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Implementation of Job Safety Analysis to Reduce Work Accident Risks in Plumbing Practice at the Building Engineering Education Study Program

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ABSTRACT

The Ministry of Manpower is actively pursuing the implementation of the Occupational Health and Safety Management System to safeguard all workers in Indonesia. One method to mitigate the risk of workplace accidents is through the implementation of Job Safety Analysis. This research is to elucidate the application of Job Safety Analysis to mitigate workplace accidents and to delineate plumbing practices among students in the Building Engineering Education program at Jakarta State University during the plumbing practice course for the odd semester of 2024/2025. The Job Safety Analysis implemented in the plumbing practice course will concentrate on pipe installation procedures. This research employs a quantitative descriptive method comprising three stages: planning, implementation, and evaluation. This study also involved modifications to the Job Safety Analysis, customized to the conditions, surroundings, and equipment of the new workshop. The modifications to the Job Safety Analysis were corroborated by specialists in occupational safety and health as well as plumbing materials. The validation results indicate that the Job Safety Analysis complies with the applicable regulations. The data collection methodology employed questionnaires and observations. The findings of this study demonstrate that the execution of Job Safety Analysis has effectively reduced the risks and hazards associated with workplace accidents. Students have effectively executed Job Safety Analysis by utilizing masks and gloves throughout pipe cutting activities. The predominant occupational hazard identified is hand cramps resulting from pipe cutting, classified as a mild injury. Concurrently, significant injuries are exceedingly uncommon in the laboratory. The adoption of Job Safety Analysis in plumbing procedures can mitigate work-related dangers.

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1. INTRODUCTION

The Ministry of Manpower is actively working on the implementation of the Occupational Health and Safety Management System to protect every worker in Indonesia. This is relevant not just for employees in companies, but also for individuals in educational institutions, such as schools, training centers, and universities (Abidin & Ramadhan, 2019). The Occupational Health and Safety Management System is integral to a broader management framework. This system includes the organizational structure, planning, responsibilities, implementation, processes, procedures, and resources necessary for the development, implementation, review, and maintenance of occupational safety and health. A technique for managing the risk of workplace accidents is the Work Accident Analysis Method, often known as Job Safety Analysis. Job Safety Analysis entails a comprehensive review of all potential hazards linked to every facet of the work being performed, allowing for the proactive identification of possible impacts (Sulistiyowati, 2019). This method involves analyzing the work processes to be put in place, recognizing potential hazards that may arise, and establishing control measures to reduce risks or accidents that could occur in the workplace (Abidin & Ramadhan, 2019). An important development to focus on is in the field of education, where both theory and practice are applied at the educational level (Ghinaya et al., 2024). Education is a domain that necessitates continuous advancement in both instructional and learning approaches (Ramadhan et al., 2022).

According to (Arisma & Mashabai, 2020), Job Safety Analysis is a structured method for recognizing potential hazards in the workplace before accidents or work-related illnesses happen. Furthermore, as highlighted by Abidin and Ramadhan (2019), implementing Job Safety Analysis is crucial for preventing and minimizing workplace accidents in laboratories. This is achieved by following established procedures, completing Job Safety Analysis forms, and executing tasks in accordance with the potential hazards identified in the analysis. Workplace accidents in the industry often occur due to a lack of understanding of safety protocols, improper use of tools, or violations of established safe work procedures. Research conducted by (Desman et al., 2023) indicates that workplace accidents in industries or factories arise from workers' noncompliance with safety regulations, often stemming from a lack of attention to occupational safety and health, particularly regarding the use of Personal Protective Equipment.

Research conducted by Sabaraya and Prastawa (2024) indicates that workplace accidents in industries or factories arise from workers' failure to adhere to safety regulations, largely due to a lack of attention to occupational health and safety, particularly regarding the use of personal protective equipment. A preliminary survey conducted by Febriyanti et al. (2020) among students from the 2016 to 2019 batches of the Building Engineering Education Study Program at Universitas Negeri Jakarta revealed that the plumbing workshop experienced the highest incidence of workplace accidents, accounting for 54.1% of the total cases.

The incidents that occurred during the practical sessions were mainly categorized as light and moderate accidents. Satrio and Wibowo (2023) highlight that using Job Safety Analysis to improve safe and efficient work procedures serves as an effective approach to reduce the risks and hazards linked to workplace accidents by implementing safety management techniques. Practical work goes beyond being merely a hands-on experience; it can stimulate cognitive processes that connect theory with practice (Nurwulan et al., 2022). The study by Saraswati et al. (2019) emphasized that workplace accidents in plumbing practice included scratches on steel plates and damage to tools, leading students to pursue a Job Safety Analysis for the execution of plumbing practice.

The research conducted by Saraswati et al. (2019) has established Job Safety Analysis; however, a trial implementation of this analysis on students has not yet occurred to evaluate the success rate of the developed Job Safety Analysis. This research is crucial for implementing the developed Job Safety Analysis, which is designed to reduce the risk of work accidents in plumbing practices. Additionally, the Job Safety analysis developed in previous research related to a workshop that is no longer in operation. In this study, we will implement slight modifications to the existing Job Safety analysis to ensure it aligns with the new workshop.

Extensive research on implementation has been conducted previously. The study carried out by (Ilham, 2020) aimed to assess the risk level of work accidents in the construction project of the Sikatak Bridge at Diponegoro University Semarang.

Additionally, research conducted by Arisma and Mashabai (2020) shows that the application of Job Safety Analysis in both manufacturing and service industries significantly decreases workplace accidents, underscoring the relevance of this approach in educational environments. Both studies suggest that the use of Job Safety Analysis has been more prevalent in industrial settings. This approach seeks to transform initial data into clearer and more understandable information. This study analyzes work hazard risks by assessing the frequency and severity of work-related incidents in line with the Minister of Public Works and Public Housing Regulation Number 10 of 2021.

This research aims to implement Occupational Health and Safety standards through the use of Job Safety Analysis in plumbing practices for students in the Building Engineering Education program at Universitas Negeri Jakarta. Consequently, this research is expected to raise awareness and commitment among all stakeholders regarding the importance of occupational safety, which will help decrease the likelihood of accidents and enhance the quality of learning.

2. METHOD

This data collection technique uses primary data obtained directly from the source. This can be obtained through the distribution of questionnaires and direct observation. This research uses the descriptive-percentage statistical analysis technique to describe the respondents' questionnaire results. The respondents' questionnaire results are processed using this statistical testing tool, and then entered into data tabulation for scoring.

The scoring results are then analyzed descriptively-percentage. The percentage of scores can be calculated using the following formula:

$$\text{Present score} = \frac{Obtained\ score}{maximum\ score} \times 100\%$$

Then, the calculation results are translated into a qualitative interpretation criteria scale, as shown in the following **Table 1.**

Table 1. Scale of Criteria for Interpreting Questionnaire Calculation Results

No	Presentation	Implementation Quality Category
1	81-100	Very Good
2	61-80	Good
3	41-60	Enough
4	21-40	Less
5	0-20	Very poor

(Sumartini dkk., 2020)

Based on **Table 1,** this study involves a total of 98 students enrolled in the *Plumbing Practice* course within the Building Engineering Education program during the odd semester of the 2024/2025 academic year. The research utilizes a non-probability sampling technique known as *saturation sampling* also referred to as *complete sampling*—where all participants meeting the criteria are included in the study. The *Plumbing Practice* course is divided into three class sessions: Session 1 with 29 students, Session 2 with 34 students, and Session 3 with 35 students. For the purpose of this research, data collection and intervention are carried out in Sessions 1 and 2, resulting in a total sample of 63 students.

The research is organized into three main stages planning, implementation, and assessment. During the planning stage, the framework and objectives of the study are formulated, along with the development of instruments for data collection and validation. The implementation phase focuses on the application of *Job Safety Analysis (JSA)* within the Civil Engineering Workshop at the State University of Jakarta, emphasizing both observation and the modification of existing JSA procedures. The modification primarily addresses safety measures and work procedures related to the installation and connection of random polypropylene (PP-R) pipes a common practice in plumbing work.

Subsequently, a validation process is undertaken to ensure the accuracy and feasibility of the developed JSA. This validation follows the principles of *research and development (R&D)* methodology, aiming to achieve a high degree of product validity before broader application. The validation process is conducted by domain experts, including professionals with relevant academic backgrounds and expertise. Specifically, the JSA instrument is reviewed and assessed by RAF, a Bachelor of Education who serves as the Occupational Health and Safety (K3) Laboratory staff, and AS, a Bachelor of Architecture who acts as the Subject Matter Expert in Plumbing. Their evaluations help ensure that the JSA instrument aligns with both pedagogical and safety standards required in practical plumbing instruction.

3. RESULT AND DISCUSSION

3.1 Hazard Identification

In this study, there are three types of hazards that will be analyzed: physical hazards, ergonomic hazards, and environmental hazards. On the physical hazard indicator, there are two statement items: "Students are careful when using cutting tools to avoid injuries" and "Students always wear protective gear when working with hot materials to prevent burns." The results of the questionnaire are shown in **Figure 1.**

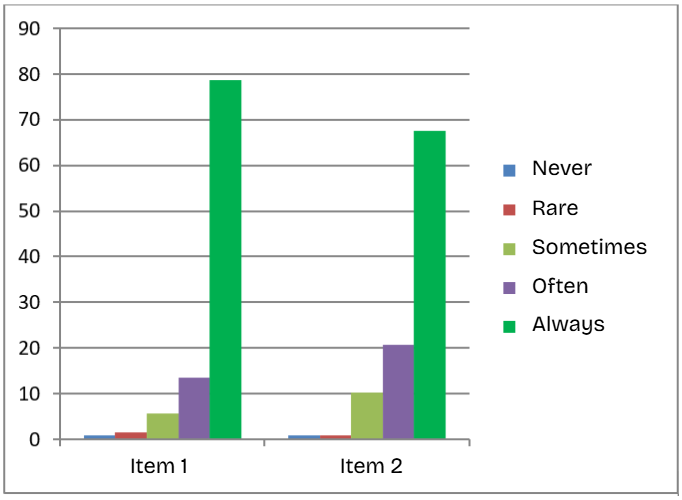

Figure 1. Distribution of Physical Hazard Frequency

In **Figure 1**, the frequency distribution results show that students participating in plumbing practice consistently demonstrate caution when using cutting tools and always wear heat protection during practical activities. This behavior reflects their awareness of the potential physical hazards commonly encountered in the laboratory, such as hand abrasions caused by pipe cutters during pipe-cutting tasks, muscle fatigue or pain due to repetitive movements, feet being struck by falling objects or tools, and respiratory discomfort from exposure to dust or other particulates. The use of gloves and masks is therefore essential as a form of personal protective equipment (PPE) to minimize these risks and ensure students' safety throughout the practice.

Meanwhile, in relation to the ergonomic hazard indicator, students were assessed based on their understanding of proper working postures and body mechanics during plumbing activities. The statements under this indicator emphasize students' comprehension of maintaining correct posture while working in a bent position to prevent back injuries, as well as understanding the appropriate techniques for lifting loads to avoid musculoskeletal strain. The results of the questionnaire, presented in **Figure 2**, provide an overview of students' awareness and implementation of ergonomic principles, which play an important role in reducing the risk of long-term injuries and enhancing overall work efficiency in the plumbing workshop.

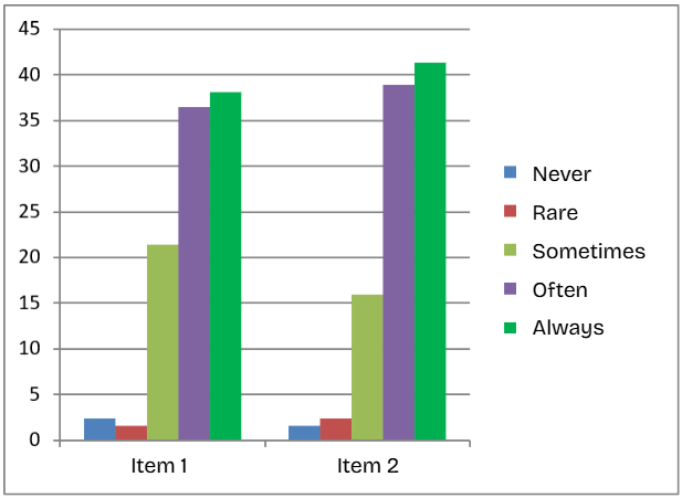

Figure 2. Distribution of Ergonomic Hazard Frequency

In Figure 2, the frequency distribution results show that students who practice plumbing always pay attention to their posture while working and lifting loads. In the job safety analysis applied to plumbing practice, it turns out that ergonomic hazards were not mentioned, so this was not included in the research observation.

On the environmental hazard indicator, there are two statement items: "Students wear masks when there is dust or particles in the air that can endanger the respiratory tract" and "Students are careful when walking on slippery floors to prevent slipping." The results of the questionnaire are shown in **Figure 3.**

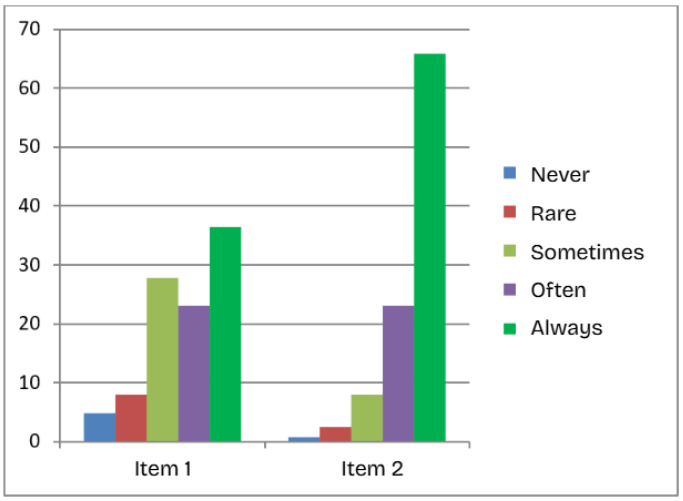

Figure 3. Frequency Distribution of Environmental Hazards

In **Figure 3,** the frequency distribution results show that among the students who practice plumbing, there are some who rarely and even never wear masks. However, they always exercise caution when walking on slippery floors. It can be seen that some students tend to neglect the use of personal protective equipment. This indicates that some students are not properly implementing job safety analysis.

Based on the observations conducted in accordance with job safety analysis, the potential environmental hazards that may occur in the laboratory during plumbing practice are fires caused by electrical short circuits, falls or slips due to the slippery laboratory, and electric shocks. Therefore, students who conduct plumbing practices should always be careful and pay attention to their surroundings.

3.2 Risk Assessment

In this study, risk assessment is measured using indicators of the likelihood of accidents and based on severity levels. For the indicator of the likelihood of accidents, there are two statement items: "Laboratory accidents are estimated to occur rarely, less than 5 times a month" and "Laboratory accidents are estimated to occur more frequently, at least 5 times a month." The results of the questionnaire are shown in **Figure 4.**

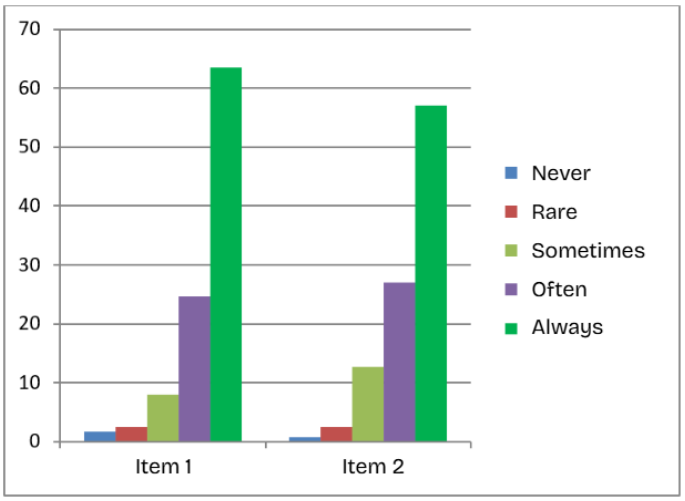

Figure 4. Frequency Distribution of Accident Probability

In **Figure 4**, the frequency distribution results reveal that most students participating in plumbing practice reported that accidents in the laboratory rarely occur more than five times per month. However, a smaller portion of respondents indicated that such accidents can happen more frequently, exceeding five incidents in a month. This variation suggests that while safety procedures are generally observed, inconsistencies in their application may still exist among students, leading to occasional lapses that increase the likelihood of minor accidents during practical sessions.

Furthermore, based on the severity level indicator, two statement items were analyzed to assess students' perceptions of accident seriousness: "Minor injuries, such as cramps, can occur when using heavy equipment in the laboratory" and "Serious injuries, such as fractures or severe burns, can occur if safety equipment is not used properly." The responses to these statements highlight students' awareness that both minor and major injuries are possible outcomes of unsafe practices.

This indicates that while students recognize the risks associated with improper use of tools or neglecting personal protective equipment (PPE), continuous reinforcement of safety culture and adherence to standard operating procedures remains essential to minimize accident frequency and severity in the plumbing laboratory.

The results of the questionnaire can be seen in **Figure 5.**

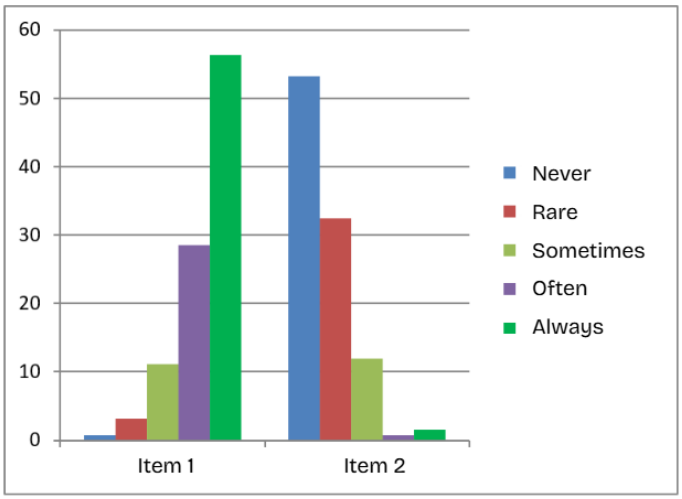

Figure 5. Frequency Distribution of Severity Levels

In Figure 5, it is known that the frequency distribution results show that minor accidents often occur in the laboratory, generally involving hands cramping when cutting pipes using a pipe cutter. Meanwhile, serious accidents almost never happen in the plumbing practice laboratory.

In this study, there are 5 levels of risk, namely insignificant (no injury), minor (light injuries such as a hand injury), moderate (moderate injuries such as falling or a scratched hand), major (serious injuries such as fractures), and extreme (fatal or life-threatening injuries). Next, all risk assessments will be analyzed with the results in **Table 2**.

Table 2. Types and Risk Ratings

No	Type of Risk	Risk Rating		Total Score				
		Severity	Frequency	TS (1-5)	M (6-10)	Mod (11-15)	Ma (16-20)	Ex (21-25)
1	Minor injuries, such as cramps, can occur when using heavy equipment in the laboratory.	2	4		**8**			
2	Serious injuries, such as broken bones or severe burns, can occur if safety equipment is not used properly.	4	1	**4**				

Based on **Table 2,** it can be seen that the types of risks identified in the plumbing laboratory are classified into two main categories: minor injuries and serious injuries. The analysis results indicate that minor injuries encompass relatively light incidents that commonly occur during practice sessions, such as cramps or mild hand abrasions resulting from excessive force when using a pipe cutter to cut pipes. These types of injuries are considered part of the routine risks that can occur due to improper handling of tools or fatigue during manual activities.

On the other hand, serious injuries, such as fractures or severe burns, are categorized as insignificant risks because they are rare occurrences within the laboratory environment. This finding suggests that while potentially severe accidents are possible, they are effectively minimized through the implementation of safety measures, supervision, and adherence to standard operating procedures. Overall, the results emphasize the importance of maintaining consistent safety practices and proper tool usage to prevent even minor injuries, ensuring a safer and more controlled learning environment during plumbing practice.

3.3 Risk Control

In this discussion, five indicators are used for risk control, namely hazard elimination, equipment substitution, engineering controls, administrative controls, and the use of PPE. In the hazard elimination indicator, there are two statement items: "Students always clean the work area regularly to prevent accidents" and "Students always move hazardous objects from the work area to reduce the risk of injury." With the questionnaire results shown in **Figure 6.**

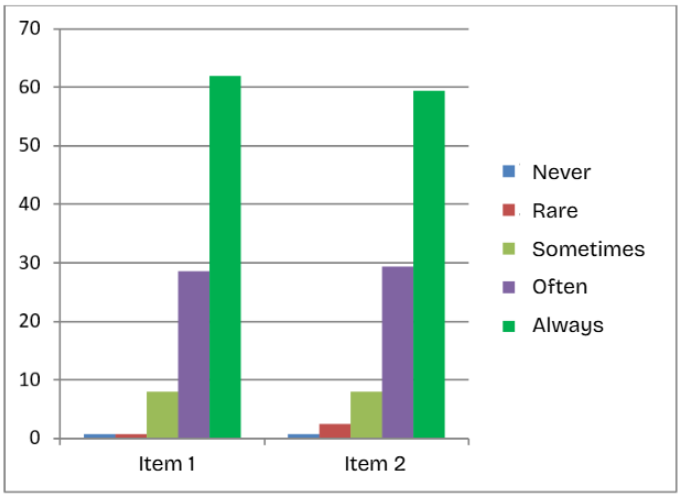

Figure 6. Frequency Distribution of Hazard Elimination

In **Figure 6,** the frequency distribution results show that students who practice plumbing always clean the work area and always move hazardous objects away from the work area. Then, on the tool substitution indicator, there are two statement items: "Students choose tools equipped with safety features to reduce potential hazards" and "Students understand to check tools before use and replace tools if they are damaged." The results of the questionnaire are shown in **Figure 7**.

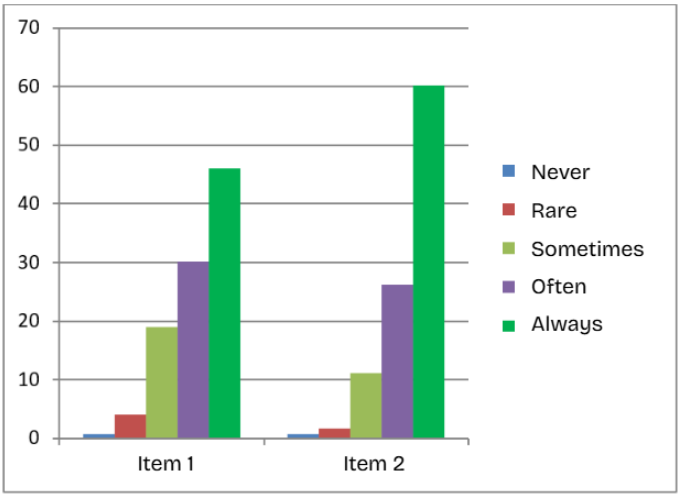

Figure 7. Frequency Distribution of Equipment Elimination

In **Figure 7,** the frequency distribution results show that students who practice plumbing always pay attention to the tools before using them and replace them with others if they are damaged.

Next, on the technical control indicator, there are two statement items: "Students check the work area and tools before starting the practicum to ensure there are no potential hazards" and "Students understand the specified safety procedures to remain safe during the practicum." The results of the questionnaire are shown in **Figure 8**.

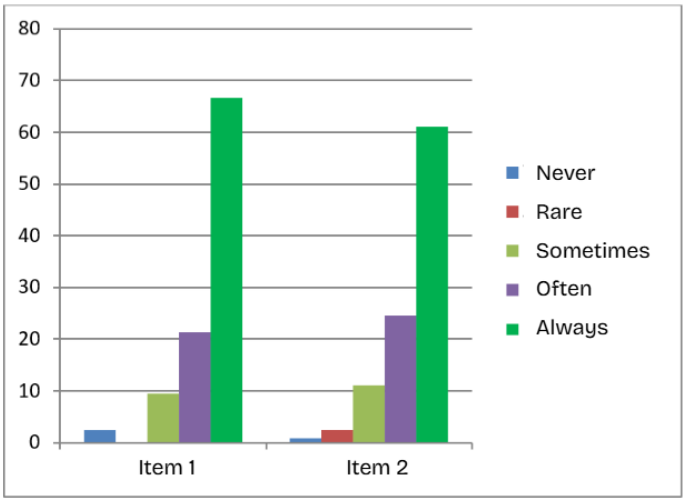

Figure 8. Frequency Distribution of Technical Control

In **figure 8,** it is known that the frequency distribution results show that students who practice plumbing check the work area and tools before starting the practicum and understand the specified safety procedures.

Then, on the administrative control indicator, there are two statement items: "Students always check the procedure documents that need to be used before carrying out activities" and "Students attend the safety training provided by the lecturer to understand safety protocols." The results of the questionnaire are shown in **Figure 9.**

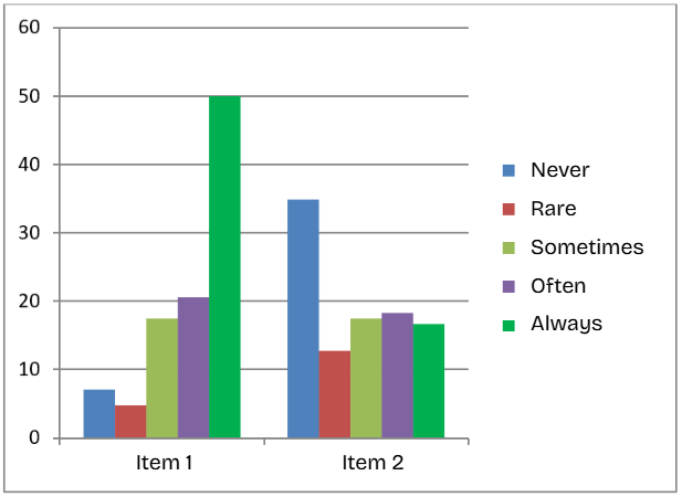

Figure 9. Frequency Distribution of Administrative Control

In Figure 9, the frequency distribution results illustrate that the majority of students participating in plumbing practice consistently review and verify the required procedural documents before commencing any activity.

This finding indicates that students demonstrate a good level of procedural awareness and compliance with established safety guidelines prior to engaging in practical work. Such behavior reflects their understanding of the importance of preparation and adherence to procedures as a preventive measure against potential hazards in the plumbing workshop.

Furthermore, in relation to the indicator of personal protective equipment (PPE) usage, the results show that students generally display a strong commitment to maintaining safety during practice sessions. The statements concerning the use of PPE highlight that students always wear protective gear such as masks, gloves, and anti-slip shoes in high-risk areas, and that they tend to select tools equipped with protective features to prevent accidents. As presented in **Figure 10,** the overall responses indicate that students possess a positive attitude toward safety practices and demonstrate awareness of the importance of using appropriate protective equipment and safe tools to minimize risks during plumbing activities.

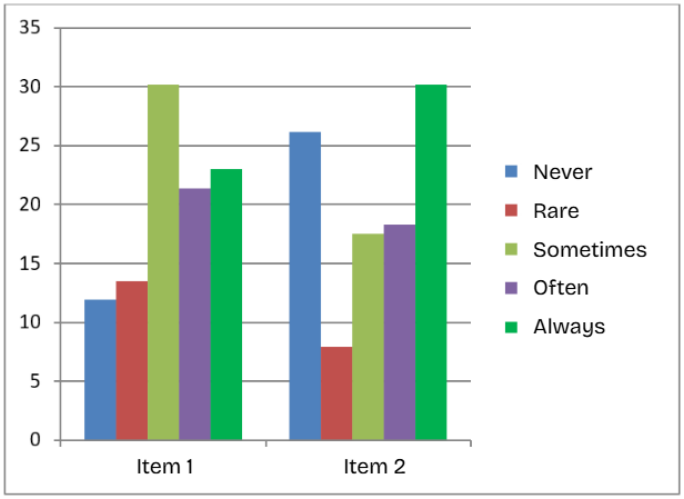

Figure 10. Frequency Distribution of Personal Protective Equipment Usage

In **Figure 10,** it is known that the frequency distribution results show that students who practice plumbing rarely use personal protective equipment such as gloves, masks, and safety shoes. After conducting analyses on the implementation of job safety analysis as mentioned above, the comparison can be seen in **Table 3.**

Table 3. Average Percentage of JSA Implementation by Dimension

No	Implementation of JSA	Percentage (%)	Category
1	Hazard Identification	85,74	Very Good
2	Risk Assessment	87,74	Very Good
3	Risk Control	79,33	Good

Based on **Table 3,** it can be seen that the aspects of risk assessment and risk identification fall into the *very good* category in the implementation of Job Safety Analysis (JSA) among students in the Building Engineering Education program at Universitas Negeri Jakarta, while the risk control aspect is categorized as *good*. This indicates that although students are capable of identifying potential hazards and evaluating the risks associated with their activities, there remains a lack of consistent awareness in applying risk control measures, particularly in the use of protective equipment and safety tools within the laboratory.

Therefore, it is strongly recommended that students be continuously reminded of the importance of using personal protective equipment (PPE) such as gloves, masks, and safety shoes as part of effective risk control in the implementation of JSA during workshop practices.

According to Aprilla and Yulhendra (2023), all risk assessments that have been conducted must undergo further analysis to determine the corresponding level of risk by considering the likelihood and severity of potential consequences. This analytical process enables the identification of priority risks that require immediate mitigation. In line with this, observations made during the plumbing practice sessions provide an overview of students' application of JSA principles in real workshop settings. The detailed observation results are presented in **Table 4,** illustrating how students manage potential hazards, apply safety measures, and implement risk control strategies during practical activities.

Table 4. Observation Results Based on Risk and Severity Levels

No	Type of Risk	Risk Rating		Total Score				
		Impact	Frequency	TS	M	Mod	Ma	Ex
1	Respiratory disorders	2	3		**6**			
2	Injured hand	1	2	**2**				
3	Fall, stumble, or slip	2	1	**2**				
4	Foot crushed by equipment or materials	2	1	**2**				
5	Muscle pain in the hand when cutting a pipe	2	4		**8**			
6	Burns due to direct contact between the skin and the heating element	4	1	**4**				

Based on Table 4, the risks in the plumbing workshop, based on their average frequency, fall into insignificant and minor categories. This shows that accidents are minimal and proves that job safety analysis provides self-protection. Thus, its implementation can reduce the risk of work accidents in plumbing practices.

The first dimension is hazard identification, which consists of three indicators: physical hazards, ergonomic hazards, and environmental hazards. Hazard identification can be prevented with proper procedural handling. In the study (Febriyanti et al., 2020), it is stated that students are expected to be more aware of work procedures, adhere to workshop regulations, and use personal protective equipment to prevent hazards from work practices.

The identification of these hazards is also effective in preventing workplace accidents, allowing the activities to proceed smoothly (Islamiah, 2023). Based on observations in the laboratory, it can be concluded that the students pay attention to the proper use of sharp and hot objects. However, some students adopt incorrect postures. Sometimes they bend over when cutting pipes or picking up objects from the floor.

The use of personal protective equipment by students during plumbing work in the laboratory. This is exemplified by the use of masks to protect themselves from dust and fine particles produced by pipe cutting. In addition, the students also pay attention to the surrounding environment, which may be slippery, and walk carefully. Thus, it can avoid them from the risk of accidents.

Next, the second dimension is risk assessment, which consists of the likelihood of work accidents and the severity level. So, each student can assess the potential risks and their severity so that they can be prevented before they occur. Thus, accident prevention is the main thing that students can do during plumbing work practice. Updating standard operating procedures can be one of the models for preventing workplace accidents.

Therefore, this research applies job safety analysis as effectively as possible to ensure the continuity of plumbing work practices. In this study, there are 5 levels of risk: insignificant (no injury), minor (light injuries such as cuts or muscle cramps), moderate (moderate injuries such as falls or scratches), major (serious injuries such as fractures), and extreme (fatal or life-threatening injuries). The results show that light injuries are minor accidents that occur in the laboratory because students only experience cramps when cutting pipes with a pipe cutter due to the hardness. Meanwhile, severe injuries such as fractures fall into the insignificant accident category because they are very rare in the laboratory.

Lastly, the third dimension is risk control, which consists of hazard elimination, equipment substitution, engineering controls, administrative controls, and the use of personal protective equipment. In risk control, more emphasis is placed on the use of personal protective equipment such as masks, gloves, safety shoes, and so on to protect oneself from potential workplace accidents.

Research (Ilham, 2020) states that workers are still less aware of the use of helmets and safety vests, but awareness of the use of safety shoes is already good. In addition, risk control should also focus more on maintaining good workshop conditions. If the working practice location conditions are good, it will minimize workplace accidents and ensure the success of the plumbing work practice. This is in line with the research (Saraswati, 2019; Sentoso & Rahayu, 2024) which states that the development of safety analysis will improve the health and safety management system in the plumbing area, and even better if supported by good workshop conditions, so it is hoped that the institution can strive to improve the conditions.

During the research observation, there were still some students who did not wear masks during the initial cleaning step, because before starting the practice, the work environment or workshop was already clean and tidy due to regular cleaning after each practice.

The research results using questionnaires and observations as data collection methods indicate that in plumbing work practices, Job Safety Analysis has been implemented well. Risk assessment and risk identification fall into the very good category in the application of Job Safety Analysis among students in the Building Engineering Education at the State University of Jakarta, with scores of 87.74% and 85.74%, respectively, while risk control falls into the good category at 79.33%.

This can be seen as a lack of awareness among students in using tools to protect themselves from hazards in the laboratory, even though these students are aware of the dangers and can assess the risks. This is in line with the research (Saraswati, 2019; Moniaga & Rompis, 2019) which states that the results of developing job safety analysis will improve the health and safety management system in the plumbing room. It would be better if supported by good workshop conditions, so the institution must strive to improve the conditions.

Unsafe actions have a significant impact on workplace accidents (80%), followed by unsafe conditions (20%) (Kristiawan & Abdullah, 2020). Additionally, in the study by Abidin & Ramadhan (2019), the statistical test results indicate that job safety analysis has been well implemented and has become a requirement for practitioners in the laboratory, ensuring smooth work practices. The research (Ahmad & Wardani, 2023) emphasizes that factors such as the quality of vocational education services, including facilities and student satisfaction, contribute to a better learning experience. The limitation of the conducted research is that the implementation of job safety analysis could not be carried out at the same location as its development due to the relocation of the practice site.

4. CONCLUSION

Based on the research results and discussion on the implementation of job safety analysis, it can be concluded that the risk and danger of workplace accidents have been minimized. This is because the students have been able to implement job safety analysis quite well. Although some students still do not adhere to the regulations outlined in the job safety analysis. The use of job safety analysis can enhance the students' knowledge of the potential hazards or accidents that may occur and their mitigation. It can be concluded that the implementation of job safety analysis in plumbing practice can reduce work risks.

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