

Risk Analysis of Laboratory Hazards with Hazop (Hazard and Operability Study) Methods

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The Industrial Engineering Faculty of Engineering University X has 5 laboratories that are used as a means of practicum and research. The laboratories contain equipment, machines and computers. The application of OSH in these laboratories is lacking, as can be seen from the condition of the laboratories where conditions such the following are present: absence of Light Fire Extinguisher (APAR) and First Aid Equipment (P3K), the absence of safety signs, improper arrangement of tools and machines for practicum, and improper placement of electrical cables and computers. This study aims to determine the potential risks inherent in the FT-UB Industrial Engineering laboratories, assess the level of risks found and subsequently provide a solution for each hazard found. The method used in this research is HAZOP (Hazard and Operability Study). The results obtained provide that the laboratory that has the highest amount of risk is the Manufacturing Systems laboratory. The many risks that arise in this laboratory are related to the use of machines, tools and practicum materials. For all laboratories, the objects of potential risk are mainly related to the absence of APAR and P3K, the absence of safety signs, and the absence of clear SOPs when entering the laboratory area.

Key words: *Risk, occupational health and safety (K3), Light Fire Extinguisher (APAR), HAZOP (Hazard and Operability Study).*

Introduction

Generally, Occupational Safety and Health (K3) are still often overlooked and this is indicated by the high number of work place accidents. Every job contains potential hazards, the magnitude of potential accidents and occupational diseases depend on the type of production, technology, and material in use, as well as the spatial and environmental conditions and the quality of management and staff. Therefore, the implementation of K3 (Occupational Safety and Health) is very important so as to reduce or even eliminate the potential hazards. Proper work safety programs protect employees at work from the risk of work accidents, damaging machines or work tools and prevent and eliminate the causes of accidents (Murdiyono, 2016). As such, good companies always care about the safety and health of their employees (Tri, 2012). Accidents are influenced by several factors such as unsafe conditions, unsafe worker actions, and the physical condition of the workers (Juliana, 2008). For these reasons, potential hazards must be immediately identified and controlled. The Hazard and Operability Study method, through the OHS Risk Assessment and Control ranking, can be applied to companies with the aim of assisting the company to identify potential hazards and provide recommendations for appropriate improvements so that the number of work accidents can decrease (Munawir, 2010).

Research Methodology

This research is about improving the implementation of the Occupational Safety and Health program with the HAZOP approach to identify and control potential hazards. This research is a descriptive study using the HAZOP method from the results of identification. Further analysis is done by grouping based on the source of danger then assesing what deviations, causes, and consequences, occur, then considering the actions that should be taken against these hazard sources.

Results and Discussion

Data for this study was obtained by searching for primary and secondary data sources. Primary data was obtained via direct observation of hazards in the area. The following is a HAZOP table developed using the types of activities and hazards; these are summarized in the source and deviations column. These categories are then developed to see the causes, consequences, and what actions should be taken against these sources of danger. This data is contained in Tables below below.

a. Statistics and Quality Engineering Laboratory

Table 3.1: HAZOP Statistics and Quality Engineering Laboratory

No.	Dangerous Sources	Deviations	Cause	Consequence	Action
1	Electricity	Electric and computer cables. The power cord on the floor from the outlet can be shifted Stop contact that is out of place (not embedded on the wall)	Lack of understanding of laboratory managers about implementing 5S There is no fixed time for laboratory maintenance	An electrical short circuit can result in a fire The cables dangling on the floor can be displaced until they are pulled and broken	Improve understanding of the application of 5S in the laboratory Perform routine maintenance on the laboratory.
2.	Electrical equipment	Socket under the table that easily moves. Power cords that stretch out and cross the floor	Poor cable management in the laboratory	The bowl breaks because it is stepped on, and kicks it to the ground if it is hit by the cable. The socket can be grounded. The cable that extends to the floor can get stuck in the legs and be twisted.	Calling the authorities to neutralize the electrical circuit and eliminate traces on the floor. Nail or open the outlet so that it does not move and shift. Alternatively use, bonding or cables, to achieve same
3	APAR, P3K, Signs	APAR is covered by practicum tools and in the research room there is no APAR. First aid kit is only in the laboratory room. There are no safety	Low responsibility for people who use practical tools in front of APAR. Lack of attention from the laboratory manager for the	Confusion in looking for fire extinguisher because it is located behind an object. Delayed accident care because they have to run	Hang the fire extinguisher on the wall, or in the laboratory on the center pole of the room. Put the first aid kit in the

		signs in this laboratory (evacuation routes, APAR indicators, hazardous material warnings, etc.).	arrangement of the room and the provision of safety guidelines.	into the laboratory room, and even further then if they do not know the position of the first aid kit.	pracitcum room, where it can be seen from all corners of the room. Procurement of APAR and P3K for the research room and also install safety guidelines
4	Administration	SOP or procedures when in the laboratory are not visible	Management does not print and paste to make it easy for students to read and notice	Students and guests do not know the rules and regulations that apply in the laboratory so restrictions are not enacted.	Procurement of SOPs and regulations in printed form of and attach to wall so that they are easy to read

b. Computer Programming Laboratory

Tabel 3.2: HAZOP Computer Programming Laboratory

No.	Dangerous Sources	Deviations	Cause	Consequence	Action
1.	Electricity	Electric and computer cables. The power cord on the floor from the outlet can be shifted. Stop contact that is out of place (not embedded on the wall).	Lack of understanding of laboratory managers about implementing 5S. There is no fixed time for laboratory maintenance	An electrical short circuit can result in a fire due to a short circuit. The cables dangling on the floor can be displaced until they are pulled and broken.	Improve understanding of the application of 5S in the laboratory. Perform routine maintenance on the laboratory.
2.	Electrical Equipment	A power line extending on the	Management's knowledge about	Cables can Entangled.	

		<p>floor. Stop contact on the floor on the traffic lane.</p>	<p>5S is lacking After being used, the cables are left alone by the students and are not tidied up .</p>		
3.	APAR, P3K, signs	<p>APAR is located on the back door of the computer room Lack of fire extinguisher for the practice room. There is no P3K. There are no safety signs such as evacuation routes, exits, and APAR guides.</p>	<p>Lack of management understanding and attention about the proper position of the fire extinguisher and safety equipment. The manager does not ask procurement to add APAR.</p>	<p>When there is a fire in the practice room people must run to the computer room to take APAR. Cannot treat injuries when an accident occurs. There is panic in evacuating during emergencies</p>	<p>Hang the fire extinguisher on the wall or on a support post. Add fire extinguisher to a large laboratory which has a lot of space. Procurement of safety signs</p>
4.	Administration	<p>SOP or procedures when in the laboratory are not visible</p>	<p>Management does not print and paste to make it easy for students to read and notice</p>	<p>Students and guests do not know the rules and regulations that apply in the laboratory so restrictions are not enacted.</p>	<p>Procurement of SOPs and regulations in printed form of and attach to wall so that they are easy to read</p>

c. Manufacturing System Laboratory

Tabel 3.3: HAZOP Manufacturing System Laboratory

No.	Dangerous Sources	Deviations	Cause	Consequence	Action
1.	Work attitude	Practical students do not use complete PPE such as gloves, masks, earplugs or earphones	There are no strict SOPs that require the use PPE. The machine is on the floor.	Scratched. Hearing loss. Bad odor. Pain in the legs and spine due to standing.	Make a SOP or strict rules regarding the use of PPE when in practicum Make a table for the engine stand.
2.	Equipment and machinery	Noisy during the practicum. The narrow room and the passage of the praktikan is blocked	Machines and tools are not organized	Hearing impairment. Hit, trip, and fall Loss of valuables and items Source of odor and disease.	Use a machine that is not noisy. Rearrange the room and apply the 5S concepts
3.	Practice machines and tools	Noisy manufacturing machine	Noisy engine because it is a machine that requires large amounts of power	Difficulty communicating, frequent use can cause hearing loss	Using PPE in the form of earmuffs
4.	APAR, P3K, signs	APAR is located on the back door of the computer room. Lack of fire extinguisher for the practice room. There is no P3K. There are no safety signs such as evacuation routes,	Lack of management understanding and attention about the proper position of the fire extinguisher and safety equipment. The manager	When there is a fire in the practice room people must run to the computer room to take APAR. Cannot treat injuries when an accident occurs.	Hang the fire extinguisher on the wall or on a support post. Add fire extinguisher to a large laboratory which has a lot of space. Procurement of

		exits, and APAR guides.	does not ask procurement to add APAR.	There is panic in evacuating during emergencies	safety signs
5.	Administration	SOP or procedures when in the laboratory are not visible	Management does not print and paste to make it easy for students to read and notice	Students and guests do not know the rules and regulations that apply in the laboratory so restrictions are not enacted.	Procurement of SOPs and regulations in printed form of and attach to wall so that they are easy to read

d. Simulation and Industrial Application Laboratory

Table 3.4: HAZOP Simulation and Industrial Application Laboratory

No.	Dangerous Sources	Deviations	Cause	Consequence	Action
1	Electricity	Electric and computer cables. The power cord on the floor from the outlet can be shifted. Stop contact that is out of place (not embedded on the wall).	Lack of understanding of laboratory managers about implementing 5S. There is no fixed time for laboratory maintenance.	An electrical short circuit can result in a fire. The cables dangling on the floor can be displaced until they are pulled and broken.	Improve understanding of the application of 5S in the laboratory. Perform routine maintenance on the laboratory.
2.	Electrical Equipment	A power line extending on the floor. Stop contact on the floor on the traffic lane.	Management's knowledge about 5S is lacking. After being used, the cables are left alone by the students and not tidied up as before	Cables become Entangled.	
3	APAR, P3K,	APAR is located on the back door	Lack of management	When there is a fire in the	Hang the fire extinguisher on

	signs	of the computer room. Lack of fire extinguisher for the practice room. There is no P3K. There are no safety signs such as evacuation routes, exits, and APAR guides.	understanding and attention about the proper position of the fire extinguisher and safety equipment. The manager does not ask procurement to add APAR.	practice room people must run to the computer room to take APAR. Cannot treat injuries when an accident occurs. There is panic in evacuating during emergencies	the wall or on a support post. Add fire extinguisher to a large laboratory which has a lot of space. Procurement of safety signs
4.	Administration	SOP or procedures when in the laboratory are not visible	Management does not print and paste to make it easy for students to read and notice	Students and guests do not know the rules and regulations that apply in the laboratory so restrictions are not enacted.	Procurement of SOPs and regulations in printed form of and attach to wall so that they are easy to read

e. Work Design And Ergonomics Laboratory

Table 3.5: HAZOP Work Design And Ergonomics Laboratory

No.	Dangerous Sources	Deviations	Cause	Consequence	Action
1.	APAR, P3K, Signs	APAR is located on the back door of the computer room. Lack of fire extinguisher for the practice room. There is no P3K. There are no	Lack of management understanding and attention about the proper position of the fire extinguisher and safety equipment. The manager	When there is a fire in the practice room people must run to the computer room to take APAR. Cannot treat injuries when an accident occurs. There is panic	Hang the fire extinguisher on the wall or on a support post. Add fire extinguisher to a large laboratory which has a lot of space. Procurement of safety signs

		safety signs such as evacuation routes, exits, and APAR guides.	does not ask procurement to add APAR.	in evacuating during emergencies	
2.	Administration	SOP or procedures when in the laboratory are not visible	Management does not print and paste to make it easy for students to read and notice	Students and guests do not know the rules and regulations that apply in the laboratory so restrictions are not enacted.	Procurement of SOPs and regulations in printed form of and attach to wall so that they are easy to read

f. Industrial Management Laboratory

Tabel 3.6 HAZOP Industrial Management Laboratory

No.	Dangerous Sources	Deviations	Cause	Consequence	Action
1.	APAR, P3K, signs	APAR is located on the back door of the computer room. Lack of fire extinguisher for the practice room. There is no P3K. There are no safety signs such as evacuation routes, exits, and APAR guides.	Lack of management understanding and attention about the proper position of the fire extinguisher and safety equipment. The manager does not ask procurement to add APAR.	When there is a fire in the practice room people must run to the computer room to take APAR. Cannot treat injuries when an accident occurs. There is panic in evacuating during emergencies	Hang the fire extinguisher on the wall or on a support post. Add fire extinguisher to a large laboratory which has a lot of space. Procurement of safety signs
2.	Administration	SOP or procedures when in the	Management does not print and paste to	Students and guests do not know the rules	Procurement of SOPs and regulations in

		laboratory are not visible	make it easy for students to read and notice	and regulations that apply in the laboratory so restrictions are not enacted.	printed form of and attach to wall so that they are easy to read
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The results of the field observations provide four potential hazards in the Statistics and Quality Engineering laboratory, four in Computer Programming laboratory, five in the Manufacturing System laboratory, two in the Simulation and Industrial Application laboratory, three in the Work Design and Ergonomics laboratory, and four potential hazards in the Industrial Management studio. The many risks that arise in the laboratory are related to the use of machines, tools and practicum materials which primarily pose danger to the eyes. Many potential hazards related to the absence of APAR and P3K, the absence of safety signs, and the absence of clear SOPs when entering the laboratory area.

Discussion

Based on the results of risk ranking, there are sources of danger that must be corrected immediately. Therefore, this section will explain some recommendations for improvement for sources of danger that have an "extreme" risk value. The recommendations for improvement are proposed by the author to overcome the potential hazards caused by hazard sources that do not meet the standard requirements in work safety and good working procedures, namely:

- a. K3 training on the use of PPE will be conducted by the university for at least one person per laboratory.
- b. A worksheet on the use PPE in the laboratory area is to be created so that assistants and practitioners can know the potential hazards that may arise and the PPE that should be used to reduce the risk of being affected by the hazards.
- c. Immediately procure APAR and P3K signs. The size and number of signs is to be in accordance with the room. The signs are to be placed in a position that is clearly visible, and easily accessible.
- d. Safety cables should be used for any cable that crosses the floor or walls. Cables are to be curld, tied and trimed cables after use. Protection for electrical sockets is to be provided as information on the switch.
- e. Print and stick SOPs in places that are clearly visible

Conclusion

1. The results of the field observations provide four potential hazards in the Statistics and Quality Engineering laboratory, four in Computer Programming laboratory, five in the Manufacturing System laboratory, two in the Simulation and Industrial Application laboratory, three in the Work Design and Ergonomics laboratory, and four potential hazards in the Industrial Management studio.
2. Potential risk hazards often occur in the studied laboratories, notably, some laboratories do not have APAR, first aid kits and signs (guide evacuation routes, exits, APAR indicators, etc.). When there was APAR and P3K, the position of such was clearly visible and was impractical to reach. Electrical equipment such as cables, sockets, and switches were messy and not well ordered, leading to the potential for electrocution. SOPs or regulations in the laboratory are not clearly visible. For chemical engineering laboratories, PPE is not required in practicum, which is clear and obvious danger when handling chemicals.
3. Recommendations are provided to attack the risks that were observed in the study; these are provided above at paragraphs a to e. The application of these recommendations should serve to reduce or eliminate the existing hazard risks that were found.



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