Potential Hazard Analysis for Higher Education Laboratory Building (Pilot Case Study in Industrial Technology Faculty)

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Abstract

The application of occupational safety and health in the university building, especially in the laboratory (mixed with classrooms) still being underrated and not concerned thoroughly. Industrial Technology Faculty is one of the examples that has a building of laboratory consisting of various departments and hazardous material/equipment. Despite the characteristics of the classroom that has not used high risk equipment, the level of danger in the laboratory building needs to be assessed accordingly, for example the need of implementing a Light Fire Extinguisher (APAR) and First Aid equipment for Accidents (P3K), the use of personal protective equipment (PPE), moreover the lack of safety signs (evacuation routes, hazardous chemicals, exit doors, etc.). In addition, indistinct some building failure is unnoticed such as the holes in the floor containing a series of electrical cables, chemical arrangement, power cables and computers that are not arranged, and many other things that have a potential risk of danger. This study aimed to determine the potential hazard risks contained in the Faculty of Industrial Technology laboratories building on the 2nd and 3rd floors of the 5 stories building, assess the level of the risks identified, and also provide solutions for each hazard found. The methods used in this research were the combination of HIRA (Hazard Identification and Risk Assessment) and HAZOP (Hazard and Operability Study). The results obtained in this study were 3 laboratories that have the highest number of risk values, namely The Chemical Engineering Introduction laboratory, Basic Chemistry Laboratory, and Chemical Engineering Operations Laboratory with the values of 252, 221, and 157. The extreme risk values for these laboratories are 83 with 6 findings, 63 with 5 findings, and 47 with 3 findings consecutively. The many risks that arise in these laboratories are related to the use of strong-smelling concentrated chemicals, tools, and practicum materials that are not well organized, do not obligate policy in the use of PPE, and many others. For all laboratories that were used as research objects, the potential hazards that often arise are related to the absence of APAR and First Aid for some laboratories, the not compulsory in the use of PPE during practicum, the absence of safety signs, laboratory equipment that is not well organized and the absence of clear guidance (SOP-Standard Operating Procedure) when entering the laboratory area/perimeter.

Keywords
Occupational Accident, HIRA, HAZOP, Hazard, and Risk Assessment.

1. Introduction
University based risk assessment is seldomly carried out due to the level functionality of the working condition, the university is considered as office building only. Because of the perception that education building is not having a higher risk of occupational safety and health. Many activities are carried out in the laboratories of the Faculty of Industrial Technology (FTI) of the Higher Education (University) such as assembling components and machines, practical activities using chemicals, data analysis with software computer, and others. A practical method is a form of educational material based on exercises, independent tasks, and practical and laboratory work (Rakhmonkulov and Usarov 2019). Activities carried out in the engineering department include assembling components and machines, practical activities using chemicals, data analysis with computer software, and others. However, these laboratories do not have operational standards when they are in the laboratory, or some have standard operating procedures but are not visible to the public and are not optimal in their implementation.

In addition, the occupational health and safety aspect is also far from standard, because not every laboratory has a first aid kit and fire extinguisher, the air ventilation system, and exhaust fan are limited, only a few laboratories have exhaust fans and the conditions are very noisy when used so that it smells bad. -the smell of chemicals can still be inhaled and also interferes with hearing, there is no emphasis on the use of PPE so that unwanted bad things can happen at any time, floors with holes and pipes used for drains that can cause tripping or near missing, electrical cables that are not neatly arranged and a lot of conditions that should not be in the laboratory that can pose dangers and risks. The prevention and curative equipment provided for the education building is underdeveloped and below the conformance of the standard (Suryoputro et al. 2018).

However, based on the Decree of the Minister of Health Number 605/Menkes/SKNI1 year 2008 on Health Laboratory Office and Health Laboratory Center Standards, each laboratory should have an excellent standard involving labor standards, facilities standards, infrastructure and tools, media, and reagent standards, laboratory safety, and health as well as recording and reporting (Kepmenkes 2008).

Based on the above problems, research will be carried out related to identifying potential hazard risks in university laboratories, and at the end of the study can provide solutions and recommendations related to potential hazards and risks in laboratories to reduce the risk of hazards so that they can cause work accidents, from near misses to near misses, fatal.

Similar research has been conducted using the Hazard Identification and Risk Assessment method metode (HIRA) Analysis of Nanotechnology Laboratory in Universities in Indonesia (Kustono et al. 2021), another research is about risk analysis and reliability of the GERDA Experiment extraction and ventilation plant at Gran Sasso Mountain underground laboratory of Italian National Institute for Nuclear Physics (Lombardi et al. 2017). However, there is still a necessity in exploring the solution to the risk in the laboratory in Indonesia.

In this study, the HIRA (Hazard Identification and Risk Assessment) method will be used as an initial assessment and then combined with HAZOP (Hazard and Operability Study) to further detail the existing hazard risks and find solutions for the hazards that have been obtained.

2. Methods

This research is descriptive quantitative with the HIRA method, namely conducting observations first and then analyzing the data starting from identifying activities and field conditions in detail that have the opportunity or potential to cause work accidents which are then carried out a risk assessment and determine the level of risk, which is then carried out will be continued with the HAZOP method, namely from the results of the identification, further analysis is carried out by grouping based on the source of the hazard which then looks at what deviations occur, causes, effects, then what actions should be taken against the source of the hazard.

2.1 Data Collection

The data collection process in this study was carried out by using the various method. Firstly, the interview, this method is used to obtain information directly by conducting questions and answers with competent parties, in this case, such as the Head of the Laboratory, Laboratory Assistant, Laboratory Student Assistants, and practitioners studying in the laboratory. Secondly, field study or observation, namely by making direct observations of the condition of the existing laboratories in the building of the Higher Education/University. In addition, the secondary data from the literature study is involved. It is one type of activity carried out by researchers to collect research materials using a literature study. Which is a study of documentation by reading books, journals, or browsing through the internet and other literature relevant to this research.

2.2 HIRA (Hazard Identification and Risk Assessment)

HIRA (Hazard Identification and Risk Assessment) is a method or technique to identify events or conditions that have the potential to pose a risk of danger by looking at the characteristics of hazards that may occur and evaluating the risks that occur through risk assessment using a matrix risk assessment (Susihono and Akbar, 2013). Furthermore, how to identify hazards by identifying processes and areas that exist in all activities, identifying as many aspects of occupational safety and health as possible in each process or area that has been previously identified, and K3 identification is carried out in all conditions, be it normal, abnormal, emergency conditions, as well as treatment (Rizki et al. 2014). The following is an assessment table for the frequency and severity based on the category of each finding (Table 1). Next, the results of the multiplication of the frequency and severity values will be seen, after the values are obtained, it will be seen that the risk falls into the category of low, medium, high, or extreme risk values (Table 2).

Table 1. Likelihood vs severity

Frequency/Opportunity/Likelihood				Consequence/Severity			
Level	Category	Description		Level	Category	Description	
		Qualitative	Semi Qualitative			Severity	Workdays
1	Rare	Thinkable, but if only in extreem condition	Less than once in 10 years	1	Insignificant	Event is not contributing to the damage and or injury in human	No work days lost
2	Seldom	Never happened, but could be happened in a moment	Once in a 10 years	2	Minor	Event is affecting a minor injury and not contributing a serious business continuity	The worker still be able to work at the same day/shift
3	Sometimes	Supossed to be happened, and might be happened in a moment	Once in a 5 years until once a year	3	Moderate	Serious injury and hospitalized, not involving permanent dissability, moderate financial lost	Loss less than 3 workdays
4	Often	Easily happened, might often happened	More than once a year until once a month	4	Major	Serious injury and involving permanent dissability and also the financial lost is influenced the business continuity	Loss in and more than 3 workdays
5	Usually	Often occurred, most likely happened	More than once a month	5	Cathastropic	Resulting in death and serious damage even can stop the business forever	Lost working day forever

Source: Kurniawati, et al (2013)

Table 2. Risk calculation

Scale		Severity					Colour Code
		1	2	3	4	5	
Likelihood	5	5	10	15	20	25	Extreme
	4	4	8	12	16	20	High Risk
	3	3	6	9	12	15	Moderate Risk
	2	2	4	6	8	10	Low Risk
	1	1	2	3	4	5	

2.3 HAZOP (Hazard and Operability Study)

According to Juliana (2008), in Pujiono et al (2013), the Hazard and Operability Study (HAZOP) is a standard hazard analysis technique used in a plan to determine safety in a new or modified system for situations that have potential hazards. In addition, based on Kurniawati et al (2013) the HAZOP is used to identify a process or operating unit, whether in the building design, construction, operation, or modification stages.

The purpose of using HAZOP itself is to see a process or operation on a system systematically which then determines whether the deviation process can lead to unwanted accidents. HAZOP systematically identifies any possible deviations from the predetermined operating conditions of a plant, looks for causal factors that allow undesirable conditions to arise, and determines the consequences that cause losses as a result of deviations, and provides recommendations or actions that can be taken to reduce the impact potential risks that have been identified (Munawir 2010 in Pujiono et al. (2013).

3. Results and Discussion

Based on the method performed, the following are the results obtained in the form of the risk levels obtained by each laboratory in this study, the chart is shown in Figure 1.

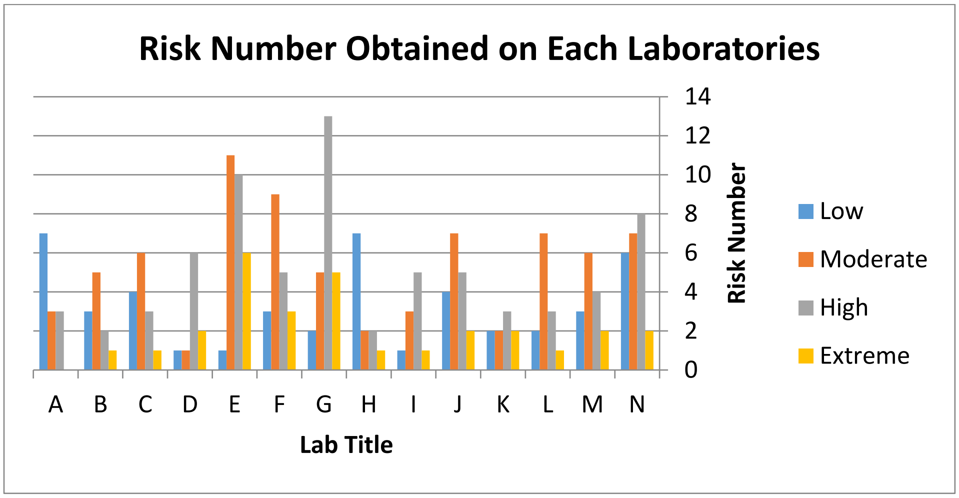

Figure 1. Risk obtained on each laboratory

The picture above is a recap of the number of risks that each Faculty of Industrial Technology laboratory has in the Higher Education building. The one with the highest number of risks is the E laboratory with a total of 28, then the G laboratory with a total risk of 25, and the third position is the N laboratory with a total risk of 23.

Different perspectives will be shown, using the value of the risk. The results of the recap of each laboratory are based on the risk value obtained by each laboratory, shown in Figure 2 below.

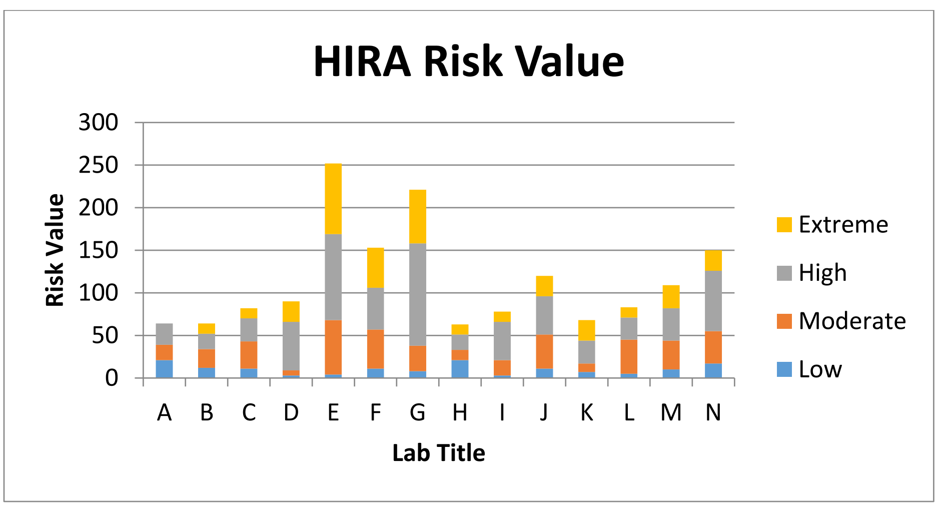

Figure 2. The recap of the risk value based on the HIRA value

From the figure above, it can be seen that the highest number of risk values is the E laboratory with the highest number with a value of 252, followed by the G laboratory with a total of 221 and the third is the F laboratory with a total of 157. There is a difference in the highest order between the number of findings (risk number) and the number of HIRA Values. Based on the total value of HIRA, the difference is shown in the 3rd order. In the figure, the risk number, the

3rd order is the N Laboratory, while based on the total value of the 3rd order on HIRA value, namely the F Laboratory, this occurred due to the F Laboratory has an extreme value that is higher than the N Laboratory.

The 13 laboratories were located on the 2nd and 3rd floors of the building. The following figure 3 is the initial mapping of the results of the total value of the highest risk level obtained from HIRA for each 2nd and 3rd-floor laboratory. Coloring for each laboratory is based on the highest HIRA value of 4 categories (low, moderate, high, extreme) as explained by Kurniawati et al. (2013) in their research, namely blue for low, green for moderate, yellow for high, and red for extreme. For the 2nd floor, there are only 2 colors, namely Green and Yellow. Green is for B and C Laboratories, while Yellow is for 4 laboratories: A, I, N, and M Laboratories. On the 3rd floor, there are 3 colors, Blue, Green, and Yellow. The Blue color is only for H Laboratories, the green color is only for L Laboratories, and the rest is Yellow for 6 Laboratories.

Figure 3. The initial risk level for each laboratory on the 2nd and 3rd floors

The following are the results obtained in the form of the level of risk levels obtained by each laboratory after being given a solution for each hazard risk which is shown in Figure 4.

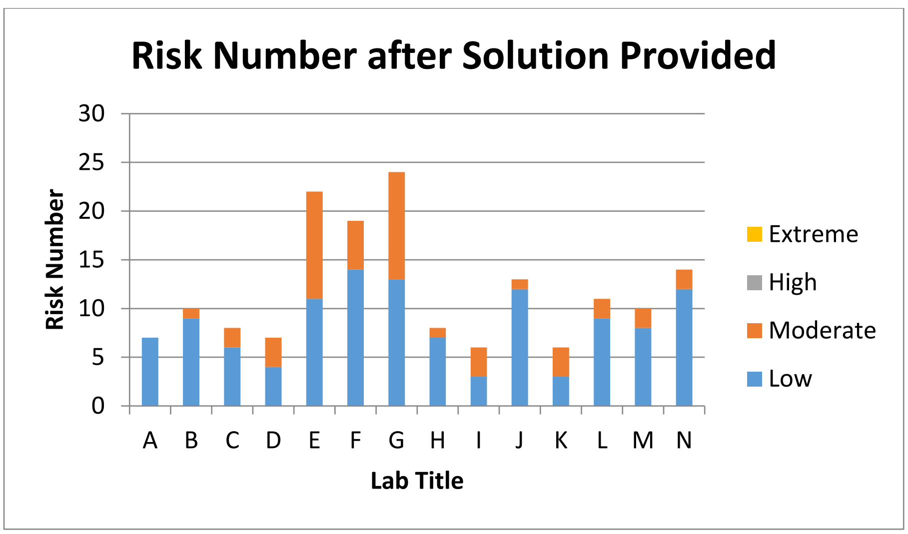

Figure 4. Recap graph of risk amount obtained by each level in all laboratories

From the picture above, it can be seen that the G laboratory has the highest number of risks, namely 24 with a low-risk level of 13 and a medium risk level of 11. In the next order, the E laboratory with a total risk of 22 with a total of 11 for low and moderate risk levels. In the third place, namely the F laboratory with a total of 19, with a low-risk level of 14 and medium 5. From these results, it can be concluded that all the laboratory uses chemicals mentioned has a lot of potential hazards.

Figure 5 below is an estimate of the recap results of each laboratory based on the risk value obtained by each laboratory based on the value of the HIRA risk level.

For the total value of the risk level of each laboratory, the highest total risk value is obtained in the G laboratory, the E laboratory, and the F laboratory with a total value of 108, 104, 76, respectively. The three laboratories are majoring in chemical engineering that uses a lot of chemicals. Before being given a solution, they had the highest total risk level, namely as a high-risk level, and after being provided with the solution, the three laboratories became a low level for F laboratory and a medium risk level for an E and G laboratory.

The results of the table above are a description of the changes in hazard risks that have been identified. If all the solutions provided can be implemented, then that is the possibility of reducing the level of hazard risk in the laboratories that are the object of this research. After calculating the post solution, for the 3 laboratories that have the highest risk values, namely E, G, and F Laboratories, the total reduction in risk values reaches 148, 113, 77 points.

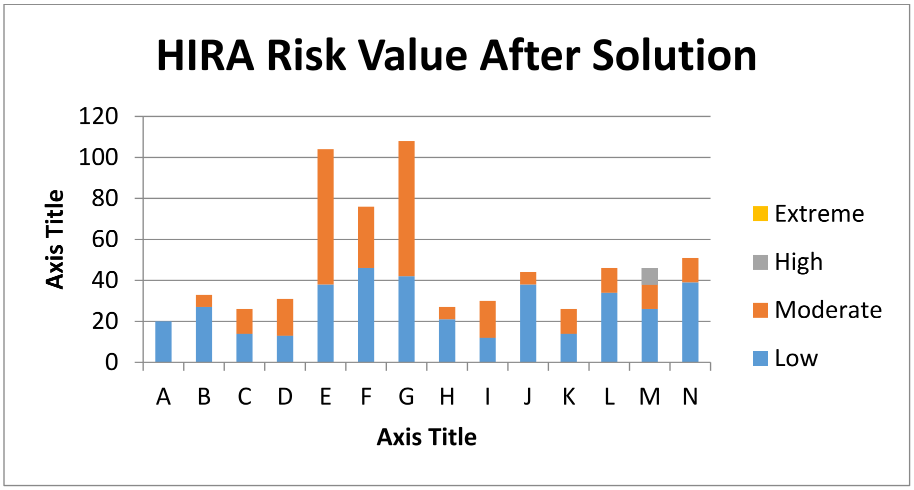

Figure 5. Graph recap of the risk value of each laboratory based on the HIRA value after solution performed

Potential hazard risks that often occur in these laboratories and have a high-extreme level value, namely some laboratories do not have APAR, first aid kits and signs (evacuation routes, exit doors, fire extinguisher pointers, etc.), if there is APAR and first aid kit, its position is not as it should be, which is easy to see, easy to reach, and easy to take, in the event of emergency fire and accident, it will be difficult to handle it. The next potential relates to the arrangement of electrical equipment such as cables, sockets, switches that are not well organized and seem messy, the worst risk that can be accepted is being stung or electrocuted. Another potential is related to SOPs or rules in the laboratory that are not visible, in the sense that the laboratory already has SOPs or regulations but they are not printed and pasted so that visitors can read and obey them, some of the rules are only in the practicum module. And for chemical engineering laboratories, the most potential is related to the arrangement and use of chemicals and the absence of the obligation to use PPE during practicum, it is clear that the potential hazards that exist are related to chemicals if they do not use PPE it will be dangerous, it can have long-term effects.

The solution given related to APAR and First Aid is to immediately procure APAR, First Aid, and signs in an amount that is adjusted to the size and extent of the room, as well as placing it in a position that is easy to see, easy to reach and easy to take. For electrical equipment, the solutions provided are, providing protection for cables that cross the floor and walls, rolling, tying, and tidying cables after use, providing protection for outlets, and giving information on switches. The solution for potential risks related to SOPs or rules in the laboratory is to print and paste in places that are easy to see and read, such as the front door so that every time students enter the laboratory, students always remember the rules and regulations. Potential related to chemicals, namely providing solutions such as laboratories must provide PPE and require every practitioner to use PPE, sort and organize chemicals to be stored according to their place and type, for managers such as laboratory assistants and laboratory assistants must always supervise for students doing the practicum.

The following Figure 6 is the mapping after being given the results of the total value of the highest risk level obtained from HIRA for each second and third floor laboratory.

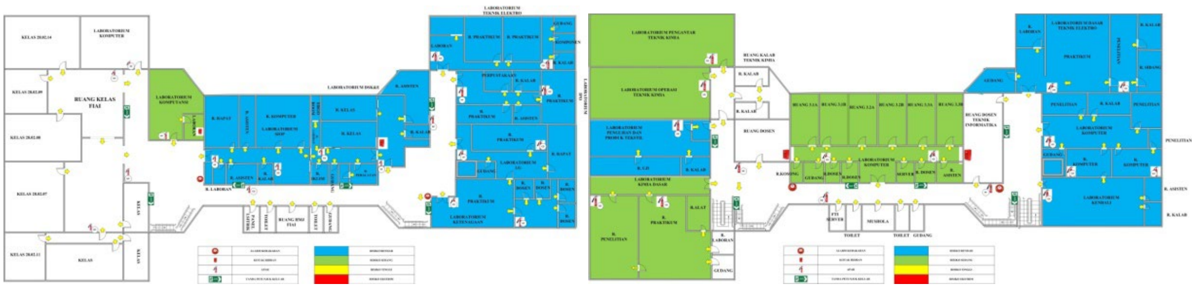

Figure 6. Risk Level after being Given Solutions on the 2nd and 3rd floor of the building

As explained in the previous sub-chapter, the color assignment is based on sources from the research of Kurniawati et al. (2013). There is a big change, the color of the new location map, if the solution is carried out, is dominated by Blue which means a low risk level for the second floor, only the I Laboratory gets a Green color, which previously on the second floor was dominated by Yellow. For the third floor, there are 2 colors Green and Blue with a balanced number, namely 4 laboratories each.

6. Conclusion

1. Among all the laboratories on the second and third floors of the Faculty of Industrial Technology building, there are 3 laboratories with the highest risk findings, namely an E laboratory, F, and G laboratory. For the E laboratory a total of 28 hazard risk findings with a total risk value of 221, the highest risk value is a high level. Furthermore, the F laboratory has a total of 20 findings, the risk value is 157, the highest level. Finally, in the G laboratory with a total of 25 hazard risk findings, the risk value is 221, the highest level value is the high risk level.
2. There is a significantly reduced risk value after performing the solution. Qualitative maps show the evolution of the risk as the solution obtained, from the majority yellow into the majority blue.
3. Every higher education building, especially that equipped with a laboratory should also consider the necessity of performing the risk analysis.

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