IMPLEMENTATION ANALYSIS OF THE OCCUPATIONAL HEALTH, SAFETY, AND ENVIRONMENTAL MANAGEMENT SYSTEM AT LABORATORY OF UNIVERSITAS INDONESIA IN 2020

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ABSTRACT

Background: The laboratory is important to conduct the experiments, investigations, and observations of various fields of scientific study. . Learning activities in the laboratory are withstanding the potential safety, health, and environmental hazards, such as chemical, physical, biological, and even emergency hazards. However, potential hazards are avoidable with risk management through the implementation of the Laboratory Occupational Health, Safety, and Environmental Management System (OHSEMS). This study aimed to analyze the implementation of OHSEMS aspects at the Laboratory of Universitas Indonesia (UI).

Subjects and Method: This was a descriptive study using a quantitative approach that conducted at the laboratory of UI in 2020. The attainment of OHSEMS implementation was measured using media in the form of a laboratory inspection checklist which UI had developed with some improvements. This checklist form has 157 questions that cover 15 aspects of OHSEMS in the form of closed questions. The inspection score is analyzed by using the gap analysis method and reported descriptively.

Results: Laboratories at UI implemented most of the OHSEMS aspects, within $\geq 70\%$ as the cutoff score (Lab A2 : 76%; Lab A4 : 78%; Lab A9 : 81%; Lab A10 : 78%; Lab F5 : 74%; Lab F12 : 73%; Lab F13 : 80%; Lab F14 : 85%; and Lab G19 : 95%), with the lowest and highest assessment range on each aspect of its OHSEMS (commitment and policy: 50-100% ; planning: 50-95% ; implementation: 79-97% ; operational control: 75-94% ; checking: 33-100% ; management review: 0-100%). The gap analysis showed that the highest gap lies in the operational control aspect (laboratory housekeeping, inventory system, and emergency preparedness and response).

Conclusion: Improvement and remedial actions still need to be taken in several aspects, particularly the aspect with the highest gap; operational control. Besides that, aspects of checking and management review must still be improved by conducting an audit.

Keywords: occupational health, safety, and environmental management system (OHSEMS), inspection, laboratory, Universitas Indonesia

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BACKGROUND

Universities and colleges are excellent educational institutions, which are places for students to learn skills and verify the scientific theory. One such learning place is a laboratory. Most institutions define the laboratory as a place conducive to conducting

experiments, investigations, and observation.

According to OSHA, a laboratory is a facility or workplace where the use of hazardous chemicals occurs and uses relatively few chemicals not used for production process activities. In practice, activities in the laboratory involve the use of chemicals and

involve the use of materials from other fields of science such as physics, biology, etc. (Wu et al., 2007; Wyllie et al., 2016; OSHA, 2011).

The laboratory's learning or research activities cannot be separated from the possible potential hazards from chemical, physical, biological, and even emergency hazards. From statistical data of OSHA, researchers in academic laboratories can be injured 11 times more dangerous than researchers in laboratories in the industrial sector. But this can be prevented by carrying out risk management through the implementation of aspects of the Occupational Health, Safety, and Environment Management System (OHSEMS) (OSHA, 2011; Subhani, 2010).

One of the laboratory incidents in college occurred in 2010 at a chemistry laboratory, Texas Technology University, a chemical explosion (Texas Tech, 2010). Besides, several laboratory accidents at other universities were frequently occurred (Wyllie et al., 2016). At the University of Indonesia, there have also been several work accidents in wet laboratories, such as cases of waste gas and chemical explosions.

Apart from safety and health aspects, environmental aspects must also be considered in implementing OHSEMS. Ho and Chen (2017) explained that in recent years there had been an increase in the number of laboratory accidents caused by liquid waste at several universities in Taiwan. These cases can be minimized through proper management of laboratory waste at universities, with a percentage of improvement of 73.2%.

PP No. 50 of 2012 article 5 paragraph 2 concerning the application of OHSMS stated that every workplace that employs a workforce of ≥ 100 workers and/or has a high potential hazard is obliged to apply OHSMS. (PP 50, 2012). OHSEMS implementation process uses PDCA (Plan-Do-Check-Action)

approach, which starts from planning, implementing, checking, and corrective actions.

One example of a university that has successfully implemented the OHSEMS aspects is the National University of Singapore (NUS). This is evidenced by the decrease in the NUS accident rate by 74.5% (per 100,000 workers) from the year 2009-2013 (NUS, 2013).

One of the fulfillments of the implementation of OHSEMS aspects in the University of Indonesia laboratory is reviewed through routine inspections. This inspection is carried out for a period of 1 time in 2 years. The first laboratory inspection was carried out in 2016 (achievement percentage =19%), and in 2018 (91%). This improvement showed that the entire UI community continues to implement OHSE aspects in all their activities, especially in the laboratory.

In this study, an analysis of the implementation of OHSEMS was carried out in the laboratory of the University of Indonesia through routine inspections. The measurements were carried out on 9 wet laboratories at the current study year spread across several UI Faculties. The percentage of achievement was calculated through 15 aspects of measurement by involving all elements of OHSEMS. This analysis was expected to be a good output to improve OHSEMS laboratories' implementation to create a safe, healthy, and environmentally-friendly laboratory.

SUBJECTS AND METHOD

1. Study Design

This was a descriptive study conducted at the University of Indonesia (UI) Laboratory from June to July 2020.

2. Population and Sample

The study subjects were laboratories in University of Indonesia which scored <70% on the previous inspection.

3. Study Instruments

The study variables were 15 aspects of OHSEMS, with a total of 157 checklists. Universitas Indonesia developed the questions in the checklist in the form of closed questions.

4. Data Analysis

The data were analyzed using the gap analysis method formula (Naroeni et al., 2016): Implementation score and reported descriptively.

$$= \frac{\text{presence of implementation} \times 100}{\text{presence} + \text{absence of implementation}}$$

RESULTS

The achievement of the implementation of OHSEMS at the Laboratory of UI

All laboratories inspected this year had reached a value of $\geq 70\%$. The percentage of achievement was calculated through 15 aspects of OHSEMS. This measurement aspect referred to ISO 45001 (ISO, 2018), ISO 14001 (ISO, 2015) Government Regulation of the Republic of Indonesia No. 50 of 2012 (PP50, 2012), as well as several OHSEMS standards in universities; University of Indonesia (UI, 2016), National University of Singapore (NUS, 2009), and Universiti Teknologi Malaysia (UTM, 2012).

Gap Analysis Implementation of OHSEMS UI Laboratory

Gap analysis is the total number of points that have not been implemented from the whole question. This gap will then be analyzed to see which aspects still need to be improved.

From the table of the gap analysis results, the highest gap was obtained in each laboratory, namely the operational control aspect. It was found that this aspect had not been implemented optimally. The highest gaps in operational aspects were in the work environment or housekeeping, inventory

systems, and emergency preparation if we look deeper. The gap analysis still needed to be further explored, considering that each aspect had a different number and portion of questions.

DISCUSSION

The achievement of the implementation of OHSEMS at the Laboratory of UI

Measurement of the implementation of OHSEMS UI laboratory which involved all elements of OHSEMS, illustrating that almost all UI laboratories had implemented the OHSEMS aspects well. The G19 laboratory achieves the highest score with the acquisition of a score of 95%. When viewed from the results of interviews and observations, the laboratory at the faculty had a very high management commitment to the OHSEMS laboratories. One superior aspect was the provision of human resources by establishing separate units for OHS faculty officers. Thus, the OHS laboratory program can be implemented and monitored effectively.

The laboratory had also routinely conducted ISO 14001 internal audits and continued to make improvements gradually.

Gap Analysis Implementation of OHSEMS UI Laboratory

The highest gap in operational control was laboratory housekeeping, inventory system, and emergency preparation and response. Lab G19 had implemented good laboratory housekeeping such as using anti-floor slips to minimize the potential for physical hazards (CDC, 2012), and Lab A10 had developed an online basis inventory system called Chemical Inventory Management System (CIMS).

**Figure 1. Bar chart of an implementation
achievement of OHSEMS at the Laboratory
of Universitas Indonesia in 2020**

OHSEMS Measurement Aspects

1. **OHSE Commitment and Policy**
2. **Planning**
3. Hazard Identification, Risk Assessment, and Determining Control
4. Legal and Other Requirements
5. Objective, Goals, and Program
6. **Implementation**
7. Resources, Roles, Responsibility, Accountability, and Authority
8. Awareness, Competency, and Training
9. Communication, Participation, and Consultation
10. Documentation and Document Control
11. **Operational Control**
12. Emergency Preparedness and Response
13. **Checking**
14. Performance Measurement and Monitoring
15. Evaluation of Compliance
16. Incident Investigation, Non-Conformity, Corrective and Prevention Action
17. Audit
18. **Management Review**

**Fulfillment of aspects of
Laboratory OHSEMS, thus can
create a safe, healthy, and
environmentally friendly
educational laboratory.**

Figure 2. Aspects of OHSEMS measurement

Table 1. Laboratory gap analysis

Aspect	A2	A4	A9	A10	F5	F12	F13	F14	G19
HSE policies and commitments	0	0	0	0	0	0	0	0	0
Planning	1	1	1	1	4	1	0	1	0
Implementation	3	3	1	3	4	0	0	0	0
Operational control	9	6	4	3	6	8	5	2	2
Examination	2	2	2	2	2	2	2	2	0
Management review	1	1	1	1	1	1	1	1	0
TOTAL	16	13	9	10	17	12	8	6	2
EFFECTIVENESS	101.5	102.5	106	91	93.5	62.5	81	91	86

For emergency preparation and response, the fire extinguishing equipment was not yet fully available in all laboratories. Socialization and training of emergency preparedness and response has been implemented (Faculties A and G) by special OHSE officers. However, in laboratory F, the entire dissemination and training was still focused on the laborer, who was also an OHSE officer. In several laboratories, its application was limited to staff because it was difficult to find a suitable time with students.

According to the ILO (2011), emergency response must be formed in good cooperation with external emergency services. For application within the UI campus, it could be done in coordination with clinics, hospitals, campus environmental security units, fire-fighters, polices, and other interested parties. Thus, it could be concluded that although all laboratories have achieved a value of $\geq 70\%$ in the overall implementation of OHSEMS aspects, improvements were still needed in some aspects, especially those with the highest analysis gap.

Reviewing the Implementation of the UI Laboratory OHSEMS in All Aspects HSE Commitment and Policy

All laboratories had compiled OHSE laboratory policies, but they had an OHSE faculty policies, not specific yet for some laboratory. This policy contained a valuable statement that included the top management's commitment to fulfill the requirements of legislation related to the quality of OHSEMS and its continuous improvement.

In the education industry, top management's commitment and actions are the most important factors in implementing OHSEMS. Without this commitment, safety management measures will almost certainly not succeed. Developing a positive safety climate requires the realization of regular top management actions (Wu et al., 2008).

Planning

All laboratories have established OHSEMS to implement all laboratory activities and determine laboratory functions as a teaching laboratory. Laboratory guidelines refer to the Laboratory OHSE Guidelines that had been compiled by the Technical Executive Unit of OHSE (TEU OHSE) UI and the Bio-risk Safety Guidelines for several laboratories. In some laboratories, OHSE basic regulations were still only installed centrally in faculties, departments or are still archived. Although these basic rules were still socialized to all laboratory practitioners, they had not been installed in laboratories.

Meanwhile, in other laboratories, basic OHSE rules were installed in the laboratory to make it easier for laboratory assistants to provide direction or socialization related to these regulations to practitioners and can always be practice applied by the practitioner.

Then in hazard identification, risk assessment, and control (HIRADC), the preparation of these documents had been carried out by all laboratories and was adjusted to the hazards that exist in each laboratory, and updated continuously. However, in some laboratories, the stages of assessing the HIRADC were still limited to general socialization. The laboratories that had filled the HIRADC form were laboratories G19 and F14 (minus residual risk level).

HIRADC is a stage that provides information related to potential hazards, risks, and their controls in the work area to protect all workers from the probability of exposure to these hazards. All laboratory parties must carry out HIRADC according to the types of potential hazards in their respective laboratory, and document the results before starting work (Lestari et al., 2019).

Assessing Health Risk Assessment (HRA) is as important as assessing HIRADC. In the HRA implementation, only laboratories G19 and F13 have carried out these measurements, although they are still not comprehensive HRA aspects. The G19 laboratory had measured physical aspects, and the laboratory F13 has measured the ionizing exposure (x-ray) of its staff routinely.

Health hazards consist of 5 types of hazards; chemical, physical, biological, ergonomic, and psychosocial factors (Hirst, 2010). The HRA implementation was carried out using three levels of measurement: Level 1: basic qualitative health risk measures, Level 2: qualitative traceability measures, and Level 3: Quantitative health risk measures (Nasri, 2019).

Identification of environmental aspects and impacts are also needed. It is one of the initial processes in environmental Management (Susanto, 2018).

Implementation

Resources for OHS laboratory officers in Faculty F are in concurrent positions while faculties A and G have a special OHSE officer. Top management must realize its commitment to providing the necessary resources to run OHSEMS and ensuring safe operations.

If adequate resources cannot be provided, and workers cannot operate safely, then risk cannot be achieved at an acceptable level, and various activities cannot be carried out (Olewski et al., 2017). Training for human resources related to its specific hazard had been conducted. It is very important to verify new employees' experience and the quality of education and training available at the university. The organization must identify and determine new employees' training needs at the time of recruitment (Olewski et al., 2017).

The laboratory has done routine OHSE

meetings attended by the laboratory, laboratory assistants, and practitioners. Establishing close cooperation between various laboratory parties needs to be done as a forum for collaboration and sharing related knowledge about HSE aspects. This will enhance the organization's safety culture and develop a safety culture in the younger generation (Olewski et al., 2017).

OHSEMS documentations were available in the laboratory. For the standard operating procedure (SOP), only the G19 laboratory had controlled documentation. This was because the document had been checked by the ISO 14001 Team during the internal audit, while in other laboratories, SOP was available but was not well controlled.

In the aspect of safety, namely the safety of biological, chemical, physical, mechanical, and radiation, the laboratory has its own supporting instruments, such as Biological Safety Cabinets (BSC), fume hoods, primary safeguarding, personal dosimeters, as well as secondary containment for preventing the chemical leaking that can cause environmental pollution (EPA, 2013). However, some laboratories have not carried out routine maintenance of some of the instruments so that they are damaged and cannot be operated.

Likewise in the aspect of physical safety, all laboratories have not used an ergonomic lab bench as a whole. Using a chair for hours without a comfortable position creates an ergonomic hazard, which causes back pain, eye strain, fatigue, and various other health issues, thus, using an ergonomic chair will prevent an ergonomic hazard by releasing a little tension and stress on the body (Asmui et al., 2012).

According to the ILO, implementation of OHSEMS can be considered good when all stakeholders fully participate in this imple-

mentation through communication and cooperation (ILO, 2009).

Operational Control

In laboratory housekeeping, several laboratories had used fingerprint for entry access. There was a clean and well-ordered work surface in the laboratory area supported by scheduling good housekeeping activities.

A good housekeeping system is the basis for preventing potential physical hazards in the laboratory (CDC, 2012). Therefore, it was still necessary to measure the work environment in all aspects by assessing the HRA, so that the laboratory can apply following the Regulation of the Minister of Health Number 70 of 2016 concerning Standards and Health Requirements for Industrial Work Environment (Ministry of Health, 2016).

The measurement was only carried out by the G19 (still limited to the physical aspect) and F13 laboratory (still limited to the temperature and humidity in the radiation chamber). The availability of a safety shower and eyewashes had also been installed in almost all laboratories except A2 Lab.

However, there were several laboratories that did not have them specifically and standards. A study related to laboratory safety evaluation is based on the requirements for the provision of safety hardware, some of which are safety showers and eyewasher (Ahmed and Mahdi, 2019).

For the procurement of tools and materials, it was usually submitted to the department, then use the services of a third party or vendor whose legality was guaranteed. When distributing tools and materials, the staff who receive the MSDS sheet from the vendor must re-verify the hazard characteristics' accuracy. This comparison is necessary. Otherwise, the information obtained will be insufficient for planning the

experimental process (McEwen, et al., 2018).

For PPE, all laboratories have posted signs at the entrance to the laboratory related to the use of specific PPE, according to the hazards in each laboratory, such as biohazard signs, radioactive, flammable materials, and so on. This is intended as information to be conveyed to all laboratory visitors to be aware of the potential dangers posed by each laboratory.

For waste handling resulting from laboratory activities, processing and distribution of waste was carried out by disposing of waste according to the temporary storage places available in each laboratory and which had been classified, such as B3 waste, infectious waste, radioactive waste, and also general waste such as water, soil, and sand. In the final stage, it all distributed through the vendors. The flow and regulations related to the processing and distribution of this waste were outlined in the form of a waste handling procedure. However, there were still several laboratories that had not developed these procedures in a controlled document.

Ho and Chen (2017) categorized potential environmental hazard factors that come from laboratory liquid waste into 4 parts, including recycling (not classifying waste clearly, not using PPE when recycling waste, spilled waste, etc.), storage (mismatch between container material and the type of liquid waste, lack of an alarm system, etc.), authorization and transportation (not getting a permit contract, not using a transport vehicle following regulations, etc.), and management (not clearly labeling container packaging, lack of a waste and emergency management plan, etc.).

Then there was a UI emergency telephone number that was installed door, and inside the laboratory, that will be connected directly to the TEU OHSE UI emergency

response service. Besides, laboratory workers can also download a UI emergency response service called the UI Panic Button to make it easier to report emergency conditions in the laboratory environment.

There is also a spill kit that needed for handling the chemical or others spill, but only lab F14 that had been standardly provided it. In each building, there are exit directions and assembly points that are easy to find and unobstructed. It can make it easier for OHSE department or faculty officers to guide the evacuation process when natural disasters occur in buildings (e.g. earthquakes and fires). The meeting point must be a minimum distance of 20 m from the nearest building and be located in a safe location (Lestari and Panindrus, 2008).

Checking

For the performance measurement and monitoring aspect, all laboratories had been inspected by the TEU OHSE UI regularly with a period of 1 time per 2 years, which is then made recommendations for improvements thorough inspection report as an output. A laboratory with a score >70 is considered to have fulfilled all aspects of OHSEMS.

Inspection is an important tool in an institution's safety program (Ashbrook, 2013). Laboratory inspections can be carried out in various forms, which aspects still have to be adjusted according to each laboratory's needs so that inspection activities can be effective (Wyllie et al., 2016). Then, if an incident occurs, the laboratory must report it to the head of the laboratory and local OHSE officers, where later OHSE officers will coordinate with TEU OHSE UI to immediately carry out incident investigations, corrective actions, and preventive actions. So far, the nine laboratories have never had a laboratory incident.

As for the audit, only one laboratory

had implemented it, namely the G19 laboratory. This laboratory had carried out periodic ISO 14001 internal audits, which then evaluated its compliance, as well as corrective and preventive actions.

Management Review

The final aspect of all elements of OHSEMS is the management review aspect. Management Review is an assessment activity for the improvement of OHSEMS on an ongoing basis. It is a means for management to make changes and improvements to the system needed to achieve organizational goals (UI, 2016).

In practice, top management or leadership will conduct a review of the OHSE management system at predetermined intervals to ensure a sustainable, adequate and effective suitability. The management review's output must be consistent with the organization's commitment to continuous improvement and must include any decisions and actions related to possible changes (OHSAS, 2007).

As previously explained, the G19 laboratory was the only laboratory that had carried out an OHSEMS audit, where the audit was carried out regularly. The last audit carried out by the G19 laboratory was the ISO 14001 internal audit in mid-2020, which was during the COVID-19 pandemic. The audit was carried out following applicable health protocols.

If we look deeper, this was certainly a reflection of the already very good implementation of OHSEMS, one of which lies in a strong management commitment. The implementation of audits was considered a crucial thing that must be done to keep to the implementation of OHSEMS.

Thus, the management review aspect still needs to be improved. This was seen from the whole lab, which almost all have not carried out an audit. The audit implement-

tation can be initiated by coordinating with various related parties, such as the faculty OHSE unit. Audits can be carried out externally and internally.

In addition, the implementation of pre-audit (try-out audits) can also be proclaimed through coordination with related parties to be well prepared for the actual audit. The benefits that can be obtained from implementing ISO 45001 and 14001 additions showed the organization had followed the principles of HSE management under an internationally approved framework (improved implementation, integration and maintenance of OHSEMS, continuous improvement in HSE performance, and so on) (SGS, 2016; SGS 2018).

Measurement of the implementation of OHSEMS UI Laboratories illustrated that almost all UI laboratories had implemented the OHSEMS aspects well, which was shown by a significant increase in the implementation of the OHSEMS aspects through routine inspections from 2016 to 2020.

With the last overall fulfillment percentage of 100% in 2020 (Lab A2: 76%; Lab A4: 78%; Lab A9: 81%; Lab A10: 78%; Lab F5: 74%; Lab F12: 73%; Lab F13: 80%; Lab F14: 85%; and Lab G19: 95%), with the lowest and highest assessment range on each aspect of its SMKL: commitment and policy: 50-100% (with the highest gap that lies in the formulation of the OHS policy); planning: 50-95% (with the highest gaps located in the preparation of HIRADC and the implementation of HRA); implementation: 79-97% (with the highest gaps located in the provision of resources (special OHS officers), safety aspects (physical, chemical, and biological), as well as document control); operational control: 75-94% (with gaps that lie in laboratory housekeeping, inventory systems, and preparation and handling of emergencies.

The highest gap compared to all aspects of OHSEMS); checking: 33-100% (with the highest gap that lies in the implementation of the audit); management review: 0-100% (with the highest gap that lies in the follow-up of audit implementation).

The gap analysis showed a need for improvements in implementing some aspects, particularly operational control, checking, and management review. All parties must contribute to enhancing the continuous implementation of the OHSEMS Laboratory aspects, especially in the provision of resources, facilities, and funds, leaders or representatives of the leadership can attend routine OHSE Laboratory meetings and management review meetings to participate in evaluating the appropriateness of implementing the OHSEMS aspects and providing input regarding corrective and preventive actions needed.

ACKNOWLEDGMENT

The researchers would like to thank the Laboratory Staff at the University of Indonesia and the University of Indonesia for allowing this study to be carried out. Thank you to all respondents who had been willing and cooperative to become subjects of the study.

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