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# *Hazard Potential Analysis Using Job Safety Analysis at the Mandala Waluya University Laboratory*

# Analisis Potensi Bahaya Menggunakan *Job Safety Analysis* di Laboratorium Universitas Mandala Waluya

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## ABSTRACT

Potential hazards in laboratories can arise from various sources, such as chemical, physical, ergonomic, biological, and mechanical hazards. This study examines the potential hazards and risk levels in the laboratories of Mandala Waluya University, which include chemical, physical, ergonomic, biological, and mechanical hazards. Using a quantitative descriptive approach through observation, interviews, and Job Safety Analysis (JSA) checklists on five main hazard aspects, risk determination was carried out based on a scale of likelihood and severity, which were classified into low, medium, and high risks. Of the 19 laboratories analyzed, most showed moderate to high risks. Therefore, this analysis focused on three laboratories with moderate to high risks, namely the Pharmaceutical Chemistry Laboratory, the Medical Electrical Technology Laboratory, and the Cytohistology Laboratory, as they had the highest risk levels, particularly related to exposure to chemical and physical hazards and the need to improve the implementation of work safety procedures. These findings emphasize the importance of strengthening risk management through the consistent implementation of K3 standard operating procedures, coupled with increased supervision, safety training, and the provision of adequate personal protective equipment to minimize the potential for accidents and ensure the safety of the academic community.

**Keywords: Laboratory, occupational safety, job safety analysis**

## ABSTRAK

Potensi bahaya di laboratorium dapat terjadi dari berbagai sumber, seperti bahaya kimia, fisika, ergonomi, biologis dan mekanik. Penelitian ini mengkaji potensi bahaya dan tingkat risiko di laboratorium Universitas Mandala Waluya yang meliputi bahaya kimia, fisika, ergonomi, biologis, dan mekanis. Dengan menggunakan pendekatan deskriptif kuantitatif melalui observasi, wawancara, dan checklist *Job Safety Analysis* (JSA) pada lima aspek bahaya utama, penentuan risiko dilakukan berdasarkan skala kemungkinan (*likelihood*) dan keparahan (*severity*) yang diklasifikasikan menjadi risiko rendah, sedang, dan tinggi. Dari 19 laboratorium yang dianalisis, sebagian besar menunjukkan risiko sedang hingga tinggi, maka dalam analisis ini diambil tiga laboratorium yang berisiko sedang hingga tinggi yaitu Laboratorium Kimia Farmasi, Laboratorium Teknologi Elektro Medis dan Laboratorium Sitohistologi menjadi fokus utama karena memiliki tingkat risiko tertinggi, khususnya terkait paparan bahaya kimia dan fisika serta kebutuhan peningkatan penerapan prosedur keselamatan kerja. Temuan ini menegaskan pentingnya penguatan manajemen risiko melalui penerapan standar operasional prosedur K3 secara konsisten, ditambah peningkatan pengawasan, pelatihan keselamatan, dan penyediaan alat pelindung diri yang memadai untuk meminimalisasi potensi kecelakaan dan menjamin keselamatan para sivitas akademika.

**Kata Kunci: Laboratorium, keselamatan kerja, job safety analysis**

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## INTRODUCTION

Occupational Safety and Health (OSH) is related to the labor system and the work environment. By implementing occupational safety and health in a company, potential work accidents that can harm workers and the company can be minimized or even eliminated.[1] According to the Occupational Safety and Health Assessment (OSHA), a workplace accident refers to an unplanned and unexpected situation for many people, as potential workplace hazards can be prevented with proper and correct procedures.[2]

Law No. 13 of 2003 concerning labor in Article 86 states that every organization is required to implement occupational safety and health measures to protect the safety and health of workers.[3] Based on data from the International Labor Organization (ILO), more than 77,708 per 100,000 workers worldwide experience accidents in the workplace.[4] Work accidents can occur anywhere and anytime, including accidents in laboratories.[5]

Laboratories are workplaces used for research, development, experimentation, and analysis of chemical substances using various tools and materials.[6] Workplaces such as laboratories have various potential hazards that can impact the safety of workers and practitioners.[7] The potential for accidents is often overlooked, according to data on workplace accidents in several university laboratories in the United States.[8] In 2018, there were 32 cases of workplace accidents in university laboratories in the United States.[9]

In Indonesia, there have been several cases of workplace accidents at different universities in the last 3 years, namely 12 cases of workplace accidents in East Nusa Tenggara due to a lack of awareness of potential hazards to workers, two workplace accidents in Yogyakarta that resulted in burns to students due to chemical spills, and one workplace accident in Bogor due to a gas leak.[10,11,12]

In Southeast Sulawesi Province, there was an explosion in a laboratory storing chemicals in the nickel industry, which caused 19 workers to suffer from poisoning.[13] Although no serious cases of workplace accidents have been found in university laboratories in Southeast Sulawesi Province, this industrial case can be used as a reference for the implementation of occupational safety, especially in laboratories. One method of analyzing occupational hazards is to use Job Safety Analysis to minimize the potential risk of workplace accidents in laboratories.[14] Compared to other analysis methods, the JSA method has the advantage of being able to identify structural hazards in each step of the work and formulate appropriate control measures to reduce workplace accidents in laboratories.[15]

The laboratory at Mandala Waluya University is a laboratory that supports the learning process for students. Based on the results of interviews with laboratory practitioners, hazard risk analysis has never been carried out, even though there are no officially reported cases of workplace accidents. However, based on these interviews, it appears that potential hazards in the laboratory need to be analyzed using JSA.

Based on the initial observations conducted by the researcher at the laboratory at Mandala Waluya University regarding the implementation of SOPs, the observations showed that several practitioners did not use complete Personal Protective Equipment (PPE), lacked awareness of potential hazards, lacked knowledge of occupational health and safety, and lacked awareness of hazards in the laboratory.

In relation to previous research from brief interviews conducted by the researcher, accidents in the workplace may be due to worker negligence, fatigue, or poor ergonomics in the workplace. Several nurses admitted to having experienced and witnessed work accidents but did not report them because they were not considered fatal. Workplace accidents that frequently occur among laboratory workers include needle stick injuries, chemical spills, and slipping and falling on slippery floors.[10]

Based on findings from various previous studies, workplace accidents in educational laboratories generally involve limited knowledge and a lack of expertise in using laboratory equipment. A number of studies show that potential workplace hazards in laboratories generally occur due to human factors.

Based on preliminary observational research and previous studies, the purpose of this study is to identify potential hazards, analyze the risks of the identified potential hazards, and determine risk control measures based on the results of the analysis using Job Safety Analysis. These potential hazards are identified through JSA with different risk levels based on a combination of severity and likelihood. Severity describes the extent of the impact that will be caused, while likelihood indicates the chance of a hazard occurring, resulting in three risk categories: low, medium, and high. These categories are used to determine priorities for control, where high risks require immediate action, medium risks require additional controls, and low risks require periodic evaluation to ensure that the level of potential danger does not increase.

## MATERIALS AND METHODS

The type of research conducted was quantitative research with a descriptive design using the Job Safety Analysis Checklist.[18] The research was conducted at the Mandala Waluya University Laboratory in July 2025. The population in this study consisted of all workers at the Mandala Waluya University Laboratory, which had 3 laboratories with moderate to high risk hazards, with a sample of 19 respondents. The sampling method used was “Total Sampling” by collecting data directly from respondents using the available questionnaire. Data analysis was carried out in several stages, namely identifying potential hazards, assessing the risks of potential hazards, and controlling hazard risks.[19]

## RESULTS

Table 1 shows that based on the characteristics of the respondents in this study, they had diverse demographic and professional profiles. Based on age distribution, the

respondents were dominated by the 23-27 age group and the 28-34 age group, each accounting for (42.11%) and the 35-38 age group (15.79%). This shows that the majority of respondents were of productive age with high potential work readiness.

In terms of gender in Table 1, most respondents were female (84.2%), indicating that laboratory activities in this institution are mostly carried out by female workers. In terms of education level in Table 1, the majority of respondents had a master's degree (57.8%), indicating that laboratory management and activities are handled by highly qualified academic personnel.

**Table 1. Distribution of Respondent Characteristics by Age, Gender, Education, Occupation and Length of Employment**

| Category | N | % |
|---|---|---|
| **Age** | | |
| 23-27 years old | 8 | 42.11 |
| 28-34 years | 8 | 42.11 |
| 35-38 years old | 3 | 15.79 |
| **Gender** | | |
| Women | 16 | 84.2 |
| Male | 3 | 15.8 |
| **Education** | | |
| D3 | 1 | 5.3 |
| S1 | 7 | 36.8 |
| S2 | 11 | 57.8 |
| **Jobs** | | |
| Lecturer | 11 | 57.9 |
| Assistant Lecturer | 8 | 42.1 |
| **Length of Work** | | |
| <6 months | 1 | 5.3 |
| 6 months – 1 year | 3 | 15.8 |
| > 1 year | 15 | 78.9 |
| **Quantity** | **19** | **100.0** |

Source: Primary Data, 2025

Based on Table 1, in terms of occupation, lecturers constitute the largest group (57.9%), while teaching assistants contribute 42.1%, indicating that both roles are significantly involved in laboratory activities. The duration of work experience in the laboratory also shows a strong trend, with (78.9%) of respondents having worked for a long time, so it is assumed that they have a good understanding of potential hazards and work safety procedures.

In Table 1, the highest identified potential hazard is the risk of physical hazards, namely the occurrence of practitioners falling while working (9.49%), reflecting that working conditions, such as floor surfaces or equipment layout, still have the potential to cause incidents. Conversely, cuts were the lowest potential hazard (0.63%), indicating that risks related to sharp equipment are relatively more controlled. These findings emphasize the need to improve physical risk mitigation, especially related to slipping or falling hazards, through routine evaluation of laboratory conditions and the implementation of stricter safety standards. The frequency distribution of hazard potential analysis among respondents based on chemical hazards in Table 2 shows that the highest type of hazard potential is skin irritation (7.59%) and the lowest is burns (1.90%). This indicates that direct interaction with chemicals is more likely to cause mild to moderate effects, but still requires strict control through the use of personal protective equipment and proper chemical handling procedures.

In the frequency distribution of respondents based on the potential ergonomic hazards of physical fatigue in Table 2, the most dominant risk was found to be physical fatigue (9.49%), followed by neck strain (8.86%). These findings emphasize the importance of ergonomic laboratory design, proportional

work distribution, and the application of safe work posture principles to minimize physical injury.

**Table 2. Distribution of Respondent Frequencies Based on Potential Hazards in The Laboratory**

| Types of Hazards | N | % |
|---|---|---|
| **Physical Hazards** | | |
| Squeezed | 5 | 3,16 |
| Pierced | 12 | 7,59 |
| Cut | 1 | 0,63 |
| Tergiling | 3 | 1,90 |
| Falling | 15 | 9,49 |
| Teriris | 12 | 7,59 |
| Noise | 2 | 1,27 |
| **Chemical Hazards** | | |
| Burns | 3 | 1,90 |
| Skin irritation | 12 | 7,59 |
| Chemical spills | 11 | 6,96 |
| Hit by an object | 13 | 8,23 |
| Infection | 6 | 3,80 |
| **Ergonomics Hazards** | | |
| Physical fatigue | 15 | 9,49 |
| Neck Tension | 14 | 8,86 |
| **Biological Hazards** | | |
| Exposure to bodily fluids | 4 | 2,53 |
| Exposure to chemicals | 7 | 4,43 |
| **Mechanical Hazards** | | |
| Stirring | 8 | 5,06 |
| Broken glass | 2 | 1,27 |
| Tripping | 11 | 6,96 |
| Burn | 2 | 1,27 |
| **Quantity** | **19** | **100,0** |

*Source: Primary Data, 2025*

In Table 2, biological hazards from exposure to patient body fluids pose the highest risk to practitioners (4.43%), while the lowest risk is only (2.52%). This analysis shows that interaction with biological materials can pose a risk of infection that must be controlled through strict procedures, the use of appropriate PPE, and regular training on procedures. Although the percentage is lower than chemical and ergonomic hazards, these biological risks have long-term impacts and serious consequences.

Based on mechanical hazards, tripping has the highest potential risk (6.96%), while the risk of burns is identified at 1.27%. These findings indicate that physical risks due to laboratory environmental conditions, such as slippery and uneven floor surfaces, suboptimal equipment layout, and cable management, require special attention and routine supervision of the laboratory.

It should be emphasized that this distribution does not represent a single hazard potential for each respondent, but rather describes the totality of potential hazards reported by all respondents. Thus, a respondent may experience more than one type of potential hazard, in accordance with the characteristics of the Job Safety Analysis (JSA) method, which evaluates each hazard incident independently based on work activities. Consequently, the total number of potential hazard incidents may exceed the number of respondents without contradicting the principles of risk analysis.

Based on previous research related to the application of the Job Safety Analysis method, relevant preventive measures are recommended, including handling chemical spills by regulating the movement of materials from low to high areas to avoid spills, ensuring that tools can be gripped safely, and using ear protection to reduce exposure to noise that exceeds safe limits. This approach provides a systematic framework that allows risk control to be carried out based on priority according to the level of potential hazards.

Based on all worker activity data, previous research findings, and laboratory examinations

at Mandala Waluya University, the process of identifying potential hazards in this study was carried out using Job Safety Analysis. The study focused on three activities with the longest duration and highest risk levels found during laboratory examinations, namely the Pharmaceutical Chemistry Laboratory, the Medical Electrical Technology Laboratory, and the Cytohistology Laboratory. This analysis shows that activities requiring intensive interaction with chemicals, the use of mechanical equipment, and biological procedures contribute significantly to laboratory risks. Thus, the JSA approach enables the determination of specific, data-based risk mitigation priorities and emphasizes the need for comprehensive risk management, consistent implementation of OSH SOPs, and ongoing training for all laboratory workers.

## DISCUSSION

The Pharmaceutical Chemistry Laboratory has a high level of risk because its practicums involve direct interaction with various active chemicals, the use of tools, tissue sampling, and data analysis. One of the chemical hazards that has occurred is the spillage of samples using solvents during the practicum process, which caused irritation and allergies. Although it did not cause serious injury, this incident shows that the use of powdered materials requires proper handling and the mandatory use of personal protective equipment. In addition, physical hazards were also a major source of this incident, namely electric shock and a lack of understanding of the use of personal protective equipment among practitioners.

These findings are in line with the theory proposed by Casban et al., which emphasizes that the identification of laboratory risks through Job Safety Analysis (JSA) must include an evaluation of potential chemical, physical, and human factors. Casban shows that chemical spills and electrical incidents are significant risks that can be minimized through standard operating procedures, safety training, and consistent use of PPE.[14]

the Medical Electrical Technology Laboratory faces mechanical and electrical risks as dominant factors. Ergonomic risks are also significant due to the use of non-ergonomic wooden chairs and prolonged practices, which have the potential to cause fatigue and human error. In this case, it is necessary to establish a good work schedule and ensure that workers get adequate rest so that their stamina and concentration during the manufacture of equipment do not experience human error. This approach is based on the principle that high workloads and long working hours can increase physical and mental fatigue. A literature study shows that heavy workloads have a negative impact on the perception of work safety and increase the probability of accidents.[15] Therefore, the Medical Electrical Technology Laboratory requires more attention in equipment management and discipline in the use of PPE. Systematic efforts are needed to increase safety awareness and equipment management in this practice environment.

**Table 3.** ***Worksheet Job Safety Analysis in Pharmaceutical Chemistry Laboratory***

| No. | Stages of work | Danger | Risk | Effect | Risk Assessment Before Operation | | | | Hirarki Control | | | | Post-Control Risk Assessment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | S | RR | RISK | Elimination | Substitution | Modific-ation of the engine | Administration | PPE | LL | S | RR | RISK |
| 1 | Collecting and preparing biological samples (e.g., tissue, serum, or cell culture | Biological | Infection or allergic reaction | impaired health, high medical costs. | 3 | 5 | 15 | H | Do not use samples contaminated with harmful pathogens when they are not relevant to the research purpose. | Use in vitro models (cultured cells) instead of animals/human tests whenever possible | Using safe tools and techniques | Safe work procedures | Gloves, masks, and eye protection | 2 | 3 | 6 | M |
| 2 | Perform the extraction of compounds from the sample using the appropriate solvent. | Chemistry | poisoning or irritation | Irritation and allergies | 2 | 3 | 6 | M | Avoid highly toxic solvents (e.g. benzene, chloroform). | Choosing a safer solvent | Acid cabinet/ extraction chamber with exhaus. | Safe work procedures | Gloves, masks, and eye protection | 1 | 3 | 3 | L |
| 3 | Conducting analysis using techniques such as chromatography, spectroscopy, or electrophoresis | Physics | Physical Injury | Centered and punctured tools | 2 | 5 | 10 | M | Avoid the use of carcinogenic or radioactive reagents if other methods are available. | Use non-toxic dyes (e.g. SYBR Safe replaces Etidium Bromide). | using safe and standardized equipment | Safe work procedures | Gloves, masks and eye protection as well as non-slip sandals | 2 | 3 | 6 | M |
| 4 | Perform tests to determine the activity of enzymes in the sample. | Biological | Irritation | Skin allergies | 3 | 3 | 9 | M | Avoid testing with toxic/irritant substrates when not needed. | Use a non-toxic fluorogenic substrate. | Using safe techniques | Safe work procedures | Gloves and eye protection | 1 | 2 | 2 | L |

| No. | Stages of work | Danger | Risk | Effect | Risk Assessment Before Operation | | | | Hirarki Control | | | | Post-Control Risk Assessment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | S | RR | RISK | Elimination | Substitution | Modific-ation of the engine | Administration | PPE | LL | S | RR | RISK |
| 5 | Analyze the data obtained from experiments and create graphs or tables. | Ergonomics | muscle tension and fatigue. | physical discomfort, decreased productivity. | 5 | 2 | 10 | M | Irrelevant (computer analysis stage). | Using validated statistical analysis software. | using ergonomic equipment) | adequate rest and good working position arrangement | Ergonomic chair | 3 | 1 | 3 | L |
| 6 | Compile a report on the results of the experiment, including discussions and conclusions | Ergonomics | muscle tension and fatigue. | physical discomfort, decreased productivity. | 5 | 2 | 10 | M | There is no chemical/biological risk, only the risk of human error in writing. | Use a standard report template. | Using ergonomic equipment | adequate rest and good working position arrangement | Ergonomic chair | 3 | 1 | 3 | L |

Source: Primary Data, 2025

**Table 4. *Job Safety Analysis Worksheet* at the Electromedical Technology Laboratory**

| No | Stages of work | Danger | Risk | Impact | Risk assessment before operation | | | | Hirarki Control | | | | | Post-control Risk Assessment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | S | RR | RISK | Elimination | Substitution | Modification of the engine | Administration | PPE | LL | S | RR | RISK |
| 1 | Gathering all necessary tools and materials, such as measuring devices (e.g., ECG, EEG), computers, | Mechanical | Physical injuries such as muscle strains or back injuries. | Impaired health can result in an inability to work effectively, as well as medical | 5 | 3 | 15 | H | Avoid the use of damaged tools or dangerous traps. | Use a modern, safer trap (e.g. CDC light trap rather than a manual trap). | using aids to lift or move | training in safe lifting techniques as well as ergonomic | Gloves and masks | 2 | 3 | 6 | M |

| No | Stages of work | Danger | Risk | Impact | Risk assessment before operation | | | | Hirarki Control | | | | | Post-control Risk Assessment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | S | RR | RISK | Elimination | Substitution | Modification of the engine | Administration | PPE | LL | S | RR | RISK |
| | and analysis software | | | expenses that may arise from an injury | | | | | | | | workplace settings | | | | | |
| 2 | Perform signal data retrieval from patients or models using medical devices. | ergonomic | Physical injuries | Fatigue | 3 | 2 | 6 | M | Avoid direct contact with live vectors. | Use non-contact traps (sticky traps, light traps, live traps with safe systems). | Ensuring medical devices are safe and standardized | adequate rest and work time | Nitrile gloves, N95 masks, boots, long-sleeved shirts/coveralls, face shields if the risk of bites is high. | 2 | 1 | 2 | L |
| 3 | Preprocessing of the captured signals, including noise removal, normalization, and signal smoothing. | ergonomic | Physical fatigue that can reduce concentration and accuracy in work. | Physical discomfort can result in decreased productivity and quality of work, as well as potential errors in data analysis. | 5 | 2 | 10 | M | Do not identify live vectors. | Use samples that have been turned off with a safe method (chilling/freezing)). | using ergonomic equipment and good working position setting | adequate rest and work time | Gloves | 4 | 1 | 4 | L |
| 4 | Perform signal transformations using | ergonomic | Physical fatigue that can | Physical discomfort can result | 5 | 2 | 10 | M | Do not identify live | Use samples that have | Using ergonomic | adequate rest and work | Gloves | 3 | 1 | 3 | L |

| No | Stages of work | Danger | Risk | Impact | Risk assessment before operation | | | | Hirarki Control | | | | | Post-control Risk Assessment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | S | RR | RISK | Elimination | Substitution | Modification of the engine | Administration | PPE | LL | S | RR | RISK |
| | techniques such as Fourier Transform, Wavelet Transform, or other techniques for further analysis. | | reduce concentration and accuracy in work | in decreased productivity and quality of work, as well as potential errors in data analysis. | | | | | vectors. | been turned off with a safe method (chilling/freezing)). | equipment and working position settings Good | time | | | | | |
| 5 | Analyze transformation results for relevant information, such as pattern detection, disruption identification, or frequency analysis. | Ergonomics | Physical fatigue that can reduce concentration and accuracy in work. | Physical discomfort can result in decreased productivity and quality of work, as well as potential errors in data analysis | 5 | 2 | 10 | M | Avoid testing pathogens in laboratories without appropriate biosafety levels. | Use molecular methods (PCR, ELISA) that are faster and safer than pathogen cultures. | using ergonomic equipment and good working position setting | adequate rest and work time | None | 3 | 1 | 3 | L |
| 6 | Compile reports of analysis results, including graphs, tables, | Ergonomics | Physical fatigue that can reduce concentration and | Physical inconvenience can result in decreased productivit | 5 | 2 | 10 | M | Remove irrelevant patient sensitive information to | Using official data processing software with | using ergonomic equipment and good | adequate rest and work time | None | 4 | 1 | 4 | L |

| No | Stages of work | Danger | Risk | Impact | Risk assessment before operation | | | | Hirarki Control | | | | | Post-control Risk Assessment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | S | RR | RISK | Elimination | Substitution | Modification of the engine | Administration | PPE | LL | S | RR | RISK |
| | and data interpretation. | | accuracy in work. | y and report quality, as well as potential errors in data interpretation. | | | | | maintain confidentiality. | document encryption. | working position setting | | | | | | |

*Source: Primary Data, 2025*

**Tabel 5. *Worksheet Job Safety Analysis* on Laboratory of Cytohistologic**

| No. | Stages of work | Danger | Risk | Impact | Stages of work | | | | Hirarki Control | | | | | Post-control Risk Assessment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | S | RR | RISK | Elimination | Substitution | Modification of the engine | Administration | PPE | LL | S | RR | RISK |
| 1 | Gather all necessary tools and materials, such as reagents, antibodies, and measuring devices | Ergonomic | Work fatigue | Impaired health can result in an inability to work effectively, | 3 | 2 | 6 | M | Avoid the use of expired or hazardous reagents without essential functions. | Choose ready-to-use antibodies/reagents (safer, less toxic)). | Selection of safe tools according to procedures | Safe procedures and adequate rest | Using gloves, masks, and eye protection | 2 | 1 | 2 | L |
| 2 | Taking a sample of the tissue to be analyzed (e.g., | biologic | infection due to exposure to viruses | exposed | 2 | 5 | 10 | M | Taking a sample of the tissue to be analyzed | Use model samples (animal tissues, cell | Safe tool selection | Safe work procedures | Using gloves, masks, and eye protecti | 1 | 5 | 5 | M |

| No. | Stages of work | Danger | Risk | Impact | Stages of work | | | | Hirarki Control | | | | | Post-control Risk Assessment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | S | RR | RISK | Elimination | Substitution | Modification of the engine | Administration | PPE | LL | S | RR | RISK |
| | biopsy). | | or microorganisms patogen | | | | | | (e.g., biopsy). | cultures) when for training. | | | on | | | | |
| 3 | Perform tissue fixation to maintain cell structure and components. | Chemistry | Poisoning or irritation due to contact with reagents | Skin irritation and allergies | 2 | 5 | 10 | M | Minimize The use of formalin/aldehyde (toxic and carcinogenic in nature). | Use an alternative neutral formalin buffer or fixative (e.g. low-concentration PFA). | Do it inside the fume hood. | Strict hygiene procedures | Gloves and masks | 2 | 2 | 4 | L |
| 4 | Slice the fixed tissue into thin pieces using a microtomy. | Physics | Scratched and punctured | Injured | 2 | 5 | 10 | M | Do not use a blunt knife (higher risk of injury). | Choose a safer fixative if possible | Microtom with a knife guard. | Microtom with a knife guard. Prosedur Safe | Using gloves, masks, and eye protection | 2 | 3 | 6 | M |
| 5 | Staining with specific antibodies for the desired target. | Chemistry | Poisoning or irritation due to contact with dye reagents. | Exposure due to hazardous substances | 2 | 3 | 6 | M | Reduce the amount of harmful reagents. | Use ready-made immunohistochemical kits. | Choosing a safe test material | Safe work procedures | Gloves and masks | 2 | 2 | 4 | L |
| 6 | Perform signal detection | Chemistry | Poisoning or irritatio | Impaired health can lead to an inability to work | 2 | 5 | 10 | M | Avoid carcinogenic | Choosing a safer reagent if | Local ventilation when using | Safe and strict working | Gloves, masks, and eye | 2 | 2 | 4 | L |

| No. | Stages of work | Danger | Risk | Impact | Stages of work | | | | Hirarki Control | | | | | Post-control Risk Assessment | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | S | RR | RISK | Elimination | Substitution | Modification of the engine | Administration | PPE | LL | S | RR | RISK |
| | using methods such as fluorescence or enzyme staining. | | n due to contact with reagents. | effectively, as well as potential errors in detection that can affect the results of the analysis. | | | | | substances such as DAB when not needed. | possible | toxic dyes. | procedures | protection | | | | |
| 7 | Observe the results under a microscope and document the findings. | Ergonomics | Physical fatigue that can reduce concentration and accuracy in work | Physical discomfort can result in decreased productivity and quality of observations, as well as potential errors in documentation. | 2 | 2 | 4 | L | There is no biological risk if the tissue is well fixed. | Choosing a safer reagent if possible | using ergonomic equipment and good working position setting | adequate rest and work time | Mask | 2 | 1 | 2 | L |
| 8 | Compile reports of analysis results, including drawings and interpretations | Ergonomics | Physical fatigue that can reduce concentration and accuracy in work. | Physical inconvenience can result in decreased productivity and report quality, as well as potential errors in data interpretation. | 4 | 2 | 8 | M | No biological risk. | Use image analysis software for objectivity. | (Using ergonomic equipment and good working position arrangement) | Adequate rest and working time setting and work time setting | Not mandatory, just a clean work environment. | 4 | 1 | 4 | L |

*Source: Primary Data, 2025*
Description: LL is *Likelihood*; S is Severity; RR is *Risk Rating*.

The Histology Laboratory shows a dominant biological risk, with cases found where samples were not tightly sealed, creating the potential for contamination of practitioners and laboratory staff. In terms of active chemical ingredients, this practicum uses chemical reagents for blood staining, with spills that can cause mild skin irritation.[16] In addition, physical hazards in this laboratory have also posed risks. There have been incidents where test tubes broke during the separation process, posing a potential for injury. Although no damage occurred during the practice, regular training is necessary to avoid recurrence, so this is assessed as a moderate risk.[17]

Based on the above discussion, the potential hazards can be categorized as moderate risk through a combination of the likelihood and severity scales for each identified incident. For example, chemical reagent spills cause mild irritation, which quantitatively has a low severity level with a score of 2 out of 5, and the likelihood of occurrence is quite high due to the frequency of routine practical work with a score of 2 out of 5. The physical risk from test tubes is given a moderate severity score of 3 out of 5 with a low to moderate likelihood score of 2 out of 5 according to the JSA matrix. Using the JSA risk matrix, all potential hazards that produce a maximum score of 4 are categorized as low risk, risks with scores of 4 to 10 are categorized as moderate, while high risks have scores of 10 to 25. Therefore, these three laboratories fall into the moderate category and require follow-up measures such as improving work safety procedures, conducting regular training, and performing routine equipment maintenance to minimize the likelihood of recurring incidents and ensure the safety of laboratory workers.[18]

Based on the above discussion of the Job Safety Analysis (JSA) in the Pharmaceutical Chemistry Laboratory, Medical Electrical Technology Laboratory, and Cytohistology Laboratory were found to have different risk characteristics, both in terms of the type of hazard and the level of exposure to practitioners and laboratory staff. In the theory proposed through JSA in chemical laboratories, the Mandala Waluya University laboratories show similarities in terms of the potential for chemical spills and irritation, which require the use of PPE and standard procedures. Meanwhile, modern laboratories, such as the Medical Electrical Engineering Laboratory and Cytohistology Laboratory, have higher risk complexity because they involve mechanical, electrical, ergonomic, and biological hazards, indicating the need for regular equipment maintenance and consistent training for laboratory workers.[19]

Safety training for practitioners and accompanying lecturers needs to be carried out regularly, including the use of Personal Protective Equipment (PPE) and mitigation of human error risks. Workload management is also important, with structured work schedules and adequate rest periods to maintain stamina and concentration. Routine maintenance of laboratory equipment is mandatory to reduce

the risk of damage and mechanical hazards. The overall laboratory safety policy must be integrated into institutional governance, with regular risk monitoring and evaluation, so that the entire academic community can work in a safe, controlled, and high-standard laboratory environment. The main findings indicate that moderate to high laboratory risks are present in the Pharmaceutical Chemistry Laboratory and the Cytohistologic Laboratory, with most laboratories falling into the moderate category according to the JSA assessment.[20]

## CONCLUSION AND SUGGESTIONS

The conclusion of the Job Safety Analysis (JSA) in the Pharmaceutical Chemistry Laboratory, Medical Electrical Technology Laboratory, and Cytohistologic Laboratory shows that each laboratory has different risk characteristics.

The implementation of integrated laboratory safety policies is required. Each laboratory must have clear SOPs related to the handling of chemicals, the use of electrical equipment, and ergonomic practices, as well as conducting regular inspections to ensure compliance.

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## CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest that could affect the results or interpretation of this study.

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