Application of Risk Identification, Risk Analysis, and Risk Assessment in the University Laboratory

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Application of Risk Identification, Risk Analysis, and Risk Assessment in the University Laboratory

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Abstract. Currently, the presence of laboratories has become a difficult thing to be separated from the learning system in the university. Moreover, there are many universities that have begun to encourage their students and lecturers to do researches more frequent, for needs both of lecture activities and theses. These conditions trigger the laboratory management to improve their service quality, such as through improvement of the comfortability. From this improvement, it is expected to increase the productivity of people who are doing their activities in a laboratory. However, while the working productivity is being prioritized, there is a problem that is often forgotten, namely health and safety environment. An unhealthy working environment has the possibility to cause stress to people who are working in it. Hazard potentials that exist in a laboratory are caused by the use of reagents and research equipment. To prevent the occurrence of these hazard potentials, deep understanding of risks potential in a laboratory is needed. Based on a research at XYZ Laboratory, a risk analysis and risk assessment are needed to be done by a laboratory, which is often used by students and lecturers in a university, with the purpose of determine the severity and likelihood level of an incident happened. Furthermore, AS/NZS 4360-2004 method, which is used in this research, is also a method to determine the priority of how handle a risk and what is the best step to prevent it.

1. Introduction

The presence of laboratories in a university has a vital function for the continuity of learning activity in various courses as well as researches [1]. With an intensive atmosphere of research, the high management need to prepare themselves to optimize the service quality and comfortability of their laboratories. In the scope of manpower, health and safety environment has an important role which cannot be separated from human resources management [2]. In addition to the requirement of a productive and competitive workforce, health condition also plays a significant role in carrying out assignments because the unhealthy working environment can increase the employees stress [3]. In other words, this problem can lead to excess tasks given by the company to a certain individual. Furthermore, according to [4], the management of working environment safety is closely related to sinergisity of work, which encourage the rise of working productivity.

Generally, hazard potentials that presence in environmental laboratory come from reagents and research equipment. Beside the benefits for the experiment activities, those chemical materials and research equipment have the potential as hazards [5]. Chemical materials in laboratory have various hazard potentials, such as corrosive, explosive, easily oxidizing, flammable, irritating, and toxic for not only human beings, but also the environment [6]. Whereas for research equipment, hazard potentials come from tools that produce heat, spin/move rapidly, fragile, heavyweight, and huge in size.

As a prevention and control of hazard that caused by work accident, occupational illness, and other accidents, a deep understanding of risks is needed. Risk is the probability of bad incidents happened or accumulation of opportunities and impact of some dangerous conditions [7]. Because of risks have different danger levels for each person and type of works, risk analysis and risk assessment are usually conducted. Risk analysis is carried out with the purpose of understanding what risks are presents in a job, how much the impact that happened from the risk, and how to prevent and overcome the hazards [7]. After risk analysis has been done, risk assessment is conducted through quantitative calculation on impact or loss that may occur, then compared with existing criteria to determine severity level of a risk and decide what steps must be done [8].

2. Methodology

XYZ Laboratory, which is about 75 m^2, contains various types of chemical properties and equipment which provide facilities for students or lecturers, from inside or outside the university, to conduct their research. There are various methodologies about risk management that issued by different organizations, such as NIST SP800-30, 2002; AS/NZS 4360, 2004; BSI Standard 100-3, 2005; and ISO/IEC 27005, 2008 [9]. The risk assessment in this laboratory was examined using a method found in AS/NZS 4360: 2004. AS/NZS 4360: 2004 standard because it provides the *six-sigma based process* (define, measure, analyse, improve, and control), involves concurrent engineering (CE) philosophy that can reduce iterative process achieving the project objectives, and calculate different impacts qualitatively [9]-[11].

Before determining the right priorities and steps for handling risks, qualitative measures must be carried out first to see how the severity and likelihood of each risk might occur. In Table 1, several levels are seen to assess the severity of a risk along with an explanation of each score. The assessment was carried out to classify the severity of the impact that could occur from a risk. There are five different levels, where level 1 shows insignificant risks or events that do not cause injuries but could cause relatively small financial losses. While the highest level is level 5 which has a very severe impact, even could cause deaths and huge financial losses.

Table 1. Qualitative measures of severity

Level	Descriptor	Detail
1	Insignificant	No injuries, low financial loss
2	Minor	First aid treatment, medium financial loss
3	Moderate	Medical treatment required, high financial loss
4	Major	Extensive injuries, major financial loss
5	Catastrophic	Death, huge financial loss

Source: AS/NZS 4360-2004

In addition, there is also an assessment of a risk based on how likely it is to occur in a work environment as indicated by **Table 2**. An assessment based on the likelihood is done to classify how often a risk can occur in a work environment. Level A is the highest level, where a risk is considered to be almost certain to occur. On the other hand, level E is the lowest level where at this level a risk might occur but only in certain conditions which are very rare.

Table 2. Qualitative measures of likelihood

Level	Descriptor	Detail
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

Source: AS/NZS 4360-2004

After assessing the level of severity and likelihood of a risk, a matrix is then developed to combine the qualitative score of severity and likelihood scores as shown in **Table 3**. From this combination, a more detailed classification of risks will be obtained that covers how urgent a handling must be done against a risk. The highest level is E or extreme risk; this classification indicates that a risk requires immediate handling so that it does not cause severe adverse effects. While the lowest level is L or low risk, where this risk means that the handling carried out is enough only through routine procedures.

Table 3. Risk priority matrix

Likelihood	Severity				
	Insignificant	Minor	Moderate	Major	Catastrophic
	1	2	3	4	5
A (almost certain)	H	H	E	E	E
B (likely)	M	H	H	E	E
C (moderate)	L	M	H	E	E
D (unlikely)	L	L	M	H	E
E (rare)	L	L	M	H	H

Source: AS/NZS 4360-2004

Legend

E : extreme risk; immediate action required
H : high risk; senior management attention needed
M : moderate risk; management responsibility must be specified
L : low risk; manage by routine procedures

3. Result and Discussion

Experimental activities held in the XYZ Laboratory mostly include sample collection, transportation, receiving, processing, experimental operation, preservation, waste disposal, and others. For each activity there are various risks depending on the kind of activity carried out. If it is not properly prevented and dealt with, it could pose a danger to personnel in the laboratory. Some of the risks that may occur from activities that exist in the XYZ Laboratory are shown in **Table 4**.

The implementation of risk analysis in the form of an assessment based on the level of severity, likelihood, and priority of several risks found in the XYZ Laboratory is shown in **Table 5**. Based on the assessment of the level of severity, there are minor (2), moderate (3), and major severities (4). The level of severity shows the highest number is the minor level (2) from the use of tools such as burette, pipette, test tube, and BOD reactor. There are two activities that show the major level of severity (4), namely taking reagents from fume hood and measurement of heavy metal with AAS. Even though it has the least amount, this level has a very large impact compared to other levels found in XYZ Laboratory.

Table 4. List of risk possibility in XYZ Laboratory

List of Activity	Risk Possibilities
Taking reagents from the fume hood	Shortness of breath, eye irritation, skin irritation, burn marks
Use of burette	Eye irritation, skin irritation, ingestion of chemicals
Use of pipette	Skin irritation, ingestion of chemicals
Use a broken measuring cup	Skin irritation, burn marks
Use of test tube	Skin irritation, burn marks
Use of oven	Exposed to heat, burn marks
Use of BOD reactor	Electric shock
Filling the water tank	Slipped, broken bone
Use of soldering iron	Eye irritation, heat exposure, burn marks, coughing
Measurement of heavy metal with AAS	Fire, explosion, poisoning

Table 5. Severity, likelihood, and priority of risk in XYZ Laboratory

List of Activity	Level of Severity	Level of Likelihood	Level of Priority
Taking reagents from the fume hood	Major (4)	Possible (C)	Extreme risk (E)
Use of burette	Minor (2)	Unlikely (D)	Low risk (L)
Use of pipette	Minor (2)	Unlikely (D)	Low risk (L)
Use a broken measuring cup	Moderate (3)	Likely (B)	High risk (H)
Use of test tube	Minor (2)	Unlikely (D)	Low risk (L)
Use of oven	Moderate (3)	Possible (C)	High risk (H)
Use of BOD reactor	Minor (2)	Unlikely (D)	Low risk (L)
Filling the water tank	Moderate (3)	Likely (B)	High risk (H)
Use of soldering iron	Moderate (3)	Possible (C)	High risk (H)
Measurement of heavy metal with AAS	Major (4)	Likely (B)	Extreme risk (E)

Besides that, there are also three levels of likelihood that differs from one activity to another found in XYZ Laboratories, namely unlikely (D), possible (C), and likely (B). From these three levels, turns out that the highest number of level of likelihood is unlikely (D). The level of unlikely (D) is owned by activities such as the use of burette, pipette, test tube, and BOD reactor. While the least found level of likelihood is possible (C) which is only owned by taking reagents from fume hood, use of oven, and use of soldering iron.

On the other hand, the level of priority is apparently dominated by two levels, namely low risk (L) and high risk (H). From these results, the risks possessed by activities such as the use of burette, pipette, test tube, and BOD reactors can be prevented and handled only by using routine procedures. Then for the risk that caused by the use of broken measuring cup, oven, soldering iron, and filling of water tank, it requires more attention and handling, supervised directly by the laboratory manager. The highest level that can be found in the laboratory is extreme risk (E) obtained from activities such as taking reagents from fume hood and measurement of heavy metal with AAS. Therefore, these activities require special handling as soon as possible.

According to [13], [14], and [15], there are several handlings which should be applied in order to ensuring the safety culture and compliance derived from the risk analysis which has been done. General handling that must be done at XYZ Laboratory is to provide occupational health and safety procedures for all activities, so that it could give understandings for each and every personnel in the laboratory. For risk with low priority level (L), it is necessary to take precautionary measures in the form of prohibiting to joke around during activities and ensuring that personal protective equipment has been worn appropriately according to the standard. Then for risk with a high priority level requires the application of limited use of access, so that each person who wants to use these tools requires permission and

supervision from the laboratory manager. Whereas risk with with an extreme priority level (E) requires laboratory staff who have been certified to carry out these activities.

4. Conclusions

Based on the result of a research that have been done at XYZ laboratory in a university, risk identification with its impact possibility, risk analysis based on the severity and likelihood levels, and risk assessment which contain of right prevention steps based on matrix is obtained. Risks in laboratories generally include experimenting activities with various equipment, which can be met in other laboratories as well, such as pipette, burette, test tube, etc. The obtained level of severity and likelihood from each risk showed different values. It indicates that the priority scales and the proper handling method for each risk at XYZ laboratory are also vary. The result of risk assessment also showed that simple personal protective equipment is not enough to handle risks at XYZ laboratory because some risks are found to be high risk and extreme risk.

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