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ANALYSIS OF THE IMPLEMENTATION OF OCCUPATIONAL HEALTH AND SAFETY IN SCIENCE LABORATORIES: LITERATURE REVIEW

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ABSTRACT

Occupational safety and health are an important part of supporting a smooth and safe science learning process. A laboratory with good occupational safety and health standards is able to support the effectiveness of learning while preventing dangerous accidents for students. The aim of this research is to analyze the implementation of occupational safety and health in Indonesian science laboratories. This type of research is a literature study. Examples of articles used are sourced from Google Scholar with the time period 2014-2023. The data analysis technique used is the synthetic matrix method. The research results show that the application of occupational safety and health in science laboratories is quite diverse. There are still many obstacles in science laboratories in implementing occupational safety and health according to standards which are influenced by human factors (knowledge) and infrastructure supporting occupational safety and health. The conclusion from this research is that there are obstacles to implementing occupational safety and health in science laboratories which are influenced by human factors and supporting infrastructure.

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Introduction

The laboratory is an integral part that functions to improve the quality of learning (Borrull and Valls 2021; Maison et al. 2019; Setiya Rini, Darmaji, and Kurniawan 2022). With a laboratory, students can gain real experience through practical activities which have an impact on students' ability to train scientific thinking skills, instill and develop scientific attitudes, as well as discover and solve various problems through scientific methods (Astalini et al. 2023; Darmaji et al. 2022; Rini and Aldila 2023). Laboratories also help students understand scientific concepts and motivate them to be more interested in learning (Emda 2017; Fitriani, Cantika, and Lolita 2021; Parong and Mayer 2018). Laboratories cannot be separated from science subjects.

Natural sciences (physics, biology and chemistry) are subjects that are closely related to laboratories. The essence of science learning is understanding and gaining knowledge about natural phenomena through a series of discovery processes which include experimentation, observation and testing (Agustina 2018; Astalini., D. A. Kurniawan., Darmaji., M. Ikhlas., Kuswanto., R. Perdana., L. Anggraini. 2020; Zezekwa and Nkopodi 2020). Ideal science learning cannot be achieved if it is not supported by the implementation of practical activities in the laboratory which functions as a place to discover and test the truth of knowledge (Aditia, Muhlisin, and Singgih 2022). So the existence of a laboratory really supports the success of the science teaching and learning process (Harefa 2020; Harefa et al. 2021).

Laboratories that support the success of the science learning process must be supported by good management, the aim of which is to organize and maintain the laboratory so that it continues to function as it should (Claxton, Hosie, and Sharma 2022; Ismara, Suharjono, and Supriadi 2021; Ismawati and Trisnowati 2019). One of the management components that is important to pay attention to is the management of laboratory health and safety standards. Laboratory K3 management functions to maintain work safety, including preventing the possibility of accidents occurring while working in the laboratory and handling them if an accident occurs (Sangi and Tanauma 2018).

Management Laboratory safety and health management is important to apply in science practicum (Wulandari and Kumoro 2018). This is because the practical activities carried out often use equipment and materials that have a high risk. In science learning there are 3 potential dangers in the laboratory including 1) Chemical hazards include carcinogenic substances, poisons, irritants, pollution, flammable materials, strong acids and bases, 2) Biological hazards can derived from culture specimens, body tissue, experimental animals, 3) Physical hazards include ionic and nonionic radiation, ergonomics, noise, heat stress, lighting, electricity, fire.

However, existing facts show that the frequency of laboratory accidents in Indonesia is still quite large (Cahyaningrum 2020; Ningrum et al. 2021; Ningrum, Fajriyah, and Budiman 2019). Quoting from Kumparan, (2023) on August 27 2023, a Diponegoro University student suffered burns due to an explosion which was thought to have come from practical chemicals. Based on the various problem descriptions presented, this research aims to analyze the management of occupational safety and health standards in Indonesian science laboratories.

Research Methods

This type of research is literature study research. Literature reviews are carried out through scientific studies that focus on one particular topic with the aim of providing an overview of the development of that topic (Win and Wulandari 2023). Research uses secondary data sourced from articles obtained with the keywords "Occupational safety and health" and "Laboratory" and "Science". The literature used is sourced from Google Scholar with a publication range of 2014-2023. The data

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analysis technique uses synthetic matrix methods.

Result and Discussion

Based on the results of the research conducted, 11 journals were found that were relevant to keywords sourced from Google Schoolar. Journal selection is based on relevance to the objectives of the research being carried out. The results of the analysis are presented in table 1.

Table 1. Analysis of occupational safety and health in the science laboratory

Authors and Year	Method	Result
(Isnainy, Hasyim, and Sitorus 2014)	qualitative descriptive	The implementation of occupational safety and health (K3) standards in chemical laboratories has several shortcomings, including the lack of alarms, fire extinguishers, emergency doors and laboratory occupational safety and health instruction posters.
(Wiratma and Subagia 2014)	R&D	Research results indicate that laboratory management is generally carried out through a series of processes, starting with procurement, use and maintenance, and the disposal of damaged equipment and materials. Each of these aspects is not yet fully implemented, and several weaknesses or obstacles remain in the implementation of laboratory management aspects. This is due to suboptimal commitment from policymakers and a low level of understanding among stakeholders regarding laboratory management.
(Sulman and Irawan 2016)	quantitative	Several things can be obtained from the management, namely: (1) chemical waste comes from the remains of making solutions, leftover practicums, results of washing tools, and expired materials. (2) Reduction in the number of chemicals stored in the warehouse by 18.5% of the total inventory, while the number of materials causing B3 waste is reduced by 29%. (3) Chemical waste processing techniques are needed before being disposed of into the environment. (4) Recommendations for proposed amendments to the SOP for Planning, Receiving Materials, Warehouse Audits to prevent chemical pollution.
(Syakbania and Wahyuningsih 2017)	qualitative descriptive	Overall, the implementation of K3 is in the good category based on 71 assessment points, as many as 54 points (76.05%) are fulfilled or in accordance with standards/regulations and 17 points (23.94%) are not fulfilled or do not comply with standards. Aspects that are not fulfilled include the lack of emergency doors, eyewash and shower, no smoke detectors, no use of blowers, the laboratory only uses fans and exhaust; does not have an evacuation plan, only safety signs for evacuation routes.
(Yana 2019)	qualitatvie	The research results show that the implementation of OHS in science laboratories involves two factors: human factors and

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		environmental factors. Human factors encompass several things, including behavioral habits during practicums, knowledge of OHS maintenance, disciplined adherence to regulations, and conducting practicums according to SOPs. Environmental factors, on the other hand, include the availability of OHS facilities and infrastructure and the availability of practicum modules.
(Nayiroh 2019)	qualitative descriptive	Several OHS indicators were not met, including human factors not adhering to laboratory SOPs and environmental factors such as prolonged handling of damaged equipment, inadequate OHS facilities and infrastructure, improper electrical outlet arrangement, and the lack of ventilation in some laboratories.
(Ridasta 2020)	qualitative descriptive	The study results showed that of the 64 initial implementation criteria, 57.85% (37 criteria) were achieved, and 42.15% (27 criteria) were not met, thus categorizing them as "poor."
(Ahmad and Susilawati 2023)	qualitative descriptive	The implementation of Occupational Health and Safety (OHS) in the chemistry education laboratory at the Pematang Siantar State Islamic Senior High School (MAN) has been fully implemented, both in terms of implementation and SOPs.
(Muttaqin et al. 2023)	qualitative	The results of the study at SMA Kota Saamarinda showed that the general safety aspect of the laboratories at both schools was categorized as good, the sensitivity aspect to student feelings was categorized as very good, the occupational safety aspect for each physics experiment was categorized as good, and the completeness of laboratory facilities was categorized as adequate. Physics laboratory management is not yet optimal due to several aspects that have not been met, such as a lack of facilities and infrastructure and a limited number of experts in physics laboratory management, both laboratory assistants and technicians.
(Annisa et al. 2023)	qualitative	The school has not met the facility and infrastructure standards for biosafety level 1 and biosecurity criteria, students have not used Personal Protective Equipment (PPE) to support the implementation of K3, and performance has not been in accordance with biosafety and biosecurity implementation.
(Faisal et al. 2023)	Mix method	Several OHS indicators were not met, including human factors not adhering to laboratory SOPs and environmental factors such as prolonged handling of damaged equipment, inadequate OHS facilities and infrastructure, improper electrical outlet arrangement, and the lack of ventilation in some laboratories.

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Based on Table 1, it is explained that the implementation of occupational safety and health in Indonesian science laboratories has various categories. There are several laboratories in the good category, but there are still many laboratories that have problems implementing K3 standards properly.

There are several factors that influence the implementation of K3 in science laboratories, including the knowledge factor possessed by users, in this case students and laboratory assistants (experts), who in implementation are often replaced or replaced by teachers so that laboratory safety and health management does not run well. Another factor based on the results of the analysis was that the biggest problem lies in the K3 supporting infrastructure. This is explained to include 1) Laboratory construction that does not pay attention to safety standards (emergency doors, ventilation), 2) Unavailability of facilities used to store high-risk materials and equipment (no fume cupboard), 3) Lack of planning and handling of practical waste. , and 4) security for preventing laboratory accidents is not given enough attention (no lab coats or PPE, no APPAR, eyewash and shower, no smoke detectors).

The implementation of occupational safety and health must be carefully considered to support the smooth and safe learning process. Implementing K3 the basic thing that needs to be understood is the potential for danger. Potential hazards in laboratories are generally classified as follows; danger of fire and explosion from flammable or explosive substances/materials; toxic, corrosive and caustic materials; radiation danger; burns; shock due to electric current; cuts caused by broken glassware and sharp objects; danger of infection from germs, viruses or parasites.

By understanding the potential dangers that can occur in the laboratory, it becomes the basis for determining occupational safety and health management policies. According to Cahyaningrum (2020) management of occupational safety and health must be based on several things including: 1) Determination of occupational safety and health policies must consider resources that support the implementation of occupational safety and health both in terms of finances and infrastructure that support occupational safety and security. , 2) Occupational safety and health planning must be based on identification of potential hazards, risk assessment and control through technical and administrative controls and the use of PPE, 3) Implementation of occupational safety and health must be based on SOPs, occupational safety and health education and training to improve understanding and how to handle when a laboratory accident occurs.

Conclusion

The implementation of occupational safety and health in science laboratories as a whole still has various shortcomings. This deficiency is influenced by the knowledge factors possessed by laboratory users and managers. Another factor that is the biggest factor in the low level of occupational safety and health in science laboratories is the infrastructure that supports safe use of the laboratory. So efforts that can be made are to improve policies for implementing occupational safety and health in science laboratories by considering supporting capacity in establishing policies, careful planning based on analysis of risks and potential hazards, and increasing knowledge in implementing occupational safety and health.

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