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Application of Risk Management Using HIRADC Method in Analytical Chemical Laboratory of University in Indonesia

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Abstract

The analytical chemistry laboratory is one of laboratories at Universitas Airlangga which is often used in conducting analytical chemistry practicum activities and research for lecturers and students. In this analytical chemistry laboratory there are various chemicals and activities that are at high risk of causing danger, especially the exposure to toxic chemicals that can lead to risk of poisoning in students and laboratory staff. The purpose of this study was to apply the HIRADC method as an effort to prevent the risk of accidents and work-related illness in laboratory users. This research method is observational by observing the source of danger and the control efforts that have been made. From the results of the identification of hazards that have been made it is known that there are 10 potential hazards that can cause 10 risks. After doing the risk assessment, it is known that there are 4 low risks, 2 medium risks, 2 high risk, and 2 extreme risks. Control efforts have been made to minimize any risks. The recommendations that can be given from this study are the provision of personal protective equipment (PPE) that is in accordance with the hazards in the laboratory as well as training on how to use the PPE.

Keywords : *HIRADC, analytical chemistry laboratory, risk.*

Introduction

Risk is a combination of the possibility and severity of an event. In the aspect of occupational safety and health (OHS), the risk is usually negative, such as injury, damage, or disruption of the operation. Risk management is an effort to manage hazards that have the potential to pose a risk to occupational safety and health to prevent accidents and illnesses caused by unwanted work in a structured and well planned manner1. HIRADC is one of many methods that hold an important part because it deals with prevention and control of hazards that are used as a reference in determining OHS program objectives and plans.

Government Regulation Number 50 of 2012 concerning the Implementation of Occupational Safety and Health System has explained that in preparing policies and formulating an OHS plan strategy, employers must at least conduct an initial review of OSH conditions which includes identification of potential hazards, assessment and risk control2. In OHSAS 45001: 2018 it is stated that organizations must establish, make, implement and maintain procedures for identifying hazards, assessing risks, and determining the control of hazards and risks required3.

According to the 2013 International Labor Organization (ILO) data, there are more than 250 million cases of workplace accidents every year and more than 160 million cases of work-related illness. From a number of these cases, there were 1.2 million workers who died from workplace accidents and work-related illness or were sick at work4. Based on data from the BPJS (Social Security Agency) on Employment, the number of occupational accidents in Indonesia is still high even though it has decreased every year. Meanwhile, until August 2017 there were 80,392 work accident cases5.

Workplace accidents can occur everywhere, including laboratories in educational institutions.

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Some examples of accidents that have occurred in the laboratory include the fire that occurred at the Chemical Engineering Laboratory, Patras, Egypt on August 27, 2005, which was caused by short circuiting in the laboratory equipment6. Another case was the accident that occurred at the Texas Tech University chemistry laboratory on January 7, 2010 due to violating the procedure for using a mixture of nickel hydrazine perchlorate chemicals in conducting research which resulted in one student losing three fingers, perforating the eyes, and experiencing burns in several body parts7.

Material and Method

Based on the method of retrieval of data, this study is observational, the data is obtained by making observations and there is no treatment of the object of research during the study. Based on the analysis, this research is descriptive, namely describing the process without analyzing relationships between variables.

The population of this study was all laboratory assistant at the analytical chemistry laboratory of Science and Technology Faculty Universitas Airlangga, which amounted to 2 people. Sampling in this study uses the total sampling method, namely the sample used in the study is all members of the population. Variables in this study included hazard identification, risk assessment, and determining control. Data collected in this study only primary data obtained through interviews with laboratory assistants responsible for the analytical chemistry laboratory and observations.

Findings

Work activities at the analytical chemistry laboratory at Universitas Airlangga consist of two activities, namely practicum by students and preparing and cleaning practicum equipment by laboratory staff. The first stage in HIRADC is doing hazard identification. Hazard identification was using the Job Safety Analysis (JSA) method. Based on the results of identification of hazards that have been carried out, obtained the potential or source of danger that exists in practicum activities by students as well as preparation and cleaning of practicum equipment by laboratory assistants are 10 sources of danger that can cause 10 risks.

After identifying hazards from work activities in the laboratory, the next step is to carry out a risk assessment. The risk assessment includes risk analysis and risk evaluation. Risk analysis is carried out by qualitative methods by assessing aspects of opportunity or likelihood and the consequences or severity then evaluating the level of risk. Qualitative risk analysis refers to the Australian Standard / New Zealand Standard (AS/NZS 4360:2004).

Based on the results of the risk assessment carried out on all work activities there are 10 risks including 4 low risk level, 2 moderate risk level, 2 high risk level, and 2 extreme risk level. The results of the risk assessment carried out on activities in analytical chemistry laboratories will be used as a basis in determining appropriate risk control efforts.

The next step is to determine risk control efforts. In this stage, the hazards and risks that have been identified are analyzed to formulate the control strategies based on each risk category. The determining control used in this research refers to OHSAS 45001:2018 that contains elimination, substitution, engineering manipulation, administrative, and PPE.

Hazard Identification

Hazard identification is the process of checking each area and work activity to identify all possible hazards8. Hazard identification can be done by several methods, including passive, semi-active, and proactive1. In this study hazard identification is carried out by using a proactive method that is carried out as a preventive and repairing effort before the loss arises due to danger at work. One technique in the proactive method, namely by making a Job Safety Analysis (JSA) conducted by analyzing potential hazards in each work activity in an analytical chemistry laboratory.

In practicum activities by students there are several potential hazards, firstly there are fragments of laboratory equipment made of glass. Most of the tools used for practicum in chemical laboratories are made of glass because they have several beneficial properties, including translucency, are not easy to react with chemicals, and have a high boiling point so that it doesn't melt at heating below 100oC9. However, equipment made of glass risks breaking when it falls and will cause a lot of broken glass scattered and can injure students and laboratory staff.

The second potential danger is the sitting position of students when recording and doing labs that are less

ergonomic. The incompatibility between the dimensions of the chair and the size of the anthropometry of the user can lead to unnatural posture and risk of causing musculoskeletal disorders (MSDs). Chairs in the laboratory use chairs that are upright, small in size, and without backrest so that they don't interfere with student mobility but with a chair like that can reduce comfort and make the posture less ergonomic.

The third potential danger is lighting in an inadequate laboratory room. The standard of lighting in the laboratory is 500 lux10. Lighting in analytical chemistry laboratories that are less or more than 500 lux can risk causing eye fatigue in students. The fourth is the electricity source. The presence of an inadequate source of electricity and errors when using it can run the risk of short-circuiting and fire.

The fifth potential hazard is the chemicals used in the practicum are corrosive. In analytical chemistry labs, students often use H2SO4 (Sulfuric acid) and HCl (Hydrochloric acid). These materials can enter the body through inhalation pathways and contact with skin and eyes and will have an effect on health. If corrosive chemicals are inhaled it can risk causing irritation to the nose and throat and can interfere with lung function. When in contact with the skin it is at risk of causing damage to the skin and painful sores. When in contact with the eyes, there is risk of causing blindness.

The sixth potential hazard is inadequate laboratory temperature. The temperature of the room that is too high when practicing can cause the body to sweat a lot and will reduce comfort and concentration when doing practicum. In addition, health problems can occur such as the appearance of white spots (milia) in the area of the nose, eyes, and forehead. The temperature of the room in the laboratory is tried between 23-26oC and there is adequate ventilation and wide windows to provide healthy environment11.

The seventh danger potential is the presence of nitrogen gas (N2) tube which is not given a protective chain to prevent from collapsing. Gas cylinders in a lab that are heavy and easily dropped when touched can risking the feet of laboratory workers and students causing injury to the legs. The eighth potential danger is the heat that comes from the heating process using methylated spirits fire. In the chemistry practicum, most of the heating process of materials or chemical solutions uses fire from methylated spirits that can be at risk of being touched by the hand when doing lab work and causing burns.

The second activity is to prepare and clean lab equipment by laboratory staff. In these activities there are two potential hazards, those are the presence of corrosive chemicals, such as H2SO4 and HCl. Corrosive chemicals can enter the body through inhalation pathways, contact with the skin, and eyes. Next is exposure to various chemicals continuously. Some chemicals can have a direct or short-term effect when exposed and some chemicals do not have a direct effect, but continuous exposure to various chemicals through inhalation and skin contact can risk negative effects on long-term health.

Risk Assessment

Risk assessment is the process of assessing the risk of each potential hazard that has been identified8. In this study, risk assessment was carried out with a qualitative risk assessment method that refers to the AS / NZS 4360: 200412. In qualitative risk assessment a scale of risk level categories will be generated, namely extreme, high, medium and low risk. The purpose of risk assessment is to determine whether the risk is still at an acceptable level or not and requires risk control8.

Table 1. Risk Assessment at the FST Analytical Chemistry Laboratory of Universitas Airlangga

No	Activity	Source of Danger	Risk	Likelihood					Severity					Total Risk	Risk Level
				1	2	3	4	5	1	2	3	4	5		
1.	Practi cum by Students	Shards of laboratory equipment made of glass	Hurt	√						√				2	Low
		Sitting position when recording and practicum	Musculoskeletal disorders (MSDs)		√					√				4	Low
		Lighting	Eye fatigue	√						√				2	Low
		Electricity	Short circuit, fire		√							√		8	High
		The chemicals used in the lab are corrosive	Inhale: irritates the nose, throat and the lungs					√				√		20	Extreme
			Skin contact: damage the skin and cause very painful sores												
			Affected by eyes: can cause blindness												
		Temperature of the laboratory room	Excessive sweating can cause discomfort and health problems such as milia					√	√					5	Medium
		There is a gas cylinder (N2) that is not given a protective chain to prevent the tube from collapsing	Can overwrite report legs or practice and cause injury and damage to the laboratory floor			√					√			9	Medium
		Heat (heating process using methylated spirits fire)	Touched hands when doing practicum	√							√			3	Low
2.	Prepare and clean lab equip ment by labora tory staff	Corrosive chemicals (H2SO4 and HCl)	Inhale: irritates the nose, throat and lungs					√				√		20	Extreme
			Skin contact: damage the skin and cause very painful sores												
			Affected by eyes: blindness												
		Continuous exposure to various chemicals	various short-term and long-term risks that might be caused					√			√			15	High

The results of the risk assessment conducted on all work activities have 10 risks including 2 extreme risk level, 2 high risk level, 2 moderate risk level, and 4 low risk level. Based on an experiment in pharmacy laboratory, spilled by chemicals such as HCl, Nitric acid, and Sulfuric acid become high-ranking risk and dangerous13.

Determining Control

Risk control is the process of taking action to eliminate health and safety risks to the extent that they can be implemented fairly or rationally. According to OHSAS 45001: 2018 a risk control hierarchy is carried out by eliminating, substituting, engineering, administrative control, and using personal protective equipment (PPE)3.

At this laboratory, efforts have been made to control any risks, including substitution efforts by replacing several detached plugs with new electrical terminals to temporarily reduce short circuiting and fire risk. Technical engineering efforts by installing local and general exchanger to reduce the risk of discomfort and health problems due to excessive sweating due to hot rooms.

Administrative control is carried out with neat storage facilities and supervision by lecturers and laboratory assistants to reduce injury risk due to glass fragments, there are wooden seats to reduce the risk of MSDs, ceilings and walls painted in bright colors and adjustable lighting to reduce the risk of eye fatigue, and provided a heat-resistant clamp for the heating process to reduce the risk of getting heat from heating spirits. Control with PPE is done by providing medical masks and medical gloves to students and laboratory assistants to reduce the risk of irritation of the nose and throat, disruption of lung function, damage and injury to the skin, and blindness as a result of the danger of corrosive chemicals used in practicum. Meanwhile, the risk of injury and damage to the floor due to being crushed by a nitrogen gas tube has not been controlled.

Conclusion

Hazard identification has been done on activities in analytical chemistry laboratory. We can conclude from the average results that this laboratory contain low-risks activities. But although risk control efforts in analytical chemistry laboratories have been carried out, there are still risks with extreme and high categories, so that control efforts are deemed less effective and need improvement.

1. Extreme category risks can be done by provision of PPE in the form of acid resistant gloves and respirators, policy making about using PPE when in the laboratory, requiring students to have a personal respirator, and conducting hazardous socialization of each chemical by lecturers or laboratory assistants and for laboratory assistants are given training in the use of PPE and instill the importance of using PPE on laboratory.

2. High category risks can be done by replacing all electrical plugs that are detached to prevent the electrical wires from being pulled out and providing electrical terminals for each device that has high electrical power. In addition, referse to health risks of laboran due to continuous exposure to chemicals can be carried out periodically medical check-ups.

3. Medium category risks can be done by optimizing the existing exhauster and adding air conditioner to prevent hot temperature, also providing a protective chain tube and put nitrogen tubes in a safer place to prevent N2 tube become falling.

4. Low category risks can be done by giving first aid kit due to Minister of Manpower and Transmigration Regulation Number 15 of 2008. The MSDs risk can be done by providing a standardized seat in the laboratory and providing cushioning on the seat to reduce pain in the sitting bones. The eye fatigue risk due to inadequate lighting can be controlled by turning on all lights in the laboratory room when practicing and immediately replacing a damaged or dead lamp. And the risk of burned out when warming up with spirits can be monitored by the laboratory during the heating process and use gloves to reduce the risk of being exposed to fire heat.

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Conflicts of Interest : None.

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