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Workshop on Enhancing Learning Relevance and Smart Industrial Process Automation Innovation at Balikpapan State Polytechnic

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Abstract

The competency gap between vocational higher education graduates and the needs of industry remains one of the major challenges in the implementation of vocational higher education in Indonesia. The 2026 Vocational State Higher Education Revitalization Program (PRPTNV) provides a strategic opportunity for Balikpapan State Polytechnic to align its curriculum with industrial demands, particularly in the field of Smart Industrial Process Automation. This workshop brought together industry experts to identify the competencies required in the oil and gas, manufacturing, telecommunications, and renewable energy sectors. The implementation methods included presentations on company profiles and graduate competency requirements, interactive discussions, and the formulation of recommendations for curriculum development. The workshop results indicated that the primary technical competencies required by industry include PLC/SCADA programming, industrial instrumentation, embedded systems and the Internet of Things (IoT), and electrical power systems, complemented by soft skills such as professional communication, occupational health and safety, and digital literacy. The workshop produced recommendations for strengthening core courses, enhancing industry–academia linkages (link and match), developing laboratory facilities, and integrating industry certification into the curriculum of the Electronic Engineering Study Program at Balikpapan State Polytechnic.

Keywords: *vocational curriculum, smart industrial automation, industry–academia linkage, electronic engineering, PRPTNV*

I. INTRODUCTION

Vocational education plays a strategic role in producing a skilled workforce capable of meeting the demands of industry. However, the rapid advancement of technology has created a competency gap between vocational graduates and industrial requirements. Consequently, curriculum alignment and improvements in the learning process are essential to ensure greater relevance to labor market needs (Ali et al., 2020; Azman et al., 2020).

The vocational higher education revitalization program has become one of the government's key strategies for improving graduate quality through strengthening educational infrastructure, enhancing human resource competencies, and expanding collaboration with business and industry sectors (Kailani & Rafidiyah, 2020). Through the *link and match* approach, vocational higher education institutions are expected to produce graduates whose competencies align with industry needs and who are well prepared to enter the workforce (Rahayu et al., 2020).

The advent of the Fourth Industrial Revolution has also accelerated the transformation of vocational education. Modern industries increasingly require workers who not only possess strong technical competencies but are also capable of adapting to digital technologies, industrial automation systems, the Internet of Things (IoT), artificial intelligence, and data analytics (Ariah et al., 2025). Therefore, developing an industry-oriented curriculum has become a critical factor in enhancing the competitiveness of vocational education graduates (Gozali et al., 2021).

As one of the vocational higher education institutions in East Kalimantan, Politeknik Negeri Balikpapan (Poltekba) has the responsibility to produce graduates whose competencies are aligned with industrial demands, particularly in a region that serves as a major hub for the oil and gas, energy, and manufacturing industries. As part of the 2026 Vocational State Higher Education Revitalization Program (PRPTNV), Poltekba organized the Workshop on Enhancing Learning Relevance and Innovation in Smart Industrial Process Automation, aimed at improving the relevance of teaching and learning to the evolving needs of industry.

The workshop invited industry practitioners with expertise in electrical engineering and information technology related to industrial electronics. Their participation was essential in providing direct insights into the competencies and curriculum content required by industry, thereby supporting the development of a more relevant and industry-responsive educational program.

This community engagement activity aimed to: (1) identify the technical and non-technical competencies required by industry in the field of Smart Industrial Process Automation; (2) examine the profiles of companies employing graduates from the Electronics Engineering Study Program; and (3) formulate recommendations for industry-oriented curriculum development.

II. METHODS

Industry needs were identified through a combination of tracer studies, field observations, and discussions with industry practitioners. Tracer studies are recognized as an effective method for obtaining information regarding the alignment between graduate competencies and labor market requirements, while also serving as a basis for industry-oriented curriculum development (Handayani et al., 2022).

In addition, the workshop was designed using a participatory approach involving lecturers, educational support staff, and industry practitioners to obtain comprehensive input regarding the competencies required by companies employing graduates. This approach is consistent with the *link and match* concept, which emphasizes the importance of collaboration between higher education institutions and industry in producing competent graduates (Azman et al., 2020).

The workshop was conducted on Wednesday, May 20, 2026, from 09:00 a.m. (WITA) onwards at the Integrated Building, Fourth Floor, Politeknik Negeri Balikpapan. The workshop implementation consisted of the following stages.

The organizing team identified industry needs through tracer studies and industry research. Company profiles and graduate competency requirements were compiled based on input from various industrial sectors that employ graduates of the Electronics Engineering Study Program. The workshop materials were prepared by the invited

speakers by integrating their practical experience at Pertamina Hulu Indonesia with academic perspectives in the field of information technology.

The workshop commenced with opening remarks from the leadership of Politeknik Negeri Balikpapan, followed by presentations delivered by the invited industry speakers. The topics covered included profiles of companies employing graduates in the oil and gas, manufacturing, telecommunications, electrical power, and renewable energy sectors; the technical competencies required by industry; and the importance of soft skills and industry certifications. The presentations were followed by an interactive discussion session involving the speakers, lecturers, and educational support staff to obtain more comprehensive feedback and recommendations.

Figure 1. Workshop on *ECOTech* at Politeknik Negeri Balikpapan

Evaluation and Recommendation Formulation Stage. The findings from the discussions and the input provided by the industry speakers were synthesized to formulate recommendations for curriculum development. These recommendations focused on strengthening core courses, enhancing *link and match* collaboration with industry, upgrading laboratory facilities, and integrating industry certification into the curriculum.

III. RESULT AND DISCUSSION

Profile of Companies Employing Graduates

Based on the findings from the industry research and tracer study presented during the workshop, graduates of the Electronics Engineering Study Program are primarily employed across five major industrial sectors.

Oil, Gas, and Energy Industry. Companies such as Chevron Indonesia, Pertamina EP, TotalEnergies, Medco Energi, and Badak NGL recruit graduates for positions in instrumentation and control, field telecommunications, electrical maintenance, automation and PLC systems, as well as HSE and safety systems. This sector requires competencies in sensor calibration, maintenance of Distributed Control Systems (DCS) and SCADA systems, and programming of Siemens and Allen-Bradley PLC/HMI platforms.

Manufacturing and Electronics Industry. Companies including Panasonic Manufacturing, Samsung Electronics Indonesia, and PT Schneider Electric Manufacturing employ graduates as electronics quality control personnel, production technicians, maintenance technicians, electronics design engineers, and factory automation specialists. Required competencies include PCB testing, SMT machine operation, and industrial robot integration.

Telecommunications and Information Technology Industry. Mobile network operators and telecommunications infrastructure providers such as Telkom Indonesia, Indosat Ooredoo, Huawei Indonesia, and Nokia Indonesia recruit graduates for positions including network engineer, BTS/transmission technician, Network Operations Center (NOC) engineer, IT support specialist, and IoT engineer. Core competencies include router and switch configuration, BTS installation, and IoT system design.

Electrical Power, Construction, and Renewable Energy Industry. State-owned electricity company PLN and EPC contractors such as PT Adhi Karya and PT Wijaya Karya employ graduates as electrical installation technicians, SCADA/AMR technicians, solar photovoltaic (PV) technicians, and substation technicians (Anggraini & Maulana, 2025). The rapid development of renewable energy projects in Kalimantan has also created growing employment opportunities in photovoltaic (PV) installation and inverter monitoring systems.

Government Institutions and Educational Organizations. Government agencies, including the East Kalimantan and Balikpapan Offices of Communication and

Information Technology (Diskominfo), the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG), the Regional Disaster Management Agency (BPBD), and educational institutions recruit graduates for technical civil service positions and vocational education instructors.

The workshop findings indicate that graduates of the Electronics Engineering Study Program have broad employment opportunities across the oil and gas, manufacturing, telecommunications, renewable energy, and public sectors. Current industrial developments require graduates who are capable of integrating electronics, information technology, and industrial automation competencies to support the digital transformation of modern enterprises (Ariah et al., 2025).

With the increasing implementation of Industry 4.0 technologies, companies require professionals who are capable of operating digitally integrated production systems and integrating hardware and software to improve operational efficiency and business processes (Didaskalou et al., 2021).

Technical Competencies Required

The workshop identified six major groups of technical competencies that should be mastered by graduates of the Electronics Engineering Study Program.

Basic and Advanced Electronics

Competency in basic and advanced electronics remains the fundamental foundation for Electronics Engineering graduates. The ability to analyze analog and digital circuits, design Printed Circuit Boards (PCBs), and troubleshoot electronic devices continues to be highly sought after by the manufacturing and industrial automation sectors (Longo et al., 2022)

Industrial Control and Automation Systems

The advancement of modern industry has accelerated the adoption of Programmable Logic Controllers (PLCs), Supervisory Control and Data Acquisition (SCADA), Human–Machine Interfaces (HMIs), and Distributed Control Systems (DCSs) across a wide range of industrial processes. These automation systems constitute the

backbone of Smart Industrial Process Automation by improving operational efficiency, workplace safety, and industrial productivity (Folgado et al., 2024).

Telecommunications and Networking

Competencies in computer networking, data communications, wireless technologies, and fiber-optic networks have become increasingly important in supporting industrial digital transformation. The integration of communication networks with industrial systems enables real-time process monitoring and control, thereby enhancing operational reliability and efficiency (Fenza et al., 2021).

Embedded Systems and the Internet of Things (IoT)

Embedded systems and the Internet of Things (IoT) represent key enabling technologies for Smart Manufacturing. These technologies allow sensors and actuators to be interconnected through communication networks to support monitoring, data acquisition, and automated decision-making. The implementation of the Industrial Internet of Things (IIoT) enables companies to improve operational efficiency through predictive maintenance and real-time data analytics (Hu et al., 2023).

Information Systems and Fundamental Computing

Proficiency in programming languages, database management, cloud computing, and data visualization has become increasingly essential for supporting the digitalization of industrial processes. The ability to process and analyze data facilitates faster and more accurate decision-making in modern industrial environments (Hu et al., 2023).

Non-Technical Competencies and Industry Certifications

The workshop also highlighted the importance of non-technical competencies, including professional communication, systematic problem-solving, teamwork and collaboration, occupational health and safety (OHS), digital literacy, and professional ethics.

Industry certifications have become important qualifications frequently required by multinational corporations and state-owned enterprises. Recommended certifications include a TOEIC score of at least 500 to demonstrate technical English proficiency, Cisco Certified Network Associate (CCNA) or MikroTik Certified Network Associate

(MTCNA) for networking, the Indonesian National Professional Certification Agency (BNSP) competency certification in the electrical power sector, the Ministry of Manpower's Electrical Occupational Safety and Health (OHS) certification, as well as industrial automation certifications such as Siemens TIA Portal Basic and Schneider Electric SoMachine.

In addition to technical competencies, industry places considerable emphasis on soft skills. Communication skills, teamwork, problem-solving ability, leadership, and adaptability to technological change are regarded as critical factors influencing graduates' success in the workplace (Longo et al., 2022).

The Smart Factory concept within the Industry 4.0 paradigm positions humans as an integral component of digitally integrated production systems. Consequently, graduates are expected to possess interdisciplinary collaboration skills, critical thinking abilities, and the capacity to work effectively alongside intelligent technologies (Longo et al., 2022).

Recommendations for Curriculum Development

Based on the workshop findings, four major recommendations were formulated for the development of the Electronics Engineering Study Program curriculum at Politeknik Negeri Balikpapan.

Several core courses should be strengthened, including Industrial Instrumentation and Calibration, PLC/SCADA Control Systems, Electronic Design (KiCad/Altium), Computer Networks and Telecommunications, Embedded Systems and the Internet of Things (IoT), as well as Electrical Installation and Maintenance Systems. Strengthening these subjects is consistent with the implementation of industry-oriented curricula adopted by vocational higher education institutions (Folgado et al., 2024).

Strategies to strengthen collaboration between the study program and industry include implementing a minimum six-month industrial internship program, establishing Memoranda of Understanding (MoUs) with companies for the *practitioner teaching* program, offering industry-certified courses, and organizing regular industrial visits. These initiatives are intended to provide students with greater exposure to real industrial environments and improve their employability.

The development of the Industrial Instrumentation and PLC Laboratory, PCB and Electronics Laboratory, Network and IoT Laboratory, and Renewable Energy Laboratory should be prioritized by equipping them with facilities and equipment that meet current industrial standards. The enhancement of laboratory infrastructure represents a key component of vocational higher education revitalization programs.

Soft skills development should include the integration of Occupational Health and Safety (OHS) principles into all laboratory-based courses, technical communication training in English, and technology entrepreneurship (*technopreneurship*) programs. These initiatives are expected to complement students' technical competencies and better prepare them for professional careers.

Furthermore, an Outcome-Based Education (OBE) approach should be implemented to ensure that every course has measurable learning outcomes aligned with the competencies required by industry. OBE emphasizes graduate competencies as the ultimate outcome of the educational process, enabling all academic activities to be systematically designed to support the achievement of these intended learning outcomes (Spady, 1994; Biggs & Tang, 2011). Strengthening collaboration with industry through internship programs, industry practitioners serving as guest lecturers, professional certification programs, and the development of industry-based laboratories should also be prioritized to reinforce the implementation of the *link and match* concept in vocational education (Azman et al., 2020).

Figure 2. Recommendations for Curriculum Development

IV. CONCLUSION

The Workshop on Enhancing Learning Relevance and Innovation in Smart Industrial Process Automation, conducted at Politeknik Negeri Balikpapan, successfully

identified the competency requirements for graduates of the Electronics Engineering Study Program based on input from representatives of various industrial sectors. The key technical competencies identified include basic and advanced electronics, industrial control and automation systems, telecommunications and networking, electrical power systems, embedded systems and the Internet of Things (IoT), as well as information systems and fundamental computing. In addition, soft skills such as professional communication, problem-solving, occupational health and safety, and digital literacy were recognized as essential competencies required by industry.

The workshop also generated several recommendations for curriculum development, including strengthening core courses, enhancing *link and match* initiatives through industrial internships and industry practitioners' involvement in teaching, upgrading laboratory facilities, and integrating industry certification into the curriculum (Rachman & Cahyono, 2025). By aligning graduate competencies with actual industry requirements, graduates of the Electronics Engineering Study Program at Politeknik Negeri Balikpapan are expected to become work-ready, adaptable, and capable of making meaningful contributions to industrial development in East Kalimantan and Indonesia as a whole.

Furthermore, the workshop successfully identified both the technical and non-technical competencies demanded by contemporary industries. Priority technical competencies include industrial control and automation systems, embedded systems and IoT, telecommunications and networking, electrical power systems, as well as data processing and digital technology skills (Folgado et al., 2024; Hu et al., 2023).

The implementation of an Outcome-Based Education (OBE) curriculum, strengthened collaboration with industry, laboratory development, and the integration of professional certification programs represent key strategies for producing graduates who are well prepared for employment and capable of adapting to the evolving demands of Industry 4.0 and Smart Manufacturing (Biggs & Tang, 2011; Ariah et al., 2025). Accordingly, the Electronics Engineering Study Program can continue to enhance the relevance of its educational practices while contributing to the development of a highly competent workforce that meets the needs of Indonesia's industrial sector.

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