Risk management of Material Laboratory, Department of Civil Engineering, Bali State Polytechnic for preparation of Occupational safety and health program

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Abstract. The purpose of this study is to determine the risks and hazards in the laboratory, it is necessary to identify hazards, risk assessment and risk control. Laboratories are often found in research and development institutions, service companies, industry and universities. The material laboratory is a place to carry out student practicum activities and conduct research which has a source of danger that can cause work accidents such as chemical explosion, fire, poisoning and ext. Work accidents can be avoided by improving the quality of Occupational Safety and Health (OSH) which is related to the process of doing work safely and working conditions that are safe and comfortable. One effort that can help is to identify hazards and risk assessments so that effective control efforts can be made to increase work productivity and reduce work accidents. Hazard identification is a process that can be carried out to identify all situations or events that have the potential to cause work-related accidents and diseases that may arise in the workplace [1]. Carry out hazard identification to answer the question of what potential hazards can occur or befall the company organization and how it can occur. Hazard identification is the first step in developing OSH risk management and a systematic effort to understand the existence of organizational hazards and is the foundation of an accident prevention and risk control program [2].

1. Introduction

1.1. Background

The obligation to introduce the term risk management by ISO 15189: 2012, will define us to focus on understanding and implementing it in the best possible way. In general, the organization proposes that its goal is either to provide good services to obtain certain results. For the material laboratory, it is one of the laboratories that has an important role in student practicum activities, lecturer and student research as well as tests related to construction projects to ensure the results are in accordance with standards, so that the test results must be reliable and accurate. [3]

The Government of Republic of Indonesia has the objective of protecting the safety of workers or laborers by issuing Law No.13, 2003 concerning Manpower, article 86 paragraph 2, namely “to protect the safety of workers or laborers in order to achieve optimal work productivity, efforts are made to work safety and health”. In addition, Article 87 paragraph 1 explain that every company is obliged to implement an occupational safety and health management system. In Regulation of Government No. 50. 2012 article...
7 paragraph 2, explains that in the preparation of OSH policies, an entrepreneur must conduct an initial review of OSH conditions which includes first the identification of potential hazards, risk assessment and risk control, second is a comparison of implementation of OSH with companies and other good sectors. The third is reviewing the cause and effect of dangerous events. The fourth is competence and disruption as well as the results of previous assessments relating to safety and the last is an assessment of efficiency and effectiveness of resources provided [4].

The Occupational Safety and Health Management System is part of the overall management system including the organizational structure, planning, responsibilities, implementation of procedures, processes and resources required for the development of implementation, achievement, assessment and maintenance of occupational safety and health policies, in the framework of controlling risks related to work activities in order to create a safe, efficient and productive workplace.

1.2. Research purposes
The objectives of this study are:
- Identifying sources of risk that occur in the material laboratory of the Civil Engineering department
- Analyze the dominant risks that have the potential to cause work accidents in the material laboratory, majoring in Civil Engineering
- Designing handling of extreme and high risks that occur in laboratory testing

2. Literature Review

2.1. Risk Management of Occupational Safety and Health (OSH)
The implementation of OSH starts with good planning starting with hazard identification, assessment and risk control of HIRARC (Hazard Identification, Risk Assessment, and Risk Control). Risk assessment according to the AS / NZS 4360 standard, the likelihood is given a range between a risk that rarely occurs to the risk that occurs at any time. According to OHSAS 18001, HIRARC is a key element in an occupational safety and health management system that is directly related to the prevention and control of hazards. HIRARC (Hazard Identification Risk Assessment and Risk Control) is also part of Risk Management which must be carried out in all organizational activities to determine organizational activities that contain potential hazards and have a serious impact on occupational safety and health [2]. Hazard identification is the cornerstone of an accident prevention or risk control program. Without recognizing the danger, it cannot be determined so that prevention and risk control efforts cannot be carried out.

The following are the steps for risk management using HIRARC [5]:
- Hazard Identification, namely the process of examining each work area with the aim of identifying the hazards inherent in a job.
- Risk Assessment, which is a risk process for hazards in the workplace.
- Risk Control, which is a process used to identify and control possible hazards in the workplace and carry out continuous reviews to ensure that their work is safe.

2.2. Risk Identification
The hazard identification carried out takes into account the following hazard factors:
- Biology (fungi, viruses, bacteria, microorganisms, plants, animals).
- Chemical material/gas/vapor/dust/liquid toxic, dangerous, explosive/flammable, corrosive, irritant, pressurized, reactive, radioactive, oxidizing, cancer-causing, inhalation hazard, environmental hazard, etc.).
- Physical/Mechanical (infrastructure, machines/tools/equipment/vehicles/heavy equipment, altitude, pressure, temperature, confined / confined spaces, light, electricity, radiation, noise, vibration and ventilation).
- Biomechanics (work posture/position, manual transport, repetitive movements and ergonomics of workplaces/tools/machines).
• Psychic/Social (excess workload, communication, management control, workplace social environment, violence and intimidation).

• Environmental impacts (water, soil, air, ambient, energy resources, natural resources, flora and fauna).

Based on the results of hazard identification carried out in the laboratory, it is known that there are several potential hazards that can occur including fire, electric shock, explosions, spills / leaks, lacerations, bruises and toxic / corrosive gas emissions, skin and eye irritation [6]

2.3. Risk Assessment
Hazard assessment identified by risk hazards through analysis and risk hazard evaluation which is intended to determine the magnitude of the risk by considering the likelihood of occurring and the magnitude of its consequences. Risk assessment includes two stages of the process, namely risk analysis and risk evaluation. These two stages are very important because they will determine the steps and strategies for risk control. Risk assessment uses a risk matrix approach that is relatively simple and easy to use, apply and present a visual representation in it. Risk assessment is carried out based on the scale of the Australian Standard/New Zealand Standard for Risk Management (AS/NZS) 4360: 2004, [4]. There are 2 parameters used in risk assessment, namely likelihood and severity. The risk assessment scale and the information used can be seen in Table 1 and Table 2 [7].

| Level | Description | Note |
|-------|-------------|------|
| 5     | Almost     | Can happen at any time |
| 4     | Certain    | Often occurs |
| 3     | Likely     | Can happen occasionally |
| 2     | Unlikely   | Rarely happening |
| 1     | Rare       | Almost never |

Table 1. Likelihood Scale on AS / NZS 4360 standard.

| Level | Description | Note |
|-------|-------------|------|
| 1     | Insignificant | No injuries, minimal financial losses |
| 2     | Minor       | Minor injuries, minimal financial losses |
| 3     | Moderate    | Moderate injury, requires medical attention |

Table 2. Skala Severity pada standar AS/NZS 4360.
4. Mayor  
5. Catastrophic

2.4. Risk Control
Hazard assessment identified by risk hazards through analysis and risk hazard evaluation which is intended to determine the magnitude of the risk by considering the likelihood of occurring and the magnitude of its consequences. Risk assessment includes two stages of the process, namely risk analysis and risk evaluation. These two stages are very important because they will determine the steps and strategies for risk control. The parameters used to carry out a risk assessment are likelihood and severity. Basically, this hierarchy defines the order in which controls are considered; controls can be selected to implement one or a combination of several types of controls as seen in Figure 1. [8].

3. Research Methods
The method of analysis in this study includes:
- Identification of potential hazards and risks that may occur in practicum activities in laboratory materials
- Risk assessment to determine risks in the low risk, medium risk or high-risk category.
- Control of dominant risks as the basis for the preparation of a material laboratory K3 work program.
- Preparation of K3 work program documents as guidelines for implementing practicum activities.

The analysis carried out in this study is an analysis in determining the dominant risks that will become a priority in handling and controlling risks related to the procurement of personal protective equipment and work support equipment.

![Hierarchy of Controls](image)

Figure 1. Hierarchy of OHS Risk Control.

4. Research Result
4.1. Description of Material Laboratory of Civil Engineering Department

The material laboratory is one of the laboratories of the Bali State Polytechnic Civil Engineering Department which is a place to apply scientific theory, theoretical testing, proving trials, research and so on for teaching staff and students of the Bali State Polytechnic Civil Engineering Department. This laboratory consists of four rooms with 2 floors, namely the 1st floor consisting of two storage rooms for equipment and a separate testing area into 2 rooms, where tests are separated based on the room requirements. While the second floor consists of two rooms, namely one class room to explain testing theories and an office room for laboratory personnel (PLP) and teaching staff. As for those on duty in this Material laboratory each semester consists of 2 (two) PLP people and 6 teaching staff.

The tests carried out in the material laboratory of the Department of Civil Engineering, State Polytechnic of Bali consist of 2 (two) tests, namely: Material Testing 1 (Concrete Job Mix) and Material Testing 2 (Asphalt Job Mix).

From the tests mentioned above, there are several chemicals that are used as testing complementary materials, such as:

- Trichlorethylene (TCE) is a nonflammable, colorless liquid with a slightly sweet and sweet odor, burning taste.
- Sulfur is the chemical element in the periodic table which has the symbol S and atomic number 16. Sulfur is a tasteless, non-metallic element. The resulting effects are shortness of breath, nausea, dizziness, unclear vision, and loss of consciousness. The toxins contained in the gas can cause problems in the body.
- Magnesium sulfate is an inorganic salt chemical compound containing magnesium, sulfur and oxygen, with the chemical formula MgSO₄. This ingredient is classified as harmless, however if inhaled it can cause nausea and vomiting.
- Sodium hydroxide (NaOH), also known as caustic soda, lye, or sodium hydroxide, is a type of caustic metal base. The potential hazard of this material is that it can be corrosive to metals and because severe skin burns and eye damage.
- Sodium sulfate is the sodium salt of sulfuric acid. In its anhydrous form, this compound is a white crystalline solid with the chemical formula Na₂SO₄, or better known as the mineral thermadite. This material is categorized as harmless, but if inhaled it can cause nausea, vomiting and cardiovascular disorders.

4.2. Hazard Identification

Based on the sources and potential hazard factors that can occur in the work environment, in the process of carrying out tests in the material laboratory of the Civil Engineering Department of the Bali State Polytechnic, the hazards that may occur can be identified as follows: noise, skin irritation, eye irritation, nausea, vomiting, shortness of breath and dizziness. The most serious potential hazard is fire. Based on preliminary data collected, accidents that have occurred in the material laboratory are minor accidents such as skin irritation, eye irritation and nausea, while serious accidents are almost a fire due to the use of TCE chemicals in the asphalt flash point testing process. The results of hazard identification can be seen in Table 3 below:

| No | Hazard Factor | Hazard Appear |
|----|---------------|---------------|
| 1  | Technical     | - Sand powder can cause shortness of breath for students if inhaled for a long time, the coarse and sharp coarse aggregate can injure and cause accidents for workers if the placement of the material is carried out carelessly, such as slipping / slipping  
- Testing the sieve analysis using a sieve machine that makes noise can cause noise for students |
Improper use of chemicals such as sulfur, MgSO4, NaOH and NaSO4 can cause hazards such as skin irritation, eye irritation, nausea, vomiting, shortness of breath and dizziness if inhaled or touched the skin.

- The use of TCE in the testing process can cause a fire.
- Dusty work environment, can cause disease if inhaled for a long time.
- Potential hazard that come from or are caused by germs or viruses in the air that come from or come from students who suffer from certain diseases.
- The effect of chemical potentials on the student body depends on the type of chemical or contaminant, the form of potential hazards of dust, gas, vapor, smoke; the toxicity of the substance (toxicity); way into the body.

Environment

Dusty work environment, can cause disease if inhaled for a long time.

Potential hazard that come from or are caused by germs or viruses in the air that come from or come from students who suffer from certain diseases.

- The effect of chemical potentials on the student body depends on the type of chemical or contaminant, the form of potential hazards of dust, gas, vapor, smoke; the toxicity of the substance (toxicity); way into the body.

Human

- Student carelessness in placing and receiving test materials, students do not use safety shoes, gloves and masks.
- Inappropriate attitudes and work methods, inappropriate work arrangements, workloads that are not in accordance with student abilities or incompatibility between humans and machines can cause fatigue and muscle errors.
- Placement of workers that are not in accordance with their talents, interests, personality, motivation, temperament or education, inappropriate workforce selection and classification systems, lack of skills of workers in doing their jobs as a result of lack of job training obtained, and relationships between individuals who are disharmony and incompatible in work organization, can cause work stress.

4.3. Risk Assessment

For known hazards, the level of risk will be sought through a risk assessment. The risk assessment is carried out based on on-site observations, interviews with PLP, and historical data on work accidents in the materials laboratory as well as distributing questionnaires to students who have carried out practicum on material testing 1 and material testing 2 in this material laboratory. Each time given will be analyzed completely. Risk assessment and analysis can be seen in Table 4. Risk assessment is carried out on all identified potential hazards. The parameters used to carry out a risk assessment are likelihood and severity. Likelihood is the probability of a work accident occurring. And severity is an assessment of the seriousness of the effect.

Based on the results of the risk assessment carried out, it shows that of the total identified potential hazards, 22% of activities have low risk potential (low risk), 57% of activities that have moderate risk potential (moderate risk) and 9% of activities that have moderate risk. high potential danger (high risk), 13% do not have activities that have a very high potential hazard (extreme risk).

| No | Source of Hazard | Potential Hazard | Potential Risk | L | S | Level of Risk | Priority of Risk |
|----|------------------|------------------|---------------|---|---|----------------|-----------------|
| 1  | The work attitude at the time of testing was not adjusted to the student's | The height of the test table or test equipment that is too high or low can | Sore | 4 | 3 | 12 | Extreme Risk |
| Students | PPE use | Chemicals | Risk Level |
|----------|---------|-----------|------------|
| do not use | PPE (masks, goggles, gloves) | MgSO4, NaOH, NaSO4 and sulfur | Skin irritation |
| Can be inhaled or in contact with skin | Dizzy | 3 3 9 | High Risk |
| The use of TCE that is not according to the procedure in the asphalt testing process | TCE reacts with a burning flame during the asphalt flash point test | Fire | 2 5 10 | Extreme Risk |
| Students do not use masks, face shield, and do not maintain a distance during the testing process which is carried out by more than 25 people | Potential hazards that come from or are caused by germs or viruses in the air that come from or are sourced from students who suffer from the disease | Threats that come from or are caused by germs or viruses | 3 4 12 | Extreme Risk |
4.4. Risk Control

Risk control aims to minimize the level of risk from the potential hazards that exist. Every risk control that is carried out will be analysed completely. The risk control and analysis of the potentials including extreme risk and high risk can be seen in Table 5 below.

| Risk Rating | Potential Hazard | Potential Risk | Risk Control                                                                 |
|-------------|------------------|----------------|------------------------------------------------------------------------------|
| High Risk   | In testing with chemicals such as MgSO4, NaOH, NaSO4 and sulfur, can be inhaled or touched the skin | Skin irritation | - Do a morning talk before doing the test  
- Making a guidebook for implementing OSH for the implementation of material laboratory testing  
- During the testing with chemicals, students should not touch these chemicals  
- Students use PPE in the form of masks and gloves  
- Do a morning talk before doing the test  
- Creating a guidebook for the implementation of OSH for the implementation of material laboratory testing  
- During the testing with chemicals, students should not touch these chemicals  
- Students use PPE in the form of masks and gloves |
|             | In testing with chemicals such as MgSO4, NaOH, NaSO4 and sulfur, can be inhaled or touched the skin | Dizzy           | - Do a morning talk before doing the test  
- Creating a guidebook for the implementation of OSH for the implementation of material laboratory testing  
- During the testing with chemicals, students should not touch these chemicals  
- Students use PPE in the form of masks and gloves |

| Extreme Risk | Use of TCE that is not in accordance with the procedure in the asphalt testing process, if TCE reacts with a burning flame during the asphalt flash point test and is not properly controlled | Fire            | - Do a morning talk before doing the test  
- Creating a guidebook for the implementation of OSH for the implementation of material laboratory testing  
- During the implementation of the test, only personnel who are competent in their fields may be carried out  
- Replacing the TCE material with another material which is less dangerous  
- Supervise students when doing tests more vigilantly and carefully  
- Forming a disaster emergency response committee  
- Perform routine disaster emergency response simulations |
|             | Students do not use masks, face shield and do not keep their distance during the testing process which was carried out by | Contracting a dangerous disease | - Do a morning talk before doing the test  
- Creating a guidebook for the implementation of OSH for the implementation of material laboratory testing |
more than 25 people during the pandemic
- Using complete PPE according to the required protocol

5. Conclusion
Based on the results of the above research, it can be concluded that the following are:

1. Based on the results of risk identification, the sources of hazards that have potential hazards in the implementation of the laboratory test materials are student work attitudes that are not in accordance with body posture, there are still students who do not use PPE and do not maintain a distance during testing and use of TCE that is not according to procedure.
2. The dominant risks that occur and are classified as high risk and extreme risk categories are 9% and 13%, namely the use of hazardous chemicals at the time of testing is classified as high risk and work attitude, the use of TCE and not using a mask at the time of testing are classified as extreme risk.
3. Risk control is carried out by conducting morning talk before the implementation of the test, making OSH manuals, changing working methods and using the right PPE for each test.

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