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THE EFFECTIVENESS OF SAFE WORK PERMIT SYSTEM TRAINING IN IMPROVING WORKPLACE SAFETY UNDERSTANDING: PRE-POST TEST INTERVENTION STUDY

Martarinza[1*], Djunaidi Z[1], Susilowati IH[1], Ajizar I[2]

[1]*Faculty of Public Health, University of Indonesia*

[2]*OHS Practitioner*

Abstract: Applying the Safe Work Permit System (SIKA) training is one approach to reduce the number of accidents. Before implementation, SIKA training is crucial as it lays the groundwork for field implementation, followed by a supervision process, weekly audits, and monthly reviews. The SIKA training material provided consists of six material modules, namely SIKA basics, organization-role-responsibility, risk assessment, permit-to-work, audit, and energy isolation. This study adopts an intervention method by providing training designed to evaluate the effectiveness of training in improving participants' understanding of work safety. It aims to evaluate the effectiveness of SIKA training in improving workers' understanding of safety. We used a quantitative approach to conduct a statistical analysis of the collected data, which involved a total of 187 participants divided into 8 training batches. This study employed the paired T-test as its statistical test. The paired sample test's significance value of 0.001, smaller than alpha, leads to the rejection of H0 and the acceptance of H1. Safe Work Permit System Training has a significant impact on improving understanding of work safety. The number of participants who were above the passing grade when the pre-test was only 42 participants (22.46%) increased dramatically to 144 participants (77.01%). SIKA training shows its effectiveness in improving understanding of work safety through a significant increase in results between pre-test and post-test results. However, we need to implement individual monitoring and evaluation after training to close the understanding gap.

Keywords: effectiveness, work permit system, training, accidents, safety understanding

Introduction

The number of accidents in Indonesia shows a trend that tends to increase every year based on Jamsostek and BPJS data from 2010 – 2022 as reported by Ministry of Indonesia Man Power (Profil K3 Nasional, 2022 and Arifuddin, R. et al, 2020). Similarly, the upstream oil and gas mining sector in Indonesia experienced an increase in work accidents from 2010 to 2023, according to data from ESDM (Energy & Mineral Source) 2016 and SKK Migas / Special Task Force Oil and Gas 2023 (Figure 1).

*Corresponding Author's Email: martarinza@gmail.com

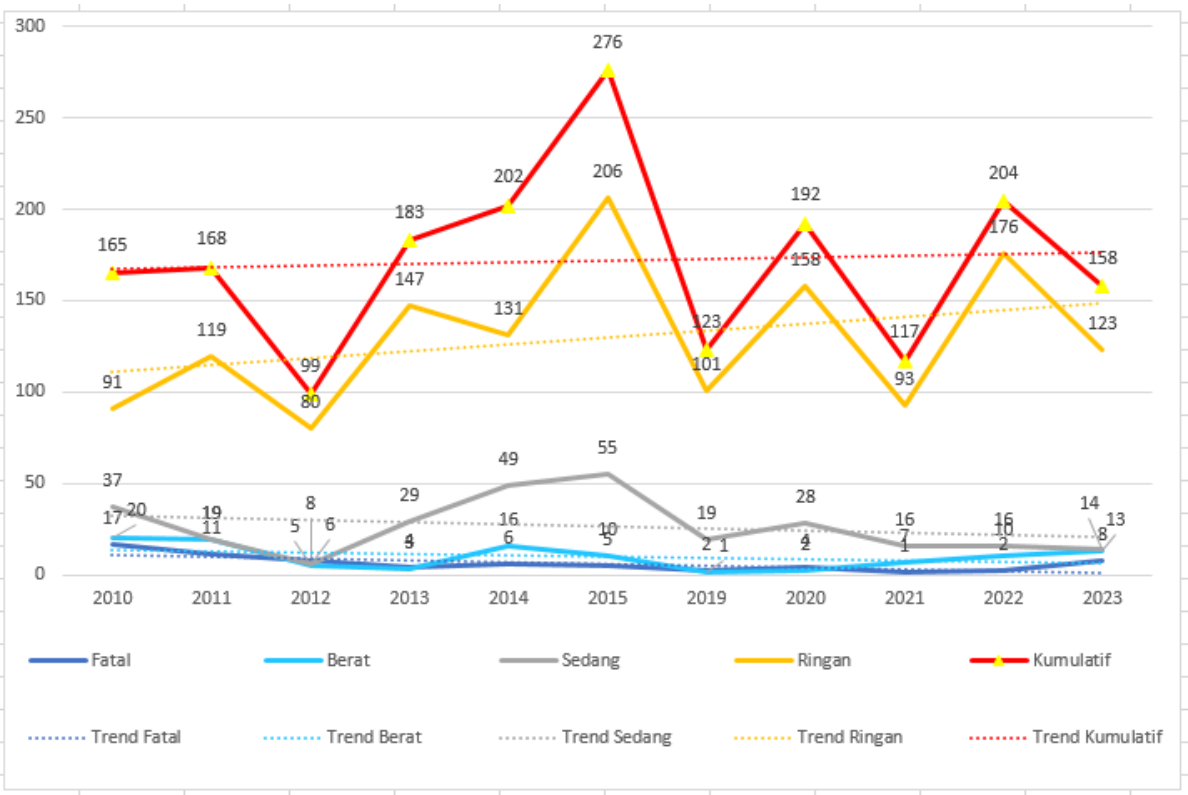

Figure 2. Accident Data in Upstream oil and gas in Indonesia (SKK Migas 2023)

Although numerous safety measures and regulations are in place, the increasing number of workplace accidents in the upstream oil and gas sector underscores ongoing difficulties in enforcing effective safety management systems. While many studies have examined the root cause of major incident, such as piper alpha disaster, research on the role of structured training programs like the SIKA in improving safety awareness and minimizing risk within Indonesia's upstream oil and gas industry remains limited.

The Piper Alpha disaster, one of the largest in the oil and gas industry always used as a good sample, with losses reaching $20 billion and 164 employees losing their lives, occurred due to various factors stemming from the leading cause. These factors included the inappropriate application of the safe work permit system. These decisions led to a series of accidents, explosions, and subsequent fires that destroyed the Piper Alpha platform (Reid, 2020). According to Jusoh et al. (2020), a permit to work (PTW) is also a significant finding in every accident in the petrochemical industry.

The importance of SIKA training become one of the most important aspect to prevent future disaster in oil and gas sector, especially in Indonesia. Given that PTW significantly contributes to accidents, The Safe Work Permit System (SIKA) training program can be applied to enhance workers' safety capabilities. The SIKA training program emerged as a structured and measurable approach to building individual capacity to respond to and manage safety risks in the workplace. The main focus is on providing an in-depth understanding of safety procedures, creating practical skills for identifying hazards, and increasing workers' awareness of potential risks they may face.

SIKA is based on five fundamental principles. Risk Management, 2) Competence, 3) Personal protective equipment, 4). Emergency Response Plan, and 5). Stop and report. Next, the SIKA training scheme implemented in the following 12 (twelve) SIKA elements: Written Implementation Procedures and Strategies, 2. Roles, Responsibilities, and Accountabilities (3). Training and Competencies, 4). (Planning & Scheduling, 5). (Risk Assessment, 6). (7 Work Permits). (Written Communication, 8). Monitoring of Work in Progress, 9). Leaving Work in a Safe Condition (10). Stopping Unsafe Work, 11). Internal and External Learning, and 12). Periodic inspections, audits, and reviews However, this study will measure the participant's level of understanding through six module categories according to Safe Work Permit System (SIKA) Guidelines No. A8-012/PT X-04000/2022-S9 of PT.X in 2022.

SIKA training plays an important role in improving safety understanding and preventing workplace accidents. This training educates workers and managers on the appropriate procedures and protocols to minimize health and safety risks (Yoon et al., 2011). In SIKA training, workers learn about the importance of obtaining work permits and the various hazards associated with specific tasks or jobs (Bahn & Barratt-Pugh, 2012).

SIKA training has benefit in helping individuals recognize potential risks and hazards in their work environment and enabling them to take the necessary precautions to mitigate those risks. With structured planning, SIKA training can also improve work efficiency and productivity. In addition, SIKA training also helps to create a safety culture within the organization. Heightened awareness of safety are anticipated among workers, motivating them to actively contribute to the maintenance of a safe working environment. Finally, SIKA training will improve communication and collaboration between workers, supervisors, and managers. This will boost the effectiveness of overall safety management and ensure that everyone is on the same page when it comes to mitigating risks and preventing accidents. Safe Work Permit System training is an effective strategy for improving understanding of occupational safety and preventing accidents (Bada & Adegboyega, 2015).

Work permit training has been shown providing the knowledge and skills required to identify and evaluate potential hazards through SIKA. Wei et al. (2019) found that the work permit training for primary health care providers in rural China can have a significant positive impact on improving the knowledge, skills, and safety performance.

Since 2019, PT X has implemented SIKA training for its workers with the expectation of reducing accidents. However, in reality, this is not entirely the case, because in the last few years, accident data at PT X has shown that accidents still occur frequently. Data from PT X's accident investigation report indicates that workers' unsafe behaviour is a significant contributing factor to accidents. Some unsafe behaviours include failure to identify hazards, failure to warn of hazards, and a lack of worker competence.

The implementation of SIKA heavily relies on SIKA training, as it lays the groundwork for field implementation, subsequently guiding the supervision process, weekly audits, and monthly reviews. Not all participants fully comprehend the training material. This raises the question, "How effective is the SIKA training in increasing the understanding of safety among workers?" and "Is there still a need for follow-up after the training?". These questions are important because the implementation of SIKA requires a fundamental understanding in order to maximally prevent accidents. These questions will

reveal any gaps in workers' SIKA knowledge, highlighting areas that require improvement. This research aims to evaluate the effectiveness of SIKA training in enhancing workers' understanding of safety. The results this training evaluation hopefully will contribute to the enhancement of the SIKA training program at PT X.

Research Methods

The research was conducted using statistical analysis of the data collected from the training participants using a quantitative approach. From the beginning to the end of the session, 187 respondents participated in SIKA training. The evaluation of training over a one-year period, from January 2023 to December 2023, divided into 8 (eight) training batches. The training participants were divided into batches due to the number of workers required to attend the training was quite large while the maximum number of participants for each training was limited to a maximum of 30 people. This research focuses on employees and contractors at PT X because they are individuals who are directly involved in work that involves high safety risks.

Teachers within the company, hold special SIKA training certifications and facilitated by guidance, provide training. Additionally, the instructor must have a Train of Trainer (ToT) certificate. The author is one of the permanent lecturers in all batches of this training, accompanied by several other lecturers taking turns as support.

The data collection method employs pre-test and post-test question instruments, comprising up to 40 questions, via Google Form to gauge participants' comprehension of work safety prior to and following their three-day training on the Safe Work Permit System (SIKA). The post-test was designed based on the presented training material to assess changes in participants' understanding levels following SIKA training. The collected data will be analyzed using descriptive analysis and a paired T-test. According to Nuryadi et al. (2017), the paired sample t-test formula is as follows:

$$\mathbf{Md\ t = \sum x\ d\ /\ N(N\text{-}1)}$$

Description:

- Md = mean of the difference between test 1 and test 2
- xd = deviation of each subject
- $\sum$x d = sum of squared deviations
- N = subjects in the sample
- N-1 = degrees of freedom

Quantitative descriptive analysis and paired T-test were conducted on the overall score, each level, each batch, and each module. By comparing the pre-test and post-test results, this study aims to measure the effectiveness of SIKA training in improving participants' understanding of work safety. Thus, the

study's findings can provide specific insights relevant to improving work safety policies in various industries.

Results:

The study provided several concepts about SIKA to a total of 187 trainees. The training consisted of six modules, each containing the basics of SIKA, such as organization duties and responsibilities, risk assessment, work permits, audits, and energy insulation.

Table 1 presents the demographics of SIKA participants, processed by researchers in 2024.

Category	Category Type	Total	Percentage
Level	PA	106	56.68%
	AA	74	39.57%
	SC	7	3.74%
Age	21-30	41	22.04%
	31-40	57	30.65%
	41-50	57	30.65%
	51-60	31	16.67%
Gender	Men	180	96.26%
	Women	7	3.74%
Employee Status	Contractor	175	93.58%
	Internal PT. X	12	6.42%

The highest age range of trainees is 31–50, with as many as 114 people (61.3%). The wide age range (23–57 years) creates diversity in views and experiences that can contribute to richer discussions through knowledge exchange during the training and a thorough understanding of work safety. Male participants dominated the gender, accounting for 180 individuals (96.26%), while contractor employees made up 175 individuals (93.58%).

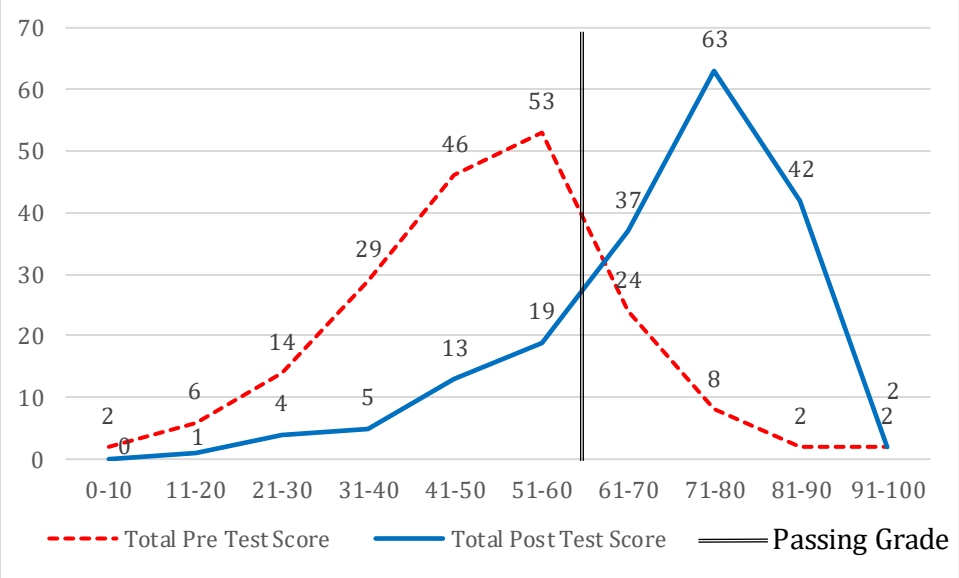

Figure 2. Distribution of pre-test and post-test scores of all participants (Processed by Researchers, 2024)

The majority of participants' pre-test scores were in the 51–60 range, as many as 53 people, as shown in Figure 2. However, in the pre-test, there were only 42 participants (22.46%) who had scores above the passing grade (60%). After the SIKA training, there was a significant increase in the participants' scores, where the highest score range was in the 71–80 range for as many as 63 participants. The number of participants who had scores above the passing grade in the post-test increased by 108 people (57.75%) compared to 144 participants (77.01%).

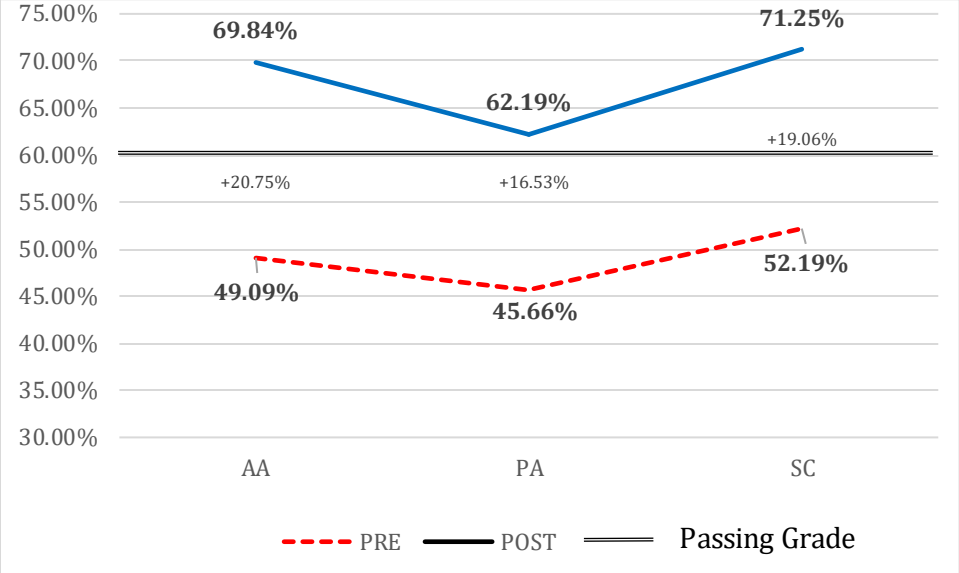

Figure 3. Pre-test and post-test scores for each participant level (Researcher Processed, 2024)

The average pre-test score at all levels is below the passing grade, with the highest value at the SC level of 52.19% (Figure 3). After training, the post-test scores of all levels experienced a significant increase above the passing grade, with the highest value remaining at the SC level, namely 71.25%, but the highest increase occurred at the AA level, where the pre-test to post-test scores increased by 20.75%.

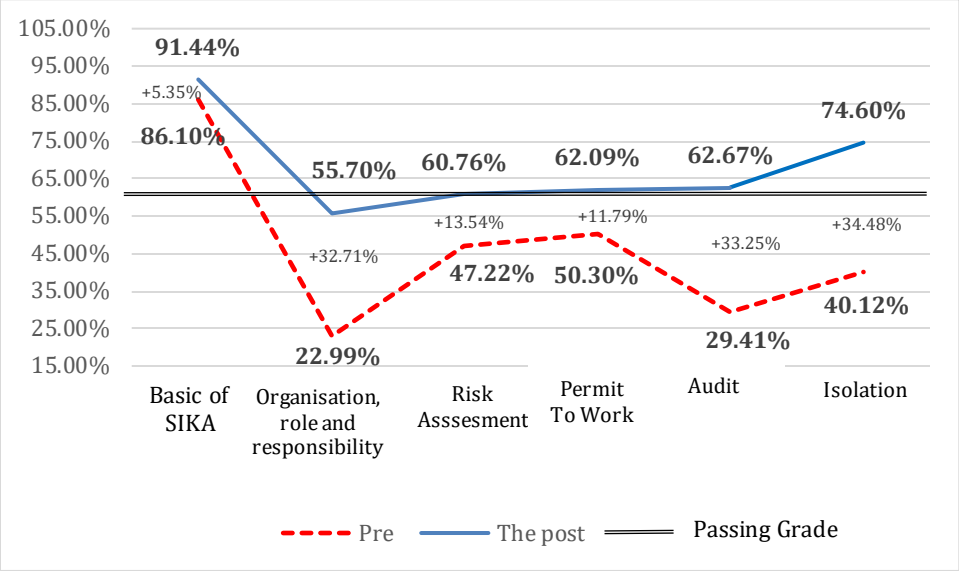

Figure 4. The average value of each module, as processed by the researcher in 2024.

The majority of participants fell below the passing grade in the entire pre-test. The role and responsibility organization module has the lowest average value, at 22.99% (Figure 4). After the SIKA training, the average value of each module increased overall, with the highest average value being in the basic module of SIKA by 91.44%. However, in the post-test score, there is still an average score below the passing grade, namely the role and responsibility organization module of 55.7%.

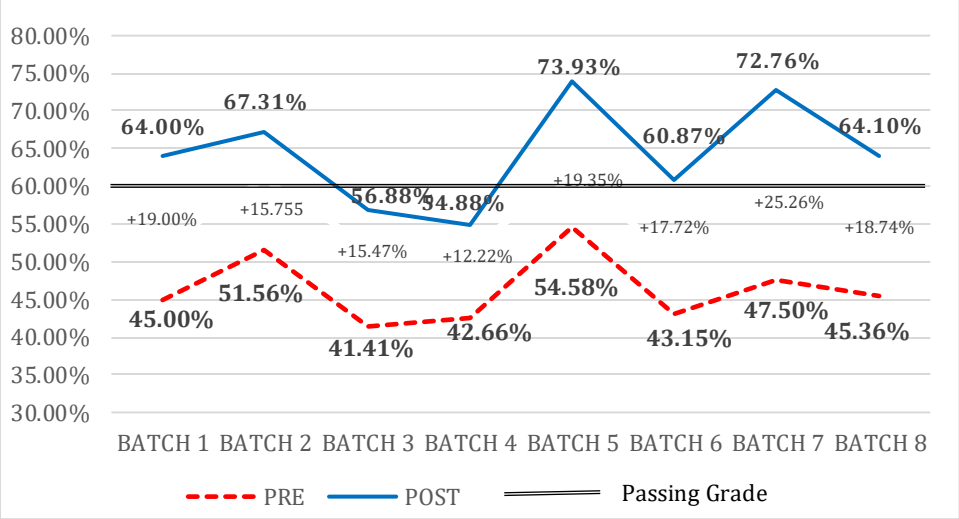

Figure 5. Comparison of SIKA training values in each batch

Furthermore, SIKA training values was compared in each batch as shown in Figure 5. In batch 5, the highest score on the pre-test only reached 54.58%. However, after the SIKA training, six out of eight batches experienced an increase that exceeded the passing grade value, with batch 5 having the highest average value at 73.93%. Batch 4 had the lowest average post-test score (54.88%) and the lowest increase in understanding (12.22%).

Table 1.2 Paired Sampled Statistics (Processed by Researchers, 2024)

Pair	Pre-Post	Mean	t	P Value
1	All	19.30	-16.700	<0.001
2	AA	19.60	-13.007	<0.001
3	PA	19.12	-11.141	<0.001
4	SC	18.80	-3.273	0.017
5	Module 1	0.05	-1.903	0.059
6	Module 2	0.32	-12.134	<0.001
7	Module 3	0.13	-13.673	<0.00
8	Module 4	0.11	-8.536	<0.00
9	Module 5	0.38	-3.232	0.003
10	Module 6	0.28	-7.987	<0.001
11	Batch 1	19.00	-6.498	<0.001
12	Batch 2	15.75	-6.450	<0.001
13	Batch 3	15.46	-6.827	<0.001
14	Batch 4	12.21	-4.175	<.001
15	Batch 5	19.35	-10.923	<0.001
16	Batch 6	17.71	-7.744	<0.001
17	Batch 7	25.25	-11.282	<0.001
18	Batch 8	18.73	-7.144	<0.001

The results of descriptive statistical analysis on 187 participants who attended the Safe Work Permit System (SIKA) training provided a positive picture of the participants' level of safety understanding. After the training, their understanding increased significantly. Following the training, the overall level of understanding increased by 19.3%. The paired t-test conducted as a whole or in various categories such as sika level, module, and batch with a confidence level of 0.05 shows that overall, there is a significant difference in pre-test scores before training and after training (post-test) with a P-value of 0.00. However, there is one category from all categories that has a P-value of 0.059, which indicates that there is no significant increase in understanding of the basic SIKA module.

Discussion

Two main approaches, monitoring and evaluation, demonstrate the effectiveness of Safe Work Permit System (SIKA) training. Monitoring and evaluation play an important role in ensuring the overall success of the SIKA implementation and assessing the progress of individual trainees. Although PT X recognizes the importance of monitoring and evaluation, the training manual does not explicitly describe these measures. In response to this need, the ILO in 2021 emphasized the importance of monitoring and evaluation as the last stage of the training program. PT X generally conducts inspections, weekly audits, monthly reviews, and annual audits to monitor and evaluate the implementation of SIKA. However, PT X does not explicitly monitor and evaluate the progress of individual trainees. This is a crucial point to consider for enhancing the quality of SIKA training in the future. The absence of individual evaluation and monitoring of participants' lack of understanding will impact the application of SIKA in the field, which may deviate due to a lack of understanding, a personal factor that can lead to unsafe conditions, as stated by Bird & Germain, (1985) in the Loss Caution Model Theory.

Identifying the factors that cause these differences can help in designing a more appropriate approach for each category. The analysis results show differences in understanding improvement between participant levels, such as Site Controller (SC) and Perform Authority (AA). Although improvement in understanding occurred at all levels, some may have experienced more significant improvement than others. Differences in the level of education at each level motivate this. Shubchan and Rossa (2021) mentioned that educational background affects individual learning outcomes.

The SIKA training modules consist of six sections, each highlighting a key aspect of workplace safety. Analysis of the pre-test and post-test results for each module revealed that there was a significant increase in participants' understanding after the training. However, there were variations in understanding improvement between modules. For example, the SIKA basics module did not experience a significant increase because the understanding of the basics of SIKA was already relatively high at 86.1%, while the role and responsibility organization module required significant attention because the level of understanding was still below the passing grade (60%). Terok et al. (2020) research reveals that a deficiency in safety knowledge can escalate the likelihood of work accidents, necessitating increased effort to enhance comprehension in more challenging modules to mitigate this potential risk. One effective method is the use of interactive questions from the instructor during training. This method allows the instructor to gauge participant understanding and identify areas that require additional support, ensuring each participant achieves adequate understanding.

Statistical test will be conducted to measure the significance of the difference between the pre-test and post-test results, in addition to analysing the improvement in understanding by module, batch, and level. The statistical test results show that there is a significant increase in participants' understanding after attending the SIKA training. The p-value <0.05 indicates that the difference between the pre-test and post-test results is statistically significant. This confirms that the SIKA training has been effective in improving participants' understanding of work safety.

However, despite a significant increase in the pre-test and post-test scores in the SIKA fundamentals module, the P value was greater than 0.05, indicating no significant difference. However, the pre-test results for this module demonstrated a high level of understanding among the participants. The results showed that although there was a significant improvement in the overall understanding of the participants after attending the SIKA training, there were still 2 out of 8 batches that still needed to reach the passing grade in the post-test. This suggests that while the training has successfully improved overall understanding, there are still challenges in ensuring that all participants gain adequate understanding. This difference in understanding improvement could be due to the different learning styles applied by the different accompanying lecturers in each batch, even though each batch has a permanent lecturer (the author). Lubis (2017) explains that different teaching styles can affect the level of understanding. Additionally, there are situations where both training batches take place during the month of fasting. Fernanda et al. (2023) explain that the fasting month's conditions, which cause a lack of nutrients or fluids, can cause fatigue, decreased concentration, or decreased motivation.

To address this, it is important to identify participants who have not yet achieved this passing grade and provide additional attention and appropriate support. Providing additional training can enhance students' comprehension of the studied material, particularly if it is complex or demands specialized skills (Ananto et al., 2023).

Variable factors may have prevented some participants from passing. One of the factors that may have contributed to some participants failing to achieve a passing grade is difficulty in understanding specific material. Learning theories such as Kolb's learning model Fuad (2015) or the VARK theory of learning styles can provide insight into how individuals absorb and process information (Widharyanto, 2017). The limited time for training can also be a significant factor (Toto, 2021), as participants may have varying capacities to absorb information due to their diverse demographic backgrounds. Furthermore, it is crucial to consider the varying learning needs of individuals. Approaches such as using a variety of teaching methods and adapting training materials according to individual learning needs can help overcome these challenges (Nasution et al., 2023).

Concrete steps can be taken to provide additional support to participants who still need to achieve the passing grade. One can make efforts such as repetition of material, additional question and answer sessions, or individual guidance (Kholilah, 2022). Individual learning styles and specific learning needs can guide the design of a participant – centre approach. Furthermore, concepts such as positive reinforcement and learning techniques that build on existing understanding can improve learning effectiveness (Krisnawardhani & Noviekayati, 2021).

These findings suggest the importance of continuous reflection and improvement in the design and delivery of future SIKA training. To ensure that all participants can reach the desired level of understanding, training materials evaluation, teaching methods adjustment, or increasing support for participants with special needs will be added. With a holistic and adaptive approach, SIKA training can become more effective in raising awareness and skills related to workplace safety.

Each teacher who provides SIKA training material has the potential to make mistakes in delivering the entire course. Good teaching will affect the understanding of the material (Sukmana et al., 2019). Teacher evaluations shall be conducted to enhance the effectiveness of training, taking into account that level supervisors are just some of the ones who require an understanding of SIKA. All workers must receive SIKA training. Accident records indicate that workers at the non-supervisor level account for the majority of accident victims. According to the company's SIKA training guidelines, this study faces limitations because it does not carry out further evaluation of the level of understanding, such as applying a second post-test after a time interval from the first one. This is important because understanding safety, especially SIKA needs to be measured not only when the training is completed but when participants implement it in every job done in the field.

Conclusion

Overall, the results of the Safe Work Permit System (SIKA) training analysis demonstrated its effectiveness in improving participants' understanding of work safety, with a significant improvement between the pre-test and post-test results. However, there were still variations in the level of understanding among participants, highlighting the need for continuous adjustment and improvement in the training design and delivery. The statistical test results also confirmed the significance of the improvement in understanding; however, the presence of participants who did not achieve a passing grade in the post-test emphasizes the importance of a more granular approach to individual progress. Given these findings, additional measures will be added in the implementation to enhance the

effectiveness of future SIKA training, thereby making it a more efficient tool for enhancing occupational safety and personnel well-being in the workplace.

To bridge the understanding gap, we need to enhance the quality of SIKA training through practical exercises and additional training. Individual monitoring and evaluation efforts must be carried out regularly (for example, annually) for each trainee to ensure optimal understanding and proper management. Lack of understanding can lead to inadequate risk assessment implementation and potential accidents. Longitudinal studies or comparisons with other methods will be added the value of training impact. Evaluation of long-term knowledge retention or behavioural changes post-training also need to be considered for the next program.

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