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Aligning Vocational Curriculum with Industry Needs: A Case Study of Electrical Power Installation Engineering Education

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ABSTRACT

This study examined the implementation and industry alignment of the Electrical Power Installation Engineering curriculum and its translation into competencies. Vocational education must respond to technological change, workplace standards, and demands for technical and transversal skills. However, curriculum relevance is often constrained by outdated equipment, uneven teacher competence, and limited industry engagement. This qualitative study used an embedded single-case design. Data were collected through interviews, observations, and document analysis, then examined using reflexive thematic analysis and triangulation. Findings showed that curriculum implementation followed a cycle of planning, synchronization, implementation, evaluation, and improvement. Industry partners contributed to competency identification, placements, internships, Teaching Factory activities, safety procedures, and assessment. Teaching Factory strengthened links between theory and authentic work practices. Supporting factors included competent teachers, school support, partnerships, and facilities. Key barriers were limited industry-standard equipment, uneven technological competence, unfavourable student-to-equipment ratios, and restricted partnerships. Curriculum implementation improved technical skills, discipline, teamwork, communication, safety awareness, adaptability, and job readiness. These findings imply that vocational curriculum reform must integrate curriculum, infrastructure, teachers, and industry collaboration. They provide a practical framework for evidence-based curriculum improvement.

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INTRODUCTION

Vocational education has a strategic position in community development because it connects the educational process with the needs of work competencies, productivity, and economic sustainability. The community needs graduates who not only master theory, but are also able to carry out work according to industry safety, quality, and efficiency standards. Technological changes are accelerating the shift in the type of work and increasing the demands on digital literacy, problem-solving, communication, and adaptability. Recent studies confirm that vocational education and training need to develop technical, transversal, and sustainable skills in an integrated manner so that graduates are able to face the transformation of the job market (McGrath & Yamada, 2023; de Souza & Debs, 2024). The failure of vocational education to respond to these changes can magnify skills mismatches, hinder job mobility, and reduce the competitiveness of the workforce. Therefore, the relevance of the vocational curriculum to industrial needs is a public issue that determines the quality and resilience of human resources and the ability of the community to adapt to economic, social, industrial, and technological changes.

Vocational High Schools are an important instrument to provide a competent middle-level workforce, especially in the technical sector that supports production activities and community services. Law Number 20 of 2003 places vocational education as education that prepares students to work in certain fields, while Presidential Regulation Number 68 of 2022 emphasizes improving the quality and relevance of vocational education according to the needs of the job market. Research evidence shows that content standards, processes, and assessments are related to graduate job opportunities, so that curriculum quality cannot be separated from employment outcomes (Andriansyah & Kamalia, 2021). School and industry partnerships are also needed to ensure learning uses actual competencies, equipment, procedures, and work culture (Estriyanto, 2021). Thus, research on curriculum alignment and industrial needs is important for schools, companies, governments, students, and the public who expect graduates to be productive, safe to work, and able to develop professionally and sustainably.

The main problem of vocational education lies in the imbalance between the competencies taught in schools and the competencies actually used in the workplace. Curricula can contain administratively relevant learning outcomes, but their implementation is often limited by lagging practice equipment, limited teacher industry experience, variation in the quality of fieldwork practices, and weak practitioner involvement in assessment. Research on the competency needs of vocational school students shows the importance of the suitability of curriculum, practical facilities, teaching materials, and competency standards with the demands of the world of work (Rahmadhani et al., 2022). Another study found that the application of 21st century competencies still faces different difficulties between teachers and students, especially in the aspects of communication, collaboration, problem-solving, and digital literacy (Mutohhari et al., 2021). This condition creates a gap between competency certificates and actual abilities, so graduates are at risk of needing retraining before being able to carry out work independently, consistently, productively, and in accordance with applicable industry procedures.

The Electrical Power Plant Engineering Expertise Program faces complex field phenomena as changes in electrical technology take place simultaneously with improved safety and automation standards. The industry needs personnel who are able to read engineering drawings, install installations, assemble panels, operate electric motors, understand controls, take measurements, find faults, and carry out preventive maintenance. However, the work readiness of TITL students does not always reflect a thorough mastery of these competencies. Candra et al. (2023) found that some TITL students after industrial placement have not shown work readiness, while Aisah and Candra (2023) show that the readiness of graduates can be classified as good but is still influenced by practical experience, motivation, and suitability of job opportunities. Automation also demands the use of Human–Machine Interface-based learning tools and industrial control systems to strengthen practical skills (Aswardi et al., 2023). This phenomenon shows that the written curriculum, practical learning, industry experience, and actual competencies of graduates do not necessarily move in harmony.

Previous research has addressed vocational relationships with industry through several approaches. Estriyanto (2021) describes teaching partnerships between schools and industry as a mechanism to implement a demand-based paradigm. Vachruddin et al. (2023) emphasize the importance of industry-based competency assessments by involving practitioners as external examiners. Yusuf and Basrowi (2023) evaluated industrial work practices using the CIPP model and concluded that internship programs can support skills and job readiness if the context, inputs, processes, and products are managed consistently. Anwar et al. (2023) also show that industrial practices strengthen students' technical, learning, methodological, social, and personal abilities, although the quality of experience can vary according to industry characteristics. The findings show that partnerships, assessments, and work experience are important elements of vocation. However, most of the research assesses the program in general and has not mapped the suitability of each TITL curriculum competency with the tasks, technologies, procedures, and work standards of the electricity industry in detail.

The literature on technological transformation expands the demand for vocational education. Magagula and Awodiji (2024) explain that the Fourth Industrial Revolution requires TVET institutions to update their curriculum, teacher competencies, infrastructure, and relationships with the workplace. de Souza and Debs (2024) identify technology integration, active learning, collaboration, creativity, and problem-solving as the main characteristics of

Education 4.0. Astuti et al. (2022) found that the maturity of digital technology competencies in vocational education still needs to be strengthened, while Suhartanta et al. (2024) showed that internship programs require information systems, cooperation documents, uniform perceptions of supervisors, and better evaluation of results. The research provides a solid foundation for vocational education reform, but it has not yet incorporated an analysis of curriculum documents, practitioner needs, learning experiences, practice facilities, and evidence of job readiness in a single TITL-specific framework. This gap is important because a small mismatch in electrical competence can directly affect safety, equipment reliability, productivity, and operational costs.

The novelty of this research lies in the preparation of the mapping of the alignment of the Electrical Power Installation Engineering curriculum based on actual work competencies, not just a general assessment of the implementation of learning or satisfaction of interns. The research links learning outcomes, practice materials, equipment, assessment methods, fieldwork practice experience, and industrial job demands in the competency gap matrix. The matrix can distinguish competencies that are already relevant, competencies that have not been adequately implemented, and new competencies that need to be integrated, such as automation, Human-Machine Interface, diagnosis-based maintenance, digital literacy, technical documentation, occupational safety, and professional communication. This approach continues the findings of Aswardi et al. (2023) regarding the need for industrial control media and the findings of Vachruddin et al. (2023) regarding practitioner-based assessments. The state of the art research lies in the integration of school and industry perspectives to produce curriculum recommendations that are operational, measurable, evaluable, and responsive to the development of electrical technology and national labor needs.

The research problem is formulated as a question regarding the suitability of the Electrical Power Installation Engineering curriculum with the competencies needed by the business and industry world as well as the factors that cause gaps in its implementation. This study argues that the work readiness of graduates is not only determined by the existence of productive subjects, but also by consistency between learning outcomes, practice intensity, equipment up-to-date, quality of industry guidance, authentic assessment, and strengthening of non-technical skills. Based on this argument, curriculum alignment is expected to increase when the industry is involved from competency identification, material preparation, practice implementation, to graduate evaluation. Research contributions include gap mapping models, curriculum revision basis, strengthening school-industry partnerships, and learning recommendations that improve competence, safety, adaptability, and sustainable absorption of TITL graduates in the industry.

RESEARCH METHODS

This study employed a qualitative embedded single-case study design to examine the implementation of the Electrical Power Installation Engineering (TITL) curriculum within a Centre of Excellence programme, focusing on curriculum implementation, school–industry partnerships, enabling and constraining factors, and student competency outcomes. The design was chosen to capture contextual processes and stakeholder perspectives on curriculum planning, synchronisation, implementation, and evaluation rather than to test causal relationships (Estriyanto, 2021; Setiawan et al., 2024). It is considered appropriate for vocational education because it involves interconnected institutional practices, workplace learning, competency standards, formal partnerships, and communication between schools and industry (Arinaitwe, 2021; Estriyanto, 2021; Hiim, 2023).

The study was conducted in the TITL programme at SMK Walisongo 2 Gempol, Pasuruan, Indonesia, which was purposively selected because it had synchronised its curriculum with industry needs and implemented fieldwork practice, internships, and Teaching Factory activities. These characteristics made the site relevant for examining how vocational curricula are translated into authentic workplace learning (Hiim, 2023; Setiawan et al., 2024). The site also presented both enabling conditions, such as institutional support, teacher competence, and industrial partnerships, and constraints including limited equipment, technological change, safety risks, and variations in teacher capacity, while its Teaching Factory programme allowed further analysis of industrial work processes, facilities, human resources, and quality control in school-based learning (Wijanarka et al., 2023)

Data were collected through semi-structured interviews, non-participant observations, and document analysis (Estriyanto, 2021; Setiawan et al., 2024), involving purposively selected participants such as school leaders, the head of the TITL programme, workshop personnel, teachers, students, and industry partners. Interviews explored curriculum synchronisation, school–industry collaboration, implementation enablers and constraints, and student development in technical skills, discipline, problem-solving, adaptability, and employability, allowing participants to describe both formal agreements and actual practices (Arinaitwe, 2021). Observations focused on practical learning and Teaching Factory activities, including equipment use, student participation, supervision, occupational safety, workplace discipline, task allocation, job sheets, and quality control (Wijanarka et al., 2023), while document analysis covered curricula, competency standards, partnership agreements, internship records, Teaching Factory procedures, safety guidelines, job sheets, and evaluation reports, with all data triangulated to enhance credibility and traceability

(Schlunegger et al., 2024).

Data were analysed using reflexive thematic analysis to identify patterns related to curriculum synchronisation, industry partnerships, enabling factors, constraints, and student competency outcomes (Braun & Clarke, 2021; Byrne, 2022), through stages of data familiarisation, deductive and inductive coding, theme development, theme review, and interpretation. Deductive codes were derived from the research focus, while inductive codes captured emerging issues such as equipment shortages, technological change, workplace discipline, and implementation gaps. The findings were then synthesised into an analytical narrative supported by interview, observation, and document evidence, with iterative analysis conducted throughout data collection to refine interpretations (Setiawan et al., 2024), and trustworthiness strengthened through triangulation, peer review, and participant confirmation while considering both convergent and divergent evidence to ensure analytical transparency (Schlunegger et al., 2024).

RESULTS AND DISCUSSION

Results

Based on the results of interviews, observations, and document reviews, four main themes were found in the implementation of the Electrical Power Installation Engineering (TITL) curriculum, namely: (1) implementation and synchronization of the TITL curriculum; (2) the role of the partnership between the business world and the industrial world; (3) supporting and inhibiting factors for curriculum implementation; and (4) the impact of curriculum implementation on student competence. The four findings are interrelated and show that the success of vocational education is not only determined by curriculum documents, but also by the quality of industry partnerships, the readiness of school resources, and the authentic learning experiences students gain.

Implementation and Synchronization of the Electrical Power Installation Engineering Curriculum

Implementation of the Electrical Power Installation Engineering curriculum is carried out through a process of planning, synchronization, implementation, and evaluation involving various stakeholders. The curriculum is not only prepared based on the school's internal policies, but is also directed to meet work competency standards and the actual needs of the business world and the industrial world. The process is carried out by adjusting learning outcomes, materials on productive subjects, practical activities, work safety procedures, and forms of competency assessment. This alignment shows that there are efforts to develop a demand-driven curriculum, so that learning outcomes are expected to be more relevant to the competencies needed in the workplace.

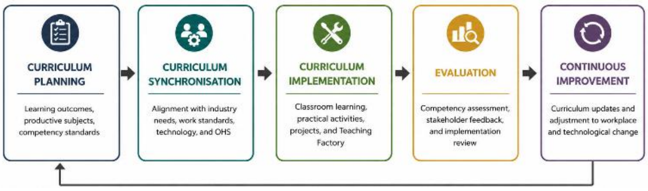


Figure 1. Continuous Cycle of TITL Curriculum Implementation

Figure 1 shows that the implementation of the Electrical Power Installation Engineering curriculum takes place as a continuous cycle that starts from curriculum planning, continues with synchronization to industry needs, then is applied through classroom learning, practical activities, projects, and Teaching Factory, then evaluated through competency assessments, stakeholder feedback, and implementation reviews. The final stage in the form of continuous improvement emphasizes that the vocational curriculum is not static, but must be continuously updated according to technological changes and the demands of the world of work. Thus, this picture confirms that the success of curriculum implementation is not only determined by good planning, but also by the school's ability to conduct continuous evaluation and improvement so that learning remains relevant to competency standards and industry needs.

Curriculum synchronization involves elements of school leaders, curriculum managers, heads of expertise programs, heads of workshops or laboratories, productive teachers, school committees, and representatives of industry partners. The involvement of these various elements shows that the development of the vocational curriculum cannot be done unilaterally. Industry partners provide information on work standards, equipment development, work culture, occupational safety and health, and competencies needed in the field of electrical maintenance and installation. The information is then translated into learning outcomes, practical materials, project activities, fieldwork experience, and operational procedures used in the learning process.

The research findings also show that the TITL curriculum has integrated theoretical knowledge with practical experience through Teaching Factory activities. In these activities, students not only learn the concept of electricity, but also engage in work processes that resemble industrial activities. Students take part in the stages of job acceptance, division of tasks, preparation of work design, use of tools, implementation of production or services, quality control, completion of work, and evaluation. The integration provides students with the opportunity to understand the relationship between the theories learned in the classroom and their application in real-life work situations.

However, the implementation of the curriculum has not been fully optimal. The alignment between the curriculum and industrial needs is still greatly influenced by the availability of practical equipment, teachers' ability to keep up with technological developments, and the proportion between the number of students and the available facilities. A curriculum that has been prepared in a relevant manner will not produce maximum competence if it is not supported by a learning environment, practical tools, and human resources that are in accordance with industry standards. Thus, the implementation of the TITL curriculum must be understood as a continuous process that requires evaluation, update, and adjustment to technological changes and job needs.

The Role of the Business and Industrial Partnership in the Implementation of the Curriculum

partnerships with the business world and the industrial world are an important element in the implementation of the vocational education curriculum. Partnerships are not only realized in the form of signing cooperation documents, but also through industry involvement in curriculum preparation, implementation of Field Work Practices, internship activities, Teaching Factory, strengthening work procedures, and introduction to industrial culture. The business world and the industrial world function as a source of information about competency needs, technological developments, quality standards, work safety, and the character of the workforce needed in the field.

In the process of synchronizing the curriculum, industry partners provide input on the technical competencies that students need to master. These inputs include the ability to use tools, understand electrical installation and maintenance, implement safety procedures, read work drawings, follow operational standards, and complete work according to quality targets. Industry involvement helps schools reduce the gap between the material taught and the work actually done in the workforce. Through this mechanism, the curriculum is not only oriented towards the completion of learning materials, but also on the achievement of measurable work competencies.

The role of industry is also seen in providing work experience for students through street vendors and internships. These activities provide opportunities for students to adapt to working hours, rules, organizational hierarchy, professional communication, individual responsibilities, and work quality demands. Experience in an industrial environment allows learners to understand that job skills are not only related to technical abilities, but also include discipline, rigor, responsibility, cooperation, and adherence to procedures. Thus, street vendors and internships are a means to bring together school knowledge with authentic work experience.

Industrial partnerships are then implemented through the Teaching Factory which presents a work pattern that resembles the production process or service in the industry. In this activity, students follow the procedures for accepting jobs, recording orders, planning, calculating material needs, implementing work, documentation, quality control, product improvement, and submitting results. The implementation of SOPs, worksheets, quality checks, and evaluation of results forms more structured work habits. Nevertheless, the effectiveness of partnerships remains dependent on the sustainability of communication, role sharing, joint evaluation, availability of practice venues, and the willingness of the industry to actively engage in learning.

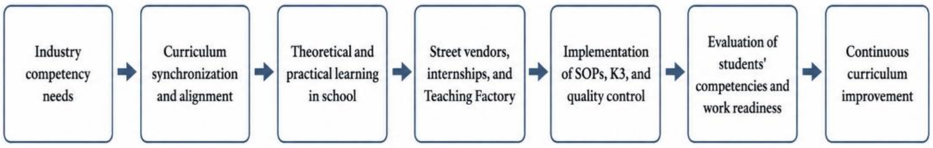


Figure 2. School and Industry Partnership Flow

The school-industry partnership flow illustrates a continuous and systematic process through which vocational education is aligned with labour-market requirements. The process begins with the identification of industry competency needs, which serve as the basis for curriculum synchronisation and alignment. These requirements are subsequently integrated into theoretical and practical learning at school and reinforced through fieldwork placements, internships, and Teaching Factory activities. During these industry-oriented learning experiences, students are required to apply standard operating procedures, occupational health and safety principles, and quality-control mechanisms that reflect authentic workplace practices. Their technical competencies, professional attitudes, and work readiness are then evaluated to determine the effectiveness of the learning process. The evaluation results provide feedback for continuous curriculum improvement, ensuring that the curriculum remains responsive to technological developments, evolving occupational standards, and changing industry demands.

Supporting Factors and Inhibiting Curriculum Implementation

the implementation of the TITL curriculum is influenced by various internal and external factors. The main supporting factors include the competence of productive teachers, school management support, the involvement of industry partners, the existence of street vendor and Teaching Factory programs, and the availability of some practical facilities. Teachers who have a background in expertise in the field of electricity play an important role in translating the curriculum into a learning experience. They not only convey theories, but also guide students in the use of tools, the application of work procedures, the resolution of technical problems, and the implementation of occupational safety.

Institutional support is also a factor that strengthens the implementation of the curriculum. This support can be seen in the policy of developing expertise programs, facilitating industrial cooperation, improving teacher competence, providing practical activities, and managing the Teaching Factory. In addition, the large number of students shows that there is an interest in TITL's field of expertise. This condition can be a capital for program development if it is followed by the provision of adequate facilities, teachers, and practice spaces. Relations with the business world and industry also open access to street vendors, technological information, work procedures, and labor competency needs.

On the other hand, limited facilities and infrastructure are the most dominant obstacles. A number of practical equipment still needs to be added and updated to match technological developments and standards used in the industry. The imbalance between the number of learners and the practice tools causes the practice opportunities of each student to be limited. These conditions can affect the depth of skill mastery because electrical learning requires direct practice, repetition, precision, and adequate supervision. Equipment that is not in accordance with industrial conditions also has the potential to create gaps when graduates enter the workplace.

Other obstacles are the limited number of industry partners, rapid changes in electrical technology, and the complexity of learning materials. Not all industries have the capacity to accept street vendor participants, provide instructors, or be involved in curriculum development. At the same time, teachers are required to continue to update their competencies in order to be able to teach the latest technology. TITL materials have relatively high safety risks so the practice must be carried out with strict supervision. If facilities, teacher competence, partnerships, and supervision are not adequately met, students can experience limitations in mastering tools, difficulty connecting theory with practice, low confidence, and reduced competitiveness of graduates.

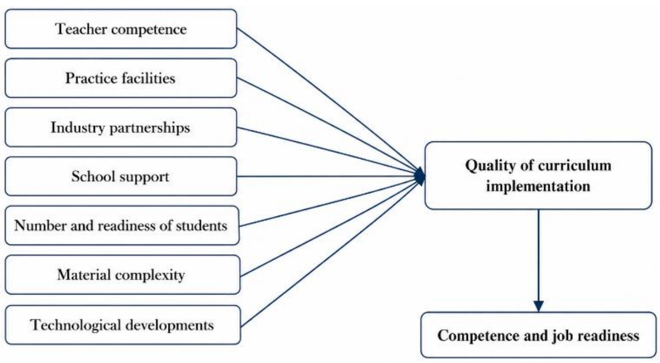
Tabel 1. Matrix of Supporting and Inhibiting Factors

Aspects	Supporting Factors	Inhibiting Factors
Human Resources	Teachers according to their area of expertise	The latest technological competence is not even
Facilities	Workshops and basic practice tools available	Limited and not entirely industry-standard tools
Partnerships	There is cooperation with DU/DI	The number and intensity of partners are still limited
Learning	Street Vendors and Teaching Factory	Practice time and tool ratio are not ideal
Students	Interest and number of learners support	Diverse early abilities and learning speed

TITL Materials	Relevant to job needs	Complex and has high safety risks
Technology	Unlocking opportunities for competency renewal	The development is faster than facility updates

Table 1 indicates that the implementation of the Electrical Power Installation Engineering curriculum is shaped by a combination of institutional strengths and practical constraints. Qualified teachers, available workshops and basic equipment, collaboration with business and industry, fieldwork placements, Teaching Factory activities, strong student interest, relevant vocational content, and opportunities for technological renewal provide an important foundation for effective curriculum delivery. However, these supporting conditions have not yet been fully optimised because teachers' competence in the latest technologies remains uneven, practical equipment is limited and not entirely aligned with industry standards, and the number and intensity of industrial partnerships are still insufficient. In addition, limited practice time, an inadequate student-to-equipment ratio, differences in students' initial abilities and learning pace, the complexity and safety risks of TITL materials, and technological developments that outpace facility upgrades may reduce the effectiveness of competency development. Therefore, curriculum implementation requires simultaneous improvement in teacher professional development, industry-standard facilities, partnership expansion, practical learning arrangements, differentiated instruction, safety management, and technological adaptation.

The relationships among these supporting and inhibiting factors, the quality of curriculum implementation, and students' competency outcomes are synthesised in Figure 2.



Bagan 3. Implementation Factor Relationship

Figure 2 illustrates that the quality of TITL curriculum implementation is shaped by the interaction of multiple internal and external factors rather than by a single institutional component. Teacher competence, practice facilities, industry partnerships, school support, student numbers and readiness, material complexity, and technological developments collectively determine how effectively the curriculum can be translated into meaningful vocational learning experiences. When these factors are adequately managed and mutually aligned, they strengthen practical learning, facilitate the application of industry standards, and support the integration of theoretical and workplace-based knowledge. Conversely, weaknesses in facilities, technological competence, partnerships, or student readiness may constrain curriculum delivery and reduce opportunities for competency development. The quality of curriculum implementation subsequently influences students' technical competence, professional behaviour, adaptability, and job readiness. Thus, improvements in graduate outcomes require an integrated strategy that simultaneously addresses human resources, facilities, partnerships, learning arrangements, safety requirements, and technological change.

The Impact of Curriculum Implementation on Student Competencies

The implementation of a competency-based curriculum and industrial needs has a positive impact on the development of students' abilities. This impact can be seen in increasing theoretical understanding, practical skills, discipline, the ability to work together, and readiness to face work situations. Learning that combines theory, workshop practice, street vendors, internships, and Teaching Factory provides a more complete experience than learning that only takes place in the classroom. Students not only know the principles of electric power installation, but also learn to apply them in work that has procedures, targets, risks, and quality standards.

Practical activities and Teaching Factory encourage students to develop technical skills, such as the use of tools, reading working drawings, installing components, checking results, applying occupational safety, and solving electrical problems. Through the work carried out directly, students have the opportunity to identify errors, make improvements, and evaluate the quality of the work. The experience strengthens the connection between conceptual knowledge and procedural skills. Students become more aware of the reasons why a procedure must be followed and the consequences that can occur if the work is not done according to standards.

In addition to technical competence, curriculum implementation also forms non-technical competencies. The implementation of schedules, division of labor, the use of worksheets, the obligation to wear personal protective equipment, and quality control help to form discipline, responsibility, accuracy, and communication skills. Students are encouraged to think critically when facing problems, work together in a team, convey work results, and make decisions based on the conditions found. This ability is important because the world of work requires workers who are not only skilled in operating tools, but also able to adapt, communicate, and work professionally.

Tabel 2. The Impact of Curriculum Implementation on Student Competency

Competency Dimension	Forms of Change Found
Knowledge	Increased understanding of electrical theory and working standards
Technical skills	Ability to use tools and carry out advanced installations
Occupational safety	Increased awareness of K3, PPE, and occupational risks
Discipline	Students are more accustomed to following schedules and SOPs
Troubleshooting	Students are able to identify and correct mistakes
Cooperation	Ability to work in teams and expanded division of tasks
Communication	Students are better able to convey the process and results of work
Technological adaptation	Students are better prepared to face changes in tools and work systems
Job readiness	Increased confidence and understanding of the industrial environment

Table 2 demonstrates that curriculum implementation contributes to multiple dimensions of student competence, encompassing knowledge, technical proficiency, occupational safety, discipline, problem-solving, teamwork, communication, technological adaptability, and job readiness. These changes indicate that industry-oriented learning does not merely strengthen students' ability to perform electrical installation tasks but also develops the professional behaviours required in authentic workplace settings. The integration of workshop practice, industrial work placements, internships, and Teaching Factory activities enables students to connect theoretical knowledge with procedural skills while becoming more accustomed to safety standards, work schedules, quality requirements, and collaborative responsibilities. Consequently, the curriculum contributes to the development of more comprehensive vocational competence by combining technical mastery with professional attitudes and workplace adaptability.

Although the impact of curriculum implementation is considered positive, the level of achievement of students' competencies is still influenced by the quality of facilities, intensity of practice, teachers' abilities, and the industry experience received. Students who get more practical opportunities tend to have better confidence and job readiness. On the contrary, limited tools and practice opportunities can lead to uneven mastery of competencies. Therefore, improving student competencies requires strengthening facilities, expanding industry partnerships, improving teacher competence, and evaluating learning that is carried out in an ongoing manner.

This study shows that the implementation of the TITL curriculum is a process that involves a close relationship between the curriculum, school resources, industry partners, and students' learning experiences. Synchronization of the curriculum with competency standards and industry needs has provided a clearer direction for learning. However, relevant curriculum documents must be followed by practical facilities, competent teachers, active partnerships, and an ongoing evaluation system.

The partnership between the business world and the industrial world is the link between the educational process at school and the reality of work. Through street vendors, internships, Teaching Factory, SOPs, and project-based activities, students gain experience that is close to real working conditions. This experience contributes to the formation of technical competence as well as a professional attitude.

Thus, improving the quality of TITL graduates requires simultaneous strengthening. Curriculum updates without practice tool updates will result in implementation gaps. Similarly, adequate facilities will not be optimal without competent teachers and ongoing industry partnerships. The success of curriculum implementation is ultimately determined by the ability of schools and industry to build a vocational learning system that is relevant, authentic, safe, and responsive to technological developments.

Discussion

The findings demonstrate that TITL curriculum implementation functions as a continuous cycle of planning, industry-oriented synchronisation, classroom and workshop enactment, competency assessment, and revision. This pattern supports Estriyanto's (2021) demand-driven paradigm, which positions occupational requirements rather than school routines as the principal reference for vocational curriculum development. It also accords with Hiim's (2023) conclusion that vocational relevance increases when school content is organised around authentic occupational tasks and jointly reviewed with workplace actors. Nevertheless, the present study extends these accounts by showing that alignment in electrical installation education includes not only task relevance and learning outcomes, but also occupational safety procedures, quality control, equipment development, and feedback-based curriculum renewal. This finding is especially important because rapidly changing Industry 4.0 skill requirements can create persistent mismatches between taught and required competencies (Rikala et al., 2024). Thus, curriculum relevance should be conceptualised as an adaptive institutional process rather than a one-time exercise in document harmonisation.

The findings concerning business and industry partnerships are broadly consistent with studies that emphasise joint planning, communication, supervision, and institutional commitment as prerequisites for coherent vocational learning. Arinaitwe (2021) found that effective collaboration requires timely planning, clear coordination, joint supervision, and formalised relationships, whereas Cahyadi et al. (2025) showed that partnership outcomes may remain suboptimal when coordination, facilities, teachers' industrial experience, internship opportunities, and standard operating procedures are insufficient. The present study confirms these principles but reveals an important distinction: partnership effectiveness was visible not merely in formal cooperation documents, but in the translation of industry information into learning outcomes, practical materials, industrial work placements, safety routines, and quality-control activities. This finding challenges partnership models that equate collaboration with memorandum signing alone. Its contribution lies in identifying partnership as a curricular production mechanism through which occupational standards are converted into school-based and workplace-based learning experiences. Consequently, industry becomes a co-designer, co-implementer, and co-evaluator of vocational competence rather than an external placement provider.

The positive changes in students' theoretical understanding, technical skills, discipline, teamwork, communication, troubleshooting, safety awareness, technological adaptability, and job readiness are consistent with recent evidence on authentic vocational learning. Wijanarka et al. (2023) reported that successful Teaching Factory implementation depends on the integration of learning management, industrial work patterns, facilities, human resources, and quality standards. Similarly, Yoto et al. (2024) found that context, input, process, and product conditions jointly determine whether Teaching Factory activities improve vocational skills, while Imran et al. (2024) demonstrated a substantial association between Teaching Factory implementation and students' work readiness. The present results also resonate with Sutianah et al. (2024), who showed that factory-based learning develops creativity, communication, collaboration, and production competence, and with Sudarsono et al. (2024), whose industry-based training model strengthened work readiness. However, this study adds electrical safety, procedural compliance, and error correction as field-specific competency outcomes that are particularly consequential in high-risk electrical work.

The study also identifies a significant implementation paradox: curriculum and partnership arrangements may be relevant on paper, yet their competency impact remains constrained by uneven teacher technological competence, limited industry-standard equipment, inadequate practice time, unfavourable student-to-equipment ratios, restricted industry participation, and differences in student readiness. This result is consistent with Rikala et al. (2024), who argue that technological transformation continually produces new and difficult-to-measure skill gaps, and with Yoto et al. (2024), who emphasise the interdependence of facilities, teacher readiness, student activity, and quality-control processes. The theoretical implication is that vocational curriculum implementation should be understood as an integrated implementation ecology in which curriculum design, human resources, infrastructure, partnership intensity, authentic tasks, and safety governance operate reciprocally. The study's novelty lies in combining these elements into a cyclical explanatory model within electrical power installation education. Unlike studies that examine alignment, partnerships, Teaching Factory, or work readiness separately, this research explains how these components interact to produce—or restrict—competency development.

Practically, the findings imply that vocational schools should institutionalise annual curriculum reviews with industry, map emerging technologies against teacher and equipment capacity, expand industrial work-placement partners, and establish measurable standards for practice duration, student-to-equipment ratios, supervision, occupational safety, and quality assurance. Teacher development should combine technical upskilling, industrial attachment, and collaborative lesson design because current expertise can quickly lose relevance when technology and workplace procedures change. Schools should also use competency evidence from workshops, industrial placements, internships, and Teaching Factory activities as feedback for curriculum revision. This recommendation is supported by Sudarsono et al. (2024), whose industry-based training model improved work readiness, and by Imran et al. (2024), who linked Teaching Factory participation with stronger employment perspectives. The study contributes a transferable school–industry implementation framework and has potential impact on curriculum governance, resource investment, teacher professional development, and graduate employability. Its central contribution is demonstrating that sustainable job readiness emerges from coordinated institutional improvement, not from isolated curriculum reform.

CONCLUSION

This study concludes that the effective implementation of the Electrical Power Installation Engineering curriculum depends on the continuous alignment of curriculum content, industry competency requirements, school resources, authentic workplace learning, and competency evaluation. The most important lesson is that curriculum relevance cannot be achieved merely through formal curriculum documents or cooperation agreements; it requires sustained collaboration among schools and industry partners through curriculum synchronisation, industrial work placements, internships, Teaching Factory activities, occupational safety practices, and continuous improvement. The scientific contribution of this study lies in proposing an integrated implementation framework that connects curriculum alignment, school–industry partnership, enabling and constraining conditions, and the development of students' technical and non-technical competencies. This framework extends vocational education literature by demonstrating how these components interact within electrical installation education, particularly in relation to safety awareness, technological adaptation, and job readiness. Nevertheless, the study is limited by its single-case qualitative design, context-specific findings, and the absence of longitudinal and quantitative measurements of competency growth. Future research should conduct comparative multi-site studies, employ mixed-method or longitudinal designs, involve broader industry participation, and examine how teacher technological competence, equipment adequacy, partnership intensity, and practical learning duration influence graduates' employment outcomes.

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