# Hazard and safety evaluation in construction sites in Malaysia: A case study

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M. Fathullah, N. R. Nik Yusoff, Vertic Eridani Budi Darmawan, C. P. Yong, C. G. Eng, S. P. Er, T. M. Ying, and W. Q. Hui



# Hazard and Safety Evaluation in Construction Sites in Malaysia: A Case Study

M Fathullah[1,2,a)], N R Nik Yusoff[1,3], Vertic Eridani Budi Darmawan[4], C P Yong[2], C G Eng[2], S P Er[2], T M Ying[2] and W Q Hui[2]

[1]*Green Design and Manufacture Research Group, Geopolymer & Green Technology, Centre of Excellence (CEGeoGTech), Universiti Malaysia Perlis (UniMAP), Perlis, Malaysia.*
[2]*Faculty of Mechanical Engineering Technology, Universiti Malaysia Perlis (UniMAP), Perlis, Malaysia*
[3]*Faculty of Earth Science, Universiti Malaysia Kelantan, 17600 Jeli Campus, Kelantan, Malaysia.*
[4]*Department of Industrial Engineering, Universitas Negeri Malang, Indonesia.*

Corresponding author: [a)]fathullah@unimap.edu.my

**Abstract.** This paper reports on case studies of safety incidents in Malaysia. In line with the efforts to reduce accidents at construction sites in Malaysia, the objective of this study is to analyze on workplace hazard, risk and safety and proposes a recommended actions on the case analyzed. A total of five case studies were conducted, in which the cases are scope to be on construction sites in Malaysia. Five hazards are identified from the case studies, which are equipment or machine falls from height, defective sockets or electrical equipment, high unfenced and unguarded working area, sharp objects or cutting blades, and noise pollution. The effects of these hazard are studied and Fishbone diagram is used to identified the root causes that lead to the effect. HIRARC is then used for further study of the hazard identified into risk analysis and risk control. Through risk analysis in HIRARC, the risk scores of each hazard are calculated, and the risk scores are analysed into a Pareto Chart. The purpose of Pareto Chart is to study on the priority of hazards to be focus on. Control measures are suggested based on descending order of priority: defective sockets or electrical equipment, high unfenced and unguarded working area, equipment or machine falls from height, noise pollution, and lastly sharp objects or cutting blades.

## INTRODUCTION

Manufacturing and construction sectors in Malaysia has been growing rapidly as Malaysia has transformed from agricultural-based to industrial based nation. However the growth of industries in Malaysia comes with huge responsibilities of safety and health on employers towards all people involved in the manufacturing activities. Safety and health in the manufacturing and construction sectors are important for every employee in the industry to ensure all employees work in a safe and protected environment. It becomes the duty and responsibility of companies to protect their employees as in any business human injury or loss is not acceptable. However, there is always the possibility that someone may have an accident happening in any business. Thus, companies require effective safety and health systems to control hazards and reduce workplace risk. Risk in the workplace can be defined as the probability of a person being injured or experiencing an adverse health impact due to danger. The probability of risk can be influenced by the nature of exposure, method of exposure, and the intensity of the effect of risk. Hazard identification and risk assessment (HIRARC) can be used to evaluate hazards by classifying their probability, severity, and frequency, and immediately addressing adverse [1-2]. Hazards can be classified into six categories which are biological, chemical, physical, safety, ergonomic and psychosocial hazard. These hazards require control measures to reduce or eliminate [3-4].

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## ABOUT THE CASE STUDY

This report analyses case studies on construction sites, construction sector is chosen to be the scope of studies due to the high frequency of accidents occurrence in this sector. Occupational Safety and Health Department's (DOSH), Malaysia's statistics recorded 169 deaths and 3,911 accidents in the construction sector in the year of 2018 [5]. The statistics of accidents at construction sites shows that the Malaysian construction industry is one of the critical sectors that needs a huge changes from the current site safety practices in order to reduce the accidents cases [6]. A total of five case studies were conducted, with the scope of construction sites in Malaysia.

In the first case studied, a construction worker died after being hit by a wooden block. The wooden block was claimed to be from a 4-meter height of the building. This case happened at a construction site located in Johor on 27 Jun 2019 [7]. Besides, a construction sites worker in Kuala Lumpur was killed by electrocution when he was testing a circuit. This incident happened on 16 May 2014 [7]. In the third case studied, a foreign worker was killed after falling from a height of 7.30 metres, while carrying out maintenance work on a water tank at a construction site in Bukit Chabang, Malaysia. This incident occured on 2 September 2019 [8]. Besides, a study from M.H.M Shoib unveiled that the construction company has a poor construction safety management [9]. In 2012, there was a case in Johor Bahru where a project had been delayed for months due to the complaints from the residents who were disturbed by the noise of piling activities [10]. All the cases studied were summarized into Table 1 and hazards for each case are identified and evaluated.

**TABLE 1.** Summarized of cases studied.

| Case study | Details | Hazards | Effect |
|---|---|---|---|
| 1 | A construction worker died after being hit by a falling wooden block. | Equipment/ machine falls from height | Disability, death |
| 2 | A construction sites worker in Kuala Lumpur was killed by electrocution when he was testing a circuit | Defective plugs, sockets or electrical equipment | Electric shock/ burns, electrical fires, death |
| 3 | A foreign worker was killed after falling from a height of about 7.30 metres | High unfenced and unguarded working area | Falling from height/ disability, death |
| 4 | Working condition of construction company Akas Permai Sdn. Bhd. | Sharp objects, cutting blades; High unfenced and unguarded working area | First aid injuries; Falling from height |
| 5 | Project delays due to the noise of piling activities. | Noise pollution | Hearing loss |

## METHODOLOGY

The first step in this study is to obtain the detailed information based on case studies related to the construction area. The detailed information includes the types of activities and previous accident records that have occurred at the construction site in recent years. Next, this study applies Fishbone diagrams, which is also known as cause-effect-diagram, to brainstorm the reason for accidents occurring in the construction area. It also provides a greater way to observe and prevent issues before the issues occur. The root cause can be classified into six categories which are man, machine, measurement, method, material and environment. Then, the potential hazards and risks at the construction area are determined with the application of Hazard Identification, Risk Assessment and Risk Control (HIRARC) from the Department of Occupational Safety and Health (2008). Lastly, Pareto analysis is carried out to decide the activity in the construction site that produces remarkable overall effect by using the 80-20 rule. The principle of analysis is that doing 20% of work can cause 80% of effects.

### Risk Evaluation Matrix

The risk level is evaluated with the technique of Risk Priority Number (RPN) for each hazard. An RPN is the quantitative estimate of each hazard related risk. It is assigned to each hazard based on the three factors which are probability of occurrence, severity rate and hierarchy of controls. Equation (1) is applied to calculate the relative risk according to the likelihood and severity of the risks. The likelihood and severity rating for the hazard exposed are shown

in Table 2 and Table 3 [11]. Based on the risk relative values, a 5x5 risk matrix as shown in Table 4 is used to assess the risk evaluation.

$$\text{Relative Risk} = \text{Likelihood} \times \text{Severity} \quad (1)$$

**TABLE 2:** Likelihood rating.

| **Likelihood** | **Example** | Rating |
|---|---|---|
| Most Likely | The most likely result of the hazard/ event being realized | 5 |
| Possible | Has a good chance of occurring and is not unusual | 4 |
| Conceivable | Might be occur sometime in future | 3 |
| Remote | Has not been known to occur after many years | 2 |
| Inconceivable | Is practically impossible and has never occurred | 1 |

**TABLE 3:** Severity rating.

| **Severity** | **Example** | **Rating** |
|---|---|---|
| Catastrophic | Numerous fatalities, irrecoverable damage and productivity | 5 |
| Fatal | Approximately one single fatality major property damage if hazard is realized | 4 |
| Serious | Non-fatal injury, permanent disability | 3 |
| Minor | Disabling but not permanent injury | 2 |
| Negligible | Minor abrasions, bruises, cuts, first aid type injury | 1 |

**TABLE 4:** The risk matrix.

| **Likelihood (L)** | **Severity (S)** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| 5 | 5 | 10 | 15 | 20 | 25 |
| 4 | 4 | 8 | 12 | 16 | 20 |
| 3 | 3 | 6 | 9 | 12 | 15 |
| 2 | 2 | 4 | 6 | 8 | 10 |
| 1 | 1 | 2 | 3 | 4 | 5 |

Low Risk  Medium Risk  High Risk

The ways to control risks can rank from the highest level to the lowest of safety and reliability, which is known as the hierarchy of control. Controls which lie higher on the inverse pyramid are more effective at reducing risk than those which lie near the bottom and are usually more expensive to implement compared to the lower tiers. Therefore, consideration of level of control measures need to be taken based on the priority of the hazards to be controlled.

1. **Elimination**: Remove the risk source on the tool, jobs, process, and machine.
2. **Substitution**: Substitution is the second-best control measure the way. The danger may not be fully reversible but could be minimized by replacing the material, substance or process with something less dangerous.
3. **Engineering** controls: Engineer/design the solution to reduce the risk like the redesign, isolation, and so on.
4. **Administrative controls**: To introduce the Standard Operation Procedure (S.O.P), training, seminars, awareness to reduce ergonomics risk.

5. **Personal protective equipment (PPE)**: PPE is the last line of defense against a hazard, so while it should not be the first option when managing risks, it may provide additional protection for any danger.

## RESULTS AND DISCUSSIONS

From the cases studied in the construction sites, there are five common effects studied which lead to five hazards. The root causes of all the effects are studied and analysed by using Fishbone diagram. Then, HIRARC is used or further analysis of the hazards in the construction sites. The risk scores of each hazard obtained from risk analysis of HIRARC are then analysed into Pareto Chart to study on the priority.

### Fishbone Diagram (Cause-and-Effect Diagram) Analysis

Figures 1 to 5 shows the Fishbone diagram used on the case evaluation. The possible root causes for each effect are brainstormed based on the 5M1E category and listed as branches from the main arrow.

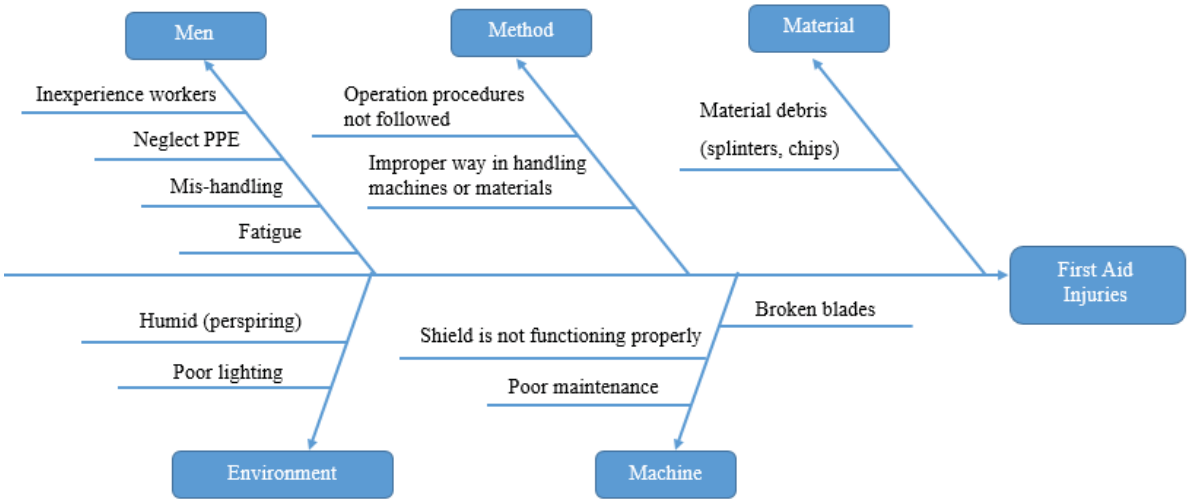


**FIGURE 1.** Fishbone diagram for first aid injuries.

First aid injuries are commonly found on the workers' body at the construction site. There are many factors that contribute to injuries. They are typically due to men, method, material, machine, and environment in this case. One of the causes that leads to first aid injuries is because the workers lack experience or they are not well trained to be working on the construction site and they might mishandle the machines. Some of the workers might neglect their personal protective equipment (PPE) during the work for convenience. Besides, the workers expose themselves to the risk of having first-aid injuries such as cuts when the way they handle or operate the machines is incorrect. For example, they did not follow the proper procedures in operating the machines or handling the material. In fact, the chips and splinters from the material debris would put the workers at risk as well in which it might harm the worker if the workers did not wear PPE. Furthermore, the external factors such as the environmental effect might put workers at risk. The hot and humid weather in Malaysia causes the workers to perspire which will affect the sight of the workers while carrying out tasks as the sweat drips into their eyes. One of the most important factors contributing to the risk of having first aid injuries is the machine that will be operated. Some construction sites use old machines that were used before for current studys, which requires frequent maintenance checks from technicians. The negligence in maintaining the machine will lead to few disabilities of the machine such as broken blade, malfunctioning shield and etc that are able to prevent or lower the risk of hurting the workers.

There are also many accidents happened at the construction area that will cause the workers disability, the root causes of the effect are listed according to the category of 3M1E (Men, Method, Machine and Environment). From Fig. 2, disability can be caused by personal problems and external factors. Works at construction area always require high attention and caution especially when a worker is handling heavy material and operating machine because it is an area involves heavy machine and material. A personal mistake not only exposing that individual at a high risk of danger, it

will also harm other workers. Furthermore, the worker that lack of practice and inexperience that apply misleading methods to operate machine and handling material during construction can also injure others. For external factors which are environment and machine, can be considered as emergency issue at the construction area. Machine broke down and lose it grid can lead to material fall from height and injure workers on the ground. Besides, the environment of construction area such as slippery floor will cause the machine loss balance and machine collision with operator. Thus, there are several root causes have been identified for the effect of disability and there are mostly related to machines at the construction area.

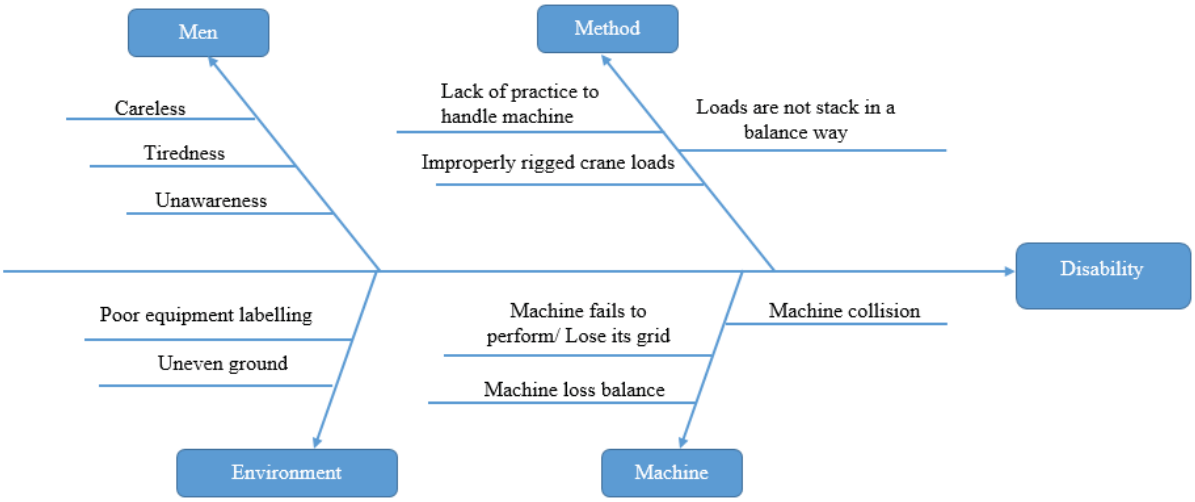


**FIGURE 2.** Fishbone diagram for disability related to machine accident.

Figure 3 shows the fishbone diagram for electric shock. Several causes that lead to the effect of electric shock are identified base on category of men, method, materials, environment, and machine. Mankind factors are due to workers that are inexperienced, unprotected when working, and unawareness of safety when handling electric appliances. Next, in term of method, electric shock happened when improper methods were used during the handling of electric appliances, this may also happen when operation procedures are not followed. Another root causes that lead to electric shock in aspect of materials is identified as lack of appropriate handling tools, with the lack of tools, the workers may just use the bare hand of any inappropriate tool when operating the electric appliances. Then, the environmental factors that causes electric shock are wet working surface and poor equipment labelling. As water is the conductor of electricity, it is important to ensure a dry working area when it comes to works that related to electricity. Equipment labelling also important to act as a reminder for workers when handling the electric appliances. In terms of machines, poor maintenance on electric appliances will also lead to electric shock.

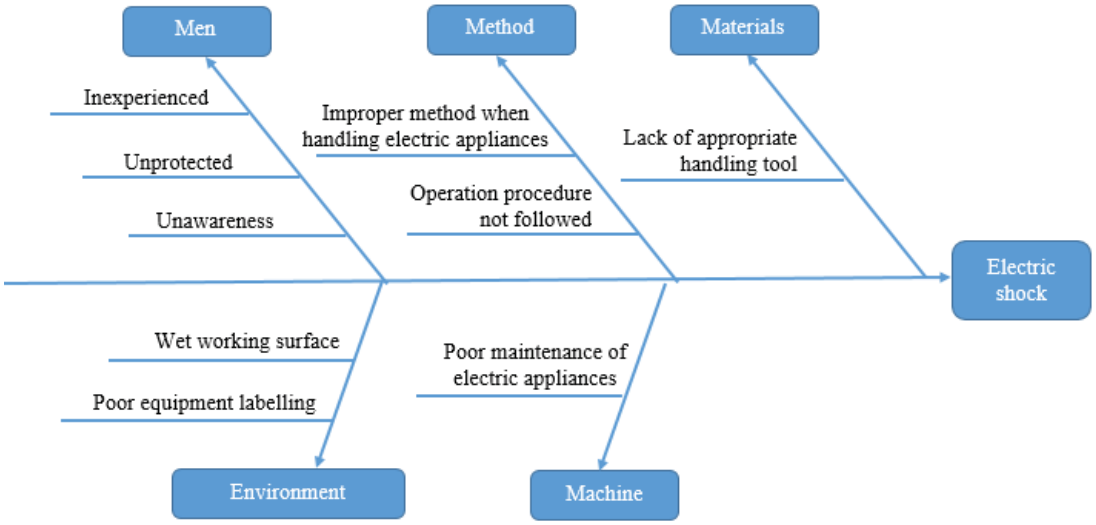


**FIGURE 3.** Fishbone diagram for electric shock.

Figure 4 shows the fishbone diagram of falling from height. Fishbone diagram help in brainstorming to identify possible causes of a problem and in sorting ideas into useful categories. There are 5 categories that identified which are men, method, materials, environment and machine. For the men category, there are three elements will lead to the effect which are lack of communication between the workers, unawareness and tiredness of worker will cause worker falling from height. Lack of planning and poor of prioritization under method category is also the causes of falling from height happened. It is important for worker to plan the work and measure the priority of the tasks to make sure the work carry out smoothly especially at high unfenced and unguarded working area. A jerry-built poor quality of materials will lead to unstable truss. Workers will be falling from the height when the truss is unstable and collapse. Other than that, dusty, weather and height is also the causes of worker falling from height. The worker working under a raining or freezing environment will increase the risk of slipping. The weather of high winds will blow loose materials off and make access equipment unstable. The distance a worker can fall have a direct bearing on the severity of injury or damage it can cause. The larger the height the serious the severity. Lastly for the machine category, there are a possibility of broken lift lead to worker falling from height. Lift is usually used to reach the upper level of the building under construction. The lift broke if it is overload or improper installation. It will harm the safety of worker and cause worker falling from height when worker using the lift to reach the upper floor.

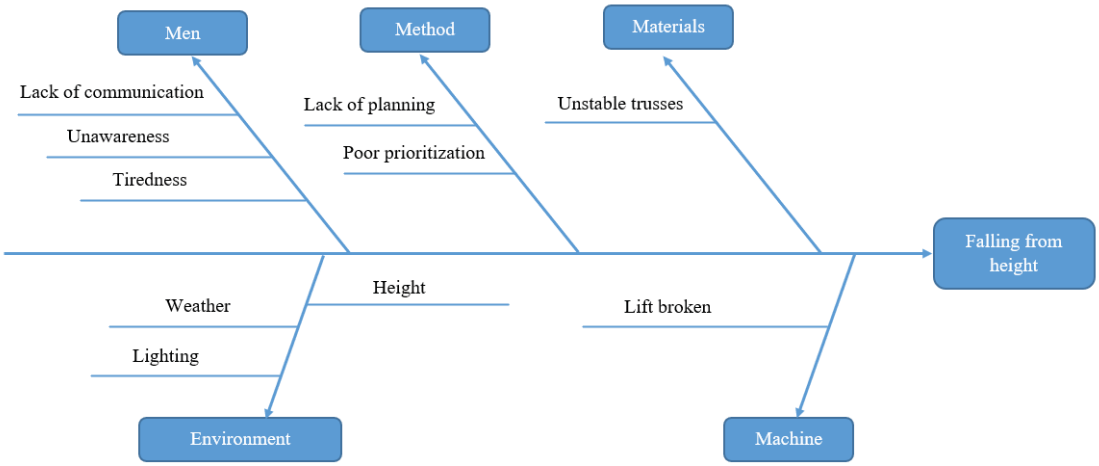


**FIGURE 4.** Fishbone diagram (causes and effects) of falling from height.

Figure 5 shows the fishbone diagram of noise pollution. Hearing loss is happened due to the noise pollution in construction site. The noise may come from different aspects which are environment, machinery, men and the methods on how they work. The workers working in construction site were expose to the noise for a long period and the construction is considered as an open area which didn't set up any noise control area in terms of environment. Besides, the workers in construction site are constantly changing due to the job progresses, they were carpenters, cement workers, steel workers, stucco workers, roofers, brick masons, ventilation installer, electricians, plumber and others. The different workers were use different machine and equipment to proceed their work. For example, machinery and vehicle used in construction sites such as jackhammers, dump trucks, bulldozer, front end loader, cement mixer, cement cutters, electric saws, taping machines, welding machines and others. The machine used without regularly inspection and maintenance will cause the noise and also machines without muffles or sound absorbing materials. Furthermore, the methods on how the workers use the machine will directly cause the hearing loss, the improper method to use the equipment and seldom put lubricants to the machine will cause the gears in machine increase the friction which make noise. With the different noises from different aspects, the workers need to shout when communicate with each other, they have no awareness that they raise their voice when communicating too. So, the noise generated from these activities are easily exceed the OSHA limit of 90 dBA. It is required the use of hearing protection devices. The assessment of risk of each activity including its rating and level is presented in a form of HIRARC analysis as in Table 5.

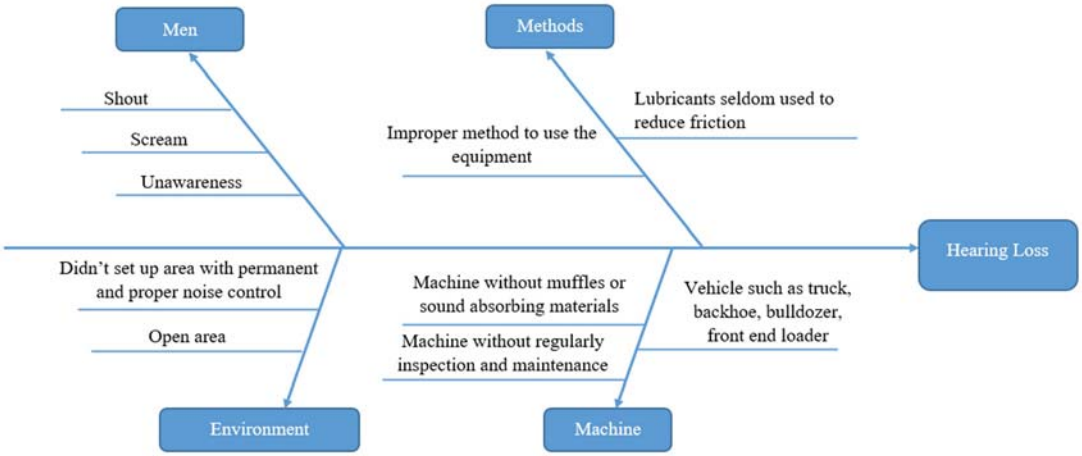


**FIGURE 5.** Fishbone diagram (causes and effects) of noise pollution.

**TABLE 5:** HIRARC Analysis on case studies.

| Hazard identification | | | | Risk analysis | | | | Risk Control | |
|---|---|---|---|---|---|---|---|---|---|
| No | Activity | Hazard | Cause/Effects | Existing Risk Control | Likelihood | Severity | Risk | Recommended Control Measures | PIC and Due Date |
| 1 | Handling machines and equipment | Sharp objects, Cutting blades | Cuts/ First aid injuries | Safe work practice | 4 | 1 | 4 | Provide hand gloves. | [*Classified PIC*], 14 Nov 2020 |
| 2 | Walking in the sites | Equipment/ Machine falls from height | Hit by falling objects/ fracture bones, disability | Personal Protective Equipment | 3 | 4 | 12 | Enclose area under heavy machine with hazard sign. | [*Classified PIC*], 14 September 2020 |
| 3 | Handling electric appliances | Defective plugs, sockets or electrical equipment | Electric shock/ burns, electrical fires, death | N/A | 4 | 5 | 20 | 1. Establish safe work procedure. 2. Provide appropriate handling and protective tools (test pen, hand gloves) 3. Scheduled maintenance on electrical applianccs. | [*Classified PIC*], 14 July 2020 |
| 4 | Operating the machine | Noise pollution | Hearing loss | N/A | 4 | 2 | 8 | Provide earmuff and earplug. | [*Classified PIC*], 14 Oct 2020 |
| 5 | Working at height | High unfenced and unguarded working area | Falling from height/ disability, death | N/A | 3 | 5 | 15 | Provide personal fall protection equipment. | [*Classified PIC*], 14 August 2020 |

Controlling the manufacturing process is essential to ensure the quality and safety can be mainained effectively [12-13]. There are a number of tools can be used to control and one of them is Pareto Analysis. Figure 6 shows Pareto table of the result obtained in HIRARC Analysis. The risk scores obtained are ranked using Pareto, it was observed that defective plugs sockets or electrical equipment leads to highest score, followed by high unfenced and unguarded working area, and thirdly equipment or machine falls from height. Noise pollution ranked number four while the least score was the hazard of cutting blades.

By applying the 80-20 rule, the Pareto chart shows that the 20% hazards that responsible for the 80% of the risk score are the three hazards of defective plugs sockets or electrical equipment, high unfenced and unguarded working area, and high unfenced and lose equipment falling. While precisely, these three hazards contribute to 79.67% of the hazard issues. Therefore, these three hazards need to be focus on to achieve the efficiency in controlling the safety issues in the construction sites. While the priority of the control measures to be taken to control all the hazards will be set with the decreasing order of the graph, where hazard of defective plugs sockets or electrical equipment has the main priority to be controlled and the least priority goes to cutting blades. As the priority to solve the hazards studied in the construction site are based on the ranking in the Pareto chart, the main hazards to pay more attention on are defective plugs sockets or electrical equipment, high unfenced and unguarded working area, and high unfenced and equipment or machine falls from height. While the due dates for all the five hazards identified are set based on the priority as well.

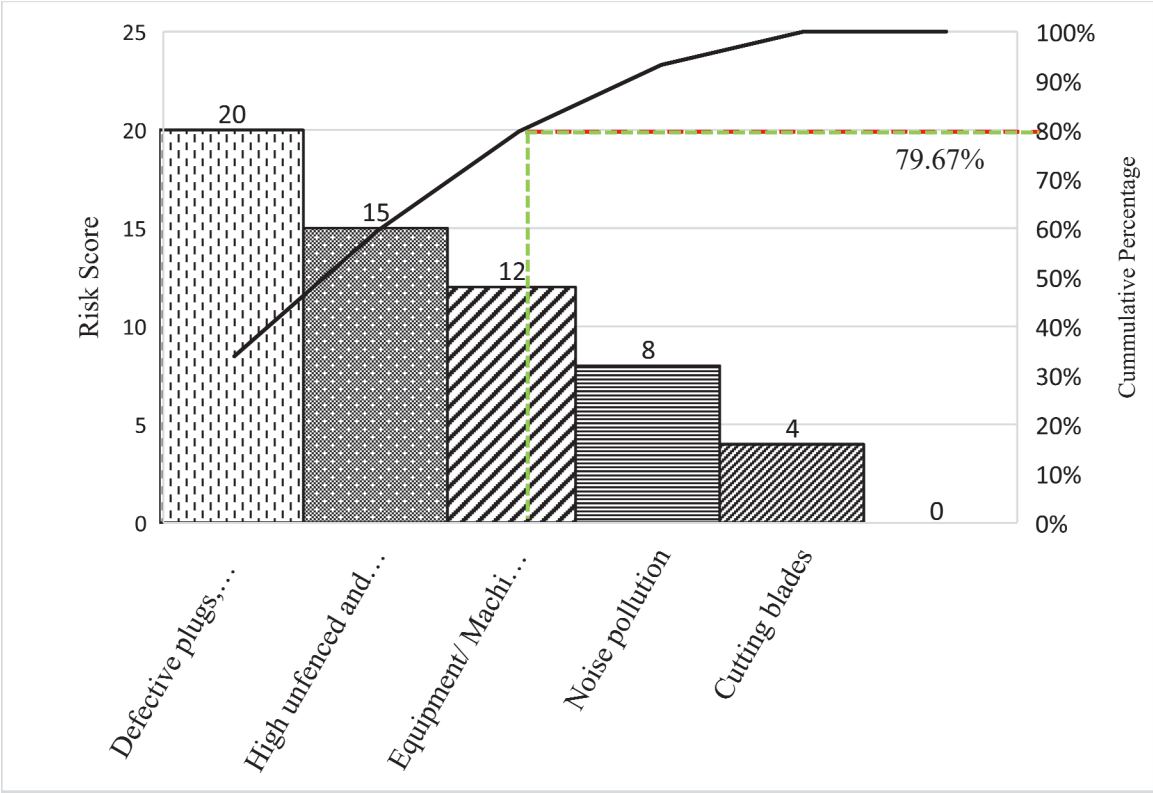


**FIGURE 6:** Pareto chart of risk scores of hazards identified.

The first hazard to be controlled is defective plugs sockets or electrical equipment. The control measures to solve this hazard are set with earliest due date of 14 July 2020. The first control measure to be taken is to establish safe work procedure, safe work procedure on handling electric appliances need to be established and emphasized in the construction sites. Next control measure is to provide handling and protective tools such as test pen and hand gloves. These tools are important to be carry by any worker who will handle electric appliances. Third control measure is scheduled maintenance on electrical appliances, the period of maintenance need to set accordingly.

The second hazard to be controlled is high unfenced and unguarded working area with due date set to be 14 August 2020. The hazard can be eliminated by avoid working at height to remove the risk from the workplace. It can be achieved by modifying the work process such as cleaning the windows from ground floor with a pole rather than using ladder to

reach the window. If the work at height cannot be avoided, control measure of personal protective equipment (PPE) must be apply with provide personal fall protection equipment to the worker. It can prevent worker falling from height and get injured. Thirdly, the hazard of heavy equipment or machine falls from height can be reduced by applying engineering control which is to isolate the workers from hazard. In the current construction area, PPE has been applied to protect the workers and reduce the impact from external forces. However, this control is still far from enough to ensure the safety of the workers at the construction area especially for the machines and materials that are mostly more than 1 ton in weight. PPE only able to protect workers from minor impact such as falls or hit by small item. The workers should avoid themselves working at blind spot or the area under any machine. Those areas need to be enclosed with hazard symbol to warn hazardous.

Next, another hazard in operating the machines on construction sites is noise pollution. The workers who are exposed to the noises for a long period of time could affect their hearing ability. This is due to the noise frequencies that are produced is different from the frequency that the ears are able to receive or handle. Thus, the workers might suffer from hearing loss if preventive measures are not taken. Therefore, the control measure that was recommended is by providing earmuffs and earplugs to the workers who have to operate the machines each time. Wearing earplugs followed by an earmuff could help to prevent the noise from the machines which in return help to encounter hearing loss. This control measure will be enforced before 14th October 2020.

Lastly, the hazard that the workers will face while handling machines and equipment is the sharp objects and the cutting blades. The exposure of these hazards puts the workers at risk of getting first aid injuries. Although they have existing risk control on the construction site which is practicing working in a safe environment, however it doesn't seem workable in preventing the workers from injuries. Fortunately, it is considered a low risk hazard at construction sites. Therefore, the recommended control measure is to provide personal protective equipment (PPE) such as hand gloves and face shield. Make the control measure as a compulsory rule for those workers who are involved in handling the machines and carrying loads such as building material. It can help to prevent or lower the risk in getting cuts and splinters on their hands and face while on work. The workers with face shields and gloves would be able to prevent cuts from flying chips and cutting blades while handling the machine or carrying the material. This control measure will be implemented before 14th November 2020.

## CONCLUSION

All in all, the case study on hazards in construction sites is investigated and studied according to the methods such as HIRARC analysis, fishbone diagram and Pareto analysis which helped to identify the hazard, to investigate the cause and effects of the hazards, and to determine which hazards have to focus as priority respectively. The reasons on how the 5 hazards occurred were investigated, so that the engineering control or prevention procedures can be made to reduce or eliminate the accidents happened. With the use of HIRARC analysis and Pareto chart, the hazard which the most priority to take action is determined through the risk rating and ranking scores respectively. The solutions or measure controls were suggested based in the hierarchy of control to reduce the hazard and accidents. It is important to work in safety area and workers should always take own safety as priority during working.

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