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The Role of Industrial Internship Activities to Improve Digital Competency of Engineering Students: Perception of Engineering Managers in Industry

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Abstract. Collaboration between the campus and the industrial world can bridge the gap that occurs between the campus and the industrial world, so that both can be integrated and synergized. This study qualitatively explored the contribution of maximizing work-integrated learning through industrial internships. The research findings from the perspective of three industry managers reveal that industrial internships can improve engineering students' digital engineering competencies such as digital engineering observation and identification, basic and technical understanding of digital technology, work safety, predictive maintenance and programming skills to be ready to enter the workforce. The implications of the research reveal that through industrial internships students can learn from mistakes and challenges faced during industrial projects, for the development of their professional competencies. In addition, the experience and development of digital engineering competencies from the industrial world can be used as a reference for their final assignments, as well as enriching the quality of their

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research and academic reports, as it can bridge the gap between formal education and the demands in the ever-evolving world of work.

Keywords: digital competency; industrial projects; predictive maintenance; programming skills; work safety

1. Introduction

The gap between the digital competencies of engineering education alumni and the working conditions in the industrial world in the digital era is an important issue that requires serious attention (Alboaouh, 2018; Herro et al., 2023; Komulainen & Sannerud, 2018). Technical education is considered the foundation to prepare students for the demands of modern industry (Jakubakynov et al., 2024). However, there is a significant gap between what is taught on campus and the competencies required by today's digital industry (Goldberg et al., 2014). The technical education curriculum has not fully responded to the development of digital technology, resulting in alumni lacking skills relevant to the latest technology in the industry (Lagoke et al., 2021; Rowe & Zegwaard, 2017). When human resources in educational institutions may not have the skills to use the latest technology, it can hinder their ability to teach digital skills that students need to enter the workforce (Panakaje et al., 2024).

The adoption of technology in engineering education, which is not in line with industry developments, results in graduates who are unfamiliar with workplace equipment (Carbone et al., 2020; Erlansyah et al., 2024; Grajek, 2022; Ha, 2022). In addition, soft skills are sometimes neglected because they focus more on developing technical skills (Brennan et al., 2023; Lucas & Grebing, 2023; Singh Dubey et al., 2022; Supriadi & Mukminin, 2024). Communication, collaboration, cultural understanding and academic climate and problem-solving skills must be mastered by technicians in industry (Brennan et al., 2023; Manning & Yuen, 2023; Peterson & Spencer 1990; Singh Dubey et al., 2022; Tierney & Lanford, 2018). If educational institutions lack collaboration with industry internships, it causes gaps in work experience and skills, communication and verbal and nonverbal performance in terms of persuasive interactions (Herro et al., 2023; Hizon et al., 2024; Stroud & Hopkins, 2016; Woods, 1998). For this reason, curriculum development is needed to be relevant to technological developments in a way: 1) determining learning objectives in terms of knowledge, skills, and attitudes of students as well as technology that needs to be mastered by students such as information literacy, the ability to use digital tools and technology-based problem solving; 2) analyzing technological needs in which resources have been included as well as the minimum requirements for competencies that students must have; 3) planning for technology integration in the curriculum; 4) training and support of educators; 5) implementing a technology-based curriculum, so that higher education can carry out work-integrated learning (Citrawan et al., 2024; Lagoke et al., 2021; Rowe & Zegwaard, 2017). The rapid development of technology also requires graduates to have high adaptability and professional educators (Habibi

et al., 2024; Habibi et al., 2023; Mukminin et al., 2023; Panakaje et al., 2024). These conditions indicate the importance of professional development for graduates to respond to rapidly evolving technological changes so as not to hinder graduates from entering the workforce (Alam et al., 2024; Goldberg et al., 2014; Herro et al., 2023).

Although many have researched the role of industrial internships (Kaminskienė & Rutkienė, 2012), there is still a need to develop a work-integrated curriculum to increase motivation. If the implemented curriculum is work-integrated, it can increase students' learning motivation because they see their employment opportunities increasing. If the implemented curriculum is not work-integrated, then it does not promote their learning motivation, so it is likely that they will receive remedial education (Dev, 1997; Dysdale & McBeath, 2018; Pantzos et al., 2023; Schunk et al., 2014), so that students' work skills increase (Alam et al., 2024; Herro et al., 2023; Wallin et al., 2014). Meanwhile, Komulainen and Sannerud (2018) show that industrial internships in Norway have improved digital engineering through industrial simulator training. In addition, skills in artificial intelligence are also needed today (Pasaribu & Widjaja, 2022). Rowe and Zegwaard (2017) provide empirical evidence that the results of industrial apprenticeship programs make a supportive contribution to improving multidisciplinary competencies, through the development of work-integrated learning curriculum improvements. Based on our observations, the efforts of universities that manage engineering faculties to collaborate with the industrial world regarding industrial apprenticeship programs in the western part of Indonesia have been carried out. However, there is still a lack of research evidence on the systematic investigation of the role of industrial internship activities to improve digital engineering competencies of engineering students. Therefore, the main research question guiding this study is: What are the roles of industrial internship activities to improve the digital competencies of engineering students?

2. Literature Review

Ha (2022) perceived that through industrial internship programs in Vietnam, it provides opportunities for students to apply theoretical knowledge to practical contexts in the world of work. Furthermore, Komulainen and Sannerud (2018) show that the industrial internship program in Norway allows students to have direct access to the latest technological equipment used by the industry such as industrial simulators operated in the petroleum industry. They transfer learning through industrial simulation training. This shows that they can learn to use software and digital systems relevant to their engineering field, thus enhancing their skills in the industrial world (Alboaouh, 2018; Goldberg et al., 2014; Herro et al., 2023; Smith et al., 2009; Townsend & Urbanic, 2013). Industrial internships thus provide an opportunity for students to learn from experienced professionals in the engineering field.

Pantzos et al (2023) reveal that students' industrial internships in Sweden can motivate them to learn through work-related activities so that they can develop

practical skills needed in the world of work. They can develop careers in the world of work because the internships maximize the contribution of work-integrated learning (Smith, et al., 2009). Industrial internships in Sweden bridge the gap between university and industry (Wallin et al., 2014). Industrial apprentices who participate in industrial projects can find areas of interest to them in a career so that they can increase their motivation to study and learn at university (Pantzos et al., 2023). Industrial internships in the Australian cities of Pert and Brisbane can build extensive professional networks with industry (Searle et al., 2018). Industry internship collaboration in Nigeria provides an opportunity to enhance the learning curriculum for student career development, because it is directly related to professional resources and mentorship (Lagoke et al., 2021). Thus, university-industry collaboration can bridge the gap between university and industry, so that students become more skilled through work-integrated learning facilitated by professional mentorship.

2.1 The Importance of Mastering Digital Competencies

Mastery of digital competencies is becoming increasingly important for engineering students because it has been systemized into almost all aspects of life and industry (Alam et al., 2024; Goldberg et al., 2014; Lucas & Grebing, 2023). Current industrial developments have adopted digital technology in various aspects of their operations and production. Engineering students who have digital skills can be more prepared and relevant to the needs of the job market, thus increasing their chances of getting a good job (Lucas & Grebing, 2023). Engineering students who have mastery of digital competencies have a competitive advantage in the job market, as they have the expertise to use software and digital tools to improve efficiency in the development, design, and production processes in engineering (Al-Sulami et al., 2024; Pasaribu & Widjaja, 2022). By mastering digital competencies, students can work faster and more effectively in completing their tasks and have an impact on the development of hard and soft skills (Brennan et al., 2023; Doherty & Stephens, 2023; Singh Dubey et al., 2022).

Students who have mastery of digital competencies can actively participate in cross-disciplinary teamwork on complex projects such as those available in the Nigerian oil industry (Lagoke et al., 2021). Furthermore, in the digital era, data becomes a very valuable asset in the world of work, so that it becomes a consideration in hiring employability (Lucas & Grebing, 2023).

Educators must continually innovate their teaching methods and integrate technology into higher education to enhance teacher performance in the learning process. By implementing project-based learning, utilizing information and communication technology, and teaching computer skills and new technologies, they can also improve students' technological competence (Panakaje et al., 2024). Thus, students have the advantage of hard skills and soft skills in engineering systems in industry (Brennan et al., 2023; Singh Dubey et al., 2022). Engineering students who master digital competencies can be achieved through learning strategies about digital technology that are integrated with the world of work, involving industry

professionals in the learning process so that there is no gap between the competencies of students and the competencies needed in the industrial world, it is easier to adjust to technological developments and industry trends that are constantly changing (Goldberg et al., 2014; Wallin et al., 2014). With various online learning platforms provided by educators, students can access the navigation of technology integration in higher education (Panakaje et al., 2024). Mastery of digital competencies has an impact on professional development and industry perceptions. Engineering students who are skilled in using digital technologies are better equipped to face the challenges and take advantage of the opportunities offered by an increasingly digitally connected industry.

2.2 Differences Between Digital Equipment on Campus and in the Industry

Differences in digital equipment between technical education and industry play a role in career preparation and the relevance of education to labor market needs (Alboaouh, 2018; Wallin et al., 2014). Digital equipment in the engineering education curriculum is more general, specifically designed for learning purposes (Lagoke et al., 2021; Mukminin et al., 2019). Another example is that CAD/CAM equipment used in industry has more advanced features and capabilities than the versions used in educational institutions (Al-Sulami et al., 2024). The technical support aspect on campus may be more limited and budget-based, whereas in industry, there is a technical team ready to assist industrial interns to operate and maintain digital equipment effectively and efficiently to improve student skills (Herro et al., 2023). On industry visits, students can see digital equipment integrated with other systems, such as automated manufacturing systems or production management systems, whereas in educational institutions, the focus is more on basic technical learning (Townsend & Urbanic, 2013).

Digital equipment in educational institutions is for student experiments and projects, while in industry, digital equipment must be optimized for maximum productivity and efficiency (Alboaouh, 2018; Herro et al., 2023). Meanwhile, data development courses in higher education focus on developing an understanding of the theory and fundamentals of data analysis. Students are taught fundamental concepts, statistical techniques, programming and machine learning algorithms, and principles of data processing. Meanwhile, industry uses data to solve practical problems, improve efficiency, and make data-driven decisions. The focus is on practical applications and results that can be directly applied to achieve specific goals to find solutions to industrial problems, and results-oriented data analysis (Grajek, 2022). Thus, the difference in the environment of using digital equipment indicates the need for soft and hard skills (Doherty & Stephens, 2023; Singh Dubey et al., 2022). In educational institutions, digital tools are usually more controlled and structured, while in industry, they must function in a more dynamic and diverse environment.

The role of industrial internships for engineering students provides an opportunity to apply theoretical knowledge in a real-world context. Through industrial internships students can observe and follow best practices applied in the use of digital

tools on industrial visits, as well as gain insight into the latest trends and developments in the industry (Townsend & Urbanic, 2013). The internship experience can help students build professional networks in the industry, for access to their careers on collaborative multidisciplinary capstone projects, so that their hard skills and soft skills are also improved (Doherty & Stephens, 2023; Goldberg et al., 2014). Industrial internships can help students identify their shortcomings through feedback from industry professionals, so they know their weaknesses and focus on improving them (Dev, 1997; Herro et al., 2023). Industrial internships help students acquire additional skills not taught in the classroom, such as practical problem solving, and interpersonal communication skills needed to succeed in a digitized work environment (Drysdale & McBeath, 2018). These conditions indicate that students can improve themselves to be more responsible for the tasks they need to complete in the workplace. The scheme of the industrial internship program is as shown in the following figure.

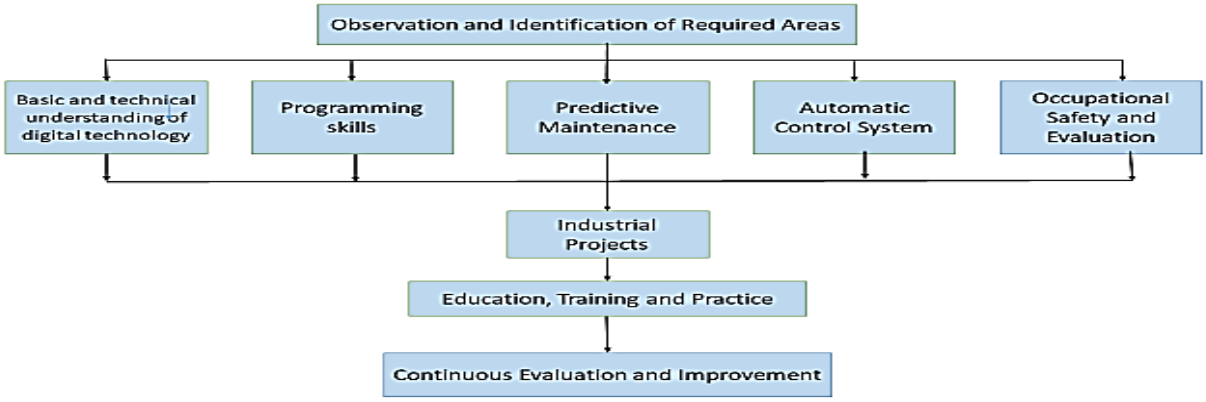

Figure 1: Scheme of the industrial internship program

Figure 1 shows that the first-time engineering students enter the industrial world is to observe and identify the fields needed according to their study program. Through observation, students can find out the specific needs and demands of the industry. For example, students can observe companies utilizing digital equipment, gaining a foundational and technical understanding of digital technology, programming skills, predictive maintenance, and automatic control systems. Through exposure to real industrial projects and work safety practices, students can continuously evaluate and improve themselves in response to the demands of their roles during internship programs.

3. Research Methodology

A qualitative research method was followed to gain in-depth insights into participants' experiences, perspectives, and behaviors, particularly in complex, real-world contexts. This approach allows for a richer understanding of the various ways in which individuals and groups interact with the phenomenon being studied,

making it ideal for exploring subjective experiences and capturing detailed data that quantitative methods might overlook.

3.1 Research Site and Sampling Procedures

The research was conducted in an industrial area in the western part of Indonesia. Based on the researcher's meeting with the director of the company in the industrial area, the engineering students who do industrial internships there are civil, electrical and mechanical engineering students. This study used purposive sampling. Thus, the participants in this study were technician managers in the fields of civil, electrical and mechanical engineering, so that the information extracted could be precise and complete. There were three participants consisting of industrial managers working in the fields of civil engineering, electrical engineering and mechanical engineering who were responsible for managing a student internship program that was in accordance with the specifications of the company they led. The selection criteria for the participants ensured that the results of data obtained from them could be trusted and was relevant to the stated research objectives (Bryman, 2016). This narrative research report is the result of semi-structured interviews, observation documentation and discussion, so that the information extracted becomes completer and more in-depth (Bryman, 2016; Clandinin & Huber, 2010). Semi-structured interviews, document analysis and discussions were carried out to explore data about industrial internship programs and digital engineering competencies of industrial internship program students at the companies they led. When theoretical saturation was reached, which reveals the absence of new insights in the final data collected, the research was considered complete (Russell & Kelly, 2002).

3.2 Data Collection

Research data was collected through semi-structured interviews to explore participants' perspectives more freely and in-depth. Semi-structured interviews allow new questions to be raised based on the arguments of the participants. In addition, industrial internship student report documents from 2022 to 2023 were reviewed. Five documents were provided by industry managers engaged in civil engineering. Industrial managers engaged in electrical engineering provided eight industrial internship student report documents while industry managers engaged in mechanical engineering provided six industrial internship student report documents. The study took place November 2023 and this paper was written in January 2024.

The sequence of the research data collection process began with the managers of civil engineering, electrical engineering and mechanical engineering. Interviews with each participant lasted approximately 60 to 90 minutes to gain insight into the role of industrial internship activities in improving the digital competencies of civil engineering, electrical engineering and mechanical engineering students. In addition, follow-up discussions with participants were used to clarify the results of interviews regarding the role of industrial internship activities in improving the digital competence of civil engineering, electrical engineering, and mechanical engineering students.

The questions posed to the participants were as follows.

1. Which digital competencies can be enhanced for engineering students through the industrial internship program?
2. How are required areas observed and identified?
3. What constitutes a basic and technical understanding of digital technology?
4. How are programming skills defined and applied?
5. What is predictive maintenance, and how is it used?
6. How does an automatic control system function?
7. What does occupational safety involve, and how is it evaluated?
8. How are digital techniques implemented in industrial projects?

3.3 Data Analysis

The results of interviews about the role of industrial internship activities to improve the digital competence of engineering students were audio recorded and transcribed to be analyzed from each word by word expressed by participants. The data from the interviews was analyzed using thematic analysis, which is a type of qualitative data analysis to identify patterns or to find themes (Braun & Clarke, 2006). The data analysis procedure started by repeatedly listening to the conversation data from the recorded interviews. Then the data was analyzed to produce themes through several stages. The first stage was to listen to the conversation data repeatedly from the interview recordings. The second stage was to form the data or transcribe it using the right format. The third stage was to interpret the data. The fourth stage was to reproduce or build the data and share it with the participants to ensure that the data was in accordance with the participants' intentions. The fifth stage was to build data credibility, so that the narrative in this research was in accordance with the responses of the participants. Building data credibility can be done through feedback on data interpretation from participants. Data on the improvement of digital engineering competencies of students participating in industrial apprenticeships was taken from the results of observations and documentation of data on students who carried out industrial apprenticeships at the place where participants worked.

All participants agreed to discuss the interview results to ensure the data accurately reflected their perceptions, enhancing the credibility and validity of the research (Mukminin et al., 2012). Researchers reviewed the interview findings with participants to confirm that the analyzed data aligned with their statements (Wald et al., 2024; Yulianti & Mukminin, 2021). Information regarding the participants' experiences—particularly on how industrial internships improve engineering students' digital competence—was verified for accuracy (Ashworth, 2003; Mukminin et al., 2012; Mukminin, 2019; Mukminin & Mcmahon, 2013; Yin, 2014). Ultimately, participants approved the use of the interview data for this research report.

4. Findings

Based on the results of discussions with participants, industrial internship students were given the opportunity to determine the specific areas of digital technology they

wanted to master. Alam et al (2024) highlight that observing and identifying the needs of both industry and education can serve as a foundation for vocational training, equipping students with future-ready skills. This underscores the importance of greater industry involvement in engineering programs in an effort to improve engineering students' competencies (Stroud & Hopkins, 2016). Additionally, involving industry professionals can enhance the effectiveness of work-integrated learning (Smith et al., 2009) while also reducing barriers to participation (Ha, 2022). Thus, industry involvement can improve students' work skills by designing multi-level engineering skills, especially in digital engineering (Herro et al., 2023). Furthermore, industrial internship students are given direction by experienced professional technicians from the industrial world, so that the competency standards expected to be mastered by industrial internship students are the standards of these professional technicians. This condition is an appropriate strategy for student learning that is integrated with the world of work (Herro et al., 2023; Komulainen & Sannerud, 2018; Ha, 2022; Smith et al., 2009).

4.1 Which Digital Competencies Can be Enhanced for Engineering Students through the Industrial Internship Program?

Participant#2 explained that the industrial internship program provides an opportunity for engineering students to improve their digital competencies in accordance with the digital technology that is operationalized in the industrial world where they do industrial internships.

> *"The industrial internship program can be very useful in improving the digital competencies of engineering students that are operationalized in our industry such as observation and identification of required areas, basic and technical understanding of digital technology, programming skills, predictive maintenance, automatic control systems, occupational safety and evaluation, and implementation of digital techniques in industrial projects."*
>
> (Participant#1)

Enhancing the digital competencies highlighted by Participant #2 during the industrial internship program would better equip engineering students to enter the workforce, address workplace challenges, and boost their competitiveness in the job market.

4.2 How Are Required Areas Observed and Identified?

Participants explained that students participating in industrial apprenticeships are given the opportunity to make observations and identify the skills they need. This is an important point at the beginning of the implementation of industrial internships for engineering students, which can have a significant impact on the success of the industrial internship program.

> *"Observation and identification of required fields helps to ensure that the skills students have are relevant to the needs of the industry and match their*

expertise, making them more adaptable and beneficial to their careers and the demands of the job market."

(Participant#1)

Participant#1's answer indicated that the observation and identification of internship students about the skills they need, at the beginning of industrial internship activities, provides opportunities for students to determine work-integrated learning experiences. This can provide work experience that is relevant to the competencies they have and the needs of the industry, so that students are truly ready to enter the world of work.

4.3 What Constitutes a Basic and Technical Understanding of Digital Technology?
Participants perceived that students as future industrial technicians need to have a better understanding of the basics and technicalities of digital technology, including the use of hardware and software, as well as the concept of computer networks.

"Mastery of hardware and software allows students as future technicians to identify, analyze, and integrate various system components, ranging from sensors to controllers and software connected through computer networks such as using PLC (Programmable Logic Controller) and HMI (Human-Machine Interface) programming software."

(Participant#2)

Participant#2's statement showed that a strong understanding of digital technology allows industrial apprentices to increase knowledge of operational productivity, as well as adapt to the technological developments that continue to occur in the world of work in this digital era. Industrial internships enable students to apply the theoretical knowledge gained on campus by working in the industry, guided by a team of skilled and experienced industrial technicians. Participants' perceptions indicated that engineering students, especially those focusing on electrical engineering, automation engineering, or mechatronics, need to master the use of PLC and HMI programming software, because PLC is the backbone of industrial automation systems. Mastering PLC programming allowed students to design, implement, and maintain control systems used in various industrial applications such as manufacturing, processing, and distribution. PLC-controlled systems can increase efficiency and productivity by automating routine and repetitive tasks. Students who were able to program PLCs could help companies optimize their operations. Meanwhile, mastery of HMI provided real-time visualization of data and process status. This is essential for effective monitoring and control, as well as for taking quick action in case of problems. HMI can display data collected by PLC systems in an easy-to-understand format, assisting operators and managers in making data-driven decisions.

4.4 How Are Programming Skills Defined and Applied?

Participants explained that the ability to program is very important for an aspiring industrial technician, especially in developing and maintaining automated control, monitoring and data processing systems.

> *"Programming skills enable aspiring engineers to develop control solutions tailored to industry-specific needs, optimize automation control operations, as well as detect errors in systems and take corrective actions to develop custom applications that leverage the latest technologies such as IoT and AI implementation."*
>
> (Participant#1)

In detail, Participant#1 revealed that through industrial internships engineering students need to develop and maintain their knowledge of automated control, monitoring and data processing systems because they are highly relevant to the needs of modern industry and technological developments. Automated control systems help reduce human intervention in the process, which could improve efficiency and reduced errors. With monitoring systems, students could collect data in real-time, enabling quick identification of problems and timely handling. In addition, being able to monitor operational conditions continuously could detect abnormal conditions that could lead to system failures or accidents. Ensuring that operations take place according to preset parameters reduces the risk of human error that could be harmful.

4.5 What Is Predictive Maintenance, and How Is it Ised?

Participant #3 pointed out that industrial apprentices need to be trained to have the ability to apply predictive maintenance using sensors and data analysis, so as to predict equipment failures before they occur, a skill that is highly valued in industry.

> *"Predictive maintenance is essential for aspiring engineers in the industry as it has a direct impact on operational efficiency, costs, and safety, as well as improving operational efficiency by reducing unexpected equipment failures, and ensuring that equipment operates at optimal performance."*
>
> (Participant#3)

The discussion with Participant#3 indicated that industrial apprentices are trained in predictive maintenance so they can respond to problems faster. This gives them a competitive advantage in keeping equipment and production processes running without a hitch, so that industrial operations run smoothly, safely and efficiently. Document analysis of engineering students' industrial internship reports shows that mastering predictive maintenance means using data and analytics to predict when a machine or equipment component will fail, so that maintenance can be performed before failure occurs. This reduces unplanned downtime and maintains continuity of operations. Predictive maintenance allows maintenance to be performed at the right time, which helps extend equipment life and ensure more reliable operations. Discussions with participants revealed that mastering predictive maintenance can

prevent equipment failures before they occur. Predictive maintenance helps prevent potential accidents and improves safety. Predictive maintenance is a key component of the Industrial Revolution 4.0, which integrates digital technology with industrial operations. Students who master these techniques will be better equipped to contribute to the digital transformation of their workplace.

4.6 How Does an Automatic Control System Function?

Participants expressed that student interns should understand the basic concepts and principles of automated control systems, including the use of sensors, to automate processes in industry as stated by the participant.

> *"Industrial apprentices are trained to master automated control systems and the use of sensors to optimize production processes and can observe preventive measures in case of hazardous conditions using effective troubleshooting methods."*
>
> (Participant#2)

Participant#2's reflections revealed that mastery of automated control systems makes technicians more valuable to the company, as they can diagnose problems to improve operational efficiency and productivity contributing to production safety, reliability and flexibility. Automated control systems could reduce errors caused by human factors, improving accuracy and efficiency of operations. Automation allows processes to run more quickly and consistently than manual intervention. Automated control systems can monitor operational conditions in real-time and make adjustments automatically to keep operations within safe limits. By automating dangerous or critical tasks, the risk of accidents can be significantly reduced. Students who mastered automatic control systems could contribute to the development of new technologies and innovative solutions in various engineering fields. Automated control systems enable the control of highly complex processes that may not be possible manually.

4.7 What Does Occupational Safety Involve, and How Is it Evaluated?

Participants revealed that industrial apprentices should understand safety procedures relevant to their work, and should have knowledge of potential risks, so as to reduce the likelihood of accidents or injuries.

> *"Mastering occupational safety has a direct impact on optimizing work output and operational efficiency, as they can identify and reduce the risks that cause accidents, protect themselves and their co-workers, thereby maintaining continuity of operations and productivity and reducing employee turnover."*
>
> (Participant#2)

Participant#2's narrative showed that technicians who understand safety can be more effective in identifying risks and taking preventive action to avoid potential

risks, improving safety and efficiency as safety standards remain high. Thus, students' mastery of safety procedures and evaluation could protect themselves and their co-workers from injuries or accidents that can occur due to operational errors, heavy equipment, or other emergency situations. Many industries are governed by strict safety regulations. Understanding and complying with safety procedures is a legal obligation that can prevent fines, penalties, or closure of operations. For this reason, industrial apprenticeship students must know and implement these procedures to ensure that they carry out industrial apprenticeship activities in accordance with industry standards applied in the workplace. Industrial apprentices, as future engineering professionals, must understand that safety is an important part of their professional responsibilities.

4.8 How Are Digital Techniques Implemented in Industrial Projects?

Participants explained that students' involvement in real industrial projects in the field when they carry out industrial internships can develop their practical experience in the world of work.

> *"Industrial internships on the part of industrial projects, have many significant benefits, such as enriching working knowledge and skills to prepare students' careers, as they can apply the theories they have learned in the classroom to real situations that are often more complex and dynamic than theoretical problems."*
>
> (Participant#3)

Participant#2's narrative revealed that being in a real industry project allows students to see how projects are planned, managed and executed from start to finish, allowing them to adapt to different working environments and to handle project pressures and deadlines. Thus, industrial internships involving real projects in the field provide a range of significant benefits to their professional and academic development. Students can apply the theoretical knowledge they have learned in the classroom to real situations, helping them understand how the concepts work in practice. In addition to acquiring specific technical skills relevant to their industry, such as the use of advanced tools and technologies, programming, or data analysis. The involvement of industrial interns in real projects teaches students how to solve problems effectively, which is an important skill in the world of work. In addition, students learned how to cooperate with others, share tasks, and manage teamwork dynamics. Furthermore, industrial apprentices gain insight into company culture, work ethic, and professional norms through valuable guidance and advice for their career development from mentorship. Based on the results of data analysis from interviews, observations of student report documents participating in the industrial internship program and discussions with participants, it was found that the level of digital engineering competency obtained by students after implementing the industrial internship program increased.

The competencies of industrial apprenticeship students in the components of identification and understanding of basic technical and basic competencies of digital engineering and work safety are at a high level. To apply such competencies during an industrial internship, especially in predictive maintenance and programming skills, still requires assistance from professional mentors in the industry, so that it can be relevant to the place of industrial apprenticeship because the data showed a moderate level. However, the knowledge of automated control systems and the implementation of digital techniques in industrial projects is weak. There is, therefore, still a need for continuous collaboration between educational institutions and the industrial world to support the improvement of students' digital competencies to be relevant to developments in the world of work. In addition, there is still a gap between the digital engineering equipment used on campus and the real conditions in industry and the world of work.

5. Discussion

The role of industry and the world of work is very important in efforts to improve the digital competence of engineering students. The world of industry and the world of work can contribute to the development of digital skills of engineering students through collaboration in delivering the education curriculum. Industry can work with educational institutions to develop curriculum that is relevant to the needs of the job market. This includes introducing the latest technology, software and tools used in the industry. Through providing internship opportunities for engineering students, they get hands-on experience in a real work environment. This helps students apply digital skills in a practical context and understand how technology is used in industry. Through real work projects as part of the internship or internship program, it allows students to work with actual industrial tools and technologies. Jakubakynov et al (2024) show that cooperation between educational institutions and industry can encourage cooperation in the use of innovative technologies and professional training. Furthermore, curriculum can be developed to ensure that it is in line with market demand, technological advances, and community needs. In addition, it can encourage cooperative programs that support collaboration to improve the implementation and use of innovative technologies to improve the quality of educational institutions.

The industrial world is the center of innovation in the development of new technologies. Collaboration between industry and technical education institutions enables the transfer of cutting-edge knowledge and skills, helping engineering students to remain relevant in the digital age (Alboaouh, 2018; Komulainen & Sannerud, 2018). In addition, industry can provide direct insight into the needs of the job market regarding the digital skills required. By understanding industry trends and technological developments, educational institutions can revise the curriculum, to ensure students have skills that match market demand (Lagoke et al., 2021; Rowe & Zegwaard, 2017). Furthermore, the world of work becomes a real laboratory for students because it provides input for educators, and students get work-integrated learning, so as to bridge the gap between universities and industry (Alboaouh, 2018;

Herro et al., 2023). Industrial internships through collaborative projects between educational institutions and companies are a clear example of how students can gain hands-on experience in applying their digital skills.

The industrial world can be a source of inspiration for students to develop engineering projects that are relevant to industry needs. By understanding the real-world applications of digital technologies, students can direct their energy to developing innovative solutions in higher education (Jakubakynov et al., 2024). In addition, through partnerships between industry and educational institutions, students can have access to the latest equipment and technologies that may not be available in an academic environment (Alboaouh, 2018). This allows them to expand their knowledge and skills in the use of digital tools that are relevant to developments in the industry. The industry can also mentor students in the development of non-technical skills that are important for career success, such as communication, leadership, and teamwork skills (Doherty & Stephens, 2023). Thus, interaction with professional technicians can help students to hone their digital skills and soft skills.

Students' active participation in industrial projects provides students with the opportunity to improve their digital skills and expand their professional networks in various disciplines. This is confirmed by Kaminskienė and Rutkienė (2012) who state that industrial internships in industrial projects can improve practical multidisciplinary skills which are relevant in industry. Furthermore, students have the opportunity to be involved in labor recruitment, as managers already know their employability (Lucas & Grebing, 2023). Thus, collaboration between industry and educational institutions can create opportunities for students to be involved in research and development of new technologies (Jakubakynov et al., 2024). Furthermore, students' industrial internship experience can be utilized for the completion of their final industrial project that they carry out in the field with industrial mentorship. When student interns can create technological innovations based on their experience in the field, it is very beneficial for the continuation of their research in completing their studies and allows them to access future career opportunities.

The involvement of industrial internship students in industrial projects that implement digital technology can provide valuable feedback to educational institutions about the quality of their students, helping educational institutions to continuously improve their curriculum to better suit the evolving needs of the industry (Lagoke et al., 2021; Rowe & Zegwaard, 2017). Through industrial internships, educational institutions can revise their curriculum by implementing learning that is integrated with work in the field. Meanwhile, future career development will be enhanced if educational institutions can maximize work-integrated learning in the field (Carbone et al., 2020; Herro et al., 2023; Ha, 2022). Collaboration between the campus and the industrial world on industrial projects can bridge the gap between the campus and the industrial world by implementing learning that is integrated with the world of work. Thus, industrial internships can

give students the confidence to compete in a competitive job market because they know the concrete evidence that the world of work needs, so they become better prepared to face challenges in the world of work.

6. Conclusions and Implications

The results of this study revealed that digital engineering skills development is highly relevant to the needs of professional technicians. The first research contribution is the mastery of automatic control systems from the industrial internship program, allowing students to access job opportunities in the digital era because of the improvement in diagnosing and solving complex problems. The second research contribution is that industrial internships carried out on industrial projects have many significant benefits, namely enriching students' knowledge and work skills because they can apply the theories they have learned in class to real situations. Another contribution is that industrial internships can develop communication, collaboration, learning about digital technology and the latest devices used in industry.

The research review revealed the importance of industrial internship programs in industrial projects that allow students to see how projects are planned, managed, and executed from start to finish, so that they can adapt to different work environments. The implications of the research reveal that through industrial internships, students can learn from mistakes and challenges faced while in industrial projects, for professional development that can be used as a reference for their final project, as well as enriching the quality of research and academic reports, as it can bridge the gap between formal education and the demands in the professional world of work. However, the limitation of this study is that the research findings cannot be generalized beyond the research sample, as the research findings are qualitative and interpretative in nature. For this reason, it is necessary to conduct research studies with other related topics involving industrial internship participants, industry partners and lecturers with a range of industrial experience.

7. References

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