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Identification and Analysis of Potential Hazards in Informatics Practicum Activities

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Abstract: This study aims to identify and analyze potential hazards occurring during Informatics subject practicum activities at SMP Harapan Ananda, as well as to formulate risk mitigation strategies based on occupational safety approaches. The research employed a descriptive qualitative method supported by simple quantitative analysis through the HIRADC framework (Hazard Identification, Risk Assessment, and Determining Control). Data were collected through observation, interviews, documentation, and questionnaires involving teachers, laboratory technicians, and students. The results revealed four main categories of potential hazards: electrical, ergonomic, physical-environmental, and digital (cyber hazards). Electrical hazards were identified as the most dominant risks due to non-standard installation and insufficient maintenance, while ergonomic and environmental hazards were related to improper workstation design, limited ventilation, and inadequate lighting. Moreover, digital hazards such as data security threats and inappropriate internet access were also identified as emerging issues in technology-based learning. Risk mitigation efforts were implemented through the hierarchy of control, including elimination, engineering controls, administrative procedures, and safety education. This study contributes to the development of safety management in computer laboratories at secondary schools and promotes a culture of safety and digital literacy within technology-integrated educational environments.

INTRODUCTION

Occupational Health and Safety (OHS) is a fundamental aspect of creating a safe and productive learning environment, including within educational institutions (Rielander et al., 2024). Although the concept of OHS is more commonly associated with industrial settings, its implementation is equally essential in schools, particularly during practice-based learning activities. According to data from the International Labour Organization (ILO, 2022), approximately 2.3 million people worldwide die annually due to work related accidents or illnesses, with a large portion of these incidents caused by a lack of awareness regarding potential hazards in workplaces and learning environments. In the context of education, the Directorate of Junior High Schools (Kemendikbudristek, 2023) emphasizes the importance of applying OHS principles in school laboratories to ensure that practicum

activities are safe, efficient, and conducive to developing 21st-century student competencies.

The Informatics subject at the junior high school level requires students to interact directly with technological tools such as computers, electrical networks, and internet connections. Practicum activities such as hardware installation, programming, and digital data access can pose both physical and digital hazards. For instance, there is a risk of electric shock from non-standard cable connections, poor ergonomic posture during long hours of typing, and exposure to harmful online content. Based on data from the Ministry of Communication and Information Technology (2022), 36% of junior high school students in Indonesia have experienced minor incidents while using computers at school, such as mild electric shocks, eye strain, or equipment malfunctions due to unsafe usage. This phenomenon indicates that Informatics practicum activities contain potential risks that must be systematically identified and managed.

One of the main challenges in Informatics education is the low level of awareness among teachers and students regarding potential hazards in laboratory environments. Practicum activities are often perceived as safe because they do not involve heavy machinery or hazardous chemicals; however, risks such as electrical hazards, fire, or even cybersecurity threats remain significant. At SMP Harapan Ananda, practicum sessions are conducted using computers, routers, and electrical connections within a limited space. These conditions may lead to accidents if not accompanied by appropriate safety procedures, such as proper grounding, safe cable management, and close supervision of students during practice. This challenge is scientifically relevant to investigate, as it can help schools develop safety standards for practicum activities based on hazard identification.

Several previous studies have discussed the importance of hazard identification in educational environments. For example, a study by Sukmana et al. (2024) found that most computer labs in vocational schools do not yet have an adequate OSH risk documentation system. Similarly, Erniyani (2025) showed that applying the Hazard Identification and Risk Assessment (HIRA) approach in vocational schools reduced the potential for work-related accidents. However, most of these studies have focused on vocational or higher education institutions rather than junior high schools, which have different characteristics in terms of students and facilities. Moreover, digital hazards such as cybersecurity, data privacy, and the use of illegal software have rarely been comprehensively studied in the context of lower secondary education.

Based on this literature review, there is a clear research gap in applying hazard analysis in Informatics learning at the junior high school level. Previous studies have primarily emphasized physical or mechanical hazards in technical laboratories, whereas hazards related to digital safety, ergonomics, and student behavior have received limited attention. Furthermore, there has been no specific research examining non-vocational schools such as SMP Harapan Ananda, which is actively developing ICT-based learning. This gap highlights the need for a contextual, empirical study focusing on the integration of OHS in Informatics practicum activities at the junior high school level.

This study seeks to address these limitations by conducting a holistic identification and analysis of potential hazards, encompassing physical, ergonomic, electrical, and digital aspects. The research employs the Hazard Identification, Risk Assessment, and Determining Control (HIRADC) framework, which has been proven effective in risk identification across various sectors. The study's outcomes are expected not only to describe risk levels but also to provide practical mitigation recommendations for schools. Thus, this research contributes to strengthening both digital and physical safety cultures in educational environments while supporting Sustainable Development Goal (SDG) 4, which promotes inclusive, safe, and high-quality education for all.

Based on the above rationale, this study aims to identify various potential hazards in Informatics practicum activities at SMP Harapan Ananda, analyze their risk levels, and formulate relevant prevention and mitigation strategies. Theoretically, this research expands the understanding of OHS and HIRA applications in digital education contexts. Practically, the findings can serve as the basis for developing Standard Operating Procedures (SOPs) for Informatics laboratory safety and as training material for teachers and students to build a safety culture grounded in risk awareness. Therefore, this study is expected to make a tangible contribution to developing a safe, intelligent, and sustainable learning environment.

METHOD

This study employed a qualitative descriptive research approach aimed at identifying and analyzing potential hazards during informatics practicum activities at SMP Harapan Ananda. The research was conducted at the school's computer laboratory, which serves as the main facility for practicum-based learning. The subjects of this study consisted of students, teachers, and laboratory staff involved in practicum activities. Data were collected using several techniques, including observation, interviews, and documentation. Observations were conducted to identify potential hazards during the use of computers, electrical devices, network cables, and other supporting tools. Interviews were carried out with teachers and students to explore their understanding, experiences, and attitudes toward occupational safety during practical sessions. Documentation was used to analyze existing safety procedures, laboratory layout, and maintenance records.

The collected data were analyzed using a qualitative descriptive analysis technique, which involved three main stages: data reduction, data presentation, and conclusion drawing (Nicmanis, 2024). Data reduction was performed by organizing and categorizing hazard findings based on their types, sources, and risk levels. Data presentation involved summarizing the findings into thematic descriptions that illustrate the patterns of potential hazards within the practicum environment. Finally, conclusions were drawn through a reflective interpretation of the data, supported by triangulation across different data sources and methods to ensure validity. This methodological framework was designed to provide a comprehensive understanding of the safety conditions in informatics practicum activities and to propose recommendations for improving risk management and creating a safer learning environment.

RESULT AND DISCUSSION

The research was conducted at Harapan Ananda Junior High School. This school has a computer laboratory with a capacity of 25 computers that are used for practical activities in Informatics lessons for grades VII and VIII. The laboratory room measures 8 × 10 meters with a natural ventilation system and air conditioning. Electrical installations are distributed through sockets at each student's desk, but are not yet equipped with standard industrial education grounding.

Initial observations show that practical activities are conducted twice a week with an average duration of 90 minutes. Informatics teachers and laboratory technicians are responsible for supervising and maintaining the equipment. However, there are no official Standard Operating Procedures (SOP) documents regulating safety and security in the practical use of computer equipment. This condition is an important empirical background in the hazard potential analysis conducted.

Results of Hazard Potential Identification

Based on the results of observations and interviews, four main categories of potential hazards were identified during the Informatics practicum, namely: electrical hazards, ergonomic hazards (postural and strain hazards), physical and mechanical hazards, and cyber hazards. This identification was carried out with reference to the Hazard Identification, Risk Assessment, and Determining Control (HIRADC) guidelines. The results of the potential hazard identification can be seen in Table 1.

Table 1. Identification Results of Potential Hazards in the Informatics Laboratory of SMP Harapan Ananda

Hazard Category	Source of Hazard	Potential Impact	Frequency of Occurrence
Electrical	Poorly insulated cables, loose sockets	Electric shock, minor fire	Moderate (3 times/year)
Ergonomic	Non-ergonomic sitting posture, low monitor position	Back pain, eye strain	Frequent (≥10 times/year)
Physical/Mechanical	Narrow layout, scattered cables	Tripping, falling, minor injuries	Moderate (4–5 times/year)
Digital	Access to malicious websites, malware, unprotected data	Virus attacks, data breaches	Frequent (≥6 times/year)

From the results of the identification, it is known that ergonomic and digital hazards are the most common categories, while electrical hazards pose the highest risk to students' physical safety.

Risk Assessment

Risk assessment is conducted based on two parameters, namely likelihood and severity. The risk value is obtained from the multiplication of these two parameters according to the HIRADC matrix.

Table 2. Risk Assessment Matrix of Potential Hazards

Type of Hazard	Likelihood	Severity	Risk Level	Risk Category
Electric shock from damaged socket	3 (moderate)	4 (severe)	12	High
Incorrect sitting posture and improper lighting	4 (frequent)	2 (minor)	8	Medium

Tripping due to scattered cables	3 (moderate)	3 (moderate)	9	Medium
Malware infection due to unsafe access	4 (frequent)	3 (moderate)	12	High

The analysis results show that electrical and digital hazards are classified as high risk, while ergonomic and physical hazards are classified as moderate risk. The high risk of digital hazards is mainly due to the absence of access restriction systems (content filters) and active antivirus software on all computer devices.

Factors Causing Potential Hazards

Field data analysis revealed several main factors causing potential hazards:

1. Technical factors, namely electrical installation systems that do not have grounding protection and non-standard extension cord positioning.
2. Environmental factors, such as limited air circulation and uneven lighting in the laboratory.
3. Behavioral factors, such as students' lack of awareness of work safety, for example, touching power cables without supervision.
4. Managerial factors, namely the absence of written guidelines or SOPs for practical safety and the lack of safety training for teachers and technicians.

These factors are interrelated and increase the potential risk if systematic mitigation is not carried out.

Risk Control Measures (Determining Control)

Based on the HIRADC results, risk control measures are developed following the hazard control hierarchy, ranging from elimination to the use of personal protective equipment (PPE).

Table 3. Risk Control Strategies in the Informatics Laboratory

Type of Hazard	Control Strategy	Type of Control
Electrical	Routine inspection of cables and sockets, grounding installation, use of laboratory-specific MCBs	Engineering Control
Ergonomic	Adjustment of table and chair height, improved lighting, training on proper sitting posture	Administrative
Physical	Reorganization of cables and furniture to create safe pathways for students	Elimination / Engineering Control
Digital	Centralized antivirus installation, website access restrictions, education on safe digital literacy	Administrative / Substitution

By implementing these controls, schools can reduce their risk level to low-medium and strengthen a culture of digital safety in the learning environment.

The results of the study indicate that the safety of computer science practical work at Harapan Ananda Junior High School has not been fully managed systematically. Although teachers play an active role in supervision, there is no written policy that guarantees the implementation of occupational safety and health principles in the laboratory. These findings are in line with the results of studies by Gasparotto et al. (2024) and Abedsoltan & Shiflett (2024), but this study makes a new contribution by adding the

dimension of digital hazards, which is rarely discussed in the context of junior high schools.

In addition, students' awareness of risks is still low. Based on the interview results, 73% of students admitted that they had never received training on computer safety. This shows the need to integrate digital K3 education into the Informatics curriculum so that students are not only technically skilled but also have good risk awareness.

Discussion

The results of this study indicate that Informatics practicum activities at SMP Harapan Ananda contain multiple potential hazards, including electrical, ergonomic, physical, and digital risks, each varying in frequency and severity. Electrical hazards, such as poorly insulated cables and loose sockets, were identified as high-risk due to their potential to cause electric shocks and small fires. This finding aligns with previous studies by Omer (2024), which highlighted that inadequate maintenance and improper electrical installation in school laboratories significantly increase the risk of accidents. The frequent occurrence of ergonomic hazards, such as incorrect sitting posture and low monitor placement, demonstrates the importance of addressing physical comfort during extended computer use, as supported by Putri et al. (2025), who found that poor ergonomics in school laboratories contribute to musculoskeletal strain and visual fatigue.

Physical or mechanical hazards, including narrow layouts and scattered cables, were categorized as moderate risk, yet they remain important because they can result in falls and minor injuries if unaddressed. These findings are consistent with research by Sari and Yousif et al. (2025), emphasizing that laboratory layout and housekeeping significantly affect student safety. Digital hazards, such as exposure to malware, unprotected data, and unsafe websites, were also identified as high-risk due to the growing reliance on technology for learning. This highlights the need for integrating digital literacy and cybersecurity practices into the school curriculum to protect students from data breaches and cyber threats.

The risk assessment conducted using the HIRADC framework provides a systematic method for prioritizing mitigation strategies. Electrical hazards require immediate intervention through engineering controls, such as proper grounding, routine inspections, and use of MCBs. Ergonomic and digital hazards can be mitigated through administrative measures, including training, policy implementation, and supervised practicum sessions. Reorganization of physical space and removal of obstacles represent effective elimination or engineering strategies for physical hazards. By applying these controls, the laboratory environment becomes safer and more conducive to productive learning.

Furthermore, the study demonstrates that awareness and training are critical components in minimizing hazard exposure. Teachers, technicians, and students must be educated on hazard identification, risk assessment, and preventive measures to create a culture of safety within the laboratory. In addition, continuous monitoring and updating of safety protocols are necessary to adapt to evolving technology and laboratory conditions. Overall, this research confirms that a holistic approach to hazard identification and mitigation, encompassing physical, ergonomic, electrical, and digital aspects, is essential

for maintaining a safe and effective Informatics practicum environment in junior high schools.

CONCLUSION

The results of the study show that practical activities in Informatics lessons at Harapan Ananda Junior High School have various potential hazards, including electrical, ergonomic, physical-environmental, and digital (cyber) hazards, with varying levels of risk from low to high. Electrical hazards are the most dominant risk due to the use of unprotected extension cords and lack of installation maintenance, while ergonomic hazards arise from disproportionate table and chair designs and inadequate lighting. In addition, the narrow layout of the laboratory, limited ventilation, and disorderly cable arrangement pose physical-environmental hazards that can compromise student safety. In the digital context, the risks of accessing harmful content, spreading malware, and leaking personal data emphasize the importance of implementing cyber security literacy in schools. Based on the results of the HIRADC analysis, risk mitigation needs to be carried out through the application of a hierarchy of hazard control, including elimination of the source of danger, technical engineering, preparation of safety SOPs, and K3 education for teachers and students. Theoretically, this study expands the application of risk identification and assessment concepts in the context of basic education, while practically contributing to the formulation of information technology laboratory safety policies, the establishment of a digital safety culture, and the improvement of a safe, healthy, and productive learning environment in the era of technology-based education.

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