

Development And Implementation Of Occupational Safety And Health With Job Safety Analysis In Civil Engineering Laboratories

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Abstract

Occupational safety and health (OSH) practices and Job Safety Analysis (JSA) are crucial for ensuring the well-being of workers and students in civil engineering laboratories. This study investigates the development and implementation of OSH practices with JSA in civil engineering laboratories to enhance safety performance and reduce accident risks. The research draws insights from various industrial settings, including construction and manufacturing, where JSA has been widely applied to identify and mitigate potential hazards. The study highlights the unique challenges faced by civil engineering laboratories, such as constantly changing physical environments and the presence of specific hazards related to experiments and tests. To address these challenges, the study proposes the integration of JSA into OSH frameworks, adapting methods like the Construction Job Safety Analysis (CJSA) to suit the dynamic nature of laboratory work. The research also emphasizes the importance of fostering a strong safety culture through employee awareness, training, and the use of innovative approaches like virtual reality (VR) in OSH education. By combining JSA techniques with comprehensive OSH initiatives, the study aims to improve hazard identification, risk assessment, and worker engagement in civil engineering laboratories. While the specific impact of integrating JSA into OSH practices on safety performance in civil engineering laboratories requires further research, the available literature suggests that such an approach can potentially enhance safety outcomes by establishing effective hazard control measures and promoting a proactive safety culture.

Keyword: Occupational safety and health (OSH), Job Safety Analysis (JSA), Civil engineering laboratories

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INTRODUCTION

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Occupational safety and health (OSH) practices and Job Safety Analysis (JSA) are crucial for ensuring the well-being of workers and students in civil engineering laboratories. This study aims to investigate the development and implementation of OSH practices with JSA in civil engineering laboratories to enhance safety performance and reduce accident risks. The research draws insights from various industrial settings, including construction and manufacturing, where JSA has been widely applied to identify and mitigate potential hazards. The study highlights the unique challenges faced by civil engineering laboratories, such as constantly changing physical environments and the presence of specific hazards related to experiments and tests. To address these challenges, the study proposes the integration of JSA into OSH frameworks, adapting methods like the Construction Job Safety Analysis (CJSA) to suit the dynamic nature of laboratory work.

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education. By combining JSA techniques with comprehensive OSH initiatives, the study aims to improve hazard identification, risk assessment, and worker engagement in civil engineering laboratories. While the specific impact of integrating JSA into OSH practices on safety performance in civil engineering laboratories requires further research, the available literature suggests that such an approach can potentially enhance safety outcomes by establishing effective hazard control measures and promoting a proactive safety culture.

Effective implementation of OHS practices can significantly reduce occupational accidents and fatalities (Feriyanto et al., 2020). Key factors that influence good OHS practices include training, safe work procedures, consultation, safety reporting, management commitment, and injury management (Barbeau et al., 2004); (Feriyanto et al., 2020). Interestingly, while large organizations often have comprehensive OHS programs, small businesses can also establish effective programs, although they may rely more on external resources (Barbeau et al., 2004). For example, in the construction industry, companies with adequate OHS management systems have better safety records and performance than those without such systems (Ayob et al., 2021).

However, challenges remain in implementing OHS practices, including lack of time, internal expertise, and production pressure (Barbeau et al., 2004). In conclusion, the importance of OHS practices applies not only in traditional industrial environments, but also in modern workplaces such as civil engineering laboratories. The establishment of an effective OHS management program, as demonstrated in the recycling industry (Leung et al., 2009), can lead to the systematic collection of accident data, identification of mitigation measures, and improvement of overall OHS performance. In addition, as technology advances, there is a need to update and clarify OHS legislation, especially in areas such as visual display units (VDUs) (Niskanen & Lehtelä, 2015). Ultimately, fostering a culture of OHS awareness among workers, including civil servants, is essential to minimize occupational hazards and ensure a safe working environment (Rahman & Mohd Kamil, 2022).

Occupational Safety and Health (OSH) measures play a crucial role in reducing accident and injury risks in civil engineering laboratories, contributing to a safer work environment. Implementing effective OSH practices can significantly mitigate hazards and improve overall safety conditions for workers and students. In civil engineering laboratories, various potential risks exist, including chemical explosions, fires, poisoning, and other work-related accidents (Pertiwi et al., 2021). To address these risks, it is essential to identify hazards, conduct risk assessments, and implement appropriate control measures.



The risk-based approach (RBA) in OSH management, as discussed in (Chencheva et al., 2024), emphasizes proactive strategies to monitor, predict, and prevent dangerous situations in advance. This approach can be particularly beneficial in laboratory settings, where hazards may not always be immediately apparent. Interestingly, while the implementation of OSH measures is crucial, some studies have found no significant association between knowledge and practice, knowledge and injury, or practice and injury (Ali & Zulkaple, 2023).

This suggests that merely having knowledge about OSH may not be sufficient to prevent accidents, and that practical implementation and consistent adherence to safety protocols are equally important. In conclusion, effective OSH measures in civil engineering laboratories should include regular hazard identification, risk assessments, and the implementation of control measures. Adopting a risk-based approach, integrating modern technologies and methodologies for risk identification, and fostering a strong safety culture through employee education and involvement are key strategies to reduce accident and injury risks (Chencheva et al., 2024); (Pertiwi et al., 2021). By prioritizing OSH, civil engineering laboratories can create a safer work environment, enhance productivity, and contribute to the overall well-being of workers and students.

Job Safety Analysis (JSA) has been widely recognized as a crucial proactive approach for identifying and mitigating potential hazards in various workplace settings. Multiple studies have emphasized its importance across different industries, including construction, manufacturing, and healthcare (Himam & Widodo, 2024); (Ayii et al., 2023); (Rozenfeld et al., 2010); (Schmitt et al., 2017). JSA focuses on the relationships among workers, tasks, tools, and work environments, providing a systematic method for hazard identification and risk assessment (Schmitt et al., 2017). It has been particularly valuable in dynamic work environments like construction sites, where the physical environment is constantly changing (Rozenfeld et al., 2010). The method has also been adapted for specific industries, such as the Construction Job Safety Analysis (CJSA) developed to address the unique challenges of construction sites (Rozenfeld et al., 2010). Interestingly, while JSA is primarily used for hazard identification, studies have revealed additional benefits. These include formalizing work processes, promoting worker participation, enhancing organizational learning, improving situational awareness, and preventing losses in dynamic systems (Albrechtsen et al., 2019). However, some limitations have been identified, such as being time-consuming, lacking an initial list of hazards, and ignoring hazards from surrounding activities (Ghasemi et al., 2023).



In conclusion, JSA remains a vital tool in occupational safety and health management, with ongoing research aimed at addressing its shortcomings and expanding its applications. Recent advances, such as the energy source-based JSA (ESBJSA), have shown promising results in improving hazard identification and reducing incident rates in high-risk projects (Zheng et al., 2017). As workplace safety continues to evolve, JSA is likely to remain an essential component of comprehensive risk management strategies across various industries.

Job Safety Analysis (JSA) has been widely applied in various industrial settings, including construction and manufacturing, to identify and mitigate potential hazards. However, its specific application in civil engineering laboratories has received limited attention. In the context of civil engineering laboratories, a study based on the lab criticality index (LCI) model identified 13 risk factors across four aspects: man, object, management, and environment (Zhang et al., 2020). The most common risk factors included insufficient safety awareness of operators, equipment failure dangers, imperfect management policies, and complex floor conditions. This research provides valuable insights into the safety status of civil engineering laboratories and offers suggestions for improving management and supervision. Interestingly, while JSA is traditionally used in static work environments, the construction industry faces unique challenges due to constantly changing physical environments and workers moving through sites (Rozenfeld et al., 2010). To address this, a structured method called "Construction Job Safety Analysis" (CJSA) was developed, which involves identifying potential loss-of-control events for detailed stages of construction activities.

In conclusion, while JSA has proven effective in various industrial settings, its application in civil engineering laboratories requires further research and adaptation. The LCI model and CJSA method offer promising approaches for assessing and mitigating safety risks in these dynamic environments. Future studies should focus on developing tailored JSA methodologies for civil engineering laboratories to enhance safety measures and reduce the likelihood of accidents.

Addressing the gap in occupational safety and health (OSH) strategies for civil engineering laboratories is indeed crucial for developing tailored approaches that address the unique risks and challenges in these environments. While the provided context does not specifically discuss civil engineering laboratories, we can draw insights from the general principles of OSH management in various industries to address this issue. The importance of recognizing the distinct OSH challenges presented by different construction scenarios and devising customized safety measures is highlighted in (Baghdadi, 2024).



This principle can be extended to civil engineering laboratories, where specific hazards and risks may differ from those found in typical construction sites or other workplaces. Implementing a risk-based approach (RBA), as discussed in (Chencheva et al., 2024), could be particularly beneficial in these laboratory settings. This approach emphasizes proactive strategies to monitor, predict, and prevent dangerous situations in advance, which is crucial in a laboratory environment where experiments and tests may pose unique risks. In conclusion, developing tailored OSH strategies for civil engineering laboratories requires a comprehensive understanding of the specific risks involved, regular risk assessments, and the implementation of proactive measures. Integrating modern technologies and methodologies, as suggested in (Chencheva et al., 2024), could significantly improve risk identification and assessment processes in these specialized environments.

Additionally, fostering a strong safety culture through employee awareness and training, as emphasized in (Baghdadi, 2024) and 8, would be essential for the successful implementation of OSH strategies in civil engineering laboratories. Job Safety Analysis (JSA) and Occupational Safety and Health (OSH) practices can significantly improve safety outcomes in civil engineering laboratories through systematic hazard identification and control measures. The implementation of JSA allows for detailed examination of work processes to identify potential hazards and establish appropriate safety controls (Rozenfeld et al., 2010); (Satrio & Wibowo, 2023). In construction and laboratory settings, JSA helps address the dynamic nature of work environments by analyzing specific tasks and stages to predict fluctuating safety risks (Rozenfeld et al., 2010). This proactive approach enables safety-conscious planning and targeted safety management efforts. Interestingly, while JSA is effective, studies show it is sometimes overused for activities where established barriers and procedures should already exist (Albrechtsen et al., 2019). However, JSA offers additional benefits beyond hazard control, including formalizing work processes, promoting worker participation, enhancing situational awareness, and facilitating organizational learning (Albrechtsen et al., 2019). To maximize safety outcomes, integrating JSA with broader OSH culture and awareness initiatives is crucial. Research indicates that environmental, organizational, and occupational factors significantly influence OSH awareness and implementation (Pratiwi & Ivanovic, 2022a). By combining JSA techniques with comprehensive OSH training and education programs, institutions can foster a strong safety culture among students and staff (Endroyo et al., 2015); (Pratiwi & Ivanovic, 2022b). This holistic



approach not only improves immediate safety practices but also prepares future professionals to prioritize safety in their careers.

Based on the provided context, there is limited direct information specifically addressing the impact of integrating Job Safety Analysis (JSA) into Occupational Safety and Health (OSH) practices on the safety performance of civil engineering laboratories. However, we can draw some relevant insights from the available information: JSA is recognized as an efficient proactive measure for safety risk assessment in industrial settings, including construction sites (Rozenfeld et al., 2010). While not specifically mentioning civil engineering laboratories, the principles of JSA could be applicable to laboratory environments as well. The Construction Job Safety Analysis (CJSA) method, developed to address the dynamic nature of construction sites, involves identifying potential loss-of-control events and assessing their probability of occurrence (Rozenfeld et al., 2010).

This approach could be adapted for use in laboratory settings to improve safety performance. Interestingly, (Albrechtsen et al., 2019) highlights that while JSA can establish hazard control, it also offers additional benefits such as formalizing work processes, promoting worker participation, enhancing organizational learning, and improving situational awareness. These benefits could contribute to improved safety performance in civil engineering laboratories if JSA were integrated into their OSH practices. In conclusion, while the specific impact on civil engineering laboratories is not directly addressed, the available information suggests that integrating JSA into OSH practices could potentially enhance safety performance through improved hazard identification, risk assessment, and worker engagement. However, further research would be needed to quantify the exact impact in the context of civil engineering laboratories.

Based on the provided context, there is insufficient direct information to address the specific hypothesis about integrating Job Safety Analysis (JSA) into Occupational Safety and Health (OSH) frameworks to enhance safety outcomes in civil engineering laboratories. However, we can draw some relevant insights from the available papers: Job Safety Analysis (JSA) is recognized as an efficient proactive measure for safety risk assessment in industrial settings (Rozenfeld et al., 2010) However, the construction industry faces unique challenges due to constantly changing physical environments and worker movements, which led to the development of Construction Job Safety Analysis (CJSA). This method involves identifying potential loss-of-control events for detailed stages of construction activities and assessing their probability of occurrence (Rozenfeld



et al., 2010). While not specifically addressing civil engineering laboratories, the literature suggests that integrating safety analysis methods into OSH frameworks can be beneficial. For instance, the fuzzy cognitive maps (FCM) approach has been applied to examine the impact of individual processes in OSH Management Systems on overall effectiveness (Sktad, 2019). This study found that leadership had the greatest positive impact on safety performance. The importance of effective safety education and training is highlighted in (Pribadi et al., 2024), which demonstrates the potential of virtual reality (VR) in enhancing OSH training outcomes. This suggests that innovative approaches to safety analysis and training can contribute to improved safety outcomes. In conclusion, while the specific hypothesis about JSA in civil engineering laboratories is not directly addressed, the literature supports the general notion that integrating structured safety analysis methods into OSH frameworks can potentially enhance safety outcomes in various work environments. Further research would be needed to validate this hypothesis specifically for civil engineering laboratories.

RESEARCH METHOD

Research and Development Research aims to develop an OSH book in Civil Engineering laboratories that aims to improve the quality of OSH in the laboratory. The final product produced is an OSH and Job Safety Analysis guidebook that meets the criteria of being valid, practical, and effective for use. As described in Chapter II, the development model used was modified from the five development models used, namely the Borg and Gall, 4-D, ADDIE, ASSURE, and Gerlach and Ely Development Models. The modified conceptual framework from various development models produces a syntax that is relevant and appropriate for designing and developing K3 and JSA learning media products. The syntax consists of: (1) needs analysis of OHS and Job Safety Analysis book; (2) Design of OHS and Job Safety Analysis book; (3) Development of OHS and Job Safety Analysis book; (4) Implementation of OHS and Job Safety Analysis book; (5) Evaluation of OHS and Job Safety Analysis book and revision; and (6) dissemination of the final product.

1. Analysis

This stage collects learning information data using descriptive analysis, observation, and documentation of lecture results in the Civil Engineering Laboratory at FT Gorontalo State University. The aspects observed included applicable laws and regulations, leadership and commitment, occupational safety and health policies, hazard identification, objectives and programs, resources and responsibilities, communication and participation with learners,



reporting and recording occupational accidents, documentation, purchasing goods and services, work environment, maintenance and repair of facilities, health monitoring, supervision, first aid, emergency or disaster preparedness, and evaluation of occupational safety and health policies. With this occupational safety and health management system, it is hoped that a safe and healthy place can be created to prevent work or practical accidents.

2. Design

The second stage is design. There are two stages that will be carried out to make the K3 book product design, namely the stages of (a) designing the K3 book, (b) compiling instruments. The product design is made in the form of a prototype by considering the needs of the K3 book in the Civil Engineering laboratory.

3. Development

At this stage, the development of the results of the design that was done previously is carried out, namely drafting the K3 book design and developing the K3 book. The goals in preparing the K3 book design include (1) needs analysis, (2) K3 book making in the Civil Engineering laboratory, and (3) testing. Furthermore, K3 book design was consulted and validated by a team of experts. After being validated by a team of experts, it was tested and asked for responses by users, namely, students. This stage includes testing and dissemination activities with the aim of reviewing the K3 book developed to meet valid and practical criteria. The trial of the K3 book that has been developed aims to determine whether the K3 book meets the criteria as a valid and practical media.

4. Implementation

The implementation stage was carried out after the K3 implementation book was declared suitable for learning by media and material experts. The K3 book was implemented in the Civil Engineering Laboratory, Faculty of Engineering, Gorontalo State University. The application in learning aims to determine the level of feasibility and effectiveness of the K3 book. The effectiveness of using the K3 book is seen from the pre-test and post-test given to compare the ability of control class students and experimental classes, which aims to determine the effectiveness of using the K3 book so that it is ready to be adopted by product users.

5. Evaluation

At this stage, the developer clarifies the data obtained from the questionnaire in the form of responses from students and lecturers, as well as the competencies, knowledge, skills, and



attitudes that must be possessed by students after participating in practical activities in the Civil Engineering laboratory by understanding the contents of the K3 pocket book.

6. Dissemination

The material contained in the OHS and Job Safety Analysis (JSA) guidelines is one of the important aspects of learning in Civil Engineering laboratories is the application of OHS and Job Safety Analysis (JSA) guidelines. The OHS guide serves as a reference to ensure that every activity carried out in the laboratory takes place safely, thereby minimizing the risk of injury, accident, or exposure to hazardous materials. These guidelines include general safety procedures, use of personal protective equipment (PPE), management of hazardous materials, and emergency protocols.

RESULT AND DISCUSSION

The initial step in this stage is to analyze the needs in accordance with the results of the modification of the development model that has been carried out. The results of the modification of the development model consist of 6 syntaxes, namely, needs analysis, design, development, trial, product evaluation and revision, and dissemination. This research produces a development product in the form of an Occupational Safety and Health (OHS) implementation book and a Job Safety Analysis book. The results showed that the application of OHS in the Civil Engineering laboratory had an achievement of 46.6%; therefore, it was included in the criteria less, and the results of the research data are shown in Figure 1.

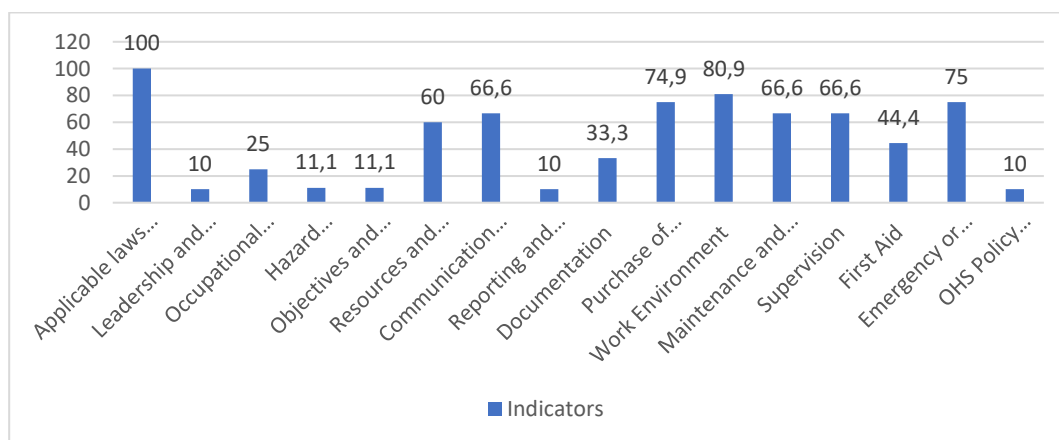


Figure 1. Achievement of K3 Implementation in the Civil Engineering Laboratory FT UNG

The results of data processing carried out from the questionnaire instruments are categorized as a good category with a value of 76%-100%, a sufficient category of 51%–75%, a category of less 26%-50% and a category of 0%-25%.

At this stage, the design of occupational safety and health books and job safety analysis books was conducted according to the results of the analysis conducted previously. In addition, the design of the resulting product testing scenario was also carried out, where testing was carried out by material experts and media experts in accordance with the validation instruments prepared by researchers. The design stage is based on the storyboard or concept map of the K3 book and the job safety analysis book that was designed.

The product developed in this research is an occupational Safety and Health book consisting of a cover, safety, and health material in Civil Engineering laboratories, Implementation of Safety and Health in Civil Engineering laboratories, and Promotion of Safety and Health in Civil Engineering laboratories. In the development stage, several activities were carried out, such as searching and collecting various relevant sources to enrich the material; making illustrations, charts, and graphs needed; typing, editing, and arranging the layout of the textbook. The following activity in the development stage is validating draft product development and revision after expert input.



Figure 2. Book Cover

The K3 and Job Safety Analysis guidelines that have been produced can be seen in the printed book. The data collected from research on the development of Occupational Safety and Health guidebooks in Civil Engineering laboratories and Job Safety Analysis are quantitative as primary data and qualitative data in the form of suggestions and inputs from the validators. Validation is the stage of media assessment before testing by students. Validation of the Occupational Safety and Health guidebook in the Civil Engineering Laboratory and Job Safety Analysis was carried out by two Material Experts and two Media Experts.

Material Expert Validation of Occupational Safety and Health Guidelines in Civil Engineering Laboratories Material experts for Occupational Safety and Health guidelines in Civil Engineering Laboratories are Dr. Indriati Martha Patuti, S.T., M.Eng. and Dr. Ir. Rahmani Kadarningsih, S.T., M.T.. The validation carried out by material experts was related to aspects of material quality and aspects of usefulness by filling out a 1-4 scale questionnaire. Recapitulation of Validation Results by Material Experts. Data on the results of the validity test by material expert validators regarding the level of validity of the Occupational Safety and Health Book in the Civil Engineering Laboratory are presented in Table 1 as follows:

Table 1. Results of Validation of Occupational Safety and Health Guidelines in the Civil Engineering Laboratory

No.	Rated Aspect	Validator		Average	Category
		V1	V2		
A	Introduction				
1	Background	3,00	3,00	3,00	Valid
2	Legal basis	4,00	3,00	3,50	Very Valid
B	K3 Civil Engineering Laboratory				
3	Civil Engineering Laboratory work environment	4,00	4,00	4,00	Very Valid
4	Potential dangers in the civil engineering laboratory	4,00	3,00	3,50	Very Valid
C	Implementation of K3 Civil Engineering Laboratory				
5	Civil Engineering Laboratory K3 Facilities	4,00	4,00	4,00	Very Valid



6	Definition and types of Laboratory Care	4,00	3,00	3,50	Very Valid
7	SOP for Practicum Implementation	4,00	4,00	4,00	Very Valid
D	Promotion of K3 in Civil Engineering Laboratories				
8	K3 Information	3,00	3,00	3,00	Valid
9	K3 Report	3,00	4,00	3,50	Very Valid
E	Closing				
10	bibliography	3,00	3,00	3,00	Valid
Overall Average				3,50	Very Valid

Based on the results of the assessment of each aspect of the Occupational Safety and Health Book in the Civil Engineering Laboratory, the overall average of the aspects assessed was 3.50 and was in the Very Valid category. In addition, all the validators concluded that the Occupational Safety and Health Book in the Civil Engineering Laboratory that had been developed could be applied with minor revisions. This means that the developed product was based on careful needs analysis. Product development has been based on: (1) the demands of the world of education; (2) the demands for the development of science, technology, and the dynamics of the world of work; (3) the needs of prospective users; (4) the demands for improving the efficiency and effectiveness of the education/learning process; (5) a comprehensive needs analysis; and (6) interesting and important problems to solve. Based on the results of this analysis and the product validity criteria, it can be stated that the book developed was deemed by experts as very feasible to implement. Based on the table, it can be seen that the assessment of the material aspects of the Occupational Safety and Health Book in the Civil Engineering Laboratory is as follows:

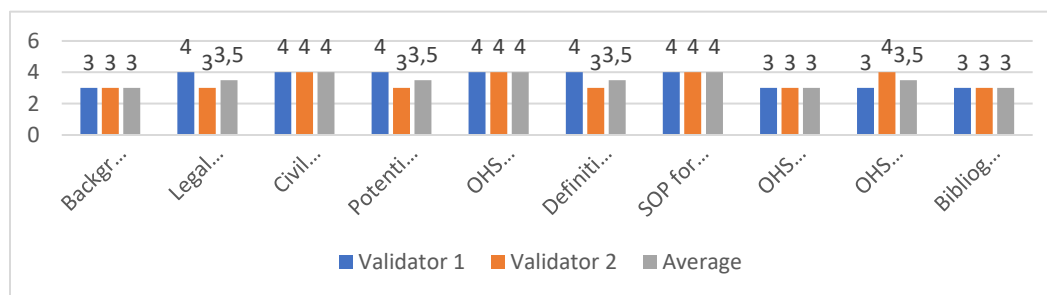


Figure 3. Histogram of the Results of Expert Assessment of Occupational Safety and Health Guidelines in the Civil Engineering Laboratory

Construct validation aspects assessed by media design experts are presentation, quality, effectiveness, and graphical aspects. The validation aims to provide input, information, suggestions, and responses to the development of K3 and Job Safety Analysis guidelines in the Civil Engineering Laboratory (FT UNG). Results of the construct validation assessment by a team of validators of the Occupational Safety and Health Guide in the Civil Engineering Laboratory. Expert validation data on this learning tool are fully presented in the appendix, and a summary is presented in Table 4. below

Table 2. Results of data processing Validation of Occupational Safety and Health guidelines in Civil Engineering Laboratories from Experts

Rated Aspect	Validator		Average	Category
	V1	V2		
Cover	4,00	4,00	4,00	Very Valid
Material	4,00	4,00	4,00	Very Valid
Graphics	3,00	3,00	3,00	Valid
Presentation	3,00	3,00	3,00	Valid
Language	4,00	4,00	4,00	Very Valid
Referral	4,00	4,00	4,00	Very Valid
Overall Mean			3,66	Very Valid

Based on table 2 the results of the validation of the Occupational Safety and Health guide in the Civil Engineering Laboratory assessment of the two validators are in the very valid category; therefore, it can be concluded that the Occupational Safety and Health guide in the Civil Engineering Laboratory that has been developed is declared very valid and suitable for use. This opinion is based on the results of the experts' assessment, which shows that: (1) the description of the material in each chapter is in accordance with the objectives to be achieved; (2) the materials contained in the book are valid in accordance with the development of science and technology; (3) the images listed are in accordance with the material described; (4) the symbols used are in accordance with the characteristics of occupational safety and health; (5) the use of units in accordance with the characteristics of occupational safety and health material; (6) the tables used are appropriate in accordance with the material described; and (7) the materials are able to develop academic skills, including cognitive, psychomotor, and affective aspects.



Material Expert Validation of Job Safety Analysis in the Civil Engineering Laboratory Job Safety Analysis (JSA) is a method of identifying hazards in a work environment, as well as control and countermeasure efforts to prevent occupational diseases or accidents that may arise from a job (Gidwany, 2018). The steps of applying the JSA method consist of 3 stages as follows (Gidwany, 2018): identification, selecting a specific job or activity, dividing it into several parts, and identifying all possible work accidents that lose control during work. Assessment, evaluation at several levels to identify work accidents, and control all risks by measuring efficiently to minimize or eliminate incidents. The purpose of implementing JSA over the long term is to involve all parts in creating safe working environment conditions and minimizing unsafe and unsafe conditions (Gidwany, 2018). The results of the expert assessment of the Job Safety Analysis (JSA) document are believed to improve occupational safety and health (K3) during the practicum in the laboratory.

Table 3. Results of Job Safety Analysis (JSA) Document Validation

No	Description	Choice			Category
		V1	V2	V	
1	Instructions for Completing the Assessment (JSA)	3	4	3.5	Very Valid
2	Language Assessment Sheet (JSA)	3	4	3.5	Very Valid
3	Fill in the Assessment Sheet (JSA)	4	4	4	Very Valid
Total Assessment Result JSA		3,33	4	3,66	Very Valid

Based on Table 3 the results of the validation of the Civil Engineering Laboratory Job Safety Analysis (JSA) Document to improve occupational safety and health (K3) in the Civil Engineering Laboratory show that: (a) the average value of the filling aspect of the assessment is 3.5, or included in the very valid category; (b) the average value of the linguistic aspect of the assessment sheet (JSA) is 3.5, or included in the very valid category; (c) the average value of the content of the JSA assessment sheet is 4 included in the very valid category. Overall, the results obtained the average value of the three aspects of the Job Safety Analysis (JSA) Document in the Civil Engineering Laboratory to improve occupational safety and health (K3) in the Civil Engineering Laboratory, is 3.66 or included in the very valid category.

Based on the results of the validity analysis of the Occupational Safety and Health (K3) book and Job Sheet products to improve Occupational Safety and Health (K3) in the Civil



Engineering Laboratory, data summarizing the validation of the products produced are presented in Table 4 below:

Table 4. Summary of Product Validity Results

No	Description	Choice			Category
		V1	V2	V	
1	Occupational Safety and Health Book (K3)	3.71	3.61	3.66	Very Valid
2	Job Safety Analysis (JSA)	4	3,90	3,95	Very Valid
Total Assessment Result		3,85	3,75	3,80	Very Valid

Based on Table 4 above about the summary of the validity value of the entire product developed, namely the development of Occupational Safety and Health (K3) books in the Civil Engineering Laboratory and Job Safety Analysis, resulting in an average value of 3.63 or in the very valid category.

The small-group trial was conducted by giving respondents the opportunity to understand and analyze K3 in the Civil Engineering Laboratory. The researchers then distributed questionnaire sheets to five students of the Civil Engineering study program at the Faculty of Engineering, Gorontalo State University. Each student gave an assessment of the book Occupational Safety and Health in Civil Engineering Laboratories and Job Safety Analysis, where the questionnaire consisted of 24 statement items. All these items review several aspects, namely aspects of material quality, material convenience, and implementation. Based on the traces of opinions that the researchers conducted on five respondents, the following are the results of the recapitulation of respondents' responses regarding product assessment in small-scale limited trials:

Table 5. Recapitulation of responses of respondents of small-scale limited trials

Rated Aspect	Respondents					Average	Category
	1	2	3	4	5		
Aspects of Material Quality	4,00	3,00	4,00	4,00	4,00	3,80	Very Practical
Aspect	4,00	3,00	4,00	3,00	4,00	3,60	Very Practical
Learning Aspect	3,00	4,00	3,00	4,00	3,00	3,40	Very Practical
Overall Average						3,60	Very Practical



Based on the recapitulation of the assessment of the small group trial results in Table 5, the overall assessment results can be calculated in the form of averages. Based on the results of these calculations, the average value is 3.60. The results of these calculations are then converted into qualitative data by following the assessment categorization guidelines, so it can be seen that based on the assessment of the users it is declared practical and can be used with some revisions.

User assessment was conducted by 35 students from the Civil Engineering Study Program, Faculty of Engineering, Gorontalo State University. Each student gave an assessment of the book product Occupational Safety and Health in Civil Engineering Laboratories and Job Safety Analysis where the questionnaire consisted of 24 statement items. The entire item reviews several aspects of appearance, material presentation, clarity, and learning benefits. The results of the assessment by users of the book products of Occupational Safety and Health in the Civil Engineering Laboratory and Job Safety Analysis are as follows

Table 6. Recapitulation of responses of large group trial respondents

Respondent	Number of Questions	Average	Category
1	24	3,71	Very Practical
2	24	3,79	Very Practical
3	24	3,67	Very Practical
4	24	3,79	Very Practical
5	24	3,71	Very Practical
6	24	3,67	Very Practical
7	24	3,79	Very Practical
8	24	3,79	Very Practical
9	24	3,71	Very Practical
10	24	3,79	Very Practical
11	24	3,67	Very Practical
12	24	3,79	Very Practical
13	24	3,79	Very Practical
14	24	3,71	Very Practical
15	24	3,67	Very Practical
16	24	3,79	Very Practical



17	24	3,71	Very Practical
18	24	3,71	Very Practical
19	24	3,79	Very Practical
20	24	3,71	Very Practical
21	24	3,79	Very Practical
22	24	3,67	Very Practical
23	24	3,79	Very Practical
24	24	3,71	Very Practical
25	24	3,67	Very Practical
26	24	3,79	Very Practical
27	24	3,79	Very Practical
28	24	3,71	Very Practical
29	24	3,67	Very Practical
30	24	3,79	Very Practical
31	24	3,71	Very Practical
32	24	3,71	Very Practical
33	24	3,79	Very Practical
34	24	3,71	Very Practical
35	24	3,79	Very Practical
Overall Average		3,74	Very Practical

Based on the recapitulation of the assessment of the limited trial results by the 35 respondents in Table 6, the overall average assessment results obtained an average value of 3.74. The results of these calculations are then converted into qualitative data by following the assessment categorization guidelines, it can be seen that based on the assessment of users of the Occupational Safety and Health book in the Civil Engineering Laboratory and Job Safety Analysis, it is declared very practical to use.

A learning impact analysis was conducted to determine the effectiveness of products validated by experts in a learning process in the Civil Engineering Laboratory. As stated earlier, the impact test of this product was carried out on as many as 30 students who practiced in the Civil Engineering laboratory. The subjects of this study were given a pre-test before participating in learning activities with the developed media and took a post-test after completing the practice in



each session held. In this learning impact test, the effectiveness measurement was carried out by determining the significance of the difference between the average test scores of the control group (pre-test) and (post-test) and the experimental group (pre-test) and (post-test) in each session using the t-test. The criterion used was that the post-test and pre-test values were significantly different if the resulting t-test value had an error probability (p) < 5%. The results of the suitability test of the Occupational Safety and Health book in the Civil Engineering Laboratory and Job Safety Analysis are as follows:

Normality test data analysis was performed using the SPSS version 13 computer application program. The results of the normality test data analysis can be seen in the Appendix and the summary is presented in Table 7 as follows

Table 7. Kolmogorov-Smirnov Test
One-Sample Kolmogorov-Smirnov Test

		Pre Test Experiment	Post Test Experiment	Pre Test Control	Post Test Control
N		35	35	35	35
Normal Parameters(a,b)	Mean	63,42	83,21	61,02	64,34
	Std. Deviation	4,340	5,781	4,320	3,714
Most Extreme Differences	Absolute	,212	,196	,101	,150
	Positive	,212	,133	,101	,150
	Negative	-,123	-,196	-,100	-,124
Kolmogorov-Smirnov Z		1,256	1,162	,599	,887
Asymp. Sig. (2-tailed)		,085	,134	,866	,411

a Test distribution is Normal.

b Calculated from data.

Based on the normality test results in Table 7, the significance values (Sig. 2-tailed) of the Experiment Pre-Test was $0.085 > 0.05$. In the experimental post-test, the Sig. 2-tailed value of $0.134 > 0.05$. In the control re-test, Sig. 2-tailed value of $0.866 > 0.05$. Meanwhile, the experimental post-test obtained an Sig. 2-tailed value of $0.411 > 0.05$. Based on the results of the normality test,



all cells have a value greater than the significance value of 0.05, so it can be concluded that the data distribution fulfills the assumption of normality.

The analysis of homogeneity test data was carried out using the SPSS version 13 computer application program. The results of the homogeneity test data analysis can be seen in the Appendix and the summary is presented in Table 8 as follows

Table 8. Homogeneity Test of the Use of Occupational Safety and Health Books in the Civil Engineering Laboratory and Job Safety Analysis by Students

Levene Statistic	df1	df2	Sig.
0.716	7	25	0.659

Based on the homogeneity test results in Table 8, the significance values (Sig. 2-tailed) is $0.659 > 0.05$. From the results of the homogeneity test, it is known that the significance value is greater than 0.05; therefore, it can be concluded that the variance of the treatment scores is the same or homogeneous. The results of the normality test showed that the pre-test and post-test data of the experimental and control classes were normally distributed. The homogeneity test showed that the experimental and control class post-test score data had a homogeneous variance. We proceed with using the t-test, which aims to prove whether there are differences in the use of Civil Engineering laboratories by using Occupational Safety and Health books in Civil Engineering Laboratories and Job Safety Analysis with those that do not use Occupational Safety and Health books in Civil Engineering Laboratories and Job Safety Analysis.

Table 9. Results of the Average Score Test of the Experimental Group and the Control Group

Class	Post Test	Lowest Score	Highest Score
Experiment	78,3851	57,15	90,91
Control	42,3609	8,35	73,35

Based on the results of the average test above, it can be seen that the average average score of the experimental class is 78.3851 with the highest score of 90.91 and the lowest score of 57.15. Meanwhile, in the control class, the average score was 42.3609 with the highest score of 73.35 and the lowest score of 8.35.



The evaluation stage was carried out during the research and development process, starting from the analysis stage until the product trial was carried out. The evaluation stage was also carried out after the data from the test results and assessments by experts and users were collected. The data were then processed for comparison with the standard criteria. Effectiveness testing was performed using a paired sample t-test. This test was conducted to compare the average of two classes that were not related to one another (two free samples).

The results of the paired sample t-test analysis are presented in the Appendix, and a summary is shown in Table 10.

Table 10. Result of Paired Sample T Test
Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Post Test Experiment	83,21	35	5,781	,977
	Post Test Control	64,34	35	3,714	,628

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Post Test Experiment & Post Test Control	35	,212	,223

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Post Test Experiment - Post Test Control	18,877	6,175	1,044	16,756	20,999	18,085	34	,000



Based on the results of the paired-sample t-test, the Sig. (2-tailed) of 0.000 was lower than the probability of 0.05. Based on this test, there is a difference in the test results between experimental class 2 and control class 2. Because of the significant difference, the K3 and Job Safety Analysis guidelines can be said to be effective in using the laboratory carefully and thoroughly compared to learning in the laboratory so far, which does not have a guide.

The results of the product trial were used as feedback to revise and evaluate the final product. Furthermore, the dissemination process uses The Solomon Fourth Group Design experimental design with the aim of determining the effectiveness of the use of guidelines and Job Safety Analysis so that it is ready to be adopted by the community and users. Based on the results of the trials that have been carried out, significant differences were obtained so that the K3 and Job Safety Analysis guidelines in the Civil Engineering Laboratory can be said to be effective in increasing knowledge of Occupational Safety and Health in the Civil Engineering laboratory compared to those used previously.

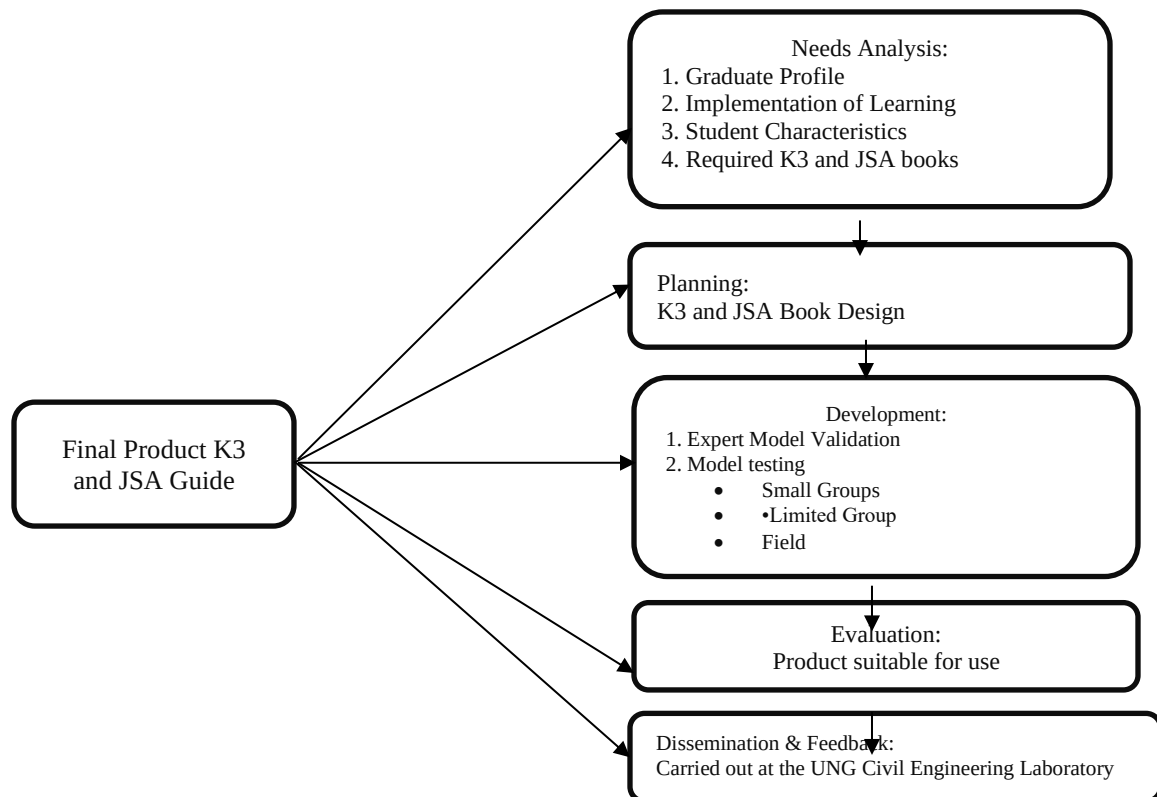


Figure 4. Final Product Review

CONCLUSION

Based on the results of the research and development that have been carried out, the following conclusions are obtained: Analysis of the needs obtained in the development of K3 and Job Safety Analysis books in the form of needs analysis, analysis of student characteristics, and course analysis. The design of K3 and Job Safety Analysis books includes product design (storyboard) containing sketches of Civil Engineering K3 and Job Safety Analysis book images in sequence to facilitate the flow of making K3 and Job Safety Analysis guides in Civil Engineering laboratories. The product design stage that produces a prototype consists of K3 and Job Safety Analysis book products in the Civil Engineering Laboratory. The product development stage of K3 and Job Safety Analysis guide start from manufacturing and are then validated by experts. Based on material expert testing, the overall average value is 3.72, where the product development is considered by experts to be valid and feasible to implement. The implementation stage of K3 and Job Safety Analysis guide products by testing the applicability of the media to lecturers and students in small groups and large group trials. The assessment of the practitioner lecturers, in this case the lecturer teaching the refrigeration engineering course, obtained an overall average value of 3.70; thus, it was included in the practical criteria and could be applied in learning in civil engineering laboratories. Based on the results of the paired sample t test, it is known that the Sig. (2-tailed) of 0.000 is smaller than the probability of 0.05.

Based on this test, it is stated that there is a difference in test results between experimental class 2 and control class 2. To determine the effectiveness of the learning media, we used the average value of each group tested, consisting of the control group and the experimental group. The average test results obtained the average score of the experimental class was 78.38 with the highest score of 90.91 and the lowest score of 57.15. Meanwhile, the control class obtained an average score of 42.36 with the highest score of 73.35 and the lowest score of 8.35. Thus, it can be seen that the average acquisition of the experimental class with learning using K3 and Job Safety Analysis guidelines is included in the interpretation of effectiveness, namely, effective. In addition to assessing feasibility, the students were asked to provide suggestions and criticisms. In general, the suggestions and criticisms given are very positive towards the Occupational Safety and Health book in the Civil Engineering Laboratory and Job Safety Analysis, as it is good and interesting, because there are clear pictures and materials that are easy to understand about the importance of occupational safety and health in the Civil Engineering Laboratory.



REFERENCES

- Albrechtsen, E., Solberg, I., & Svensli, E. (2019). The application and benefits of job safety analysis. *Safety Science*, 113, 425–437. <https://doi.org/10.1016/j.ssci.2018.12.007>
- Ali, N. F., & Zulkaple, R. (2023). Occupational Safety and Health (OSH) Knowledge, Practices and Injury Patterns among Solvent Manufacturing Workers: A Cross-sectional Study. *Malaysian Journal of Medicine and Health Sciences*, 19(s14), 47–55. <https://doi.org/10.47836/mjmhs.19.s14.6>
- Ayii, S. M., Multazam, M., & Syam, N. (2023). Application of Job Safety Analysis with Work Accidents in the Refinery Section. *Jurnal Ilmiah Kesehatan Sandi Husada*, 12(2), 383–390. <https://doi.org/10.35816/jiskh.v12i2.1099>
- Ayob, A., Ibrahim, A. M., Mokhtar, H., Syamsyiah, N. R., Din, A. Z. M., Zahid, M. Z. A. M., Rahim, M. A., & Zakaria, M. H. (2021). Evaluation of occupational safety and health at construction site in state of Perlis. *IOP Conference Series: Earth and Environmental Science*, 682(1), 012005. <https://doi.org/10.1088/1755-1315/682/1/012005>
- Baghdadi, A. (2024). Navigating occupational safety and health challenges in sustainable infrastructure projects: a comprehensive review. *Frontiers in Built Environment*, 10. <https://doi.org/10.3389/fbuil.2024.1414366>
- Barbeau, E., Roelofs, C., Youngstrom, R., Sorensen, G., Stoddard, A., & LaMontagne, A. D. (2004). Assessment of occupational safety and health programs in small businesses. *American Journal of Industrial Medicine*, 45(4), 371–379. <https://doi.org/10.1002/ajim.10336>
- Chenchewa, O., Sukach, S., Rieznik, D., Petrenko, I., Lashko, Ye., & Hladiuk, O. (2024). MODERN CONCEPT OF OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT WITH A RISK-BASED APPROACH. *Municipal Economy of Cities*, 4(185), 221–227. <https://doi.org/10.33042/2522-1809-2024-4-185-221-227>
- Endroyo, B., Yuwono, B. E., Mardapi, D., & Soenarto. (2015). Model of Learning/Training of Occupational Safety & Health (OSH) Based on Industry in the Construction Industry. *Procedia Engineering*, 125, 83–88. <https://doi.org/10.1016/j.proeng.2015.11.013>
- Feriyanto, D., Abdulmalik, S. S., & Zakaria, S. (2020). Occupational Safety and Health (OSH) Practices and Its Influenced Factor - Review OSH in Malaysia. *International Journal of Advanced Technology in Mechanical, Mechatronics and Materials*, 1(3), 108–117. <https://doi.org/10.37869/ijatec.v1i3.36>
- Ghasemi, F., Doosti-Irani, A., & Aghaei, H. (2023). Applications, Shortcomings, and New Advances



- of Job Safety Analysis (JSA): Findings from a Systematic Review. *Safety and Health at Work*, 14(2), 153–162. <https://doi.org/10.1016/j.shaw.2023.03.006>
- Himam, M. T., & Widodo, E. (2024). Work Accidents Analysis in Lathe Workshop - JSA with FMEA Approach. *Procedia of Engineering and Life Science*, 7, 62–69. <https://doi.org/10.21070/pels.v7i0.1584>
- Leung, M. K. H., Ng, A. W. Y., & Chan, A. H. S. (2009). Occupational safety and health management for the recycling industry. 2009 16th International Conference on Industrial Engineering and Engineering Management, 1027–1030. <https://doi.org/10.1109/ICIEEM.2009.5344444>
- Niskanen, T., & Lehtelä, J. (2015). Finnish discourses of the stakeholders on development of the implementation of EU legislation concerned with occupational safety and health in computer work. *International Journal of Occupational Safety and Ergonomics*, 21(4), 413–425. <https://doi.org/10.1080/10803548.2015.1086194>
- Pertiwi, I. G. A. I. M., Aryawan, I. G. M. O., Kristinayanti, W. S., Andayani, K. W., Putri Indrayanti, A. A., & Sudiarta, K. (2021). Risk management of Material Laboratory, Department of Civil Engineering, Bali State Polytechnic for preparation of Occupational safety and health program. *IOP Conference Series: Earth and Environmental Science*, 626(1), 012027. <https://doi.org/10.1088/1755-1315/626/1/012027>
- Pratiwi, I., & Ivanovic, Y. (2022a). Analysis of the Effect of Occupational Safety and Health (OSH) Culture on Implementing OSH Awareness: A Case Study. *Jurnal Teknik Industri*, 23(1), 17–30. <https://doi.org/10.22219/JTIUMM.Vol23.No1.17-30>
- Pratiwi, I., & Ivanovic, Y. (2022b). Analysis of the Effect of Occupational Safety and Health (OSH) Culture on Implementing OSH Awareness: A Case Study. *Jurnal Teknik Industri*, 23(1), 17–30. <https://doi.org/10.22219/JTIUMM.Vol23.No1.17-30>
- Pribadi, A. P., Rahman, Y. M. R., & Silalahi, C. D. A. B. (2024). Analysis of the effectiveness and user experience of employing virtual reality to enhance the efficacy of occupational safety and health learning for electrical workers and graduate students. *Heliyon*, 10(15), e34918. <https://doi.org/10.1016/j.heliyon.2024.e34918>
- Rahman, N. H. A., & Mohd Kamil, N. L. (2022). Strengthening Occupational Safety and Health Policy in Malaysia: Exploring the Awareness of Civil Servants. *Public Policy and Administration*, 21(1), 38–54. <https://doi.org/10.5755/j01.ppaa.21.1.28201>
- Rozenfeld, O., Sacks, R., Rosenfeld, Y., & Baum, H. (2010). Construction Job Safety Analysis. *Safety Science*, 48(4), 491–498. <https://doi.org/10.1016/j.ssci.2009.12.017>



- Satrio, E. M., & Wibowo, K. (2023). PENERAPAN JOB SAFETY ANALYSIS (JSA) DALAM MENGANALISA KESELAMATAN DAN KESEHATAN KERJA (K3) PADA PROYEK PEMBANGUNAN. *Jurnal Teknik Sipil Dan Arsitektur*, 28(2), 89–94. <https://doi.org/10.36728/jtsa.v28i2.2533>
- Schmitt, J. M., Wilson, D. E., & Raber, J. M. (2017). Occupational Safety and Health. In *Management of Animal Care and Use Programs in Research, Education, and Testing* (pp. 279–318). CRC Press. <https://doi.org/10.1201/9781315152189-14>
- Sklad, A. (2019). Assessing the impact of processes on the Occupational Safety and Health Management System's effectiveness using the fuzzy cognitive maps approach. *Safety Science*, 117, 71–80. <https://doi.org/10.1016/j.ssci.2019.03.021>
- Zhang, Y., Mao, P., Li, H., Xu, Y., You, D., Liu, H., Huang, W., & Yuan, J. (2020). Assessing the Safety Risks of Civil Engineering Laboratories Based on Lab Criticality Index: A Case Study in Jiangsu Province. *International Journal of Environmental Research and Public Health*, 17(17), 6244. <https://doi.org/10.3390/ijerph17176244>
- Zheng, W., Shuai, J., & Shan, K. (2017). The energy source based job safety analysis and application in the project. *Safety Science*, 93, 9–15. <https://doi.org/10.1016/j.ssci.2016.11.009>

