

Risk Assessment in Chemistry Laboratory, Faculty of Chemical Engineering, UiTM Pasir Gudang Campus

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Abstract: *Accident can happen anytime and anywhere. To avoid the accident, the hazard must be reduced and controlled. In this study, the method of Hazard Identification, Risk Assessment and Risk Control (HIRARC) was used in order to minimise the hazard. This study was conducted in Chemistry Laboratory, Faculty of Chemical Engineering, UiTM Pasir Gudang Campus. This laboratory was chosen because most of the first-year students did their experiments which involved chemicals and apparatus in this laboratory. This study started with identified the potential hazards, followed by risk assessment, which is to calculate the risk level and lastly implementing the risk control, if necessary. From the results obtained, there were 8 major routine activities in this laboratory. The highest risk level value was 6, which contributed from 3 activities. The activities are handling chemicals in the fume hood, disposing acidic waste chemicals and preparing solutions. There are some recommended controls measures need to be implemented to make sure the risk level can be reduced in the future. In conclusion, the HIRARC method used in this study is a useful method to identify the potential hazard in order to minimised the accident rate.*

Keywords: Hazard Identification, Risk Assessment, HIRARC

1. Introduction

Laboratories, as well as other workplace is the place where the work conducted is exposed to hazards and risk. Due to the hazardous operations in laboratories, it is exposed to accident and has potential of injuries, illness and damage (Lehmann et al., 2009) (Dodo et al., 2020). Laboratories in any institution require students and staff to conform with basic safety principles to reduce injuries and accidents. The laboratories must contain sufficient space and special design according to the nature of the laboratories themselves (Al-Obaidi et al., 2018) to minimize the potential accidents.

To overcome and reduce the number of accidents, Department of Occupational Safety and Health (DOSH), an organization's body under the Ministry of Human Resources is responsible to ensure a safe environment, safety and health of the worker at the workplace. DOSH always conduct investigation every month by sector or state to analyze the accident rate and the factor that contribute to the accident. According to DOSH guidelines, Hazard Identification, Risk Assessment and Risk Control (HIRARC) is a method used to identify all the hazards, risks and introduce preventive measures so that the risks can be reduced or controlled. Identifying hazard and accessing risks are important to reduce the probability of accidents and should be a big

issue (Barahim 2010) (Rout & Sikdar 2017). Not only that, but it can also avoid incidents that are costly, time consuming, stressful and inconvenient (Ahmad et al., 2016).

Risk is important to be quantified and assessed in support for risk management. Organizations that have already carried out risk assessment in their work, have experienced positive changes in their practice (Shuaib et al., 2009). The risk assessment process should be continuous performed and should not be regarded as a one-off practice.

HIRARC consist of Hazard Identification, Risk Assessment and Risk Control. Hazard identification is the process of examining each work area and work task for the purpose of identifying all the potential hazards (Ahmad et al., 2016). Risk assessment is the process after the potential hazards being identified. Risk assessment is the process where the level of risk will be categorized based on risk matrix (DOSH, 2008). Lastly, risk control will be implemented if necessary, depends on the level of the risk.

In this study, HIRARC was conducted in Chemistry Laboratory, Faculty of Chemical Engineering, UiTM Pasir Gudang Campus to determine the risk level. Chemistry Laboratory in this institution is the laboratory where most first-year students did their experiments. Normally they will be involved with chemicals and apparatus in this laboratory. This study was conducted in the hope of preventing unwanted incident as reported by some researchers.

Al-Dahhan et al. (2017) reported that some unwanted incidents happened in the fume cupboard/hood in their chemistry laboratories because of the maintenance issues. The periodic maintenance of fume cupboard is an essential part to avoid the degradation capacity of the ventilation, in turn can reduce the accident. The study conducted by Hussein et al. (2017) revealed some accidents happened in their chemical laboratory in 2016 due to lack of maintenance and safety test by qualified personnel. The accident was chemical spillage, accompanied by water flood. This accident was caused by a blocked sink while a rusty and old water tap was dripping water for at least 19 hours before the accident.

Due to these reasons, this paper was discussed about risk assessment in Chemistry Laboratory, Faculty of Chemical Engineering, UiTM Pasir Gudang Campus. The risk assessment is important to implemented in this laboratory because first-year students need to be exposed to safety precautions at the initial stage.

2. Methodology

Method used in this study as shown in flowchart from Figure 1 below.



Figure 1: Methodology Step

Hazard Identification

To identify type of hazards exist in the laboratories, observations have been made by the team members with the cooperation of Assistant Science Officers who are familiar with the equipment's, materials and all the possible hazards. The hazards being identified from the activities that almost done by students in this laboratory. Risk identification is the basis of risk management (Li et al., 2019).

Risk Assessment

Risk assessment refers to the possibility of quantitatively measuring the impact or loss caused by a particular phenomenon associated with the activities (Li et al., 2019). The identified hazards will be rated in two terms; likelihood and severity. Likelihood indicates the number of event's occurrence in certain time. It is assessed based on the experience, analysis and measurement (Shuaib et al., 2009). Likelihood (L) has rating from 'most likely' to 'inconceivable'. Table 1 shows the rating for likelihood.

Table 1: Likelihood and Rating

Likelihood (L)	Classification	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 at some time in future	3
Remote	Has not been known to occur after many years	2
Inconceivable	Is practically impossible and has never occurred	1

Source: (Department of Occupational Safety and Health, Ministry of Human Resource, 2008)

Severity (S) indicates the level of effects on health, environment or equipment. It can be divided into five categories which are negligible, minor, serious, fatal and catastrophic. The explanation for severity as shown in Table 2.

Table 2: Severity and Rating

Severity (S)	Classification	Rating
Catastrophic	Numerous fatalities, uncoverable property damage	5
Fatal	Approximately one single fatality, major property damage	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

Source: (Department of Occupational Safety and Health, Ministry of Human Resource, 2008)

Risk of each hazard can be calculated by using Equation 1 below. The equation helps to categorize the hazard either at high, medium or low level.

$$R = \text{Likelihood (L)} \times \text{Severity(S)} \quad (1)$$

Table 3 below shows the Risk Matrix values which consists of likelihood (L) and severity (S). Risk matrix ranking is a common tool used for risk assessment in many industries (Muniandy, 2015). There are three risk levels which are high (red), medium (yellow) and low (green).

Table 3: 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

Source: (Department of Occupational Safety and Health, Ministry of Human Resource, 2008)

Risk level: 15-25 = high
5-12 = medium
1-4 = low

Risk Control

Risk control is a step or improvement that need to be done in order to avoid risk at the workplace. Risk control is the last step in HIRARC flow chart because it is run when all the previous methodology is done. To implement the control measures of hazard, hierarchy of control is provided, and it has five parts which are elimination, substitution, engineering control, administrative control and Personal Protective Equipment (PPE). Implementing risk control for every hazard need to follow the hierarchy of control (Agwu, 2012 and Adiputra, 2015) as shown in Figure 2.

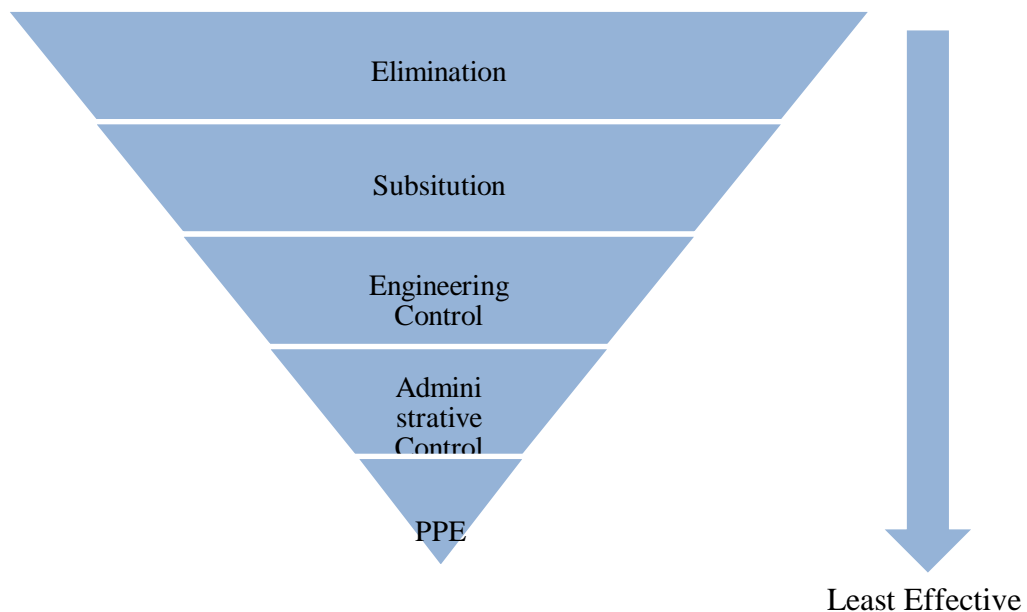


Figure 2: Hierarchy of Controls

Source: (National Institute for Occupational Safety and Health)

3. Results and Discussion

The results of risk level in Chemistry Laboratory was shown in Table 4. The risk level was ranked based on risk matrix. There are some activities and possible hazards occurred in this laboratory.

Table 4: Risk Level of Hazard in Chemistry Laboratory

Activity	Potential Hazard	Risk Level
Handling chemical in the fume chamber	Hazardous material exposure	6 (Medium)
Disposing acidic waste chemical	Reactions from harmful chemical	6 (Medium)
Preparing solution	Hazardous material exposure	6 (Medium)
Heating or drying process in the oven	High temperature tray in the oven	4 (Low)
Titration process	Potentially harmful chemical	2 (Low)

As shown from the table, the risk level for all potential hazards is in the medium and low range. For an activity that use chemicals like handling chemicals in the fume hood, disposing acidic waste chemicals and preparing a solution, there are some potential hazards that might be occurred. The risk level for all activities mention above is 6, which is in the medium range. Based on DOSH (2008), if the risk level is medium, it is suggested to implement a temporary control measures to avoid the accident.

The person who handle chemicals in fume hood and prepare a solution can have the potential of being exposed to the hazardous chemicals. So, to avoid from any accident happen, it is suggested that the person need to wear proper personal protective equipment (PPE) like thick gloves, safety glasses and safety shoes. The person needs to know the suitable PPE before they want to handle any chemicals. The study conducted by Dodo et al. (2020) also revealed that the users in laboratories must have knowledge on potential hazards to increase the safety awareness and practices.

For an activity of disposing acidic waste chemicals, the potential hazard that may occur is reactions may occur between harmful chemicals. The risk level for this potential hazard also 6. To avoid from any undesired event, it is recommended that all waste containers is clear and properly label to avoid any confusion from users. This control measure also agrees with study conducted by Al-Obaidi et al. (2018). From the study, they suggested that clear labelling system and proper storage is important in postgraduate laboratories that have many different types of chemicals. Other than that, in this chemistry laboratory, all containers need to be separated based on their category and the user need to clear up all the spillage immediately (if any) as some of safety precautions. All recommendations mentioned above is under administrative control in hierarchy of control.

Another two activities in this chemistry laboratory have the low risk level. The activities are heating or drying samples in the oven and titration process. For low risk level, the hazard may be considered as acceptable and further reduction may not be necessary (DOSH, 2008). Overall, the finding in this study which is medium and low risk level were aligned with studies conducted by Shuaib et al. (2009) and Ibrahim et al. (2019). From their studies, they also conducted risk assessment in the laboratory at their institution and found the results is in low and medium range.

4. Conclusion

In conclusion, this chemistry laboratory in Faculty of Chemical Engineering, UiTM Pasir Gudang Campus has medium and low range of risk level. The value of risk level 6 (medium)

is somehow near to low risk level. However, it is strongly recommended that safety precautions need to be taken to make sure the safety of people in this laboratory is at the top level and to avoid any accident happen in the future. Further studies also need to focus more on other laboratories due to variations of hazards and risks.

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