia which prioritize working in a healthy and safety manner (Bakri, Zin, Misnan, Yusof and Mahmood, 2006). The latest changes to the OSHA 1994 was the replacement of the (Classification, Packaging and Labelling of Hazardous Chemicals) Regulations 1997 (CPL Regulations) with the Occupational Safety and Health (Classification, Labelling and Safety Data Sheet of Hazardous Chemicals) Regulations 2013 (CLASS Regulation) and the aim of the CLASS Regulations is to ensure hazardous

chemicals are well managed in order to reduce the risk of chemical accidents in the workplace. The Department of Occupational Safety and Health (DOSH) under Ministry of Human resources are responsible in carrying out enforcement under the act.

Under the OSHA 1994, Section 29 stipulate the needs for a Safety and Health Officer at workplace however the Safety and Health Officer 1997 Order states that a Safety and Health Officer is only required for construction projects with sum exceeding twenty million ringgit only. Thus for smaller construction projects with sum not exceeding twenty million there is no legal responsibility to hire a safety and health officer to assist the project in safety related requirements which may result in higher risk of workers being exposed to hazard leading to injuries and accidents at site. As mentioned by Kanchana, Sivaprakash, and Joseph (2015), small scale projects are more prone to construction site accidents compared to large scale projects as the small scale projects are not aware of the safety requirements. In addition to that, without a safety and health personnel to carry out safety related trainings to workers, inexperienced workers are more prone to accidents.

Part VIII (Notification Of Accidents, Dangerous Occurrence, Occupational Poisoning And Occupational Diseases, And Inquiry) and section 32 of the OSHA 1994 requires employer to notify the nearest DOSH Office on any accident, dangerous occurrence, occupational poisoning or occupational diseases which has occurred at his workplace while Medical Practitioner are required to report patients they are treating whom they suspect are diagnose with any occupational disease or poisoning. This part also states that the Director General can sought for an inquiry to be held with regards to any accidents

or occupational related diseases to further understand the nature and causes of the issue. This part is further strengthen under the Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease Regulations 2004 (NADOPOD), which states the requirement of employer to immediately inform the nearest DOSH office with respect to any notifiable incident as stated in this regulation under the First, Second and Third Schedule through the usage of JKKP 6 form for work-related accident or dangerous occurrence and the usage of JKKP 7 form for Occupational poisoning or occupational disease. Exception as stated under the regulation of notification such as reporting of any death, injury or condition of a person shall not apply to a patient when undergoing treatment in a hospital or surgery by a doctor or dentist. Employers are require to submit a yearly register to DOSH through the usage of JKKP 8 form before the 31st of January each year summarizing the incident data of the previous year.

2.5 **ACCIDENT UNDER-REPORTING**

Apart from legal requirement on accident reporting as explained in previous section, the importance of accident reporting is to find the root cause in order to carry out effective mitigation measures and not for the purpose of fault finding which are the general perceptions of industries and stakeholders thus leading to under reporting. There have been many cases of under reporting particularly at small construction projects at rural areas and National Institute of Occupational Safety and Health (NIOSH) in a report mentioned that 80 percent of accidents at Malaysian workplace are not reported (News Straits Times, 2017). Studies on under reporting of accidents by Lim (2008) in construction industry in Malaysia identified one of the factors of under reporting are human factor related in which

organization lack knowledge and importance of accident reporting. Probst and Estrada (2010) in their studies found that under reporting was significantly higher compared to reported accidents especially in working environment with poor safety culture and practices due to inconsistent safety enforcement. Studies by Moore, Cigularov, Sampson, Rosecrance, and Chen (2013) discover that the frequent reasons given by workers for not reporting accidents in a construction site were related to fear of retaliation and negative consequences if they were to report the accidents thus giving the perception to workers that injuries are part of the job in the construction industry.

Thus it proves to be a challenge to researcher carrying out studies on root cause of accidents due to under reporting and usually those reported cases are only cases that are not able to be hidden due to the impact they cause such as those involving workers fatality or the public. Majority of the minor and medium accidents are usually not reported thus leading to a difficulty in understanding the actual safety culture and practices in the construction industry in Malaysia. Nevertheless, this study will try to analyze as much as possible the root cause of accidents in construction industry based on the reports obtained in a mega project in Klang Valley Malaysia.

2.6 PAST STUDIES ON FACTORS LEADING TO WORKPLACE INCIDENTS

2.6.1 Man

Research from Kolo (2015) and Kadiri et al. (2014) found that human error such as carelessness, negligence and failure to follow safety rules cause accident while Haslam et al. (2005) found that common cause of construction accidents in the UK are human factors

related and Hinze, Huang, and Terry (2005) also state that human errors are mainly responsible. Examples include incorrect working method of individual worker or working team and incorrect equipment being used as well as not using personal protective equipment. Aksorn and Hadikusumo (2007) also identified the elements of human error which are laziness and doing works they are not skilled in.

Another Man factor causing accident are identified as lack of training which is also supported by previous research by Goh et al. (2016) and this was also supported by findings from and Kadiri et al. (2014) who state that non-certified skill labour are at risk of workplace accident. The implementation of safety and health training in the US shows that the statistics of construction fatality rate has declined by 47 percent since the federal government adopted "collaborative safety" nearly a decade ago. Out of every 100,00 workers, the fatality rate has significantly dropped from approximately 12.9 fatalities in 2000 to 9.6 in 2008. Further statistics shows that the number of dangerous work injuries in 2008 are 5071 cases and has reduced from 5657 in 2007 showing a reduction of 20 percent (Earl, 2010). Lack of skills in workers carrying their works (Aksorn & Hadikusumo, 2007) are one of the problems that occur at the construction site causing accidents. Most of the workers at construction site do not have adequate skills and knowledge partly because of low educational levels (Zou & Zhang, 2009 and Tam, Zeng, and Deng, 2004) which affects their safety knowledge and working skill.

Over the years, there had been several studies on the impact of safety and health training on injury in the construction industry. Mbuvi et al. (2015) states that knowledge, skill and ability of workers towards workplace risk have the possibility in minimizing accidents. Training (Teo, Yean, and Sern, 2005) and toolbox meeting (Bizzell, 2008) are

considered effective training method to prevent construction accidents among workers as they provides the workers with what information on hazards present and how to work safely at construction site while giving updated safety information to workers. A study by Lingard and Rowlinson (1997) reported that there was a highly significant improvement in construction site housekeeping after the implementation of a safety training program at seven construction sites in Hong Kong. A study by Kinn, Khuder, and Busesu (2000) on the effect of safety orientation and training among plumbers and pipefitters in north western Ohio to prevent injury at work reported that employee safety orientations help to reduce the rate of injuries significantly. In one of the study done in Batam Indonesia by Permana (2007), it was discovered that one of the safety practices is education and training which are to be provided to the workers constantly as refresher to prevent and reduce accidents. According to Paringga (2010), education and training are designed to prevent human error that may cause accidents. This is to enable workers to perform a repetitive task with skill. Lai, Liu, and Ling (2011) also stated that safety training is the most effective tools in mitigating hazard as training helps to improve workers skills and abilities to identify hazard.

2.6.2 Management

Studies by Rozenfeld, Sacks, Rosenfeld, and Baum (2010) and Lingard and Holmes (2001) found that poor management skills resulting in poor planning and implementation of safety measures at the workplace correspond to poor safety commitment. A study by Asilian-Mahabadi, Khosravi Hassanzadeh, Hajizadeh, and Behzadan (2017) also states that the

reluctance of organization to allocate resources for safety related issues and lack of organizational commitment apart from poor safety awareness among organizations top management among the factors influencing accidents at workplace. Without the commitment of the top-levels in terms of resources and support, implementation of safety activities and plans will no doubt be hard since safety issues often compete with other operations issues, notably productivity (Wiegmann, Zhang, Von Tahden, Gibbons, and Sharma, 2004 and Zohar, 2008).

According to Petersen (2000), excellent health and safety commitment by management must fulfil the following criteria such as management and supervisors exhibits safety through their daily behaviour in line with safety as a major core value of an organization, management and supervisors are involve in overall aspect of safety including planning and execution at workplace, taking the necessary actions related to safety which is visible to employees, allow flexibility when required based on situation and open to feedback and good positive relationship with employees. Wilson, Haines, and Morris (2005) also shares few similar criteria as mentioned by Petersen (2000) as keys to successful safety programs which are involvement to the project from the top management to the workers below, a qualified personnel to support and facilitate the process, commitment by senior managers and stakeholders, a supportive environment and an open communicative organisation in which discussions are made and every workers' opinions evaluated.

One of the study done by Griffith and Howarth (2001) defined that management commitment is done through safety policy which is a publish statement reflecting the organization vision and mission in relation to the management of health and safety matters.

Furthermore, Dorji and Hadikusumo (2006) did a study on safety management practices in Buthanese construction industry explained that safety policy is a written statement of principles and goals which can demonstrate top management's commitment to ensure safe working methods and environment at the construction sites. Involvement of the management team in safety and health culture are important in cultivating positive beliefs, practices, norms and attitude in health and safety practices in the key players (Misnan & Mohammed, 2007). Another important factor which can significantly affect the success of safety in workplace is the degree of employee involvement in health and safety programs. These factors, combine with the continuous support and commitment from the top management is vital in ensuring the success of safety intervention in improving the level of safety in the workplace (Kuorinka 1997 and Wilson et al., 2005). Kartam, Flood, and Koushki (2000) found that several organizational factors that contributed to safety incidents include poor record keeping and incident reporting system and poor management of the workforce by relying too much on sub-contractors.

2.6.3 Method

A research conducted by Workplace Safety and Health Council (WSH) in a report titled 'Case Studies Of Accidents Involving Working at Height' published in 2017 by the Singapore Ministry of Manpower who studied 15 cases of accidents involving working at height. In the report, it was conclude that majority of the accidents was due to Risk assessment not adequately conducted and did not fully captured all the work activities and was very general such as risk assessment for working on scaffolding did not capture the work of erecting and dismantling scaffold and the risk assessment of using ladders only cover A-frame ladder and did not cover the use of extension ladders.

A research report by Loughborough University titled "Causal factors in construction accidents" reported that most construction accidents are found not covered in the risk assessment being done and most of the risk assessment are general and would not have prevented the accident. The report further stress that the construction industry should focus on actively assessing and controlling the construction risk and not conducting risk assessment just for the sake to fulfil requirements which ended up becoming a paper exercise which is not helpful in really preventing accidents in the industry. Several methods and models have been proposed by researchers in the past connecting risk assessment to construction hazards to signify the importance of conducting risk assessment which consist of hazard identification and risk control. Examples are method proposed by Liu and Tsai (2012) which focuses on construction hazard types and causes, Mitropoulos and Namboodiri (2011) technique on measuring construction activities and their risk, and Carvajal (2008) who proposed the Occupational Safety and Health Cycle which include risk assessment and prevention out of the five safety cycle he proposed and this model was later adapted by Sanchez, Pelaez, and Alis (2017) in his proposed model which further stresses on risk assessment and risk prevention to prevent accident in construction sites.

Studies by Cheah (2007) in the construction industry in Singapore found that insufficient intervention from government in contractor safety programme and ineffectiveness of current safety legislation as contractors tend to practice the minimum requirement in terms of safety and health leads as a factor to construction safety. The researcher also believed that external pressure such as tighter and harsher legislation can help to improve the level of safety and health among contractors rather than waiting for the contractors to improve on their own. Hamid, Yusof, and Singh (2003) identified lack of

enforcement by authority as one of the factor of poor safety and health implementation at workplace and a study by Au Yong, Ali, and Ahmad (2014) also found that government involvement through inspection by authorities were significant in improving the safety performance of the workplace.

2.6.4 Machine

Previous studies related to machinery factor include studies by Lubega, Kiggundu, and Tindiwensi (2000) and Pipitsupaphol and Watanabe (2000) who found mechanical failure and unsafe equipment as few of the causes of accidents. Mohammadfam, Soltanzadeh, Moghimbeigi, and Akbarzadeh (2014) in his study found that failure in equipment and machinery together with unsafe actions and conditions plays an important role in construction related accidents while Kadiri et al. (2014) also identified poor equipment and maintenance as part of the vast factors leading to construction accidents.

2.6.5 Material

In terms of material factors, there were some previous studies such as by Kadiri et al. (2014) who conclude that lack of protection during material transportation including storage can cause workplace incident and by Kemei, Kaluli, and Kabubo (2015) who also relate poor arrangement of construction materials including equipment to construction accidents. Studies by Williams et al. (2017) found that poor material handling as one of the causative factor in construction accidents while Haslam et al. (2005) and Palaniappan, Sawhney, Janssen, and Walsh (2007) relate construction accidents to material standard and suitability of material used.

2.6.6 Environment

Studies by Im et al. (2009) who associates the constant changes of worksite condition in construction projects due to the nature of the work with construction related incidents. Goh et al. (2016) also states that environmental factors such as poor jobsite conditions due to poor housekeeping as responsible for accident at construction sites while Abdelhamid and Everret (2000) states that jobsite condition such as inadequate guarding, slippery and muddy surface, hazards arising from poor housekeeping and limited working area can cause hazard and affect workers safety on construction site. Hamid, Majid, and Singh (2008) did a study on construction accident based on data obtained from DOSH and elaborate that jobsite condition such as poor materials and equipment including waste arrangement, slippery and muddy surface and poor illumination contributes to construction incident. Studies by Abdullah and Wern (2011) found that the risk of construction accident increase due poor jobsite condition such as messy and cluttered due to poor housekeeping.

CHAPTER 3

METHODOLOGY

3.0 INTRODUCTION

As mentioned in the title, this chapter will discuss on the research methodology of the dissertation in which the research strategy and approach will be explained. This chapter also includes the data collection method, data analysis, considerations on ethics and the limitations during carrying out the research project.

3.1 RESEARCH APPROACH

A qualitative research was carried out to achieve the objective of the dissertation. As summarized in Table 3.1 adapted from Miles and Huberman (1994), a qualitative research is generally more suitable for research that have small samples in which its outcomes are not measurable and quantifiable. Based on Collis and Hussey (2013), a qualitative research also offers a more in depth description and analysis of a certain topic without limiting the scope of the research which differs a qualitative research to a quantitative research. Despite that, the outcome of a qualitative research may not always be recognized as reliable due to the fact that this type of research is primarily based on the skills and abilities including how a the researcher evaluate and explain the data obtained. As mentioned by Bell (2005), a qualitative research does not always reflect the opinion of a wider population due to the small samples analyze.

Table 3.1
Features of Qualitative & Quantitative Research

Qualitative research	**Quantitative Research**
The aim is a thorough, comprehensive description.	The aim is to categorize features, calculate them, and construct statistical models in an attempt to explain what is observed.
Researcher may only know more or less beforehand what he/she is searching for.	Researcher knows clearly beforehand what he/she is searching for.
Recommended during initial stages of research projects.	Recommended during later stages of research projects.
The design emerges as the study proceeds	All aspects of the study are taken into consideration and determined before data is collected.
Data gathering is done by the researcher	Questionnaires or equipment as tools to gather numerical data.
Data is in the form of words, pictures or objects.	Data is in the form of numbers and statistics.
Subjective – individuals interpretation of events is important ,e.g., uses participant observation and reports including in-depth interviews etc.	Objective: seeks precise measurement & analysis of target concepts, e.g., uses surveys, questionnaires etc.
Qualitative data is more valuable but it is time consuming, and less able to be generalized to the wider population.	Quantitative data is more effecting, able to do hypotheses testing, but may miss circumstantial detail.
Researcher tends to become subjectively immersed in the subject matter	Researcher tends to remain objectively separated from the subject matter.

Source : Miles & Huberman (1994)

3.2 SELECTED QUALITATIVE APPROACH

The research approach that was used for this research was the secondary data analysis and inductive approach. Based on Turner (1997), the secondary data analysis is the analysis of an existing databases and the primary component would include the analysis of data with the purpose of either continuing the original research analysis, addressing different questions not addressed in the original research, or using different methods to address the original research questions. In this study, the researcher aims to use secondary data to address the root cause of construction accidents in the Malaysia context based on the Ishikawa fish bone methods used in previous research by Hola et al. (2017). As qualitative research is very time consuming, beginning well before the data collection (e.g., issues of gaining access) and continuing after (e.g., analysis and verification). It is not uncommon for a qualitative database to represent years of work by the primary investigator and substantial funding through a variety of sources (e.g., universities, grant agencies). Considerable time, money, and personnel could be saved through secondary analysis of an already existent data.

Another approach in this study is the inductive approach in which the researcher produce conclusions based on spesific observation from the data obtained in the study. According to this approach, researchers begin with specific observation, which are used to produce generalized theories and come up with conclusions from the research. The inductive approach aims to generate meanings from the data set collected in order to identify patterns, comparisons and associations observed in order to reach conclusions. As stated by Saunders, Lewis, and Thornhill (2012), inductive approach does not prevent

researcher from using existing theory to formulate the research question to be explored. The main weakness of the inductive approach is that it produces generalized theories and conclusions based on a small number of observations only therefore questioning the reliability of the research results (Denzin & Lincoln, 2005).

3.3 DATA COLLECTION METHODS

Actual incident reports for a mega construction project was obtained for research purposes and the type of incident ranges from fatality, permanent disability, temporary disability, medical treatment, first aid cases, near misses, property damage and environmental damage. The term fatality refers to cases in which at least 1 worker suffers from fatal injuries while permanent disability refers to incident in which at least 1 worker suffers from injuries that causes them to permanently lose the ability to use any portion of their body parts (regardless of the percentage of disability) due to construction related incidents. Temporary disability and medical treatment are incidents in which workers are send for medical treatment and both are cases where workers are able to return to work after their injury has healed. The only difference is that temporary disability are cases which requires more time to heal and are term as injury with more than 4 days medical leave (reportable incident as per NADOPOD 2004) while medical treatment cases include outpatient treatment and those with medical leave of 3 days and below. First aid cases are cases in which the construction site first aider can attend to which are usually minor issues such as small cuts or wounds while near misses are incidents that have the potential to cause injury but due to circumstances, the injury was avoided. Property damage and environmental damage are cases where no workers are injured but significant impact occurs to the property or environment due to construction activities.

3.4 DATA SELECTION (INCIDENT REPORT CASES)

The data will be limited to construction incident reports with reports obtained from 2016 until end of April 2018 with cases that are reported and complete incident reports submitted are taken into the studies as reports with insufficient details or incomplete reports will give researcher insufficient information for analysis. All the incident report cases are prepared by competent construction personnel who are experience in the industry based on their positions which are Project Directors, Project Managers and Safety and Health Managers from both client and contractor. The methods used by these competent personnel are primarily based on site investigation including interviewing the affected parties (victims and witness) before preparing the official incident report. The study are very based on the information obtained from the reports and some factors maybe more significant compared to the other factors as this study are focus entirely on construction industry in a Malaysia context and the results may differ compared to previous studies conducted in similar or other industry overseas.

3.5 DATA COLLECTION PROCEDURE

The researcher working under the Safety, Health and Environment (SHE) Department approaches Mr S who is Head of Department of SHE in early June 2018 to get verbal approval on obtaining construction incident reports for research purposes which can be useful to the company in identifying important factors leading to construction incidents at the mega project. The results will be very useful as the data was never analyzed prior to this which was agreed by Mr S who also states that he intend to present to the top management as a key indicator of areas lagging in the project in order to achieve better

workplace SHE performance which includes an incident free workplace. Further verbal approval was then obtained from Mr R the Project Director in the presence of Mr S after explaining the purpose of the research and how the data can benefit the company including presentation of the data from Mr R to the project client. However, the two main criteria given was that since full confidentiality must be done by the researcher in his university thesis to ensure that the data are solely for educational purposes and should never disclose the source or anything related to the mega project due to the image of the project including stakeholders concerns and public perception as accidents and incidents are a very sensitive subject and the second criteria was that the data analysis should only be done after working hours which will not affect the researchers day to day work at the company which was fully agreed by the researcher. The researcher then obtained the records from the filing room and internal server in end June 2018 and thus begin analyzing and summarizing the data obtained.

3.6 **DATA ANALYSIS**

All the incident reports will be analyzed in details and a summary of incidents will be compiled into a table to show the types of incidents as explained above and a short brief description of what happened. Each incident report will then be studied thoroughly to understand and obtain information such as types of activity during incident, time incident occurs, types and classification of incidents and detailed analysis of the incident reports done in order to gain more in-depth understanding of unsafe act and unsafe condition causing construction incidents. The data analyzed will also identified construction incident

factors which are people, machine, material, method and environment. Each factor will be further analyzed and divided into specific root causes to better identify the specific issue and areas required for improvement rather than just the People, Method, Material, Machine and Environment factor which is very wide. The example of root cause are as in Table 3.2 which are just preliminary and root causes will be further removed or added by the researcher based on the data from the incident reports as research progresses. The information will be presented in tables and charts for better understanding and easy visual to readers.

3.7 **ETHICAL CONSIDERATIONS**

As mentioned earlier in the data collection procedure on the importance of confidentiality due to the image of the mega project and the company, the researcher will slightly amend the information in the incident reports such as removing the names of victim, exact jobsite location in which incident occurs, vehicle number plates and other information seems necessary to ensure upmost confidentiality of the source of the data being obtained. However, all the information amended will not affect the outcome or analysis of this study as the information amended are not used in analysis of the required information. This data obtained is strictly for research purposes and not meant for any unintentional usage apart from the objective of this study as mention

Table 3.2

Root causes of factors leading to construction incident

Factors	Example of Root causes
People	-Inadequate training / knowledge of the job -Lack of experience -Misunderstood instruction given -Confusing / conflicting direction / demands -Others
Method	-Inadequate risk assessment - Lack of work coordination and control -Inadequate planning and monitoring of initial operation -Inadequate design criteria -Others
Machine	-Inadequate inspection -Inadequate repair and servicing -Inadequate human factor consideration -Inadequate removal or replacement of defective / unsuitable items -Others
Material	-Improper handling of material -Improper transportation of material -Improper storage of material -Inadequate communication on CSDS -Others
Environment	-Hazardous atmosphere -Reduced visibility -Extreme temperature -Others

Source: Researcher Data (2018)

3.8 **CONCLUSION**

This study will adopt the qualitative research approach in which the researcher will focus on the phenomenology as the theoretical perspective (Robert & Sari, 2003) in which the researcher will try to understand in depth the events (construction incidents) and their interaction with the possible causal factors (People, Method, Material, Machine and Environment) based on secondary data analysis and inductive approach. The data will primarily consist of actual incident reports as mentioned due to the time limitation. The study will try to identify root causes leading to construction incidents as research progresses. Brannen (2017) states that according to The Dilemma of Qualitative Method by Herbert Blumer, qualitative study should be flexible so that the research can always adapt and look towards a different direction based on the information continuously obtained during the process of data collecting, coding and analyzing in order to get better understanding of the issues studied.

CHAPTER 4

RESULTS AND DISCUSSION

4.0 INTRODUCTION

This chapter begins by describing the summary of data obtained and analyze following by detailed analysis on the types of activity during incident, time incident occurs, types and classification of incidents on construction related incidents followed by the factors leading to construction accidents such as man, material, machine, method and environment factors

4.1 SUMMARY OF DATA OBTAINED

Incident report from 2016 to 2018 was obtained from the project and analysis were done by the researcher to identify several key information such as the activity being carried out during the incident, the time in which incident occurs, the category of incident including the extent of injury or damage, the type of incident whether it is due to unsafe act or unsafe condition and the root cause analysis to gain better understanding of the research topic. A total of 73 incident report were obtained consisting of 8 reports from 2016 where the project just started, 45 reports from the year 2017 and 20 reports in 2018 taken up till end of April 2018. All the data in this research are solely based on the incident report submitted by the project subcontractors to the client and the data are extracted based on the details written in the report together with the researcher insight based on the details written to categorize them into the appropriate table accordingly. The overall 73 incident report being

summarize in this research include details on incident date and time are attached in Appendix A. Some details such as people name, vehicle number plate, name of places was amended to ensure confidentiality of the project. The details amended do not affect the outcome or analysis of this study as the details are not used in analysis and are merely to show readers that the data obtained are genuine and from actual incident reports happening during a construction of a mega project in Malaysia.

4.2 TYPES OF ACTIVITY DURING INCIDENTS

From the data analyzed, the activities taking place during incidents are majority from construction works since the data is obtained from a construction project. However there are few incidents which are non-construction related such as security incidents and traffic management as summarized in **Figure 4.1.**

Out of the 73 incident reports, the highest number on incidents occurred are related to Operating Mobile Construction Equipment/Vehicle in which incident occurs due to works involving the operation of crane, excavator, backhoe lorry, low loader, truck, trailers and cement lorry amounting to 20 incidents from the data obtained. Examples of incident occur include construction vehicle striking or damaging nearby property such as hitting barrier, gates, poles or other vehicles. Few incident occurs due to crane and lorry losing balance during operation causing the vehicle to overturn or falling into nearby slope or drains. It can be conclude that since this construction project involves a huge area stretching over several kilometers on pier construction works along some major and busy routes in Klang Valley thus the numbers of construction vehicles involve are huge as works are

carried out simultaneously at few locations by different subcontractors since space constraint is not an issue in this project. In simple words, the more construction machinery is involve, the higher the risk of incidents involving construction machinery can happen. If compared to a high rise project of building hotels or residential condominiums, the construction area are more limited and thus there is lesser construction vehicles involve due to space constraint and this will certainly reduce the risk and numbers of incidents involving construction vehicles.

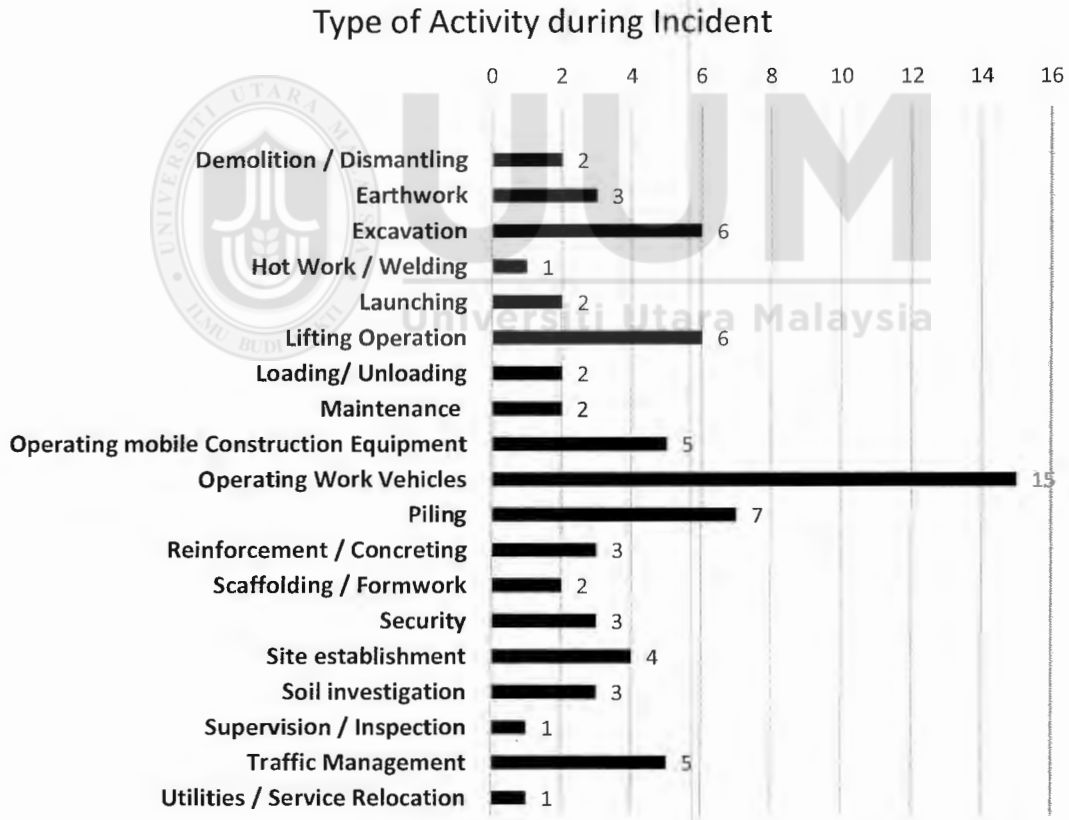

Figure 4.1
Types of activity during incident
Source: Researcher Data, 2018

The second highest type of activity which occurs during incident are Piling and followed by Excavation and Lifting Operation. Piling incidents account to 7 cases from the data obtained in which there was a case whereby a workers' hand got caught during piling operation leading to injury and 2 cases in which failure of piling machine parts cause the load to drop during work. The remaining cases consist of 2 cases in which public underground pipe were damaged due to piling works and the other 2 cases are movement of soil and earth due to piling works causing safety issues to nearby buildings and properties. Piling are major process of construction as piling works involves driving piles into the earth to build the foundation of a building and a poor foundation can cause the building to collapse during later stages of construction as the foundation is not able to take the full load of the building being built above it. The piling process involves boring machine to dig holes and piling machines to drive piles and during the process involves a lot of shaking and heavy vibration to nearby structure and thus few of the incidents as analyzed from the data are related to movement of earth and soil and in some cases can cause the nearby building to crack and damage and in some extreme cases causes landslide due to the rapid earth movement. Piling machine was one of the machine exempted from certificate of fitness based on the Factories And Machinery (Exemption of Certificate of Fitness For Hoisting Machine) Order 2015 and this order requires employer to carry out risk assessment, ensure safe operating procedure, routine maintenance and inspection conducted, training to those involve in the piling activity and proper documentations to record all the relevant information on the piling machine and activity.

Lifting Operation and Excavation recorded 6 incidents and examples of Lifting operation related incidents include improper lifting activity without proper lifting plan and supervision which creates danger and risk to workers including loss of load being lifted. There is also one incident in which a worker got his finger caught under the timber while the timber is being lowered down to the ground. Lifting operation involving cranes are consider high risk activity due to the nature of the activity which can cause severe injury including fatal cases if not managed properly. The importance of competent crane operators together with trained lifting supervisor and riggers including signalman to facilitate the lifting process in accordance to the lifting plan being prepared are very crucial in determining a safe lifting operation. Information such as weight of the load, safe working radius, safe boom angle, condition of soil, wind speed are important as any of these factors if wrongly calculated can lead to catastrophic event such as overturning of cranes. Recently DOSH Malaysia issued a Special Order in 2017 relating to Safe Lifting Operation (*Perintah Khas Ketua Pemeriksa Kepada Pengurus Projek Berkenaan Pengurusan dan Pengendalian Selamat Kren Menara 2017)* which required Project Managers of construction project to ensure all the components of safe lifting operation such as valid certificate of fitness of crane, hiring of competent operator, permit to work system, inspection of Lifting gears in good condition, functioning of all safety devices on crane and proper documentations are comply at all times at workplace.

Excavation related incidents include collapse of wall structure due to excavation activity leading to a worker being injured in the process, backhoe fell down due to working at slope area and cases of excavation activity damaging utilities such as underground piping and cables. Excavation activity are also consider another high risk activity due to the

constant changes in the work environment as the continuous excavation and digging by excavators cause constant unexpected movement of earths and soils can affect the stability of the earth condition which can lead to workers being buried underneath or machines falling from slope due to changes on the ground condition just like what happened in one of the incident from the incident report obtained. Just as recent as October 2017, 11 workers (10 foreigners and 1 Malaysian) lost their life due to a sudden earth movement at a construction site in Penang leading to the workers being buried alive cause concern among the public and authorities and this incident resulted in the contractor being blacklisted and further summons and penalties imposed on them by DOSH Malaysia as reported in News Straits Times (2017) and other local medias. A Guidelines on Occupational Safety and Health in Construction Industry (Excavation Work) 2017 was introduced few months prior to the incident emphasizing on risk management and risk control of excavation activity clearly shows the importance of safety aspect during excavation works and if this guideline was adhered by the contractor in the Penang incident particularly on slope protection and slope monitoring; it is very possible that the incident might have being prevented.

4.3 **TIME INCIDENT OCCURS**

An analysis was also done on the time of incident to determine the probability of incident occurring during certain hours of the day and the time frame has been divided into 2 major division which are normal working hours of 8 am-5.59 pm and overtime working hours which include night works ranging from 6 pm-7.59am as shown in Figure 4.2. The analysis found that 56 incidents occurred during normal working hours in which 22 incident occurring between 8am to 12pm and 34 incidents occurring between 12pm to 6pm. There were only 17 cases of incident occurring after normal working hours in which 10 cases

occurring from 6pm to 12 am and 7 cases after 12am until 8am and this was due to the low level of activity and low number of workers and machineries operating at night in order to minimize the noise level. Under the The Planning Guidelines For Environmental Noise Limits And Control 2004 by the Department of Environment Malaysia clearly states that the allowable noise level residential area must be below 50dBA from 10.00pm to 7.00am (based on Schedule 1 of the Guideline) and since this mega project involves a long stretch of construction works passing through various residential locations, thus the night activity had to be reduced to prevent complains from nearby residents. In addition, this mega project was subject to strict and stringent requirements under the Environmental Impact Assessment especially in implementation of noise barrier as past projects such as the Star and Putra lines in Klang valley was flooded with complaints by public as reported in an article on the Star Online titled "Drowning out the noise" dated 31 July 2016.

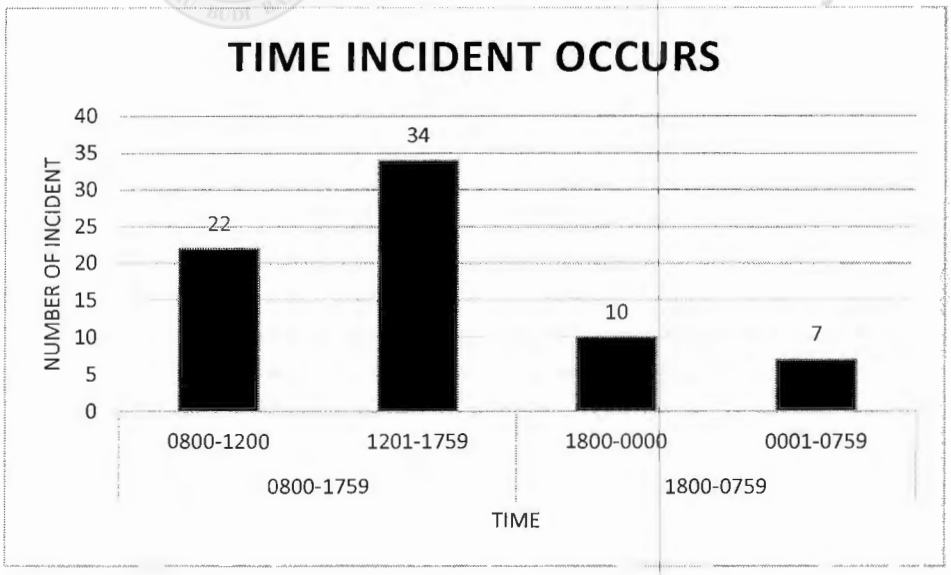

Figure 4.2
Time Incident Occurs
Source: Researcher Data, 2018

4.4 TYPES AND CLASSIFICATION OF INCIDENT

The researcher also analyze the data to identify the types of incident that occurs and found that a high number of the incidents was due to being "struck by stationary or moving objects" which recorded a total of 15 cases and example of cases involve workers being hit by machinery and public vehicle during work and few cases of damage to construction equipment especially barriers being hit by both construction and public vehicles. This is follow by 12 cases of "striking against stationary or moving objects" in which construction activity such as boring and piling works, excavation, soil drilling, movement of construction machinery causing damage to public utilities such as underground piping and water pipe, fiber optics cable, overhead and underground electrical cable.

This is follow by 6 incidents of "crane related incident" and "Caught in or between object or moving object" such as getting caught between concrete bucket and starter bar, getting caught between extension pile and starter pile and getting caught between load and the surface to land the load. 5 out of 6 incidents of caught in or between object or moving object ends with workers receiving medical treatment due to finger or hand injury as the hand is consider the tools workers used the most during work and especially during handling two separate objects during a single activity and further analysis found that these incidents could have been prevented if workers use a tool to guide the object instead of using their hands to guide the object. In addition, using a high quality hand protection such as an impact resistant hand glove may have reduced the injury but usually construction site workers are only given basic glove or sometimes even without glove based on the extent of injury suffered by workers in these 5 cases.

The results analyzed also shows 5 incidents of "Collapse of formwork/ failure of support structure" such as collapse of retaining wall and evidence of rebar jig collapse after being partially dismantled and left over the night. There is also 5 incidents of "slip, trip, fall" in which 3 incident involves workers slipping, tripping and fall during work while the other 2 incident involves machinery skidding from track. The remaining types of incident are as summarized in Figure 4.3.

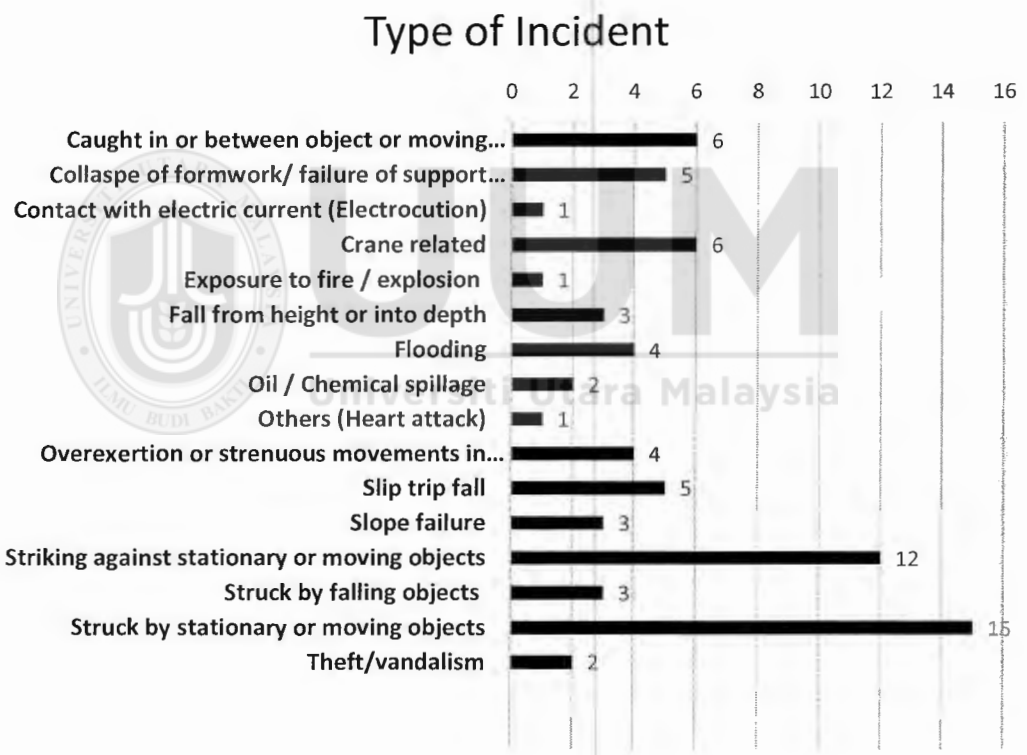

Figure 4.3
Type of Incident
Source: Researcher Data, 2018

From the incident reports obtained, the incidents were classified into different classes based on the consequences of the incident such as fatal incidents, lost time injury with permanent disability, lost time injury with temporary disability, first aid cases, near

miss, dangerous occurrence, environmental incident, traffic incident, property damage incident and others. The Malaysia OSHA 1994 NADOPOD was used as the main baseline in drafting and determining the majority of classes of incidents and the researched added few other categories such as traffic and environmental incident was added in order to categorize all the 73 incident reports into appropriate and suitable classes. A special classes named "others" was added to take into consideration incidents that may happen in construction sites such as theft or riot among workers. The definition of each incident and the analysis from the 73 incident reports are as summarized in **Table 4.1.**

Based on the earlier model propose by Heinrich consists of the ratio 300-29-1 states that for every 300 near miss incident, there is a possibility of 29 minor injury and 1 major injury coincides with the data from this study as shown in Table 4.1 whereby 23 near miss incidents together with 17 minor injury and 2 fatal cases are very alarming and coincides with the model proposed by Heinrich. From the data analyze, the highest number of incidents are Near Miss incidents recording a total of 23 incident from 73 reports followed by 16 traffic incidents and 11 medical treatment cases. Other significant data are 2 cases each related to fatality accident, Loss time injury causing temporary disability and dangerous occurrence at the workplace which are consider reportable incidents under the Occupational Safety and Health Act 1994. Under NADOPOD, an employer needs to immediately inform the nearest DOSH using the appropriate forms (JKKP 6,7) if any workers suffered work related fatalities, serious bodily injury as listed under First Schedule of the Regulation, Dangerous Occurrence as listed under Second Schedule and Occupational Poisoning as listed under Third Schedule.

Table 4.1
Summary of type, definition and number of incident

Class	Type	Description of Incident	No. of incident
1	Fatality	An incident that results in the death of the person due to an occupation activity.	1
1A	Fatality	An incident that results in the death of the person not related to an occupational activity on site.	1
2	LTI Resulting in Permanent Disability	An incident which involves injury to an employee that prevents the person from following his normal occupation and involves permanent disability.	0
3	LTI Resulting in Temporary Disability	An incident which involves injury to an employee that prevents the person from following his normal occupation for 4 days or more	2
4	Medical Treatment Case	An incident resulting in lost time of less than 4 days which needs medical care.	11
5	First Aid Case	An incident with injury that needs one-time treatment and does not require ongoing medical care.	4
6	Occupational Poisoning / Diseases	An incident results in work related poisoning or disease as diagnosed by a Registered Medical Practitioner	0
7	Near Miss	An incident that may, under slightly different circumstances, have caused injury, environmental or property damage.	23
8	Dangerous Occurrence	An incident that results in danger such as the bursting of abrasive wheel, collapse or overtuning of crane, explosion or fire, collapse of structure or scaffolding or electrical short circuits.	2
9	Environment Incident	An incident causing adverse environmental impacts	7
10	Traffic Incident	Traffic or public related incidents	16
11	Property Damage	Any damage to the works, contractor or 3rd Party property	4
12	Others	An incident that results in the death of an employee off site and not related to the occupational activity. Any incident relating to theft, security issue, riots, fight among workers and etc	2

Source: Researcher data, 2018

There are 16 cases of traffic incident involving public vehicles travelling in adjacent to the site boundary and barriers together with construction related machineries and vehicles entering and exiting the construction site via the public road. As highlighted by SOCSO in an article published by Malaymail (2018), commuting to work or work related travelling has increased by 75% from 2008 to 2017 and in 2017, 47 percent of accidents amounting to 32890 cases reported to SOCSO are commuting related accidents. As the project involves a lot of public road safety issues due to the construction works being carried out on existing road which include road widening and utilities relocation to make way for new piers for the tracks, a lot of safety measures such as a comprehensive Traffic Management Plan were continuously revised to add in additional control measures due to the constant changing of affected public roads throughout the construction stage. In addition, under the Guidelines For Public Safety And Health At Construction Sites 2007 and Reg. 18(1), Building Operations And Works Of Engineering Construction (Safety) Regulations, 1986 under the Factory and Machinery Act 1967 states the requirement that should there be any construction works carried out over, or in close proximity to a highway or any other place where movement of vehicular traffic into and out of the work site may cause danger to the public, the working area must be equipped with adequate barriers, warning signage, warning lights and traffic control by a designated traffic controller who is usually equipped with high visibility vest and flag or baton trained in handling incoming traffic

The fatal incident at the jobsite was due to a skilled Malaysian worker working on a launching gantry who fell together and was crushed beneath when the launching gantry suddenly collapse during launching works. Another fatal incident was due to a Malaysian

lorry driver who had suddenly went unconscious and pass away even though first aid treatment was given to him at the construction site. Two Loss time injury causing temporary disability resulted in workers being given 47 days and 78 days continuous medical leave leading to loss of skilled workers to the respective company. The first incident was due to a skilled welding worker's left hand got caught between an extension pile and a starter pile while carrying out a driving RC pile activity while the second incident was due to machinery topple leading to the injury suffered by the operator.

The loss of workers due to workplace accident has long being highlighted especially with the Iceberg concept by Bird and Germain (1996) on direct and indirect cost of an accident to an organization. Based on the Iceberg concept the indirect cost (uninsured cost) can range from 5-50 times the direct cost (insured cost). Examples of direct cost are usually cost that people normally think of such as medical treatment at hospital including operation and follow up while compensation cost are more towards workers who suffered from permanent disability or to family members who had lost somebody due to work related incident and these costs are usually covered in large organizations who normally bought insurance for all their workers.

In Malaysia, workers in construction industry are also protected via Social Security Organization (SOCSO) scheme and Construction Industry Development Board (CIDB) green card scheme specially for construction workers both Malaysian and foreigners. Immediate indirect cost include resources spend to investigate the incident, cost to bring in temporary workers and train the workers to carry out the skilled task, loss of production due to operation being stop for a duration, cost to repair the damage machinery or property and cost to clean up the affected area. The indirect cost are usually what affects

organization financially the most as these indirect and uninsured cost can drag from months to years after the incident has happened and can even lead to bankruptcy especially when lawsuits and legal cases are involved. Some legal cases can even cause DOSH to revoke their license if they are competent firms doing specialize trades such as elevators company and tower crane erection company causing them to be blacklisted from carrying out the trade. In addition, loss of reputation and trust from customers and clients can cause huge loss to organizations in the prospect of getting future projects.

4.5 CAUSE OF INCIDENT- UNSAFE ACT AND UNSAFE CONDITION

As explained in the Domino theory, one of the root cause of incidents are unsafe act and unsafe condition and sometimes incident happened as a combination of both unsafe act by workers and unsafe working condition. As explained by Heinrich (1959), Unsafe action such as taking shortcuts, not following procedures, not wearing appropriate Personal Protective equipment and other workers related factors account to 88% of incidents while unsafe condition such as slippery surface, unprotected edges, uncovered floor opening, insufficient lighting and other work environment factors account to 10% of incident while the remaining 2% of incident were unpreventable or known as act of God. The researcher had analyze the 73 incident reports and categorized into unsafe act or unsafe condition which leads to the respective incidents and there are some incident which are caused by a combination of unsafe act and condition. The results analyzed found that 15 incidents are primarily caused by unsafe condition while 31 incidents are primarily due to unsafe act while the remaining 27 incidents are combination of unsafe act and unsafe condition. This

figure is illustrated in Figure 4.4 showing that unsafe act accounts to 79% of the incidents based on the data obtained from the 73 reports if we include those incidents that happen due to a combination of unsafe act and unsafe condition. The types of unsafe act and unsafe condition leading to incident successfully identified by the researcher consist of 21 unsafe acts and 14 unsafe conditions are listed in Table 4.2.

The unsafe act and unsafe condition are then further categorised into several factors which are adapted based on Ishikawa fish bone diagram which are People, Method, Material, Machine and Environment to identify the exact root cause of incident based on the 73 incident reports obtained.

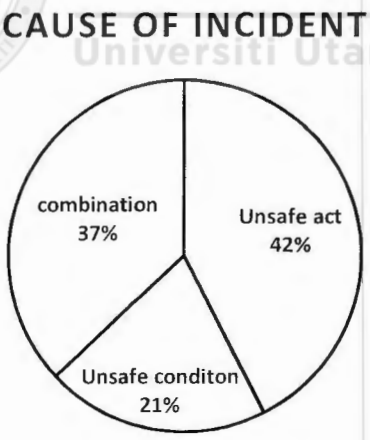

Figure 4.4
Cause of Incident
Source: Researcher Data, 2018

Table 4.2
Types of unsafe act and unsafe condition

Causes of Incident	Description
Unsafe act	• Confusing/ conflicting direction/demands • Failure to follow procedure/ method statement • Failure to secure • Failure to warn/ supervise • Failure to wear PPE • Improper decision making • Improper lifting • Improper loading • Improper placement • Improper position for task • Inadequate work planning and arrangement • Lack of experience • Lack of supervision/monitoring • Operating at improper speed • Operating equipment without authority • Operating without relevant competency/skill/training • Overexertion of physical capacity • Physically or physiologically not fit for job • Removing safety devices • Unclear assignment or responsibility • Using defective equipment
Unsafe condition	• Congestion or restricted motion • Defective tools/ equipment/ material • Extreme weather condition • Inadequate environmental control equipment • Inadequate guarding/barriers/ isolation • Inadequate maintenance of environmental controls • Inadequate planning and monitoring of initial operation • Inadequate warning system • Inadequate workplace planning • Silt trap overflows • Soft ground • Sunken piloting area • Unexpected movement hazard • Unprotected slope

Source: Researcher data, 2018

4.6 ROOT CAUSE OF INCIDENT

In this research, the People category was further divided into Man and Management in which Man refers to employee while Management refers to employers for better insight into the actual root cause when it comes to the 'People' factor as the data analyze shows that this factor is very significant and thus the researcher decides to expand the factor. Thus the factors which will be discussed to have a further insight on the root cause of incident in construction site are Man, Management, Method, Machine, Material and Environment. Few of the incidents are related to one specific root cause as majority of the incidents are a combination of few factors of root cause.

4.6.1 MAN

From the incident report analyzed, more than half (62%) of the incident are caused by the factor Man or combination of Man and other factors consisting of 45 out of the 73 incidents analyzed. The most significant root cause on the Man factor are "Ignorance to procedure requirement" which consist of 16 incidents in which workers failed to follow to safe working procedure leading to incidents at construction site such as not following crane safe operating procedure on safe lifting method by not preparing lifting plan, not following procedure on underground utilities mapping and detection causing damage to cables and piping during works and not construction vehicles disobeying traffic procedures causing traffic incident and damage to traffic equipment such as barriers. The next most significant root cause under the Man factor is identified as "inadequate training or knowledge of the job" to carry out the job in a safe manner consisting of 14 cases. The incidents could have been prevented if workers stop the work since they do not know how to do it but despite having lack of knowledge and training, the workers still proceed to carry out the work

leading to incidents. Example of the incidents include workers working nearby machinery (excavator) working radius unaware of the hazard of being struck by the excavator, worker not trained in handling chemical transferring causing spillage of 20 litres of diesel to the ground during transferring work and worker suffering from burns due to improper handling and poor identification by worker on the damage hose of welding machine during torch welding activity. Other Man related cause include confusing/conflicting direction or demands, false judgement, lack of experience, misunderstood instruction given and physically or physiologically not fit for the job as summarize in Figure 4.5.

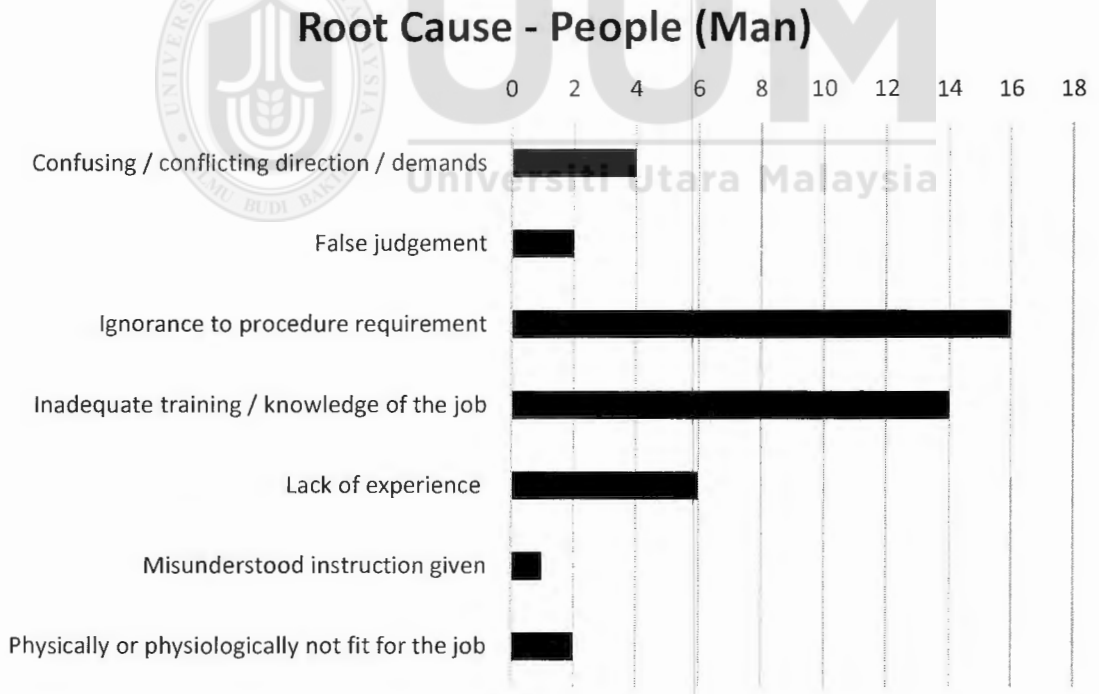

Figure 4.5
Root Cause of Incident due to People (Man) Factor
Source: Researcher Data, 2018

The Man factor as identified in this study are related to "ignorance to procedure" in which workers tend to ignore procedure and believe to take shortcuts during works thus leading to construction incidents. This finding is similar to findings by Kolo (2015), Kadiri et al. (2014) and Haslam et al. (2015). To workers especially foreign workers from under developed countries in which safety measures are not a norm to them, working in a Mega Project in Malaysia and requiring to comply to the various safety requirements is seen as a burden to the workers and when an opportunity arises or when not under supervision, these workers will revert back to their normal working attitude by either not wearing the personal protective equipment such as safety harness during working at height or just simply removing the machinery guarding to hasten up their work at the construction site. This finding can be explained by the Domino Theory which states that workers tend to learn or obtain unsafe characteristics from the social environment which can be related to the foreign workers from under developed countries with poor safety compliance leading to them making wrong decisions by taking shortcuts or ignoring procedure which is seen to them as troublesome and all these will lead to them carrying out unsafe act which ends up with incidents. This finding can also be related to the human factor theory in which workers tend to carry out inappropriate response and inappropriate activities which can also be related to workers being lazy which is similar to findings by Aksorn and Hadikusumo (2007).

Laziness can be associated with being ignorant to procedure as workers who are lazy will tend to take short cuts and so in the process will ignore the safe working procedure in order to get the job done quickly and they put themselves at risk of being injured. For

example, workers will just simply ignore the requirement to inspect condition of tools before use due to being ignorant and complacent as they assume that the tools will be in good condition since they just use it the day before. In some cases, workers tend to do modification or use damage tools as it will be troublesome and waste of time to wait for their supervisor to get them a new tools while in some instances, workers tend to use unapproved tools or unsuitable tools just because they are lazy to go to the store to get the right tools as to these workers, the urgency of getting the job done fast is more crucial compared to the safety during works. Using the wrong tools for the wrong job can easily lead to construction incidents. In addition to that, peer influence by workers at the construction site can easily cause workers to disobey the safe working procedure as the worker may feel that since everybody else is taking shortcuts thus he should do so as well.

Another factor related to Man as found in the study are "inadequate training/knowledge of the job" and this finding is similar to previous research by Mbuvi et al.(2015), Bizell (2008), Permana (2007) and Kinn et al. (2000) correlating effect of training with reduce rate of workplace incident. This findings can also be linked to the Human Factor Theory in Chapter 2 which states that accidents happen due to Overload such as lack of training as define under Situational factors. The Human Factor Theory also mention Inappropriate response which can be related to this finding in which workers are supposed to feedback to the management if they do not know how to carry out a particular work but since workers tend to keep quiet due to fear of being replaced or removed from the construction site, they proceed to Inappropriate activities which are doing the task eventhough they do not know how to do it safely and due to that incidents happen. Due to

inadequate knowledge, workers may tend to take unnecessary risk which they feel are acceptable as they may have been doing so in previous construction project and there was nobody to tell them that it was wrong and there exist a safer method to carry out the task. It is also assume that workers who are inexperience are not able to identify hazards and risk present during work compared to their experience and skilled counterparts and during emergencies or sudden changes to a construction work, the inexperience workers are not able to react as they do not know what needs to be done and often they will take poor actions that lead to them making wrong judgement leading to incidents. There are also cases in which some workers were found to just want admiration and in their bid to impress their employer by agreeing to carry out a particular task eventhough they are not skilled and trained in doing it and this can lead to accident. For example, getting a carpenter worker to drive a machinery such as a forklift just because the worker said he is able to handle the forklift is very risky and dangerous as he may not be fully aware of the hazard and risk associated with handling the forklift and to ensure safety, the worker need to be tested in terms of theory and practical skills prior to allowing him to handle the forklift.

In Malaysia construction industry which comprises of construction workers from various nationalities such Bangladeshi, Indonesian, Pakistan, Myanmar, China and India can be a major problem for effective training to be carried out as most of these workers have low level of education and furthermore, most of the foreign workers are only able to speak in their mother tongue while only few are able to converse in simple Bahasa Melayu. In addition, even though constant on job training is carried out, the high turnover of workers in which skilled workers often left for better opportunities elsewhere after gaining adequate

experience and skills eventually lead to new inexperience workers who needs to be re-trained and will need time to gain the experience and skills to carry out the construction work. Due to shortage of workers and the time constraint in construction industry, these inexperience workers will surely be tasked with doing skilled works even though they are not fully prepared thus eventually leading to construction incidents.

4.6.2 MANAGEMENT

As mentioned earlier, the study also analyzed the Management factor and results show that this factor is also significant in causing incident as 49 out of the 73 incidents are related to the Management factor and combination of Management factor and other factors. The most contributing factor is due to "inadequate work planning and arrangement" which leads to 15 cases mostly involve incident during transportation of construction materials to the site and within the site involving lorry, truck, concrete mixer, low loader and one incident on improper stacking of kentledge block during unloading leading to toppling of the blocks. The other significant root cause of Management factor is 11 cases due to "lack of supervision/monitoring" as identified from the incident report in incident such as slope failure and flooding incident due to lack of constant monitoring at the working area and lack of competent lifting supervisor to monitor the crane works leading to unsafe crane activity. These factors can be linked to Petersen Accident/Incident Theory as explained in Chapter 2 which states that decision to err due to misjudgment of the risk can be link to inadequate work planning in which site personnel assume that the works carried out is not dangerous and thus they choose to err and proceed to carry out the task without proper planning and consideration of what might went wrong as they assume that nothing will

happen. Lack of supervision can be linked to the System Failure under the same theory which theorizes that poor policy, responsibility, inspection, correction will lead to workplace accident and that is why inspection especially routine and consistently done is important to identify hazards at the workplace. Other management factors include improper/insufficient work delegation, inadequate assessment of required skill, inadequate communication within organization, inadequate implementation of procedures, inadequate policy, procedures or documents, inadequate training or briefing conducted and unclear assignment of responsibility by the management as summarize in Figure 4.6.

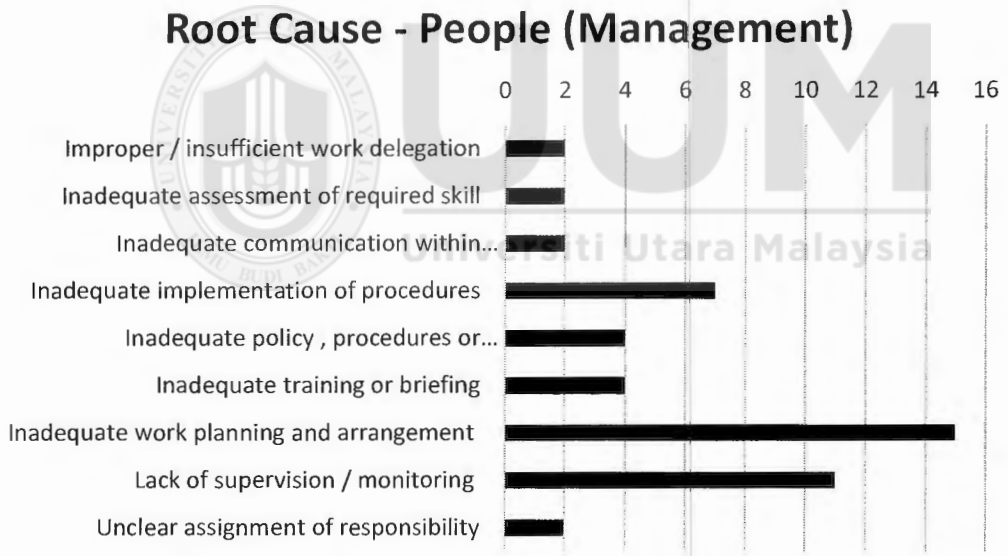

Figure 4.6
Root Cause of Incident due to People (Management) Factor
Source: Researcher Data, 2018

The Management factor as identified in this study can be associated with poor management commitment. The reason is due to the fact that if management fails to plan an effective safety program shows that the management is not committed to safety at the

workplace as supported by previous research by Rozenfeld et al. (2010) and Lingard and Holmes (2001). In addition, under Section 15 of the Occupational Safety and Health Act 1994 clearly states the responsibility of employer (management) to provide information, instruction, training including supervision to workers during works. Due to the constant chase for progress at the construction site, many decisions were made in a hurry without fully comprehending the risk and thus many of the safety aspects are not being focus on and this can lead to construction incident. Poor planning in terms of manpower often lead to insufficient workers to carry out the task and these workers are forced to do a huge amount works beyond their means causing them to be exhausted and tired including suffering from injuries during work. Safety and health at workplace are often just on paper and not really implemented as management tends to value progress over safety which is a very common issue in Malaysia construction industry mainly because they have the mindset that progress means profit while safety compliance are time and resource consuming which does not bring in profit. Other examples of poor planning and arrangement usually occurs during the initial construction stage when the temporary access road in the construction site often shifts and changes and when the new changes are poorly communicated to all subcontractors and their workers including suppliers, there tend to be incident during movement of vehicles and workers at the jobsite. In addition, due to the sudden changes and as a result of poor planning, there is insufficient signage and barriers to warn vehicles and workers on the changes in the access road and this can cause accidents as drivers and workers will tend to use the access road that they are familiar and will assume that the road is still safe to use.

The lack of supervision by competent supervisor was related to inadequate lifting supervisor to monitor few locations of lifting activity carried out at the same time. A lifting supervisor is tasked with preparing the lifting plan and to monitor the lifting activity but due to shortage of trained lifting supervisor at the workplace, scenario in which a lifting supervisor are forced to oversee several lifting activity carried out concurrently occurs. This leads to poor supervision and poor focus by the lifting supervisor as he may overlook the process and in some cases, the lifting activity are too far apart thus standing supervision was not possible. Apart from lifting activity, other work task in which a competent supervisor are often not present due to attending meetings or discussions thus worker are left to work alone and without supervision, these workers will take short cuts as explained in the Man factor previously. Apart from that, there were instances in which supervisor level employee tends to sit in the office cabin which are well equipped with air-conditioning with the excuse of doing paperwork and rarely go to the construction site which is usually hot and dirty to monitor works being carried out and rely solely on photos or messages from workers at site to inform him on the progress instead of checking it out personally. Further analysis also found that there were some instances in which main contractor relies too much on subcontractor to carry out the works in a safe manner assuming the subcontractor knows how to work safely and there are instances where subcontractor further employs sub-subcontractors to carry out the works and usually these people are not aware of the safety requirements required by the main contractor and with poor oversight by both main contractor and subcontractor personnel, these sub-subcontractor most often work in an unsafe manner due to lack of supervision and monitoring causing accidents.

4.6.3 METHOD

The next factor studied in this research is the Method factor and this factor is also significant in causing incidents based on the 73 reports analyzed as the Method factor was identified in 55 incidents as part of the root cause leading to the incident and a very significant root cause under the Method factor was Inadequate inspection/risk assessment. This factor can also be related to the theories in Chapter 2 such as Swiss Cheese Model as weakness in the different levels in the organization in which inadequate risk assessment shows weakness at management level while inadequate inspection shows weakness at operational level and accidents occurs as a result of hazard passing through the organization safety system without any barrier thus leading to incident. A total of 24 incidents was found to be due to inadequate inspection/risk assessment being carried out during works such as concreting works, lifting works, launching works, excavation works, welding works, dismantling works causing worksite incident. This include not conducting worksite job hazard analysis (part of risk assessment) prior to starting works and there were some cases in which some ad-hoc activities were not fully captured in the risk assessment such as the case of 20Litre of diesel oil spillage in which there was no risk assessment conducted and no risk control in the oil transferring work activity. Another significant root cause of Method factor was identified as Lack of work coordination and control with 11 cases in which majority of the cases was due to lack of coordination with the respective government body in fully identifying the underground piping both new and old piping leading to the piping being damage causing water burst and water interruption to nearby public in few separate incidents. Other Method factors include inadequate mitigation measures,

inadequate monitoring of construction, inadequate planning and monitoring of initial operation and inadequate specification/standard as summarized in Figure 4.7.

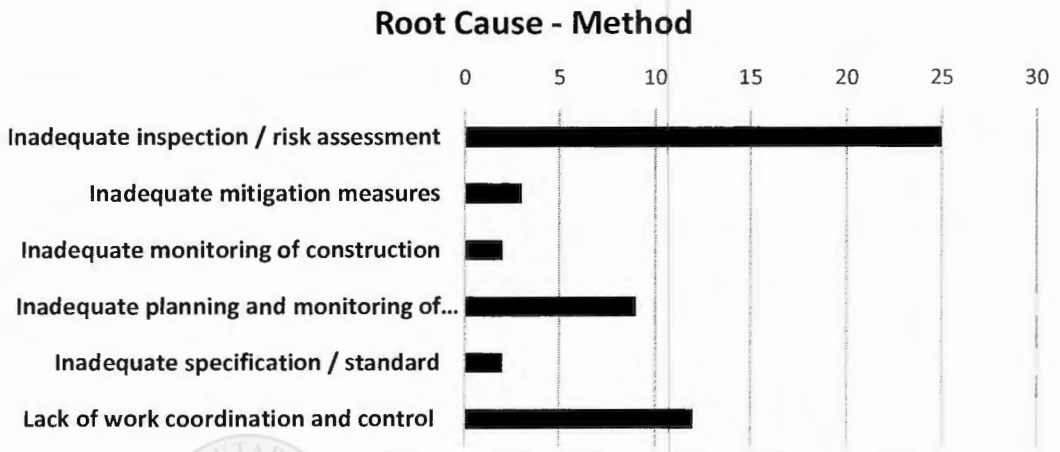

Figure 4.7
Root Cause of Incident due to Method Factor
Source: Researcher Data, 2018

Inadequate inspection and inadequate risk assessment as found in this study happens due to no proper documented risk assessment being done in which possible hazards are not identified. This findings coincides with previous research by Sanchez et al. (2017) and Carvajal (2008) who shows the importance of risk assessment in managing accidents at construction sites through the models they proposed. Some construction works are carried out without taking into consideration the hazard they may pose to workers and since there is no documented risk assessment, most of the workers are usually not aware on the hazard they may face and how to overcome them. The only usual information given to workers are more towards instructing them to complete a certain task by a certain period and never on the safety aspects as to contractors in the construction industry, it is a norm to them to have to face with dangerous and hazardous working situation as it is part and

parcel of the job and that is why the construction industry is known with the label "3D" signifying dangerous, difficult and dirty. Inadequate risk assessment can also be related to poor control measures suggested by contractors which are very reactive and focus solely on using Personal Protective Equipment and not aiming at controlling the source of hazard or eliminating/substituting the hazard present at the work site. Some jobsites enforces on carrying out daily toolbox talk before starting work but these session are usually not effective as it is simply carried out by supervisor and workers just sign on the attendance record to fulfill the requirements and no discussion on the hazard and control measures of the work activity of the day is being done.

There were few instances in which there was risk assessment conducted but the recommended control measures such as barricade at edges of the building was not fully implemented can be related to lack or inadequate inspection being carried out. This is due to the fact that if routine workplace inspection is carried out, most of the non-compliance such as barricade at edges of the building would have been identified and corrective actions taken thus preventing the accidents such as workers falling from height happening. Workplace inspection can be further separated into internal and external inspection in which internal inspection is done by site supervisors, site engineers, safety personnel including safety and health committee established at the workplace. A summary of the inspection report are usually prepared by the safety personnel which is then given to the contractors for them to reply with evidence of corrective actions done and failure to close the findings within stipulated time are usually followed up with internal summons or Stop work order. However, effectiveness of this system is very dependent on the management to enforce the Stop work order and usually, project managers and management will be

lenient towards contractors in order for contractors to be able to carry out their work and continue worksite progress.

External inspection is enforcement conducted by DOSH Malaysia in enforcing the Occupational Safety and Health Act Under Part XI (Enforcement and Investigation) of the OSHA 1994 provides DOSH officers with power to enter workplace and conduct inspection including taking samples and measurements related to safety and health compliance without any prior notice and employer found not co-operating in the inspection can be penalized a maximum penalty of RM10,000 fine or jail term not exceeding 1 years or both. This part also states that DOSH officers have the power to issue prohibition notice (NOP) *for high risk activity/process/equipment that pose immediate danger to worker life* (equivalent to immediate *stop work order*) and employers are required to stop all related work until they reply to DOSH officer the propose corrective measures they have taken and the notice will only be lifted once the DOSH officer is satisfied with the corrective measures proposed and implemented. For activity with safety and health risk to workers but do not pose immediate danger, DOSH officers will issue an improvement notice (NOI) for employers to carry out improvement while the work activity continues to run as normal. Employer found not taking necessary actions to close the notice by improving on safety and health measures on the issue raised in the notice can be penalized a maximum penalty of RM50,000 fine or jail term not exceeding 5 years or both and a further RM500 fine per day can be imposed on employer who choose to ignore the notice and continue working even though prohibition notice has been issued.

External enforcement are usually more effective compared to internal enforcement and it plays an important role to ensure that the contractors obey the safety requirements as stipulated under the local legislation as contractors are more afraid of being penalized which may even lead to court cases and jail term which will no doubt affect their credibility for future projects. This is supported by previous research carried out by Au Yong et al. (2014) and Cheah (2007). However, an official report by The Star Online (2016) quoted DOSH Director General who told reporters that there are over 600 construction sites in Malaysia and the numbers are increasing daily, however DOSH have only 12 safety inspectors thus the enforcers are not able to conduct random spot checks on all the sites effectively and in addition there are some sites which requires several days of inspection due to the size of the project. As a summary, it can be said that safety compliances done at workplace are for due to fear of being penalized by authorities and for the sake of complying to legal requirements and not because safety is important and prioritized at the workplace because if safety is indeed a priority thus the rate of construction accidents would surely decrease from year to year instead of increasing.

4.6.4 MACHINE AND MATERIAL

The study also try to identify the Machine Factor in causing incidents at the construction site and 20 out of the 73 incidents are related to failure of machinery such as inadequate inspection of machinery including equipment such as failure to identify damage equipment parts causing incident when using the defective equipment. Another root cause is due to inadequate human factor consideration in poor planning and consideration for the

movement of machinery caused heavy machinery to hit and damage the existing barriers during movement at the site. The remaining Machine data are as summarized in Figure 4.8. Another factor studied in this research is the Material Factor and results show that 9 incidents are related to Material factor and findings include improper handling, storage and transportation of materials and inadequate planning on purchasing materials such as cases of damage scaffolding being used to support falsework and few incidents in which material such as rebar, cast pile and kentledge block toppled during transportation and stacking. The Material data are as summarized in Figure 4.9.

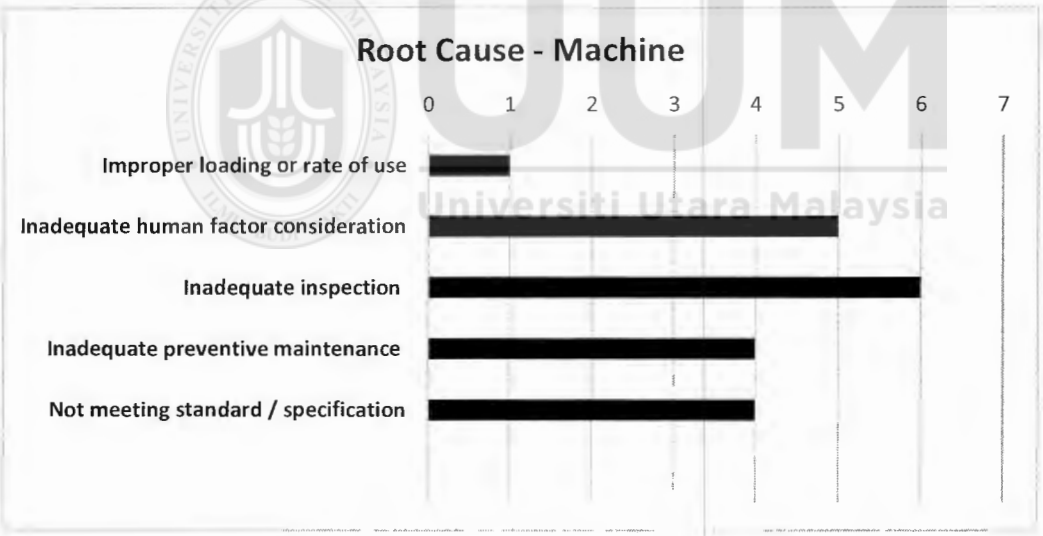

Figure 4.8
Root Cause of Incident due to Machine Factor
Source: Researcher Data, 2018

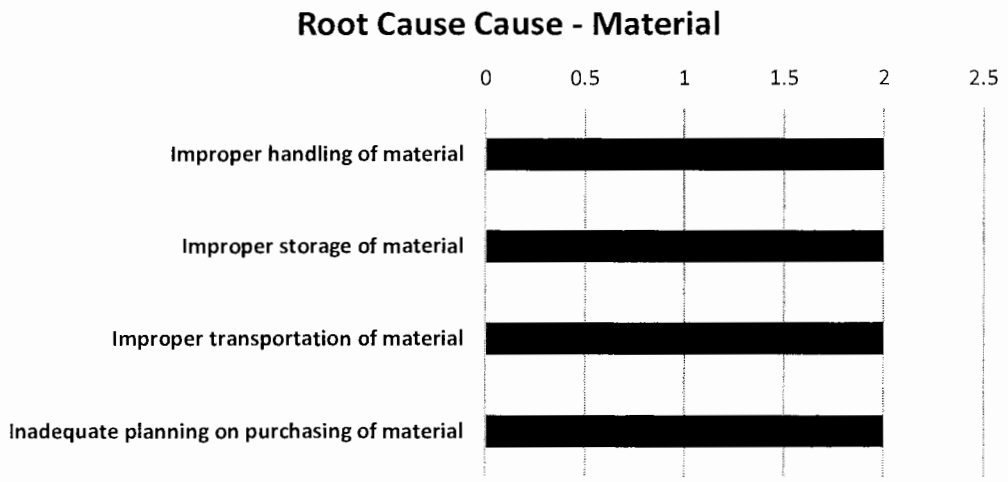

Figure 4.9
Root Cause of Incident due to Material Factor
Source: Researcher Data, 2018

The Machine and Material factor are not that significant in leading to incident based on the results obtained. However, among the factors related to machine are due to inadequate inspection being carried out on the machine thus leading to failure of the machinery during use such as failure of braking system or hoisting gears. For example a machine such as an excavator, there is the daily visual checking by the operator and the monthly maintenance by the machinery company but in most cases, the operator tends to just simply tick on the daily checklist without doing any thorough checking to indicate that all the parts such as the brake, horn, hydraulic oil, rear mirror, rotating beacon are functioning properly as the operator feels complacent to inspect the same machine he has been using daily. This complacency together with box ticking on the daily checklist can lead to damages on parts of the machine not being identified and for example during emergencies such as machinery going down the slope area, the brake was found not functioning thus leading to collision at the construction site. In terms of Material factor in

which improper handling and storage can be related to overstacking of construction materials leading to imbalance and materials tumbling. In some cases, poor storage such as storing too many materials on soft ground or adjacent to slope area leads to construction incident. Inadequate planning on purchasing materials can be related to not enough plastic barriers including blinking light to cater for the temporary closure and diversion as part of road safety thus leading to vehicle and public incidents.

4.6.5 ENVIRONMENT

The next factor studied was the Environmental Factor which contributes to 21 out of the 73 incidents based on the data obtained. A very significant root cause leading to incident at the construction site is associated with poor jobsite condition. This root cause can be associated with the environmental factor of workplace which are unsafe condition as explained under the Multiple Causation Theory since most of the incident are related to heavy machinery entering the site to work and due to poor jobsite condition causing the machinery to either topple or unbalance or stuck due to machinery entering into soft uneven ground. This soft uneven ground can also be related to Ergonomic Trap which are incompatible workstation as explained under the Petersen Accident/Incident Theory. Other root cause identified under Environmental factor are inadequate maintenance of environmental controls such as poor maintenance of silt fence, sedimentation pond and slope protection causing environmental incidents such as flooding on public road and slope erosion after continuous usage and exposure to poor weather. Another root cause identified

are extreme weather condition and reduced visibility related to heavy rain and fog as summarized in Figure 4.10

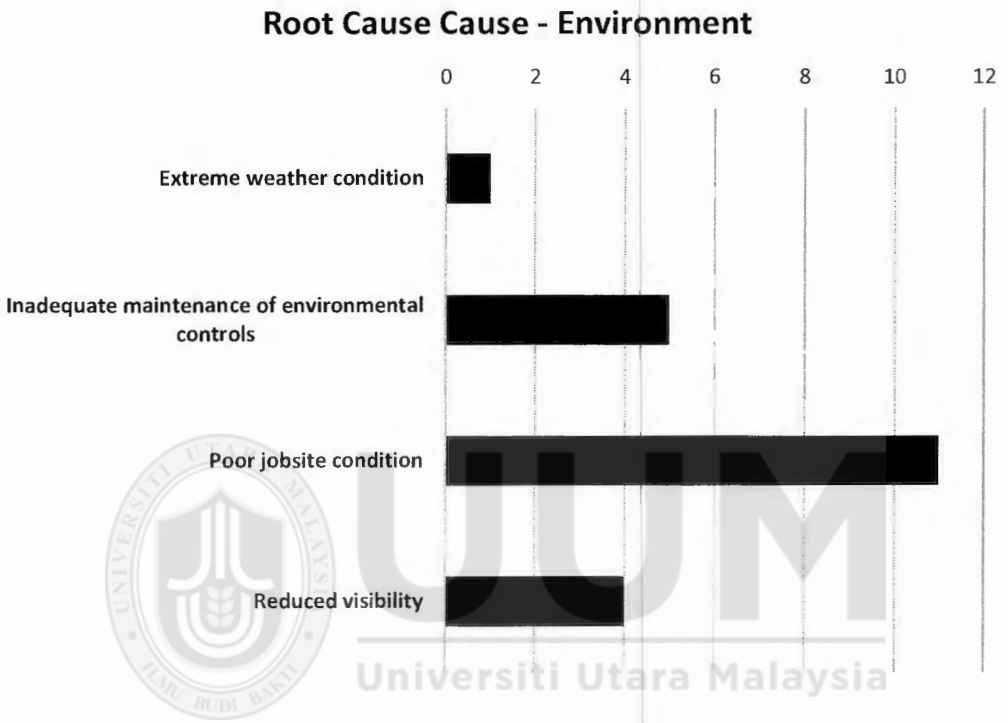

Figure 4.10
Root Cause of Incident due to Environment Factor
Source: Researcher Data, 2018

As identified under environmental factors on poor jobsite condition, the working environment plays an important part as poor working environment such as uneven ground, slope area, slippery road, congested workplace, poor housekeeping and poor traffic management can lead to various incidents involving heavy machinery and this is supported by previous research carried out by Abdelhamid and Everret (2000), Im et al. (2009) and Goh et al. (2016). As the construction worksite is constantly changing due to the continuous work activity being carried out, thus the risk could change from day to day. In addition, construction site are usually faced with space constraint in which workers, machinery and

material are all cramped into the same working area. In addition to that, the jobsite condition can also change due to external factors such as heavy rain which can cause flooding which is a very normal occurrence in construction project as the permanent drain may not be constructed while the temporary drain are usually not able to cater for the sudden influx of high rain volume. The risk posed by environmental factors especially poor jobsite condition can also be due to poor housekeeping which can be overcome if the contractors enforced a strict and consistent housekeeping program and it is to be noted that some environmental factors such as adverse weather conditions causing uncontrolled heavy rain and wind including thick fog causing poor visibility are act of nature which is unavoidable but measures can be in place such as having a lightning detector machine to detect upcoming thunderstorm so that high risk activity such as working at height or crane activity can be stop or minimize until the weather permits. In addition, there must be clear instruction by the management to stop all high risk works involving heights and heavy machineries during poor and adverse weather.

CHAPTER 5

CONCLUSION

5.0 INTRODUCTION

This chapter begins by summarizing the overall findings in this study including areas for future research. This is then followed by recommendation on how to improve the safety culture in Malaysia construction industry based on the researcher's opinion and insight.

5.1 SUMMARY OF THE FINDINGS

The main objective of this study was to explain the significant factors leading to construction incident such as people, material, machine, method and environment factors. Results of the studies show that the Man and Management under the People factor are the most significant factor as they contribute to more than half of the 73 incidents that was studied. Findings such as ignorance to procedure requirement and inadequate training/knowledge of workers coincides with theories explained in Chapter 2 whereby all these theory stresses on human error such as workers fault (Domino Theory), inappropriate response by worker (Human Factor Theory), decision to err (Incident Theory), unsafe act and condition (Multiple causation theory) while poor planning and site supervision can be link to gaps and weakness in the organization leading to incidents (Swiss Cheese Model). Factors such as Method and Environment factors was also found to be significant to construction incidents while the Machine and Material factors are slightly insignificant

based on the data obtained solely from this study. Other objective in analyzing the information such as types of activity during incident found that the usage and Operating of Mobile Construction Equipment/Vehicle if poorly managed in terms of a safe system of work can lead to a high number of incidents in the construction industry as found in this study. Other areas of activity which are high risk in causing accidents such as Piling, Excavation and Lifting Operation are as discussed in Chapter 4. The studies also found that construction incident in this project tends to happen during the day time compared to night time but other factors need to be considered which includes location of the construction site whether it is nearby residential area or not as all these can influence the outcome as construction site nearby residential area tends to have reduce night time construction works due to local regulations and requirements by the local authority. To summarize, the objectives of the study is achieved based on the results obtained by the researcher after analyzing the incident reports obtained.

5.2 RECOMMENDATION TO IMPROVE SAFETY AT WORKPLACE

5.2.1 Government

Despite close to two decades there has been not much revision to OSHA 1994 in the last 10 years and based on the studies and root cause identified, the question arise on whether the OSHA 1994 and its contents is effective and relevant with the current working environment. The question arise whether are the current requirements not strict enough and are the current penalties of RM50,000 and 2 years jail for employer who failed to carry

out their responsibility in ensuring a safe and healthy work place not strong enough to send the message of safety to industries and stakeholders. There has been proposal by industries and stakeholders during safety conference such as Conference of Occupational Safety and Health (COSH) 2017 held at Putra World Trade Centre to increase the penalties to RM500,000 which is 10 times the current penalty but nothing has been finalized and amended up to date. In the conference itself, industry also proposed on the delegation the responsibilities of enforcement and inspection of machineries at workplace to third party firms due to the long processing time when carried out by government officers with insufficient workforce as explained earlier but there has not been any development on the issue up to date. Since legal requirement only dictates that a safety officer must be hire for construction project exceeding RM20 Million thus construction project below that value usually do not have a safety officer thus the implementation of safety programs at these sites are very low and near to none. The latest update to this was an announcement made the Ministry of Human Resources as published on an online report in September 2018 (Astro Awani, 2018) which states that there will be amendment and revision of 9 Acts by the end of the year as most of the acts has been outdated and no longer relevant and they should have been revised years ago and among them are the Occupational Safety and Health Act 1994 and Employment Act 1955.

5.2.2 Client and designer factors

Clients play an important roles as they are consider the paymaster to a construction project and thus client should allocate cost for safety implementations including emphasizing the importance of safety apart from only ensuring timely completion of the construction

project. There have been cases of poor allocation of resources for safety related highlighted in previous studies and Olantuji (2007) states that some construction company or contractors tend to use only a small portion of the resources allocated by client for safety measures such as employing unskilled workers in order to maximize their profit. There have been some improvement in recent years due to increasing pressure from the public to ensures public safety as a result of construction accidents involving public casualties which is supported by a study by Fung (2014) found that more effort and resources had being invested by clients to improve the site safety in recent years. Apart from cost, when a project falls behind due to delays and unforeseen changes, clients play an important role in giving extension of time to contractors to ensure that sufficient time is given to carry out the construction works in a safe manner. When this extension is not given by the client an in order to catch up with the delay, poor safety consciousness and decisions from contractors that compromise the site safety endangers the life of workers has been identified as a factor to site accidents (Kadiri et al., 2014). Olanguju et al. (2013) states that construction project that are carried out in a fast manner due to the short time period for project completion tends to have poor workmanship and many errors that can lead to injuries and accidents. Another external party playing a key role in construction related activity is the designer such as architect or consultant and Fung (2014) states that poor design of buildings together with inadequate and faulty designs by consultants may create hazards and unnecessary risks during works. Palaniappan et al. (2007) found that poor planning together with poor selection of low quality building materials by consultants can lead to failure of construction structure which can lead to injuries at site. Cheah (2007) highlighted on the importance of involving all parties such as architects and consultants in

the planning stage so that all the possible hazards can be identify and mitigated at an early stage. New guidelines related to safety and health are introduced by DOSH recently such as the Guidelines of Occupational Safety And Health in Construction Industry 2017 which includes client and consultant involvement in mitigating construction risk but since they are just guidelines, it is not compulsory and mandatory for the industry to follow and implement them strictly.

5.2.3 Education and awareness

Apart from legal approach, another important aspect that can improve the overall safety culture in Malaysia is through education and to create more awareness not only among workers but the overall workforce regardless of their level. Compare to other foreign countries in which the safety culture is excellent such as South Korea or Japan, the responsibility of safety falls onto all level of employees from managers to engineers and supervisors but sadly in Malaysia, the responsibility to implement and enforce safety falls entirely on the safety officer or safety supervisor due to the low awareness on safety and health among the general workforce. It has to be understood that there are usually many engineers and supervisors at a construction site but usually only one safety officer thus it is not possible to put the responsibility entirely on the safety officer to enforce and implement all the safety requirements by himself. This kind of mindset need to change and among the way to change them is through creating awareness from young at education level that stresses on the importance of OSH at the workplace. In a news report (News Straits Time, 2017) the chairman of the NIOSH, Tan Sri Lee Lam Thye emphasize on the importance of teaching safety and health at schools and further states that incidents inside and outside schools could have been prevented if students and teachers were

knowledgeable on safety. A study by Sambasivam et al. (2017) did a study on safety and health hazards in school setting and although there was no high risk present, the study conclude that it is important to ensure the school environment is safe and healthy to ensure that students and teachers attending the school are protected from OSH hazards such as physical and chemical hazard. To achieve this, it is important that the school management including students are knowledgeable in OSH in order for them to be able to identify the potential hazards at school and on how to mitigate the hazards present. Thus teaching the subject of OSH from young can certainly create an increase awareness and a future in which safety and health is important and part of the working culture.

5.3 FUTURE RESEARCH

This research aims at finding the root cause of accidents in the construction industry but is limited to only a mega project in the Klang Valley only and may not fully represent the actual scenario for the whole country. Thus, further research which involves a wider scale and perhaps obtaining data from the whole Malaysia is required to have a better picture of the actual scenario and root cause of the construction industry in Malaysia. In addition to that, increasing the number of incident reports used for analysis and also conducting interviews with experienced construction personnel including doing survey using questionnaire to obtain more data for analysis can be considered for future research. Another future research recommended can include studying on the safety culture and how to improve the safety culture among the construction industry in Malaysia. All this aims at achieving valuable information that can improve the level of safety and health in Malaysia particularly the high risk construction industry.

5.4 CONCLUSION OF STUDY

Based on the findings in this study, the People factor which was further divided into Man and Management plays an important role in preventing incident at construction site. Based on the Man factor, by preparing the workers for the task including providing information, training and supervision to workers can help workers to work in a safer manner in addition to providing workers the necessary tools, equipment and personal protective equipment. The Management also plays an important role especially through their visible commitment towards safety implementation by having a workplace safety program which include risk assessment being carried out for all activities and the proposed mitigation measures to manage the hazard. Apart from that, management are encourage to take safety into their own hands by becoming proactive and not to rely on external parties such as government intervention which are considered reactive and may be too late in preventing incidents at the construction site. The culture and perception that safety at the workplace is the sole responsibility of safety officer must change as a safety program can only be effective in preventing workplace incident when all the parties from workers to supervisors to management level play their respective role with regards to OSH at the workplace.

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Appendix A

Summary of Incident Reports

No.	Incident Date	Incident Time	Brief Description
1	18-10-2016	06.00 AM	One (1) security had been hit by an I-beam when he is in the process to remove the public barricade.
2	1-11-2016	08.50 AM	A motorcyclist fell down while trying to avoid sunken piloting trench. Another accident happens when two cars behind the motorcycle collide when trying to avoid hitting the motorcyclist.
3	16-11-2016	14.30 PM	A concrete mixer truck was delivering concrete to CH 0. When it reached at Jalan Utama, the mixer truck accidentally hit one of Telecom pole and the cable loose from its hook.
4	16-11-2016	20.00 PM	Notified by Site Safety Supervisor, 9 nos of concrete barrier fell into sewerage pipe work area. CCTV evidence shown trailer had hit the concrete barrier from the alignment and concrete barrier fallen into the existing sewerage pipe approximately 3 hours after the misalignment of concrete barrier.
5	16-11-2016	17.30 PM	A low loader was delivering concrete pipe culvert at chainage 1900. After unloading the culvert pipe, the low loader was on the way out when it accidentally slip and its front tyre fell into monsoon drain.
6	19-11-2016	11.00 AM	A 55 tonnes mobile crane with registration no. BGN28XX and PMA no. SL-PMA407XX was heading to chainage 1900. When it reached at chainage 1700 the crane got stuck at soft ground of haul road. The crane managed to get out from the area with the rescue of excavator around 1230 hrs.
7	5-12-2016	17.20 PM	Lorry (from supplier TKH, No. plat: W76XXY) arrived at approximately 1520hrs delivering clay brick (2 pallet), OPC 20 bag and wire mesh. The lorry drove into the piloting area and the front tyre stuck into the soft ground.
8	10-12-2016	11.30 AM	Approximately at 1130hrs on 10th Dec 2016, during drilling of micropile point 114d at SGB 31, the silt fences and railing gave way and soil fell into the monsoon drain. No injuries recorded.

9	19-1-2017	16.25 PM	Just after 1600hrs heavy rain commenced and stopped at 1625hrs. The heavy deluge of rain water caused the sites temporary sedimentation ponds to overflow at the risers. This discharge resulted in ILPP carpark and the building aprons to be flooded with silty water. The heavy rainfall also caused the ILPP pond to overflow its banks and caused Jalan Jelutong to flood. Flooding was also noted at the housing area at vicinity of Jalan Institute.
10	22-2-2017	14.30 PM	At 1350hrs, received report from Traffic Marshal regarding a sink-hole on the road surface at SDW 24 North Bound road towards Sungai Buloh. Upon further excavation, it was found that the sinking holes is due to the existing concrete slab was hacked and found a plywood placed to protect the hacked drain box culvert by Sub-contractor to allow the celcom cable ducting laid underneath
11	25-2-2017	18.00 PM	At approximately 1730hrs, heavy rains ensued and stopped at 1900hrs. The heavy rain and the discharge from temporary sedimentation pond at SB3 caused waters to overflow at the IPS paddy fields, resulting in flooding at the new DOA quarters with silty waters. The rain commenced again during the night further contributing to this discharge.
12	17-3-2017	01.30 AM	At around 0110hrs on the 17th of March 2017, hoarding installation was in progress. However, at around 0130hrs, a car was identified driving from Kepong had run over the traffic cones that were used for the road tapper and hit into the back of the lorry that was park within the work zone to unload metal hoarding. The lorry driver was brought to Hospital Sg. Buloh for medical check. The lorry driver also sustained minor dislocated leg and treated outpatient.
13	30-3-2017	08.40 AM	A tipper lorry laden with crusher run coming from Jalan BS 3/1 illegally crossed Jalan Putra Permai into the site entrance. In the process of doing so the lorry caused a collision between 2 cars and a traffic light. The 2 cars (a Proton Wira and a Perodua Kenari) were driven by members of the public and coming uphill
14	18-4-2017	02.15 AM	Existing retaining wall suddenly collapse causing injury to a worker's leg

15	18-4-2017	13.30 PM	Complain from nearby company railway company found that there's 2 location of the track suspect to have experience settlement & movement which is at The suspected root cause of the movement & settlement are due to the rock blasting activity.
16	18-4-2017	14.15 PM	1 backhoe and 2 workers commence site clearing work and dismantling of guardrail at traffic light junction at approximately Chainage 25 cause damage to fiber optic cable underground.
17	21-4-2017	03.30 AM	The 50 ton crawler crane was tasked to unload and adjust the position of PDA frame from the trailer. While unloading and swinging the PDA frame from trailer, the operator felt a slight tilt of the crawler crane. The crane operator suddenly decided to lower down the PDA frame causing damage to 8 nos. of plastic barrier
18	2-5-2017	15.50 PM	Plastic barriers and plastic hoarding which were not secured properly toppled over into public parking area, due to extreme wind and heavy rain.
19	4-5-2017	03.30 AM	Underground fiber optic cable at depth 0.1m damaged during premix excavation
20	4-5-2017	16.30 PM	Heavy rain started causes flooding at three locations, MP07, KBN08 and KB14. Existing control measures and sediment basin not adequate. No injury and property damages were noted due to this accident.
21	10-5-2017	11.40 AM	A motor grader (rental) suffered engine failure at downhill section of access road adjacent SB1. As a result of engine failure and downhill gradient caused the motor grader to slide out of control onto berm of temporary SB1 and narrowly missed hitting the coming vehicle.
22	13-5-2017	11.00 AM	A trainee was doing housekeeping in front of TXX's site office. Whilst he attempted to open a steel cabinet door, the handle broke and he injured his hand. He was send to Hospital Serdang and got the wound stitched as outpatient treatment.

23	15-5-2017	16.45 PM	A low loader was in the process of relocating reinforcement bar and while the low loader was travelling up a slight incline at Chainage 1500, the load of rebar partially slid off back of low loader onto the internal site road. The load slid off because timber logs were used to support the bars on the low loader and the load was also not secured to the low loader.
24	02-06-17	11.40 AM	Excavator traversing site almost hit an overhead cable
25	17-06-17	23.00PM	A 55 ton mobile crane was setting up for lifting of valve (wt: 4.5 tonne). SHE team found out that the mobile crane outrigger setting out was not as per manufacturer recommendations and no lift plan for the 4.5 ton valve.
26	25-07-17	16:00PM	The delivery and offloading of the site office under the existing TNB pylon cables, without TNB approval and works conducted in restricted zone. Received official warning from TNB.
27	02-08-17	11:30AM	While boring rig machine (BG38) started drilling at point SDW33-1, found out that clean water gushing out from the ground. It was found that the machine scratched an underground 600mm SYABAS water pipe at approximately 500mm depth.
28	07-08-17	18:15PM	The loader carrying a cast pile head rolled over on the public highway, no injuries reported.
29	09-08-17	16:08PM	Mobile crane was stuck during arrangement for parking to start work, no damage to the machinery and properties, weather fine, no involvement from and to public.
30	14-08-17	11:30AM	An inspector of work (SC), fell from his bike while travelling inside work area at west portal due to slippery access. He was refer to a back specialist saw and declared fit to work.
31	21-08-17	10:00AM	While site clearing activity was in progress at location DPS09. The excavator operator has pushed down a tree and the branches of the tree fell off on the road plastic barriers nearby.

32	23-08-17	09:30AM	A skylift required to exit the site onto the highway from P47. The flagman stopped the public traffic but a motorcyclist still travelling along the road unable to stop and lost control and hit into another motorcycle park at the site entrance.
33	25-08-17	16:00PM	It was observed a mobile crane was set-up to lift a rebar pile. Lifting plan present at site contained false and inaccurate data that reflected a lift that was outside the allowed lifting capacity approved by the manufacturer of the crane.
34	08-09-17	08:45AM	Mr. CXXXX a sub-con dump truck driver was found unconscious over the wheel of his dump truck, first aid was administered but to no avail, Mr CXXXX died at the wheel of his dump truck.
35	28-9-2017	12:00PM	TMDT truck driver (MXX) was transporting GI wire for Traffic maintenance works and while turning the truck driver estimated wrongly, hit the middle of GI boom gate and cause it to bend out of shape.
36	29-9-2017	14:30PM	During mechanical excavation works the excavator bucket severed underground armoured cable 25mm^2.
37	30-9-2017	16:30PM	During piling operations carried out by DXXXXXX Venue Team the kelly bar lifting steel wire suddenly snapped causing the load to fall.
38	7-10-2017	15:50PM	4 wheel vehicle bearing registration number (VAE 61XX) moving towards downhill (Station Hill), skidded uncontrolled and stopped horizontally.
39	9-10-2017	13:35PM	Southbound Water Bowser truck (ETA 33XX) collided in a partial head-on with a Northbound Empty Dumptruck. The driver had his leg trapped and injured. He was sent to Serdang Hospital
40	14-10-2017	00:50AM	Last night the rebar jig on Pier CCC 13 was dismantled and removed. This morning prior to works starting it was witnessed that the vertical rebar was leaning over 90 degrees implying a collapse has occured.
41	19-10-2017	12:30PM	During concreting of pier head on pier CCCS 27, the crane (SL PMA 327XX) being used to hoist up the concrete suddenly stopped moving causing the bucket to hang mid-air

42	19-10-2017	19:19PM	During piling operations driving in a steel casing using a vibro hammer at point TNES 15-2 the steel casing being driven broke at the welding joint.
43	20-10-2017	17:00PM	A tipper delivering 20T of sand toppled over sidewards when unloading
44	23-10-2017	09:45AM	During mechanical excavation works as part of the piloting works scope using a backhoe a 11KV 240mm sq xlpe cable was struck and caused the power system to trip.
45	23-10-2017	13:00PM	A roller compactor toppled over off the haul road near access 2. The operator is conscious and talking and send to clinic to receive outpatient treatment
46	31-10-2017	14:45PM	During torch burning activities at base plate level (1.5m below ground level) the torch flame was intermittent due the flow of the gas. The burner requested someone from the ground level (where the oxy and acetylene cylinder are located) to shut off the cylinder valve. A TXX excavator operator who happened to be nearby helped to shut the valve. The burner cleaned the nozzle. The burner instructed to open the valve. Once the gas re-flow, suddenly after the flashback arrestor the hose ruptured and ignited catching the TXX operator on the face and front of the body. Suspected minor trauma and was given first aid on site and sent to clinic for further medical attention by TXX site supervisor. The acetylene hose at 1cm away from flashback arrestor was found to be damaged.
47	4-11-2017	09:30AM	CXXXXX whilst clearing a concrete footing using a tracked excavator during demolition works pulled out and damaged 2 (two) number of 11kV cables which were cast into the footing.
48	18-11-2017	11:00AM	Three pieces of stacked Kentledge Blocks which was just unloaded and stacked on top of each other, toppled over and fell down.
49	22-11-2017	15:15PM	Around 1600 heavy downpour occurred in Jalan Utama. The area is interfacing between XXX5 and XXX6. The bund constructed in XXX5 site cannot cater of high run off rainfall volume and burst, the water overflowed onto Jalan Utama causing flash flood

50	5-12-2017	16:30PM	Mr. Yan TXXX WXX was carrying out his Post Concreting Inspection inside the Pilecap area at TNE 26, slipped and fell and injured his wrist.
51	10-12-2017	08:30AM	A Battery for genset and 2nos of aircon outdoor unit were found stolen.
52	16-12-2017	15:40PM	A 10 wheeled lorry transporting sand to site toppled at CH200. The incident happened when the lorry was tipping to unload the sand. The driver suffered minor lacerations on his upper back.
53	27-12-2017	12:00PM	En Mohd Sharul NXXXXX employed by the SC for M&E lost control of his motor cycle reg no: VB 55XX, model type: Honda Wave Alfa, colour: red after passing through the wheel wash and skidded near the entrance of Cyberjaya site area. He failed to notice a sand bundle in front of the wheel wash.
54	2-1-2018	16:15PM	Soil Investigation work was carried out. During mechanical excavation works to a depth of 4.5m, It was witnessed water was flowing from the excavation and underground piping was found damaged
55	13-1-2018	17:30PM	During SI drilling works at TPSS20-CBH5 around 5pm. At a drilling depth of 1.5m, the PIC noticed water rushing out from the S.I borehole. Suspected underground pipe burst.
56	15-1-2018	08:10AM	On inspecting falsework scaffolding, it was identified a number of scaffold components were damaged, on investigating it was concluded the components must have been struck by moving site vehicles
57	15-1-2018	18:15PM	Worker Mohammad RXXXXX injured his hand when it got caught in between concrete bucket and starter bar. X-ray showed that the Injured person finger does not have any cracks or breaks and only external injury confirmed in x-ray by hospital Serdang.
58	30-1-2018	12:30PM	The butterfly valve of a skid tank at near CXXX North station was broken, causing spillage of diesel. To contain the diesel spill, it was transferred into a 200L drum. However, due to improper method of fuel transfer, the excess diesel spilled on to the ground.
59	3-2-2018	13:35PM	A worker's left hand got caught between an extension pile and a starter pile while carrying out a driving RC pile activity. The worker was sent to Serdang hospital and require operation thus considered temporary disability of left hand.

60	7-2-2018	10:55AM	A worker, Name : Arif Miah, no passport: bl0686XXX.Whilst dismantling mould formwork pier was knocked off the work platform approx 3m high and fell to ground. Medical treatment and discharge from hospital the following day
61	20-2-2018	08:30AM	The Sub-Contractor supervisor found out the company tools and materials were stolen during his first day work once come back from long break for CNY festival.
62	23-2-2018	02:30AM	Existing old water pipe 25mm dislodge during activity to install 250mm water pipe.
63	2-3-2018	15:40PM	During roughening up works on Column, 3rd Lift, a worker fell approx 0.5m onto the column shuttering in front of him. On visual inspection the IP had minor injuries to the back of the head and facial injuries. Received few days medical leave
64	4-3-2018	23.40pm	A launching gantry / beam launcher collapsed at a construction site in Jalan JXXXXXXX killing one of the workers and causing permanent disability to another
65	5-3-2018	12:00PM	Passenger hoist's operation team has found that a crack on the tie back at level 11 that may endangers the operation of the passenger hoist. HSE team was notified and instructed them to lower down both passenger hoist cages to ground floor.
66	12-3-2018	10:30AM	During HSE Audit it was Observed 3 workers was beside the excavator whilst the machinery was swinging. (Very likelihood of person(s) being struck by moving machinery). Exclusion zone not in place, Banksman not available.
67	13-3-2018	20:00PM	During segment launching, slight deformation of secondary beams was noticed. worker finger got caught , SBG launching has been stopped until design issue has been sorted. Minor cut on worker finger.
68	15-3-2018	15:00PM	A backhoe carrying out V ditching, slipped down the embankment.
69	17-3-2018	11:55AM	A Worker assisting in grounding a load caught his right thumb between the load being landed and the timber packing it was being landed upon. Send for treatment at clinic and refer to hospital requiring surgery

70	24-3-2018	23:18PM	TM 1x144c fiber optic cable damage due to slope trimming using an excavator.
71	26-3-2018	20:50PM	At 8.50pm today, rough terrain crane 45 tonne has complete the works and go to park the crane at designated parking area at DD40, however the brake has malfunction and cause half of the crane body fell down in the monsoon drain.
72	4-4-2018	09:59AM	At SDW11 the fluid stabilisation (polymer) pipe burst and caused the slurry over flow to Jalan Kuala Selangor (Kepong Bound).
73	23-4-2018	13:13PM	Slope erosion is observed near the Taman NXXX EXXX silt trap area. Initial investigation shows water continuously leaking from the water tank belongs to nearby Institut SXXXXX Malaysia which is located on top of the slope. The water flows to the silt trap area which is at lower ground through the damaged drains and caused the slope erosion.

Note: Brief Description was amended by replacing words with the alphabet X on items such as People Name, Vehicle Number Plate, Places, Street Name to ensure confidentiality of the project in which the data is obtained.