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The Application of Programmable Logic Controllers (PLC) in Vocational Education

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Abstract

This article outlines a systematic training program aimed at introducing and improving participants' comprehension of Programmable Logic Controllers (PLCs), a fundamental element in industrial automation systems. The training employed practical, hands-on workshops concentrating on fundamental PLC principles, hardware types, programming languages, and operational procedures. The participants were vocational school educators, students, and undergraduate engineering majors. The findings indicated substantial enhancements in the understanding and utilization of PLCs in automation activities, effectively connecting theoretical education with practical industry applications. The results further illustrate the efficacy of experiential learning in cultivating practical skills necessary for meeting the requirements of Industry 4.0 settings.

Keywords*: Programmable Logic Controllers, Industrial Automation Training, Experiential Learning, Industry 4.0*

1. INTRODUCTION

The swift advancement of industrial automation in the context of Industry 4.0 has highlighted the necessity for expertise in automation instruments like Programmable Logic Controllers (PLCs) [1]. Initially launched in 1969 by General Motors, PLCs have transformed industrial control by providing programmable, scalable, and efficient substitutes for conventional relay-based systems. Their integration into manufacturing, process industries, and smart systems has rendered PLC literacy indispensable in vocational and technical education [2].

In contemporary industrial settings, the utilization of PLCs has become synonymous with sophisticated control systems. They can integrate several input and output devices to oversee intricate industrial operations in real time. [3] This versatility and adaptability have established PLCs as a fundamental technology in both extensive industrial facilities and little automation initiatives. As companies increasingly adopt digital transformation, the demand for experts skilled in designing, programming, and troubleshooting PLC systems has surged significantly. Educational institutions, particularly in vocational and technical disciplines, must provide students with practical experience and a robust theoretical understanding of PLCs to address the industry's changing requirements [4].

Moreover, including PLC-based education into the curriculum enhances technical competencies while cultivating critical thinking and problem-solving skills. Exposure to real-world automation settings enables students to comprehend the application of theoretical concepts to practical systems more effectively [5]. This congruence between education and industry requirements guarantees that graduates are prepared for employment and capable of

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efficiently addressing contemporary automation concerns. Consequently, initiatives like specialized training programs are essential in bridging the divide between academia and industrial practice [6].

2. METHOD

This session employed hands-on teaching in a specialized automation laboratory, with PLC simulation devices and laptops with pre-installed PLC programming software. The training was conducted by university staff as an element of an organized community service initiative. Thirty participants engaged in the program, including vocational school instructors, engineering students, and final-year students specializing in electrical and industrial automation engineering. The course was structured as an all-day intense event, segmented into many practical modules to guarantee a thorough comprehension of the subject matter.

The introductory lecture offered a comprehensive review of PLCs, addressing their historical context, industrial significance, and classification according to hardware architecture—specifically compact and modular varieties. Participants were acquainted with the fundamental elements of a PLC system and their corresponding functions. The workshop thereafter advanced to programming foundations, presenting various PLC programming languages including Ladder Diagram (LD), Function Block Diagram (FBD), Instruction List (IL), Structured Text (ST), and Sequential Function Chart (SFC). Participants were instructed through immediate examples of the application of these languages in controlling sequences.

During the concluding session, participants were assigned the job of simulating fundamental automation processes that incorporated sensor inputs, timers, counters, and logic gates within the ladder diagram environment. They acquired skills in programming, simulating, and diagnosing typical industrial automation tasks, including the control of conveyor belts, signal lights, and motor start/stop operations. The workshop ended with a joint reflection and conversation to assess participant comprehension and address inquiries. Each participant was provided with digital copies of their project files for subsequent study and evaluation.

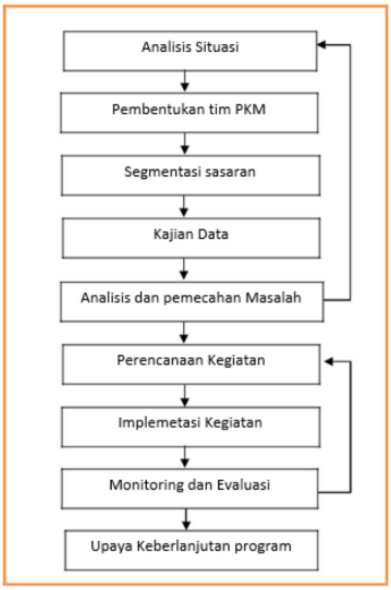

Figure 1. PkM Methodology

3. RESULT AND DICUSSION

The training program yielded distinct and favorable results regarding theoretical comprehension and practical proficiency. Participants, comprising students and educators with

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limited prior exposure to PLC systems, exhibited the capacity to comprehend essential concepts including PLC architecture, hardware kinds, and programming frameworks. They effectively developed and simulated fundamental ladder logic programs, implementing them in real-time situations that encompassed sensor inputs, output control, and automation logic. These activities allowed participants to directly engage with the execution and management of automation processes via PLC systems.

Furthermore, the practical aspect of the training markedly improved engagement and knowledge retention. Participants demonstrated significant interest and motivation during the sessions, especially in the interactive programming and troubleshooting components. The organized, sequential presentation of the content clarified intricate technical aspects and promoted cooperative learning. End-of-program reflections revealed that the training was both informative and empowering, as it provided participants with new, market-relevant abilities.

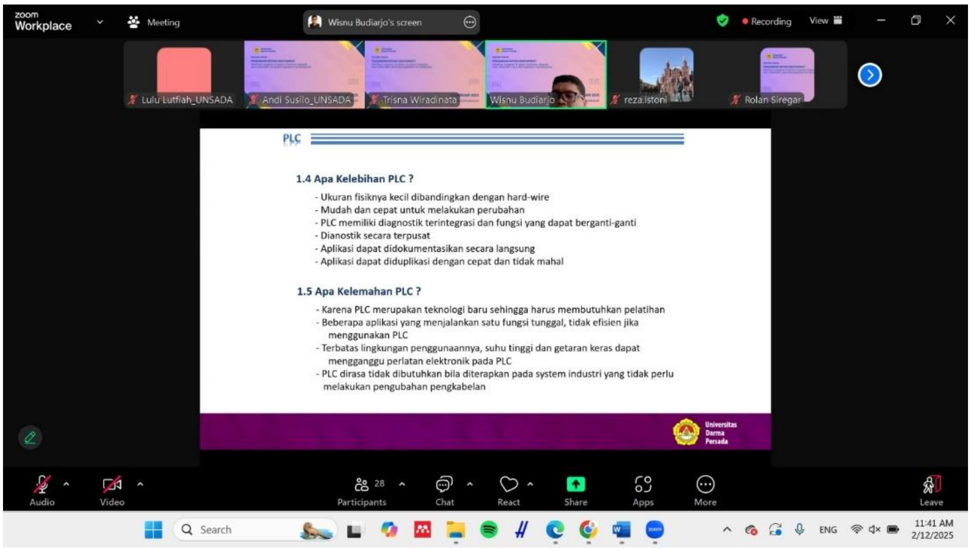

Figure 2. Presentation of material

The findings corroborated that a focused and practice-oriented training strategy is exceptionally successful in cultivating automation competencies. The exposure to authentic industry circumstances within a regulated educational setting enabled participants to connect academic theory with practical application, equipping them for advanced study or immediate workforce integration.

Figure 3. Presentation of material II

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4. CONCLUSION

The PLC training program effectively achieved its goals of talent enhancement and knowledge dissemination in industrial automation. It exemplifies the integration of industrial technology instruction into vocational and engineering education. The project supported local educational institutions and contributed to the overarching objective of preparing a workforce compatible with Industry 4.0 standards.

PLCs serve as a crucial connection between theoretical knowledge and practical application, enabling participants to acquire experiential proficiency with programmable automation systems. Future training programs may be enhanced to incorporate sophisticated courses, including human-machine interface (HMI) programming, analog signal processing, and industrial communication protocols. Enhancing collaboration among higher education institutions, vocational schools, and industry stakeholders will be essential for securing enduring, comprehensive automation proficiency. This program illustrates that PLC-based training is both pertinent and essential for equipping the forthcoming generation of industrial professionals.

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