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Safety Practices, Hazard Risks, and Standard Operating Procedure Compliance: A Study on Mechanical Engineering Students

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ABSTRACT

Accidents, in general, can occur anywhere regardless of place and time. However, the risk of accidents may be reduced if preventive measures are taken early. This study was conducted to identify safety practices and hazard risks among students during practical classes in the Machine Workshop, Department of Mechanical Engineering, Politeknik Ungku Omar, Ipoh, Perak, involving students who utilize this workshop. A questionnaire survey method was used to collect relevant information and data from 98 respondents, consisting of students. The analysis revealed that 99% of respondents had never been involved in any accidents while in the workshop, 100% wore appropriate personal protective equipment (PPE) when operating machines, 98.4% stated that they were given safety reminders and briefings before starting activities, and 84.2% of respondents believed that the existing safety measures were adequate. For hazard risk assessment, machine-related hazards were identified as the highest risk at 39.1%, followed by Fire and Explosion hazards (32.8%), Electrical hazards (20.3%), Slip/Trip/Fall hazards (15.6%), Lighting issues (10.9%), and 9.4% for Noise, Indoor Air Quality, and Dust Particles. In addition, 74.1% of respondents felt safe from accidents while conducting practical activities in the workshop, whereas 4.7% felt it was unsafe regarding potential accidents involving themselves. Therefore, greater emphasis and focus should be placed on the correct and safe use of machine equipment as well as strict adherence to established safety measures to enhance students' confidence in workshop safety, thereby reducing the likelihood of accidents occurring.

1. Introduction

Safety practices and compliance with Standard Operating Procedures (SOPs) are fundamental components in maintaining a secure and efficient working environment, particularly within engineering and technical education settings. Workshops and laboratories often involve exposure to various mechanical, electrical, and thermal hazards, which can pose significant risks to students and

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instructors if safety measures are not properly implemented. Consequently, the establishment of a strong safety culture is essential to prevent accidents, injuries, and property damage. Understanding the relationship between safety practices, hazard risks, and SOP compliance is crucial in assessing the effectiveness of existing safety management systems. Adherence to SOPs ensures that operations are carried out systematically and safely, minimizing the potential for human error and equipment failure. Meanwhile, awareness and enforcement of safety regulations encourage students to adopt responsible behaviors that reflect industry standards and best practices.

In the context of Technical and Vocational Education and Training (TVET), promoting safety awareness not only protects individuals but also prepares future engineers and technicians to meet professional safety expectations in the workplace. This study, therefore, aims to evaluate the level of safety practice, identify common hazard risks, and determine the extent of SOP compliance among students in a mechanical workshop environment. The findings are expected to contribute to the enhancement of safety management strategies and reinforce the culture of preventive safety behavior in educational and industrial settings. An accident is an unexpected incident that can occur at any time and in any place. In the workplace, particularly in workshops, the risk of accidents is higher due to the presence of various equipment, machines, and materials that may pose hazards [1-3]. Therefore, safety aspects must be given serious attention to ensure that the working environment remains controlled and safe. Workshop safety is not only related to the use of Personal Protective Equipment (PPE), but also involves proper equipment maintenance, workplace layout/ergonomics, and the attitude and behavior of workers themselves. Carelessness or negligence in adhering to safety regulations can result in serious injuries such as cuts, burns, or damage to exposed body parts [4-6]. Hence, systematic preventive measures and continuous studies on the causes of accidents must be carried out to ensure that the accident rate can be reduced. Among the main contributing factors are unsafe working environments, poorly maintained machinery, and negligence of workers when performing tasks. If all these factors can be effectively addressed, the risk of workshop accidents can be minimized, and worker safety can be better assured [7-8].

Awareness of workplace safety and health issues should be given top priority because accidents can occur at any time without warning. Although safety measures have been implemented, accidents still occur, leading some to believe that they are inevitable and difficult to prevent. Lack of knowledge in operational handling and insufficient awareness of existing risks is among the main causes of workplace accidents [9].

In addition, the regulations for the use of equipment and machinery provided through the Standard Operating Procedure (SOP) also play an important role in guiding users. Misuse or operation of machinery without proper skills can lead to serious accidents. Malaysia's commitment to occupational safety and health is reflected in the implementation of the Occupational Safety and Health Act (OSHA) 1994, which emphasizes self-regulation and shared responsibility between employers and employees [12]. Despite the presence of regulations, workshop accidents continue to occur due to inadequate supervision, insufficient safety training, and improper machine maintenance [13]. This highlights the need for continuous evaluation of safety practices and the cultivation of safety awareness among machine workshop users. Individual factors such as engaging in playful behavior while working, poor health conditions, lack of training, reduced concentration during tasks, and ego also contribute to accident risks [10-11].

Before 1994, Malaysia had various acts and regulations that were specific only to certain types of occupations and hazards. However, disciplined workers who consistently comply with safety regulations are the most important factor in reducing workplace accident rates. In line with efforts to realize human capital development that encompasses various aspects of technical skills, it is hoped that the findings of this study can provide a significant impact on the advancement of Technical and

Vocational Education and Training (TVET) in Malaysia. In the context of Technical and Vocational Education and Training (TVET), machine workshop safety is particularly important, as students often lack sufficient experience in handling industrial machinery [9]. Their limited exposure to real-world working conditions increases the likelihood of errors and unsafe practices. Therefore, integrating safety education into the curriculum and ensuring strict compliance with Standard Operating Procedures (SOPs) are fundamental steps in reducing accident risks [10–11]. Effective safety management not only protects individuals but also enhances learning outcomes by fostering discipline, responsibility, and technical competence among students [12]. This will in turn create training and opportunities for students to achieve semi-professional levels in technical fields through responsible educational institutions such as schools, polytechnics, training institutes, universities, and others. Therefore, a strong academic framework must consider current developments, and industry needs to ensure high-quality education [13]. Overall, there are several factors that contribute to accidents in workshops, namely, negligence, lack of knowledge or training, poor equipment condition and inadequate safety management and planning [14].

Most workplace accidents can be prevented if students consistently comply with the established safety procedures. Therefore, workshop safety is highly important as it involves individuals performing tasks within that environment. To ensure that safety can be effectively managed and implemented, safety aspects must be integrated as part of daily practices and embedded into the organizational work culture. Awareness of occupational safety and health issues should remain a top priority, as accidents can occur unexpectedly despite the implementation of preventive measures. This has led to the perception that accidents are unavoidable and difficult to control. However, insufficient knowledge of operational procedures and limited awareness of potential hazards are among the main causes of workplace accidents.

Despite continuous efforts to improve safety awareness and implement Standard Operating Procedures (SOPs) within technical and engineering education environments, accidents and unsafe behaviors still occur in workshops and laboratories. Many students tend to underestimate the potential risks associated with machinery, tools, and hazardous materials, leading to unsafe practices that may result in injuries or equipment damage. Furthermore, limited supervision, inadequate safety training, and inconsistent adherence to SOPs can further increase the likelihood of accidents.

Previous studies have shown that compliance with safety regulations is often influenced by individual attitudes, institutional policies, and the availability of safety resources [15]. However, there is a lack of comprehensive assessment on how these factors interact to affect students' overall safety performance in educational workshop settings. Without sufficient data and analysis, institutions may face challenges in identifying critical areas that require improvement in safety management systems.

Therefore, this study seeks to address the existing gap by examining the relationship between safety practices, hazard risks, and the level of SOP compliance among engineering students. The outcomes of this research will provide valuable insights for enhancing workshop safety standards and developing more effective training programs that foster a culture of safety awareness and compliance.

2. Methodology

Research Methodology refers to the methods, approaches, and procedures used to achieve the objectives and goals of the study. The selection of an appropriate methodology is crucial as it ensures that the study is systematic, organized, and focused in addressing the research questions. In this study, the methodology employed consists of several main stages, namely:

i. Research Design
This study adopts a quantitative approach through the survey method. This approach was selected because it is suitable for measuring the level of safety practices as well as identifying hazard risks among students during practical work in the machine workshop.

ii. Research Instrument
The primary instrument used in this study is a questionnaire, which was developed based on the research objectives. The questionnaire is divided into two main sections, Section A and Section B.

Section A: Questions related to respondent profile or demographic information, as well as students level of safety practices while in the workshop.
Section B: Questions related to the types of hazard risks present in the Machine Workshop during students practical activities.

To measure the level of safety practices and risk perception, this study employs the Likert Scale. This scale enables respondents to select answers linearly based on the intensity or degree of their agreement with a statement. The Likert Scale was chosen because it is one of the most widely used measurement techniques in social science and psychological research, and it can provide deeper insights into respondents' opinions, perceptions, and experiences. Fig.1 shows Machine Workshop, Department of Mechanical Engineering.

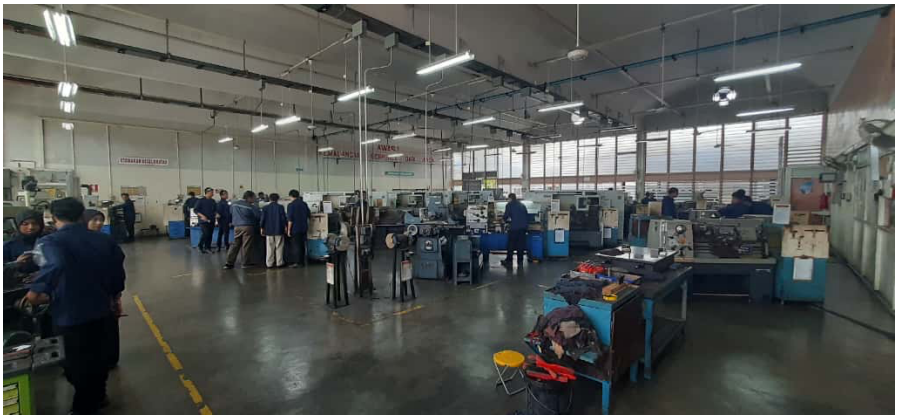

Fig. 1. Machine Workshop, Department of Mechanical Engineering

3. Results

The questionnaire survey method is one of the most widely used research techniques for collecting primary data in social science and educational studies. It involves the systematic use of structured questions to obtain information directly from respondents about their attitudes, perceptions, experiences, or behaviors. This method is particularly effective for studies that aim to gather quantifiable and comparable data from a large group of participants within a relatively short period of time. In this study, a questionnaire survey method was used to collect relevant information and data from 98 respondents, consisting of students. The survey was administered during scheduled workshop sessions to ensure a high response rate and to capture accurate information from actively involved students. All collected responses were compiled, coded, and statistically analyzed to evaluate the overall level of safety practices and to identify the predominant risks encountered during practical activities. The information obtained from the distribution of questionnaires was collected and analyzed to evaluate the level of safety practices as well as the risks faced by the

respondents while carrying out practical activities in the Machine Workshop. This analysis focuses on two main aspects, namely:

i. Section A: Safety practices in the use of equipment and facilities in the workshop.
ii. Section B: Potential hazard risks encountered by students during the implementation of practical activities.

Table 1 and Table 2 present the findings related to Safety Practices in the Machine Workshop and Hazard Risks in the Machine Workshop, derived from the analysis of the questionnaire responses administered.

Table 1
Safety Practices in the Machine Workshop

No.	Item	Yes	No	Not sure
1	Have you ever experienced any accident or injury while undertaking activities in this Machine Workshop?	1.0%	99%	0%
2	Do you utilize the appropriate Personal Protective Equipment (PPE), such as safety goggles and safety boots, when operating machinery in the workshop?	100%	0%	0%
3	Do you utilize the appropriate Personal Protective Equipment (PPE), such as safety goggles and safety boots, when operating machinery in the workshop?	98.4%	0.8%	0.8%
4	Are you subject to reminders or advisories from the Technician, Instructor, or Supervisor in the event that you do not utilize the required Personal Protective Equipment (PPE) while operating machinery in the workshop?	94.5%	3.1%	2.3%
5	Are you subject to reminders or advisories from the Technician, Instructor, or Supervisor if you do not utilize the required Personal Protective Equipment (PPE) while operating machinery in the workshop?	84.2%	0.2%	15.6%
6	In your opinion, are the existing Warning Signs and Standard Operating Procedures (SOPs) in the Machine Workshop adequate to ensure effective communication of safety reminders to user?	78.1%	9.4%	12.5%
7	Do you perceive yourself to be safe from accidents and potential hazards while undertaking activities in this Machine Workshop?	74.1%	4.7%	21.2%

Table 2
Hazard Risks in the Machine Workshop

No	Item	Low	Moderate	High
1	What is the level of electrical hazard risk that may lead to accidents in the Machine Workshop?	32.8%	46.9%	20.3%
2	What is the level of fire and explosion hazard risk that may lead to accidents in the Machine Workshop?	31.3%	35.9%	32.8%
3	What is the level of slip, trip, and fall hazard risk that may lead to accidents in the Machine Workshop?	35.2%	49.2%	15.6%
4	What is the level of machinery-related hazard risk (e.g., entanglement, crushing, abrasion) that may lead to accidents in the Machine Workshop?	16.4%	44.5%	39.1%

5	What is the level of noise-related hazard risk that may lead to accidents in the Machine Workshop?	36.7%	53.9%	9.4%
6	What is the level of Indoor Air Quality (IAQ)-related hazard risk that may lead to accidents in the Machine Workshop?	42.2%	48.4%	9.4%
7	What is the level of dust particle–related hazard risk that may lead to accidents in the Machine Workshop?	31.3%	59.4%	9.4%
8	What is the level of lighting-related hazard risk that may lead to accidents in the Machine Workshop?	46.9%	42.2%	10.9%
9	Overall, what is the level of safety in the Machine Workshop?	10.2%	16.0%	73.8%

The analysis of the Safety Practices questionnaire indicates that 99% of respondents reported never having been involved in an accident while in the Machine Workshop, whereas only 1.0% of respondents reported having experienced an accident. These findings suggest a high level of student compliance with safety regulations. Furthermore, all students (100%) reported wearing Personal Protective Equipment (PPE), such as safety goggles and safety boots, when operating machinery. This demonstrates that students take proactive measures to protect themselves from potential accident risks. Prior to commencing practical activities, 98.4% of respondents stated that they received safety reminders or briefings from their instructors. In addition, 94.5% of respondents acknowledged that they would be reminded of or advised by technicians, instructors, or supervisors if they failed to wear PPE while operating machinery. This highlights the active role of instructors in ensuring that safety compliance is maintained both before and during workshop activities. Based on the survey, 84.2% of respondents agreed that the existing safety measures are adequate to safeguard users, while 78.1% of respondents indicated that the warning signs and Standard Operating Procedures (SOPs) displayed in the Machine Workshop are sufficient. In terms of safety perception, 74.1% of respondents reported feeling safe in the workshop, 4.7% reported feeling unsafe, and 21.2% were uncertain. Fig. 2 shows Standard Operating Procedures (SOPs) in the Machine Workshop adequate to ensure effective communication of safety reminders to user.

Fig. 2. Standard Operating Procedures (SOPs) in the Machine Workshop

For the hazard risk survey, respondents perceived machinery-related hazards (e.g., entanglement, crushing, abrasion) as the highest risk at 39.1%, compared to other hazards, followed by fire and explosion hazards (32.8%), electrical hazards (20.3%), slip, trip, and fall hazards (15.6%), lighting hazards (10.9%), and 9.4% for noise exposure, indoor air quality (IAQ), and dust particle hazards. The predominance of machinery-related hazards may be attributed to the fact that the majority of practical activities involve the use of machines, thereby increasing the likelihood of such accidents compared to other hazards. From the data analysis, lighting-related hazards were identified as the lowest risk in the Machine Workshop. This indicates that the available lighting sources,

whether from artificial lighting or natural daylight, are sufficient for respondents to safely conduct practical activities. Overall, 73.8% of respondents perceived the level of safety in the Machine Workshop as high, 16.0% as moderate, and 10.2% as low. Fig. 3. shows the existing warning signs in the Machine Workshop adequate to ensure effective communication of safety reminders to users. In conclusion, the findings from the hazard risk survey indicate that machinery-related hazards pose the highest level of risk in the Machine Workshop, primarily due to the frequent use of mechanical equipment during practical activities. This suggests that while students are generally aware of potential dangers, machinery operation remains the most critical area requiring strict supervision and preventive control measures. Fire and explosion, as well as electrical hazards, also present notable risks that necessitate consistent monitoring and safety reinforcement. Conversely, lighting hazards were identified as the least concerning, indicating that the workshop's lighting conditions both natural and artificial are adequate to support safe working practices.

Overall, the majority of respondents perceived the workshop as a safe environment, with 73.8% rating safety levels as high. The presence of adequate warning signs and visual safety cues further contributes to student confidence in the existing safety measures. Nonetheless, the results highlight the importance of maintaining proactive safety management, particularly concerning machinery operation, fire prevention, and electrical safety. Continuous evaluation, regular maintenance, and reinforcement of safety awareness are essential to sustaining and further improving the safety culture within the Machine Workshop.

Fig. 3. Existing Warning Signs

In summary, the findings indicate a well-established safety culture characterized by strong compliance, proactive supervision, and adequate infrastructural support. Continuous reinforcement of safety practices through education, monitoring, and systematic evaluation remains crucial to sustaining and improving the overall safety performance within the Machine Workshop environment.

4. Conclusions

This study highlights that safety practices among Mechanical Engineering students in the Machine Workshop are generally at a high level, as evidenced by the overwhelming use of Personal Protective Equipment (PPE) and the positive perception of existing safety measures. The findings revealed that the majority of students comply with safety requirements, feel adequately briefed, and consider the workshop environment safe for practical activities. Nevertheless, the analysis also identified machinery-related hazards as the most significant risk, followed by fire, explosion, and electrical hazards. These results underscore the importance of strengthening preventive measures, particularly regarding the safe handling of machinery, to further reduce potential accident risks. Overall, while the level of compliance and awareness is commendable, continuous monitoring, effective

enforcement of Standard Operating Procedures (SOPs), and regular safety training are crucial to ensure long-term sustainability of safe practices. By embedding safety awareness into the learning culture, institutions can not only minimize accident risks but also cultivate responsible attitudes among students, aligning with the broader goals of Technical and Vocational Education and Training (TVET) in Malaysia. The findings of this study are expected to serve as a reference for management and instructors in further strengthening safety practices in the workshop, thereby fostering a culture of safe working habits among students. Ultimately, enhancing safety culture in technical education requires not only compliance but a sustained institutional commitment to cultivating responsible and safety-conscious graduates.

Based on the findings of this study, several recommendations can be made to further strengthen safety practices, hazard awareness, and compliance with Standard Operating Procedures (SOPs) among Mechanical Engineering students in the Machine Workshop. First, institutions should enhance safety training and awareness programs through regular workshops and hands-on sessions that emphasize proper machinery handling, hazard identification, and emergency response procedures. Integrating safety modules into the curriculum will help students internalize the importance of safety from the early stages of their education.

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