

Development of apd compliance observation instrument based on risk matrix for smk smaw welding practices

¹⁾Rahmad putra Ardyansyah, ²⁾Saifuddin Karim, ³⁾Marsono, ⁴⁾Rezaqi

^{1,2,3,4)} Mechanical Engineering Education, State University of Malang, Indonesia

*Correspondence Author: saifuddin.karim.ft@um.ac.id

Article Info

Keywords:

Personal protective Equipment;
Observation Instruments; Risk Matrix, SMAW

ABSTRACT

Occupational Safety and Health (K3) is an important aspect in learning SMAW welding practices because it has a high risk of work accidents. Based on the results of initial observations in the Machine Workshop of SMKN 1 Tuban, it was found that many students still did not use complete Personal Protective Equipment (PPE) during practice. This study aims to develop a valid and effective risk matrix-based PPE compliance observation instrument to reduce K3 violations in SMAW welding practices. The research method used Research and Development (R&D) with the ADDIE model which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. The research subjects were 37 students of class X Mechanical Engineering. The research instruments were a checklist for PPE use, work condition observation sheets, and a risk matrix. The validation results by three experts obtained an average score of 4.65 with a very valid category, while a CVR value of 1.00 indicated that all instrument indicators met the content validity criteria. The implementation results showed that the number of PPE use violations decreased from 81 to 37 violations. The average PPE use compliance score increased from 1.857 to 3.914. The *Wilcoxon Signed Rank Test* results showed a significance value of $p < 0,001$ and the N-Gain analysis obtained a value of 0.6127 with a moderate category. Thus, the risk matrix-based PPE compliance observation instrument is effective for improving OHS culture in SMAW welding practices.

Informasi Artikel

Kata Kunci:

Alat Pelindung Diri;
Instrumen Observasi; K3; Risk Matrix; SMAW

ABSTRAK

Keselamatan dan Kesehatan Kerja (K3) merupakan aspek penting dalam pembelajaran praktik pengelasan SMAW karena memiliki risiko kecelakaan kerja yang tinggi. Berdasarkan hasil observasi awal di Bengkel Mesin SMKN 1 Tuban ditemukan masih banyak siswa yang belum menggunakan Alat Pelindung Diri (APD) secara lengkap saat praktik. Penelitian ini bertujuan untuk mengembangkan instrumen observasi kepatuhan APD berbasis risk matrix yang valid dan efektif untuk menurunkan pelanggaran K3 pada praktik las SMAW. Metode penelitian menggunakan Research and Development (R&D) dengan model ADDIE yang meliputi tahap Analysis, Design, Development, Implementation, dan Evaluation. Subjek penelitian adalah siswa kelas X Teknik Mesin sebanyak 37 siswa Instrumen penelitian berupa checklist penggunaan APD, lembar observasi kondisi kerja, dan *risk matrix*. Hasil validasi oleh tiga ahli memperoleh rata-rata skor 4,65 dengan kategori sangat valid, sedangkan nilai CVR sebesar 1,00 menunjukkan seluruh indikator instrumen memenuhi kriteria validitas isi. Hasil implementasi menunjukkan jumlah pelanggaran penggunaan APD menurun dari 81 menjadi 37 pelanggaran. Rata-rata skor kepatuhan penggunaan APD meningkat dari 1,827 menjadi 3,914. Hasil uji *Wilcoxon Signed Rank Test* menunjukkan nilai signifikansi sebesar $p < 0,001$ dan analisis N-Gain memperoleh nilai 0,6127 dengan kategori sedang. Dengan demikian instrumen observasi kepatuhan APD berbasis risk matrix efektif digunakan untuk meningkatkan budaya K3 pada praktik las SMAW

Article History

Received : 15/08/2026

Revised : 10/09/2026

Accepted : 21/10/2026

✉ **Corresponding Author:** (1) Rahmad putra Ardyansyah, (2) Department of Mechanical Engineering Education, (3) Institution of State University of Malang, (4) Malang, Indonesia, (5) Email: saifuddin.karim.ft@um.ac.id

1. Introduction

Occupational safety and health is an important aspect of vocational education because students are not only required to master their skills, but also to understand and apply work safety procedures according to industry standards[1]. Shielded Metal Arc Welding (SMAW) is one of the practical activities that carries a high risk of work accidents. SMAW welding practice has various high-risk hazards such as exposure to the welding arc light, molten metal sparks, welding fumes, electric shocks, and fire risks that can lead to workplace accidents if not properly managed. [2] The use of Personal Protective Equipment (PPE) is one way to prevent work accidents. However, research shows that the level of compliance in using PPE among vocational high school students is still relatively low[3]. Even though the use of Personal Protective Equipment (PPE) has been made mandatory, research shows that the level of compliance with using PPE among vocational high school students is still relatively low. This low compliance is influenced by the students' lack of awareness about work hazards, low risk management, and the non-optimal safety supervision system in the workshop environment. This situation shows a gap between the established work safety standards and the students' behavior during practical activities. The initial observations made at the SMKN 1 Tuban Machining Workshop show that compliance with PPE usage is still not optimal. Out of 37 students participating in SMAW welding practice, only 23 students wore welding helmets, 4 students wore welding gloves, 1 student used a mask, and 1 student consistently used a leather apron. The total number of PPE violations found reached 81 violations. This data indicates that most students are not using PPE completely, which could increase the risk of accidents during welding practice. This phenomenon can be explained through the Behavior Based Safety (BBS) theory which states that safety behavior is influenced by the process of observation, reinforcement, and feedback on individual work behavior[4]. The more often safe behavior is observed and given positive reinforcement, the more likely it is to become a work habit. Besides that, the Health Belief Model (HBM) explains that a person will be more compliant with preventive actions if they perceive that the risks they face are serious enough and can cause harmful consequences[5]. In the context of welding practice, understanding the risks is expected to help students be more compliant in using PPE. Various previous studies have developed learning media and K3 instruments to increase workplace safety awareness in vocational education environments. Dila Utami's research developed a digital-based PPE checklist application that helps monitor the use of PPE[6]. Other research

shows that hazard identification using a risk management approach can increase students' awareness of potential work accidents. However, most of these studies still focus on improving occupational health and safety knowledge or awareness and have not integrated PPE compliance observation tools with a risk matrix approach that can systematically show the risk level of each violation. One approach that can be used to address this limitation is applying a risk matrix as the basis for assessing the risk level of each PPE violation that occurs during welding practice. A risk matrix is one of the methods in risk management used to determine the level of risk based on the combination of the likelihood of a hazard occurring and the severity of its impact[7]. Likelihood describes the chance of a hazard occurring, while severity shows the level of seriousness of the consequences if that hazard happens. In this study, a 5×5 risk matrix approach is used, combining five levels of likelihood and five levels of severity to produce different risk levels. Through this approach, potential hazards can be categorized into low, medium, high, and very high risk levels, making it easier for users to determine the right control actions. In vocational education, the risk matrix not only serves as a risk identification tool but also as an educational medium that helps students understand the consequences of each workplace safety violation. The use of a Risk Matrix aligns with the principles of risk management explained in ISO 31000, namely risk identification, risk analysis, risk evaluation, and ongoing risk control. Additionally, this approach is also relevant to the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) method, which is widely applied in occupational health and safety systems. Through this approach, potential hazards can be identified early on and managed based on the priority level of the risks, helping to minimize the chances of workplace accidents during welding practice.[8],[9] Based on previous research and initial observations, there are still limitations in studies on the development of observation instruments for PPE compliance that are integrated with a risk matrix in SMAW welding practices at vocational schools. The novelty of this research lies in developing an observation instrument that not only records the level of PPE compliance but also identifies the risk level of each violation through a risk matrix approach. This way, the developed instrument can function both as an evaluation tool and as a safety education medium for students. Based on this explanation, this research aims to develop an observation instrument for compliance with PPE use based on a risk matrix that is valid and effective to support the implementation of Occupational Safety and Health (OSH) in SMAW welding practices at vocational high schools. The results of the study are expected to become an

alternative OSH monitoring tool that is more systematic and contribute to strengthening the safety culture in vocational education.

.2. Method

This study is a research and development (R&D) project aimed at improving students' discipline in using personal protective equipment based on a risk matrix to reduce occupational health and safety (OHS) violations in SMAW welding practice. The development model used is ADDIE, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation[10]. This research was carried out at the mechanical engineering workshop of SMKN 1 Tuban in the even semester of the 2025/2026 academic year. The subjects of the study were 37 students of class X TP 1 who took part in SMAW welding practice. The sampling technique used was a census technique, meaning the entire population was used as the research sample because the population was relatively small and all students of class X Machining Engineering 1 were involved in the practical activities[11]. All students participated in the observation activities from the first to the third stage. However, in the fourth observation, only 34 students were present because three students did not participate in the practical activities at that stage and were therefore not included in data collection for that phase. To maintain consistency in the paired analysis, the data from the three students with incomplete attendance were removed from all stages of analysis, so the final sample analyzed was 34 students.

At the analysis stage, three methods were used to collect initial data: field observation, structured interviews with the practice teachers, and document study. Field observation was carried out directly in the workshop to identify the actual condition of PPE use by students during SMAW welding activities. Interviews were conducted using a semi-structured interview guide to gather information regarding potential hazards, PPE usage habits, and safety implementation challenges from the teachers' perspective. Document study was done to review violation records and available safety documents at the school. The analysis results show that there are still various PPE violations that could increase the risk of workplace accidents in the practice workshop. In addition, it was found that observation instruments based on a risk matrix have not yet been systematically developed for the context of SMAW welding practice at vocational high.

The design phase was carried out by creating observation instruments consisting of: (1) a checklist for PPE usage, (2) a work condition observation sheet,

(3) a 5×5 risk matrix, and (4) a guide for using the instruments. The choice of a 5×5 risk matrix was based on its ability to provide a more detailed risk assessment compared to smaller scales, as well as its suitability for assessing risks in a workshop environment[7][12]. The instruments were designed based on standards for PPE use in SMAW welding practice, which includes welding helmets, gloves, safety shoes, masks, and leather aprons. Additionally, a risk assessment format was prepared that integrates two main dimensions, namely the likelihood of hazards occurring and the severity of the impact[7][12]. At the development stage, the instruments that had been designed were validated by three experts consisting of lecturers from the Mechanical Engineering Education Study Program and a productive teacher in Machining Engineering. Validation was carried out using an assessment sheet with a 1–5 Likert scale to evaluate five aspects: the appropriateness of indicators, clarity of language, ease of use, suitability of the risk matrix, and measurability of indicators. The content validity of the instrument was tested using the Content Validity Ratio (CVR) based on Lawshe's formula. The validation results showed an average score of 4.65, which falls into the very valid category. The CVR calculation resulted in a value of 1.00, meaning all indicators met the content validity criteria and are suitable for use in research [8]. Instrument revisions were made based on qualitative feedback from the validators before the instrument was applied in the implementation stage.

This study used a single main observer, who was the researcher themselves. Therefore, testing for inter-observer reliability, like Cohen's Kappa or the Intraclass Correlation Coefficient (ICC), wasn't done in this study. This is one of the methodological limitations we acknowledge and recommend addressing in future research by involving at least two trained observers.

The implementation stage was carried out by applying observation instruments during SMAW welding practice activities over four observation sessions. The observations were conducted directly by the observer, focusing on each student's use of PPE during the practice. Before the observation, the observer studied the instrument usage guide to ensure consistent data recording. The PPE compliance indicators observed included the use of welding helmets, welding gloves, safety shoes, masks, and leather aprons. Each indicator was scored 1 if the student used the PPE according to the rules, and 0 if they did not. Each student's compliance score was obtained from the total number of indicators met, ranging from 0–5. The higher the score, the higher the student's level of PPE compliance.

In addition to observing compliance with PPE use, this study also uses a 5×5 risk matrix to identify the risk level of each violation found during practice. The risk level is determined based on the result of multiplying the likelihood and severity values. The resulting score is then categorized into low, medium, high, and very high risk levels, which can be used as a basis for determining risk control priorities.

The evaluation stage is carried out to assess the feasibility and effectiveness of the developed instrument. Evaluation is done based on expert validation results, the level of compliance in using PPE, the number of PPE violations, and students' responses to the use of the risk matrix-based observation instrument. The evaluation results are used as a basis to understand the effectiveness of the instrument in supporting the implementation of Occupational Health and Safety (OHS) in SMAW welding practice. The evaluation stage is conducted to assess the quality and effectiveness of the instrument that has been developed. Formative evaluation is done based on feedback from validators during the instrument development stage. Meanwhile, summative evaluation is conducted after the instrument is implemented by analyzing observation data using paired sample t-tests and N-Gain to find out changes in the level of PPE compliance after the instrument is applied.

The research data was collected through observation, interviews, and documentation. Observation was used to gather data on compliance with PPE usage and the number of PPE violations during practice. Interviews were conducted to find out students' responses to the implementation of the risk matrix-based observation instrument, while documentation was used to support the data from observations and the research implementation process.

Data analysis was done using both quantitative and qualitative descriptive methods. The quantitative analysis included calculating content validity using the Content Validity Ratio (CVR), descriptive statistics like mean and standard deviation, paired sample t-tests to see differences in compliance levels before and after the instrument implementation, and N-Gain analysis to find out the level of improvement in PPE usage. Meanwhile, interview data were analyzed qualitatively to support the quantitative findings obtained during the study[13][14][15].

A paired sample t-test analysis was conducted if the data were normally distributed for 34 students who had complete observation data from the first to the fourth observation. Two students were not included in the analysis because they were absent for the last observation and therefore did not meet the requirements for paired data[16]. This study used a single main observer, which was the researcher, so

inter-rater reliability testing was not conducted and is considered one of the study's limitations that could be addressed in future research

3. Results and Discussion

This study produced an observation instrument for Personal Protective Equipment (PPE) compliance based on a risk matrix, developed to support the implementation of Occupational Health and Safety (OHS) in Shielded Metal Arc Welding (SMAW) practices. The developed instrument includes a PPE usage checklist, an observation sheet, a 5x5 risk matrix, and observation implementation guidelines. Before being used, the instrument went through a validation process by three experts, consisting of a Mechanical Engineering Education lecturer and productive Machining Engineering teachers. The validation results showed an average score of 4.65 in the very valid category, while the Content Validity Ratio (CVR) of 1.00 indicated that all indicators have excellent content validity and are suitable for use in research. Implementasi instrumen dilakukan pada kegiatan praktik pengelasan SMAW selama empat kali observasi. Observasi pertama hingga ketiga diikuti oleh 37 siswa, sedangkan observasi keempat diikuti oleh 34 siswa karena tiga siswa tidak hadir pada saat kegiatan praktik. Perbedaan jumlah peserta tersebut menjadi salah satu pertimbangan dalam interpretasi hasil penelitian.

Table 1. Recap of PPE Usage Compliance

Jenis APD	Obser vasi 1 (n=3 4)	Observasi 2 (n=34)	Observas i 3 (n=34)	Obser vasi 4 (n=3 4)
Helm Las	21	24	26	31
Sarung	4	1	23	33
Tangan				
Sepatu	34	34	34	34
Safety				
Masker	2	1	1	30
Apron Kulit	1	0	1	5

The data in Table 1 shows that the use of PPE increased across almost all indicators. The use of welding helmets went up from 21 students in the first observation to 31 students in the fourth observation. The use of welding gloves saw a significant increase from 4 students in the first observation to 33 students in the fourth observation. There was also an increase in the use of masks, which went from just 2 students in the first stage to 30 students in the fourth stage. Meanwhile, the use of leather aprons is still considered low, even though it increased compared to the initial condition, from 1 student in the first observation to 5. The insignificant change in the use of leather aprons could also be influenced by a floor effect, which is a condition where most respondents initially didn't use leather aprons due to insufficient numbers, making the observable room for improvement very limited. As a result, the changes that occurred during the observation period weren't big enough to produce a statistically significant difference. The use of safety shoes, on the other hand, showed a very good level of compliance since all the students present wore them during every observation.

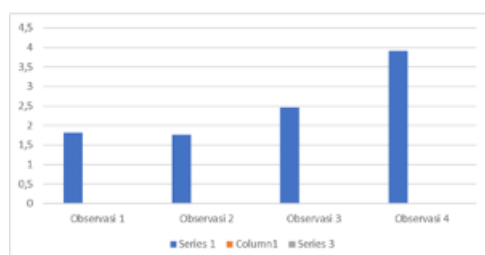
To give an overview of compliance trends, the average scores of PPE users in each observation are shown in Table 2.

Table 2. Descriptive Statistics of PPE Usage Compliance Scores

Observasi	Jumlah Siswa	Rata-rata Skor
1	34	1,82
2	34	1,76
3	34	2,50
4	34	3,91

The results in Table 2 show that the average compliance score slightly decreased from 1.82 in the first observation to 1.76 in the second observation. However, in the third and fourth observations, there was a fairly significant increase, reaching an average of 3.91. This indicates that the implementation of the observation instrument based on the risk matrix has the potential to support an increase in students' compliance with the use of PPE after the implementation process is carried out repeatedly.

Figure 1. Graph of the average development of compliance



scores for PPE usage

Based on Figure 1, the average compliance score for using PPE shows a tendency to increase during the implementation of the risk matrix-based instrument. Although there was a slight drop in the second observation, the increase started to appear in the third observation and reached its highest value in the fourth observation. This condition indicates that repeating observations along with providing risk levels through the risk matrix has the potential to raise students' awareness of using PPE according to safety procedures.

Table 3. Number of PPE usage violations

Observasi	Jumlah Pelanggaran
1	81
2	83
3	57
4	37

The data in Table 3 shows that the number of PPE violations decreased quite significantly. In the first observation, 81 violations were found, and it increased slightly to 83 violations in the second observation. However, in the second observation stage, students began to understand the use of the risk matrix, and the number of violations dropped to 57, and in the fourth observation stage it dropped drastically to 37 violations.

The decrease in the number of violations indicates that students are increasingly understanding the importance of using PPE as a risk control measure. The risk matrix used in the study helped students recognize the level of danger in each welding activity, which encouraged them to adopt safer work behaviors.

Before conducting the hypothesis test, a normality test was first carried out to find out whether the differences in scores for the use of personal protective equipment (PPE) between the initial observation and the final observation were normally distributed or not. The normality test was done using Shapiro-Wilk because the number of research samples was less than 50 respondents ($n = 34$).

The normality test using Shapiro-Wilk showed a significance value of 0.006 ($p < 0.05$). This indicates that the data on the difference in PPE usage scores is not normally distributed. Therefore, the analysis of the difference before and after the intervention was done using the Wilcoxon Signed Rank Test.

Table 4. Normality Test

Variabel	Shapiro-Wilk Sig.
Selisih (Obs4-Obs1)	0,006

The effectiveness of the instrument was tested using the paired t-test, Wilcoxon Signed Rank Test, and N-Gain. The analysis results showed that there was a significant difference in the level of PPE compliance before and after the implementation of the instrument.

Table 5. Descriptive Statistics Before and After Implementation

Kelompok	N	Mean
Observasi Awal	34	1,827
Observasi Akhir	34	3,914

The analysis in Table 5 used 34 students who had data for both the initial and final observations. This number was adjusted according to the research conditions because three students did not participate in the fourth observation. Next, a Wilcoxon Signed Rank Test was conducted to compare compliance scores before and after the instrument was implemented.

Based on the results of the Wilcoxon Signed Rank Test, a Z value of -5.045 was obtained with a significance value of $p < 0.001$. Since the significance value is less than 0.05 ($p < 0.05$), there is a significant difference between the PPE usage scores in the first and fourth observations. This result shows that PPE usage increased after the intervention was given.

Table 6. N-gain Results

Mean Awal	Mean Akhir	Skor Maksimum	N-Gain	Kategori
1,827	3,914	5	0,6127	Sedang

The N-Gain value is 0.6127. Based on the N-Gain interpretation categories, this value falls into the medium category ($0.30 \leq g < 0.70$). This result shows that the intervention given was able to increase students' use of PPE with effectiveness in the medium category.

4. Conclusion

The conclusion of this study successfully developed an observation instrument for Personal Protective Equipment (PPE) compliance based on a risk matrix that can be used in SMAW welding practice at the Mechanical Engineering Workshop of SMKN 1 Tuban. The developed instrument consists of a PPE usage checklist and a risk matrix that serves to identify the level of hazard risk during practice activities. The implementation results show that the developed instrument is effective in increasing students' compliance with PPE use and reducing the number of Occupational Health and Safety (OHS) violations.

The improvement in compliance with PPE use is shown by the increase in the average compliance score from 1.81 in the initial observation to 3.91 in the final observation. In addition, the number of PPE violations decreased from 81 violations to 37 violations after implementing the instrument. Based on the study results, the Wilcoxon Signed Rank Test showed a significance value of $p < 0.001$, indicating that there is a significant difference in PPE use between the initial and final observations. These results show that the intervention provided was able to increase PPE use among students during practice activities. Moreover, the N-Gain analysis results showed an average value of 0.6127, which falls into the medium category. This indicates that the intervention provided has a moderate effectiveness in increasing students' PPE use.

The findings of this study show that integrating a PPE checklist with a risk matrix can be an effective preventive supervision strategy for building a workplace safety culture in vocational education. The instrument not only serves as an evaluation tool but also as an educational medium that helps students understand the level of risk of each work activity. Therefore, an observation instrument based on a risk matrix has the potential to be one of the options for strengthening OHS implementation in practical learning at vocational schools.

Daftar Pustaka

- [1] K. I. Ismara *et al.*, "The Implementation of Occupational Health and Safety Using Zerosicks in Indonesia Vocational Education," *Elinvo (Electronics, Informatics, Vocat. Educ.*, vol. 9, no. 1, pp. 76–89, 2024, doi: 10.21831/elinvo.v9i1.60586.
- [2] P. Pongky, A. Andry, and K. Rusba, "IDENTIFIKASI BAHAYA DAN PENGENDALIAN RISIKO PEKERJAAN PENGELASAN SMAW (SHIELDED METAL ARC

- WELDING) PADA PEMBUATAN PAGAR DI CV. XYZ," *IDENTIFIKASI*, vol. 12, no. 1, pp. 403–410, Feb. 2026, doi: 10.36277/identifikasi.v12i1.1300.
- [3] E. N. Fadila, Andriyani, and T. Srisantyorini, "Analisis Pengaruh Penggunaan Alat Pelindung Diri (APD) Terhadap Tingkat Kecelakaan Kerja dalam Perspektif Keselamatan dan Kesehatan Kerja (K3)," *Galen J. Ris. Ilmu Farm. dan Kesehat.*, vol. 1, no. 2, pp. 12–31, May 2025, doi: 10.71417/galen.v1i2.10.
- [4] J. Spigener, G. Lyon, and T. McSween, "Behavior-based safety 2022: today's evidence," *J. Organ. Behav. Manage.*, vol. 42, no. 4, pp. 336–359, 2022, doi: 10.1080/01608061.2022.2048943.
- [5] N. Daniati *et al.*, "The Health Belief Model's Application in the Development of Health Behaviors," *Heal. Educ. Heal. Promot.*, vol. 9, no. 5 Special Issue, pp. 521–527, 2021.
- [6] L. F. A. Doeangge, P. Noviadi, S. A. Adzra, and G. K. Putri, "Pengembangan Aplikasi Keselamatan dan Kesehatan Kerja CAPEDE (Checklist Alat Pelindung Diri) Berbasis Android pada Pekerja Di Industri Karet Kota Palembang," *J. Sanitasi Lingkung.*, vol. 4, no. 2, pp. 42–47, 2024, doi: 10.36086/jsl.v4i2.2599.
- [7] jihan faradillah, "Industrial Engineering Journal MENGGUNAKAN METODE LIKELIHOOD DAN Industrial Engineering Journal – System," vol. 02, no. 2, pp. 54–66, 2024.
- [8] H. Ponda and N. F. Fatma, "Risiko Keselamatan Dan Kesehatan Kerja (K3)," pp. 62–74.
- [9] M. F. Pratama, E. Ismiyah, and A. W. Rizqi, "Analisis Risiko (K3) Metode Hazard Identification Risk Assesment And Risk Control (HIRARC) di Departemen Laboratorium PT. ABC," *J. Ilm. Giga*, vol. 25, no. 2, p. 88, 2022, doi: 10.47313/jig.v25i2.1922.
- [10] I. Kalimantan Muhammad Arsyad Al Banjari Jalan Adyaksa No, "Sirajuddin and Alfah-Implementation of The Addie Model (Analysis, Design, Development, Implementation, Evaluation) in PHP-Based E-Learning in The Era of Pandemic 49," p. 7, 2020.
- [11] P. D. SUGIYONO, *METODE PENELITIAN KUANTITATIF KUALITATIF dan R&D*. BANDUNG: ALFABETA, 2019.
- [12] K. Cao *et al.*, "J-TETA : Jurnal Teknik Terapan," vol. 4, no. 2, pp. 103–111, 2025.
- [13] F. R. Wilson, W. Pan, and D. A. Schumsky, "Recalculation of the Critical Values for Lawshe's Content Validity Ratio," *Meas. Eval. Couns. Dev.*, vol. 45, no. 3, pp. 197–210, Jul. 2012, doi: 10.1177/0748175612440286.
- [14] T. A. H. Kandora *et al.*, "Pengenalan Keselamatan dan Kesehatan Kerja (K3) bagi Siswa SMK Negeri 5 Pinrang: Evaluasi program edukasi berbasis simulasi," *Room Civ. Soc. Dev.*, vol. 4, no. 4, pp. 647–658, 2025, doi: 10.59110/rcsd.677.
- [15] T. Zhafira, N. Fithriani, F. Cholida, I. D. Handayani, and W. A. Prawesthi, "Peningkatan K3 dan Produktivitas Pekerja Konstruksi pada Proyek Rumah Kos," vol. 5, no. 1, pp. 88–96, 2026, doi: 10.55123/abdikan.v5i1.7158.
- [16] Novita Sari Maria, Siti Khafifah F, Afta Geosasmita Saragih, Aini Wardana, Prihatin Ningsih Sagala, and Ruth Sahanaya Manik, "Analisis Penerapan Rme Berbantuan Geogebra Untuk Meningkatkan Hasil Belajar Siswa Dengan Uji Paired Sample T-Test," *PESHUM J. Pendidikan, Sos. dan Hum.*, vol. 4, no. 3, pp. 4648–4653, 2025, doi: 10.56799/peshum.v4i3.8636.