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Feasibility of Intelligent Electrical Installation Trainer to Support Industry 4.0 Competency for Students of SMK PGRI 3 Malang

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Abstract

The electricity industry is undergoing a transformation from conventional systems to intelligent, digitally connected, and efficient electrical networks, driven by rapid technological advancements in the Industry 4.0 era. As a result, professionals in this sector must acquire skills in emerging technologies such as automation, artificial intelligence (AI), and the Internet of Things (IoT). To address this evolving need, the Electric Power Generation study program at Vocational High School (SMK) PGRI 3 Malang has adopted a Project-Based Learning (PjBL) approach. This study investigates the feasibility and effectiveness of an Intelligent Electrical Installation trainer as a learning tool in supporting student competencies aligned with Industry 4.0 requirements. Initial observations indicated that students exhibited low interest and difficulty in understanding modern electrical systems. The implementation of PjBL is expected to increase student engagement and improve their technical capabilities in designing and implementing IoT- and automation-based electrical systems. The study employs a research and development (R&D) methodology using a branch-based ADDIE model (Analyze, Design, Develop, Implement, and Evaluate). Validation results show a high level of feasibility, with media and content experts rating it at 91.5% and student feedback at 88%. This research contributes to the field of vocational education by developing and validating an innovative, technology-driven instructional model tailored to Industry 4.0 demands. It offers practical insights into enhancing teaching strategies through project-based learning, thereby better preparing vocational students for the high-tech workforce.

Keywords: Project-Based Learning, Intelligent Electrical Installations, Students Competency

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INTRODUCTION

The energy sector is one of many industries that have been significantly impacted by the quick advancement of technology in the Industry 4.0 era (Ghobakhloo, 2020; Ghobakhloo & Fathi, 2021). A smart electricity system that is more efficient, adaptable, and digitally connected is beginning to replace the traditional electricity installation system, which previously only concentrated on

distribution networks and the use of traditional devices (Kwiotkowska et al., 2021). To manage, monitor, and maintain the electrical system, this transition not only depends on more energy-efficient electricity sources but also incorporates cutting-edge technologies like automation, artificial intelligence (AI), and the Internet of Things (IoT) (Ahmad et al., 2022). To compete in the increasingly sophisticated industrial era, workers in the electricity sector must possess more sophisticated skills, such as programming, data analysis, and management of digital technology-based systems, in addition to understanding the fundamentals of electrical installations (Taha et al, 2023; Zbaravska et al, 2020).

Vocational High Schools (SMK), which are in charge of generating competent and employable workers, must be able to adjust to these developments by modifying their curricula and teaching strategies to meet the most recent demands of the business world (Qin, 2024; Yoto et al., 2024). SMK PGRI 3 Malang is one of the schools attempting to revolutionize its educational system, particularly in the Electric Power Plant (PB) Study program. To meet this issue, new practice-based and applicable teaching strategies must be created so that students not only comprehend the theory but also acquire practical skills that they can use right away in the workplace. Project-Based Learning (PjBL), which emphasizes project-based learning to refine students' technical and critical thinking skills, is one teaching strategy that has shown promise in vocational education (Belu et al., 2021; Gunarathna et al., 2024).

Through project-based learning, students can actively participate in the design, development, and implementation of a system that addresses actual issues that the industry faces (Derkach et al., 2023). This method enables students to comprehend some crucial elements when learning intelligent electrical installations, including data analysis to increase energy efficiency (Samad & Setyabudhi, 2023), automation device programming (Kovalchuk et al., 2022), and IoT-based electrical system design (Kayohana et al., 2023). Students who use PjBL in their education not only acquire a stronger academic understanding but also acquire problem-solving, practical skills, and teamwork—all of which are essential for overcoming the demands of the digital age workplace (Suarti & Alfandi, 2024). To better educate students to contribute professionally in a fast-paced, high-tech workplace, this strategy also teaches them to think creatively while solving challenges in the energy business (Prasetya et al., 2024).

According to the findings of observations made by researchers at SMK PGRI 3 Malang, students majoring in power generation are still not very interested in learning about electrical power installations. According to (Astuti et al., 2021), students seem less engaged in practice, quickly lose interest, participate less in technical discussions, and struggle to comprehend fundamental ideas about contemporary electrical systems. Many students become inactive and less motivated to follow the content during the learning process because they do not comprehend the principles of automation and digitalization-based electrical power installations, which are part of the needs of Industry 4.0 competencies (Handoko et al., 2023). Only a tiny percentage of students meet industry-recognized proficiency levels, and the majority of students still struggle to apply the principles they have learned to real-world situations, as evidenced by the learning evaluation results (Jalinus, 2021). One of the contributing elements, according to researchers, is that

the learning methodologies being employed do not entirely align with the needs of pupils in the digital age. Instructors have not made the most of technology-based teaching tools and resources that are pertinent to the power industry's current state of development. Researchers contend that the use of more creative teaching strategies is required to address this issue. With its emphasis on authentic project-based learning, Project-Based Learning (PjBL) can be a useful tool for improving student engagement and developing their electrical power installation knowledge. Students will be increasingly involved in finishing projects using this method, which will meet the requirements of Industry 4.0 skills. These projects will range from system design to the use of Internet of Things (IoT)-based technologies and electrical automation. Using PjBL (Prastyaningrum dkk., 2024; Raschke dkk., 2023).

Numerous studies have looked at how well Project-Based Learning (PjBL) works in vocational high school education by helping students improve their learning outcomes in real-world application contexts (Hamdani & Suherman, 2021; Sudjimat & Permadi, 2021) and develop advanced thinking skills related to technology and innovation (Oschepkov et al., 2022; Purwanto et al., 2023). Additionally, PjBL promotes the development of critical thinking in technical problem solving (Baidowi dkk., 2023), clear and effective technical communication skills (Menggo dkk., 2023), creativity in creating novel solutions to industry challenges (Pérez-Rodríguez dkk., 2022), and collaboration skills in multidisciplinary teams (Ccama-Mamani dkk., 2021). Several research studies have been carried out to produce novel learning media in the context of vocational education, particularly in studying the Electrical installation system to increase the quality of the learning process in the Industry 4.0 age. An effective Electrical Lighting Installation Practice kit that is 80.8% practicable for learning is produced by the Feasibility of Smart Building Training Kits for Learning Media (Sukir et al., 2023). A vocational high school program also examined project-based learning of IoT-based lighting installations to create communities that were able to improve students' skills by 69%, theoretical-practical knowledge by 73%, and collaborative learning by 74% (Bunyamin, 2023). The creation of interactive multimedia blended learning in electrical lighting installations, which raised student skills from 76.67% to 83.85% after learning, is another study that is pertinent to studying electrical installations in vocational high schools (Sigiro, 2021). Students' good competencies can therefore be enhanced by creating a competency-based professional learning plan for electrical installations in vocational high schools (Hinon dkk., 2020).

The application of intelligent electrical installation learning based on projects in vocational high schools is one area where this study differs from earlier research. The competencies acquired were still subpar if earlier research on intelligent electrical installation trainer learning had only looked at lights. The majority of the earlier research mentioned above merely explains the fundamentals of electrical lighting installation, leaving students unprepared to handle the demands of the fourth industrial revolution. This undoubtedly results in a shortage since students can acquire the practical skills required in the contemporary industrial sector in addition to understanding general theory or practice.

The purpose of this study is to assess the viability and efficacy of utilizing the Intelligent Electrical Installation Trainer to assist PGRI 3 Malang Vocational High School students in developing Industry 4.0 competencies through the Electric Power Generation Program's Project-Based Learning paradigm.

METHOD

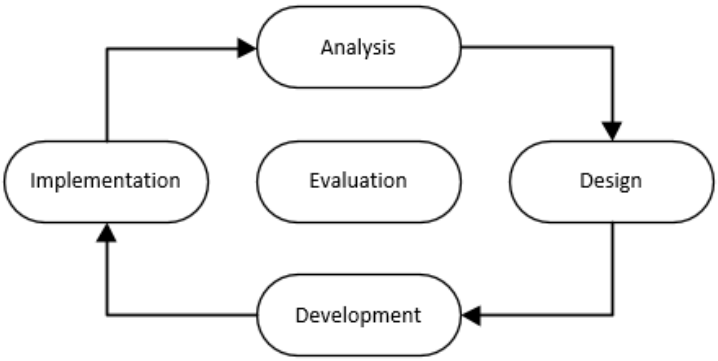
This study was carried out at SMK PGRI 3 Malang, one of the vocational education establishments that specializes in the subject of electricity, which is situated in Lowokwaru District, Malang City, East Java Province, Indonesia. The ADDIE development model (Damarwan et al., 2022; Isa et al., 2023) is a systematic model with five main stages: analyze (analysis), design (design), develop (development), implement (implementation), and evaluate (evaluation). This study employs a research and development method approach that refers to this model.

Researchers carried out field observation exercises and preliminary investigations of current circumstances and learning requirements during the Analyze stage (Taruno et al., 2025). These investigations focused particularly on pertinent and contextual learning materials, in this case, the requirement for an Intelligent Electrical Installation trainer as a practice tool for class X students of the Electric Power Generation Expertise Program. The goal of this observation is to have a thorough understanding of the shortcomings of the current educational materials and the possibilities for creating more creative materials using the Project-Based Learning (PjBL) methodology. Additionally, based on the findings of the needs analysis, the Intelligent Electrical Installation trainer design process was executed at the design stage. This included creating job sheets or student worksheets that would facilitate the trainer's implementation as a hands-on learning tool that is integrated with the curriculum and the demands of the workplace. To give students a gradual and organized understanding of the labor procedures involved in electrical power installation, this job sheet's design is organized methodically and contextually. The previous design's realization process was completed at the Develop stage, which involved producing an Intelligent Electrical Installation trainer and worksheets as hands-on educational resources for the electrical industry. When developing these items, technological, pedagogical, and student requirements factors are taken into account. Following development, a feasibility test process is conducted by experts comprising learning media experts and material experts (content) to evaluate the product's suitability and quality for SMK students' needs and learning standards (García-García et al., 2022). The Intelligent Electrical Installation trainer and the verified task sheets are put to the test during the Implement stage of the Electrical Power Installation practice learning process at SMK PGRI 3 Malang. Determining the degree of efficacy, efficiency, and appeal of the media created for students is the goal, as is gathering empirical feedback on the use and implementation of the media from both teachers and students. The final step, evaluate, is a thorough assessment of every phase, from conception to development to execution. This assessment serves as a foundation for future growth and enhancement of the learning methodology as well as the product design. This study's data gathering procedures included

observation, interviewing, and giving questionnaires to participants who were actively engaged in the learning process (Yanto et al., 2022).

The judgments of specialists (expert judgment) who are skilled in their respective domains are evaluated to determine the validity of the research instrument (Nurrahman et al., 2023; Wafudu et al., 2022). Teachers who already hold professional accreditation in the subject of electricity are chosen as the experts (Taryana dkk., 2023; Yadav dkk., 2022). An observation sheet with three assessment items—Technical Quality, Content and Objectives, and Instructional Content—is used to test the instrument's reliability (Amirrudin dkk., 2021; Izah dkk., 2023). Since class X PBB is an industrial class in the field of strong currents that are in line with the skills (Elayyan, 2021; Gurjanov et al., 2020; Hardhienata et al., 2021). 30 students were chosen as responders to assess the instrument's internal consistency. The study's participants included SMK PGRI 3 Malang class X PBB students, media and material specialists (about curriculum and learning media), and practicum teachers of electrical installation. To objectively characterize and make inferences based on statistical data from the research instrument, quantitative descriptive techniques were employed to analyze data from this research procedure.

Figure 1. The Stages of the ADDIE Model



RESULT AND DISCUSSION

As a first step in creating the Intelligent Electrical Installation Trainer for Electrical Installation Practice exercises at SMK PGRI 3 Malang, a needs analysis was carried out. The goal of this study is to make sure that the learning materials created are contextually appropriate, genuinely relevant, and meet the requirements of the relevant curriculum as well as the needs of the students. Activities involving needs analysis are conducted by gathering data from a variety of sources, including in-person observations in the classroom, interviews with subject matter experts, and examination of the school's curriculum documents. Learning Objectives (TP), Learning Achievements (CP), and other instructional resources, such as teaching modules that serve as the primary source of information for the electrical practice learning process, are the specific subjects of the analysis (Nilamsari, 2023). The most recent curriculum introduced in SMK, the Merdeka Curriculum, which highlights the value of project-based learning and 21st-century skills in enhancing industrial revolution competency, was used to conduct this analysis.

The learning media designer must review the Learning Achievements and Learning Objectives in the independent curriculum to gain a thorough understanding of the fundamental and core competencies that students must possess for the media (Intelligent electrical installation trainer) to be developed in a way that meets the learning objectives (Haryudo dkk., 2021; Mustakim dkk., 2024; Novaliendry dkk., 2020; Salutina dkk., 2024). Additionally, to adapt to the Intelligent Electrical Installation Trainer's design and functionality, the examined teaching modules offer a summary of the content structure, instructional strategies, and evaluations utilized during the learning process (Abdulrahaman et al., 2020; Gallagher & Savage, 2023; Hamilton et al., 2021; Hooda et al., 2022). To serve as a guide for the media design process, learning objectives that are specifically relevant to the subject of smart buildings (Metallidou et al., 2020; Mhlongo et al., 2023; Salsabila & Khairudin, 2021). One of the main topics of contemporary electrical power installation practices has been identified and condensed (Álvarez Macías et al., 2025; Islam & Hasanuzzaman, 2020; Quispe et al., 2025). These goals include proficiency with supporting devices and technologies, design and installation abilities, and a comprehension of the fundamentals of intelligent electrical systems. Table 1 provides an organized overview of all the learning objectives related to intelligent electrical materials.

Table 1. Learning Objectives Related to Intelligent Electrical Installations in Electrical Power Installation Practices

No	Learning Objectives
1	Knowing the parts and design of Intelligent Electrical's electrical installation control systems.
2	Putting into practice the installation process for Intelligent Electrical's electrical installation control systems.
3	Evaluating the installation of electrical control systems (Intelligent Electrical).
4	Implementing components and layout of electrical installation control systems (Intelligent Electrical).
5	Installing an electrical installation control system (Intelligent Electrical).
6	Checking the installation of the electrical installation control system (Intelligent Electrical).

For students to work by the Project-Based Learning (PjBL) learning model, a trainer-designed design has been created as an electrical installation guide for them throughout the design stage. A worksheet design has also been completed. Figure 2 shows the design plan for the trainer kit component for intelligent electrical installation. In an attempt to increase proficiency in the fourth industrial revolution, the students themselves created the intelligent installation trainer device, which will subsequently be put to the test in the next stage. Figure 3 displays the learning exercises for intelligent electrical installation techniques as a means of enhancing proficiency.

Figure 2. Intelligent Electrical Installation Kit Trainer Design

Figure 3. (a) Students Designing an Intelligent Electrical Installation. (b) Testing The Final Installation.

(a) (b)

By monitoring how each component performed and carrying out real-world experiments based on the prepared worksheets, the intelligent electrical installation trainer's performance testing was carried out to assess the design created by the pupils. Component functionality testing was also necessary to determine whether each component in the kit was functional, as shown in Table 2.

Table 2. Performance Test On Intelligent Electrical Installation Training Kit Components

No	Component	Specification	Functionality	
			Yes	No
1	Series 2 switch	Bardi Smart WiFi Touch Wallswitch - EU 2 Gang	√	
2	Series 3 switch	Bardi Smart WiFi Touch Wallswitch - EU 3 Gang	√	
3	Breakers	BARDI Smart BREAKER ON OFF Switch Wifi	√	
4	Electric socket	Bardi Smart Wall Socket EU MF 10A	√	
5	Lamp	Philips LED 4 watts 3pcs	√	
6	Inbow Dos	White color box	√	
7	PVC	3 Meter	√	

The next exam is a hands-on experiment based on the worksheet, which includes installing intelligent electrical installations with (1) series 2 switches and series 3 switches, as well as (2) Bardi Smart Wall Socket electric sockets and Smart WiFi Touch Wall switch capabilities. The electrical installation can function properly in both of its practical tests. The electrical installation system demonstrates this by operating according to its purpose. Furthermore, testing of the materials and media on the trainer was necessary to determine the quality of the trainer kit used. This material and media testing was conducted by two experts, with the test aspects as shown in Table 3.

Table 3. Validation Results of Intelligent Electrical Installation Product Trainer Kit Materials and Media

No	Assessment Aspects	Maximal Scores	Expert Assessment 1	Expert Assessment 2	Mean Score	Percentage (%)	Categories
1	Content quality and purpose	50	46	45	45.5	91%	Very Feasible
2	Instruksional Quality	50	47	45	46	92%	Very Feasible
	Total	100	93	90	91.5	91.5%	Very Feasible

The intelligent electrical installation trainer kit product was validated by curriculum and teachers, two material and media specialists in this case, to ascertain its acceptability as a learning medium based on PjBL Electrical Installation Practice in SMK. According to the two experts' validation results, it was quite possible to use it for educational purposes.

As part of the Electrical Power Installation Practice learning process, Intelligent Electrical Installation was put to the test in class. Thirty students from SMK PGRI 3 Malang's Electrical Power Plant Engineering Expertise Competence Class X took the test. As part of the Electrical Power Installation Practice

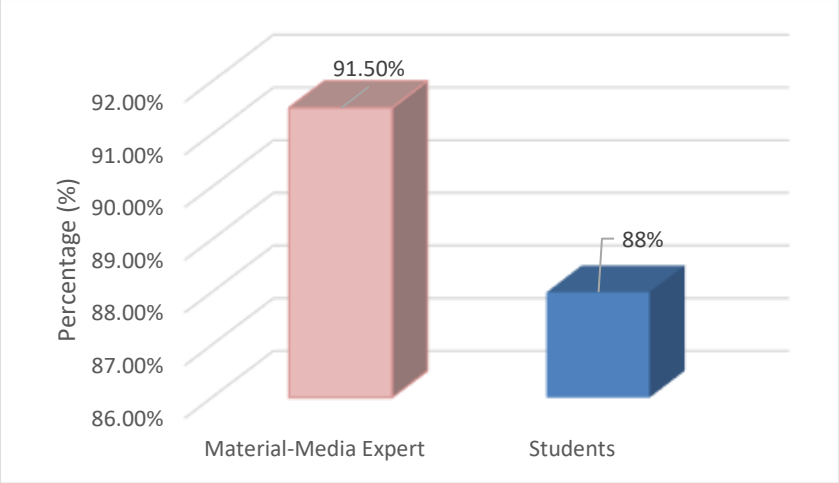
curriculum, students were required to assess and plan smart electrical installations according to the SOP. The results of students' assessments of learning about intelligent electrical installation are displayed in Table 4.

Table 4. Student assessment of the learning developed

No	Assessment Aspects	Maximal Scores	Total Scores	Percentage (%)	Categories
1	Technical Quality	300	265	88%	Feasible
2	Content and Purposes	300	268	89%	Feasible
3	Instructional Content	300	264	88%	Feasible
	Total	900	797	88%	Feasible

Figure 4 displays the findings of student evaluations of intelligent electrical installation learning as well as validation by material-media specialists.

Figure 4. Validation results by material and media experts and student assessments of the Intelligent Electrical Installation PjBL learning that has been developed



An average of 91.5% was found based on the validation results of two experts, each representing the field of learning materials and media, when it came to the viability of using the Project-Based Learning (PjBL) learning model based on the Smart Electrical Installation Trainer. According to this score, the educational materials fall within the "very feasible" range for use in teaching electrical power installation techniques. This evaluation covers several crucial topics, including how well the content aligns with fundamental skills, how clear the learning objectives are, how accurate the content is, how media and methods are integrated, and whether the design is both aesthetically pleasing and functional. According to these findings, the structure and content of the Intelligent Electrical Installation course are thought to be highly suitable for meeting the requirements of the Merdeka Curriculum's basic competencies, particularly those about mastering contemporary electrical installation technology based on intelligent

building systems. Thus, this medium offers a contextual learning strategy that can give students the abilities they need in the workplace, in addition to being relevant in terms of content.

A short study with 30 students from SMK PGRI 3 Malang also had very positive results, in addition to expert confirmation. The Intelligent Electrical Installation Trainer media is highly appropriate for use as a hands-on learning tool, according to 88% of the total students who replied. Multimedia indicates that the usage of multimedia in teaching and learning activities is well-received by pupils. Additionally, students who have utilized the Intelligent Electrical Installation training tool offer helpful criticism and attest to its efficacy. They claimed that because of its appealing appearance and simple-to-understand content, this educational tool can stimulate interest in learning. Furthermore, it is thought that using this medium makes previously abstract ideas easier to understand and makes them more practical and tangible. This improves student' desire for learning, focus during the learning process, and self-assurance in doing electrical installation procedures on their own.

Intelligent Electrical Installation is also thought to be able to better assist instructors' roles as facilitators, as a hands-on learning tool. In addition to imparting knowledge, teachers also assist students in carrying out actual problem-based projects that are created as part of the lesson plan. Teachers may concentrate more on helping students develop their abilities, track their progress, and give more effective one-on-one supervision with the help of this medium. Overall, it can be said that the Intelligent Electrical Installation Trainer is deserving of being utilized and incorporated into the hands-on Electrical Power Installation learning process based on both expert validation and student answers. In addition to enhancing learning from a pedagogical standpoint, this media is pertinent to the needs of technological advancements in the electrical industry today.

DISCUSSION

According to the study "Feasibility of Intelligent Electrical Installation Trainer to Support Industry 4.0 Competency for Students of SMK PGRI 3 Malang," the smart electrical installation trainer that was created was deemed appropriate for use as a teaching tool. According to the findings of validation by media and content specialists and effective educators, the trainer satisfied the requirements for design, functionality, security, and material relevance to industry 4.0 requirements, including the use of Internet of Things (IoT) technology, automated sensors, and control systems. Utilizing this trainer can enhance students' technical proficiency, practical comprehension, and learning interest in the subject of contemporary electrical installation, according to limited student trials. All things considered, this trainer can succeed in bridging the gap between classroom instruction and the needs of the increasingly automated and digital industrial world.

Regarding the incorporation of automated control and Internet of Things (IoT)-based technology into electrical installation learning devices, this study shows notable distinctions from earlier findings. Instead of incorporating digital technologies like smart sensors, remote controls, and microcontroller-based automation, the majority of earlier research (Nilsook & Wannapiroon, 2020; J.

Pereyras, 2020; Rosales, 2022; Zbaravska et al., 2020) solely created analog-based or conventional trainers. For instance, studies by (Sukardjo et al., 2022) did not apply an Industry 4.0-based strategy and instead concentrated on learning fundamental electrical installation procedures. Current industry needs are met by the trainer created in this study, which enables students to learn application-based monitoring, NodeMCU-based control systems, and smart device integration (Lee, 2020; Yahya, 2023; Yudha et al., 2024). ======= In fact, several studies have started digitizing learning materials, including those by (Fadel et al., 2025; Matondang, 2021; Rizkiansyah & Yunus, 2022; Salutina et al., 2024), but they haven't yet offered direct IoT-based skill training. Comparisons with trainers from studies by (Haryudo et al., 2019; Nwineh & Okwelle, 2018; J. G. Pereyras, 2020) also demonstrate the benefits of the intelligent electrical trainers in these studies, since they stress digital skills, problem-solving, and system connectedness in addition to technical expertise. This makes them more appropriate for fostering the alignment and connection between vocational education and the contemporary industrial world that relies heavily on technology (Ismail & Hassan, 2019; Roll & Ifenthaler, 2021; USMAN, 2023; YISA, 2023). Thus, by offering useful electrical installation learning solutions that are responsive to the Industrial Revolution 4.0, these findings close a gap that has not been addressed by numerous prior studies.

In the context of vocational education, this study is extremely important, especially for the Power Plant Engineering expertise program. The study's findings suggest that incorporating automatic control and Internet of Things-based technology into educational materials can make the curriculum more relevant to the demands of contemporary business. It follows that to improve students' technical and digital skills, vocational institutions must begin implementing instructional materials that take into account the advancements of Industry 4.0 technology. To support contextual and adaptive learning, educators must also become more technologically literate and proficient in managing smart device-based learning. These findings give policymakers a solid foundation for promoting the use of cutting-edge learning resources in vocational high schools and fostering industry-education cooperation in the creation of curricula and useful resources. In general, this research helps to speed up the transformation of vocational education to better adapt to the automation and digital technology-based nature of the workplace.

The narrow breadth of implementation and testing techniques is one of the research's shortcomings. First, the trial was not representative of the varied conditions and needs of other vocational schools in terms of facilities, instructor competency, and student characteristics because it was limited to one school and a small number of responders. Second, despite validation by media and subject matter experts, no long-term efficacy studies were carried out to improve overall student learning outcomes and capabilities, including the influence on critical thinking, problem-solving, and preparedness for the workforce. Regarding methodology, a more impartial quantitative examination of the influence of trainer utilization on learning outcomes is constrained by the descriptive-qualitative research technique. Furthermore, software integration and the creation of cloud-based monitoring systems or mobile applications have not received enough attention, and the development focus is still primarily on the device's technical

features (hardware). The trainer's potential as an entirely IoT-based learning tool is thus still underutilized. To overcome the difficulties of fully integrating Industry 4.0 in vocational education, these limits point to the necessity of additional research involving more schools, enlarging success metrics, and creating more thorough supporting software.

Significant prospects for additional development and in-depth research are presented by this study. Evaluating the long-term efficacy of hiring trainers is a crucial step that must be taken, especially in terms of enhancing students' technical (hard) and non-technical (soft) skills, like problem-solving, critical thinking, and teamwork—skills that are crucial in the 21st-century learning environment. To see how flexible and adaptable these trainers are in supporting vocational education learning toward a system that is more adaptive and relevant to the demands of the times, their use may eventually be extended to a variety of other productive subjects in the field of electricity, even across competencies, like industrial automation and control systems.

CONCLUSION

At SMK PGRI 3 Malang, an Intelligent Electrical Installation learning model has been effectively created to serve as a teaching tool for hands-on Electrical Power Installation. An Intelligent Electrical Installation trainer kit, which is specifically made to increase student competency in the field of electricity, particularly in the use of smart building technologies, is used to promote project-based learning. In addition to honing students' technical abilities, this learning gives them the chance to exercise their creativity, critical thinking, and problem-solving abilities by designing and carrying out individual projects. Using a learning strategy that allows for freedom in terms of student creativity and innovation, students can develop a smart electrical installation system based on work procedures that have been established in the form of Standard Operating Procedures (SOPs). It is anticipated that this will be able to support student-centered learning and adjust to the features of 21st-century learning, which prioritize productivity and teamwork.

Two specialists, namely material experts and learning media experts, have validated the Intelligent Electrical Installation trainer kit created in this study. This trainer kit is in the "very feasible" category for use in practical learning, according to the validation results, which yielded a feasibility score of 91.5%. This validation addresses several topics, including the media's relevance to learning objectives, convenience of use, completeness of functionality, clarity of visualization, and curriculum compatibility. Furthermore, the findings of the trainer kit's trial use, which involved 30 grade X students in the Electrical Power Installation Engineering expertise program, revealed that 88% of the students thought the learning materials were "feasible" to utilize. This confirms that the Intelligent Electrical Installation trainer kit is not only technically and theoretically possible, but also acceptable to students and facilitates learning in the field.

However, several limitations to this study should be taken into account for future research. The multimedia component of learning support is one area that needs improvement. It is advised that future development involve making learning multimedia more thorough and interactive to support the efficacy of the

learning process. Interactive animation, system work simulations, instructional movies, and the inclusion of more captivating visual components and backgrounds in the content presentation are examples of the types of multimedia that can be created. In addition to manual practice, this seeks to provide students with digital visualization components that enhance their comprehension of the technical principles being taught. To encourage creative, engaging, and project-based learning that is in line with the advancement of educational technology and the current electrical industry, it is intended that Intelligent Electrical Installation learning will grow more optimally in the future.

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