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Development of the Omron CP1E PLC to Support PLC Practicum Activities in the Control System Engineering Laboratory

Gitut Sudarto[1,*] Minar Titis Santoso[2] Nusriningyati[2]

[1]*Electrical Engineering Department, Surabaya State University, Surabaya, Indonesia*
[2]*Family Welfare Education Department, Surabaya State University, Surabaya, Indonesia*
[*]*Corresponding author. Email: gitudsudarto@unesa.ac.id*

ABSTRACT
Programmable Logic Control (PLC) is a microprocessor used for automation in industrial processes such as control and supervision. For this reason, PLC courses are important to be given to students as a preparation for entering the industrial world. PLC subject must be supported by a trainer who can represent the original form of PLC equipment in the Industry. The Department of Electrical Engineering (TE) at the State University of Surabaya (UNESA) has a PLC subject as one of the mandatory subjects that must be taken. However, the Department of Electrical Engineering UNESA still uses the Omron C28H PLC as a media trainer. To increase the effectiveness of learning in the classroom, it is necessary to optimize the Omron CP1E PLC instead of C28H. This article will describe the results of the development of the Omron CP1E PLC at the Control Engineering Laboratory of the UNESA TE Department. The results showed that the development of the Omron CP1E PLC trainer needs to be done because it is more efficient than the C28H PLC.

Keywords: *PLC Omron C28H, PLC Omron CP1E, Practicum Quality*

1. INTRODUCTION

PLC is a computer microprocessor used by industry that accepts input from input devices about stored-program logic and produces output to control industrial devices [1]. A programmable Logic Controller (PLC) has been used to design and construct a control unit [2]. Generally, PLC is used in the control and supervision sector. There are many types of PLCs offered by the market such as the Zelio PLC by Schenider, the Melsec FX series from Mitsubishi, and Omron. TE UNESA Department uses PLC Omron as a media trainer for students. The use of trainers aims to provide work simulations in an industry with practical equipment in laboratories or workshops. The use of trainers in education has proven to be effective in increasing understanding [3]. To maximize the use of trainers, a renewable type of device is required [4]. Renewable here means that it is still widely used by surrounding industries [5].

Currently, TE UNESA uses the Omron C28H PLC trainer for PLC subjects. Trainer C28H is a type of trainer whose operation still uses a console specially provided by Omron. The use of this console makes the Omron C28H PLC more difficult for students to use because of its low level of flexibility. In addition, the Omron C28H PLC is still not integrated with the output load. So for the circuit testing process, the PLC must be integrated with external load devices. This process seems inefficient and requires more tools. For this reason, it is necessary to update the trainer equipment to improve the efficiency and effectiveness of learning in the classroom. Furthermore, the researchers developed the Omron CP1E PLC trainer as a replacement for the Omron C28H PLC. The Omron CP1E PLC is the latest version of Omron. The operating system can already be done using a computer via USB and the internet. CP1E also has a load that is directly integrated with the trainer, making it easier for students when doing simulations. This article will describe the planning for the development of the Omron CP1E PLC trainer. The purpose of this research is to produce a new Omron CP1E trainer that is suitable for use.

2. RESEARCH METHOD

2.1. Method

The research was conducted using the development method. The steps in this research include: (1) analysis, (2) design, (3) understanding, (4) implementation, and (5)

evaluation. This step is repeated until the most ideal design is found for use in the field. In simple terms the steps in this study are shown in Figure 1.

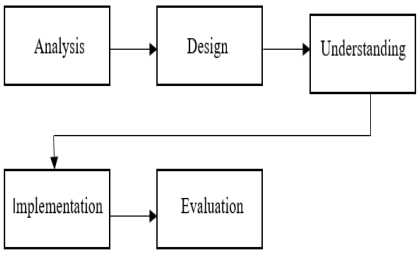

Figure 1. Research Method

The analysis phase contains needs analysis activities in research. After finding the needs in the research, proceed to the second phase, namely designing instruments or tools. When the tool has been designed, an in-depth understanding of the functionality of the tool is carried out before testing. When the understanding phase has been completed, the next step is to implement or apply the design to the actual situation. The results of the analysis are then evaluated by the validator. If the decision at the evaluation stage is good, then it is continued to develop the next device. However, if it is not good, revisions are made to then return to the implementation and evaluation stages. This method is carried out until a trainer device is produced that is effectively used by students in class. There are five implementations used to test the effectiveness of this trainer including (1) validation of the CP1E trainer; (2) the implementation of learning activities using the CP1E trainer; (3) student activities during the learning process using the CP1E trainer; (4) response students after taking lessons using the CP1E trainer; (5) student competencies (attitudes, knowledge, and skills) after participating in learning using the CP1E trainer.

2.2. Research Subject

The research subjects used students from the Electrical Engineering Department in 2017, totaling 11 students with 10 male and 1 female student.

2.3. Place and Time of Research

The research was carried out at the Laboratory of Control Engineering Laboratory. Integrated building A8.04.12 Department of Electrical Engineering. The research time is June – November 2019.

3. RESEARCH RESULT AND DISCUSSION

The results of the study will describe the results of the analysis of the two tools to be compared, namely PLC C28H and PLC CP1E. PLC C28H analysis gives the results which will be shown in Table 3.1 as follows.

Table 1. CH28E. PLC Specifications

Component	Specification
Input	14 Input Point
Output	12 Output Point
Voltage Input	12 VDC

The form of the C28H PLC used in this study is shown in Figure 2 and Figure 3.

Figure 2. PLC C28H

Figure 3. *Console* PLC C28H

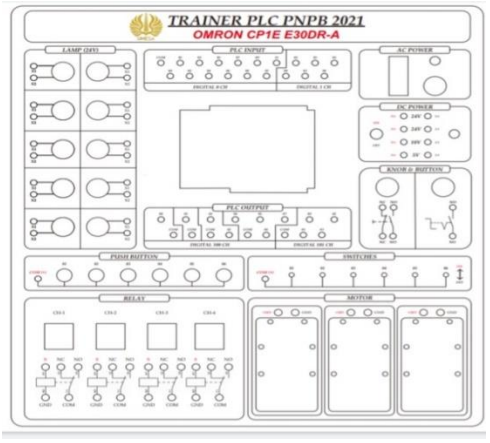

Figure 4. CP1E PLC Trainer Design

Furthermore, a PLC trainer CP1E was designed. PLC CP1E arranged on an acrylic board with a size of 49 cm x 46 cm. In the first design, the CP1E PLC trainer consists of 15 indicator lights consisting of five red indicator lights, five yellow indicator lights, five green indicator lights; four willing; five switch buttons; and one PLC CP1E with I/O 16 inputs and 12 outputs. The first design view of the CP1E PLC trainer is shown in Figure 4 as follows.

4. RESULT

In the Trainer Validation instrument, 3 aspects are assessed with a total of 15 aspects which are assessed by the validator. It is namely Media Conformity with Curriculum, Media Display, and Quality, Media Conformity with Practicum Module. The recapitulation of the results of the Trainer validation calculation is shown in Table 2.

$$Mean\ skor = \frac{\sum V}{\sum P} \quad (1)$$

Description:
M = Mean skor
V = $\sum$ Validator's answer
P = $\sum$ Validator x $\sum$ item

The input from the first validator will then be used to improve the trainer that has been designed by the researcher. Indicator lights are used to indicate the type of connection that is currently occurring in a circuit. The indicator light represents the working simulation of the load used in the circuit. However, considering the size of the trainer, using too many indicator lights will not give good results. Space is needed so that students who are doing practicum can focus on the main equipment of the trainer, the PLC is not an indicator light. The purpose of the validator to provide this design revision is to improve the effectiveness of the designed trainer design.

5. CONCLUSION AND SUGGESTIONS

5.1. Conclusion

The results of the PLC CP1E trainer design show several advantages of this trainer compared to the C28H PLC. The first advantage is that the CP1E PLC trainer design is simpler and is assumed to be easy for students to understand. Both of these PLCs can be operated from various types of computers. So this PLC can be operated using more than one computer. Unlike the C28H which can only be used using one console. The third advantage is that this trainer can be kept up to date because the CP1E PLC can already be integrated with the internet. A little development is needed to make up for some of the shortcomings of the CP1E PLC trainer.

5.2. Suggestions

Based on the results of the first validation, there are suggestions to reduce the number of indicator lights used. This aims to provide space for several other PLC components to make it easier to read and seem simple. Positive support is needed for the development of this tool so that it can produce good trainers for the learning process in the classroom by students.

Table 2. Trainer Validation Result

No	Rated Aspect	Evaluation				∑
		1	2	3	4	
Media Compatibility with Curriculum						
1	Media trainer following the teaching material delivered				1	4
2	Making trainers helps to understand the material presented				1	4
Display and Media Quality						
1	Trainer design			1		3
2	The suitability of the size of the trainer box with the series			1		3
3	Circuit layout on the trainer				1	4
4	Clarity of drawings/circuit schematics on the trainer (explanation of component symbols and part names of each circuit)				1	4
5	The writing on the trainer is legible				1	4
6	Wiring-point layout accuracy			1		3
7	Connector cable lenght according to needs			1		3
8	Ease of connecting the connector on the trainer				1	4
9	Ease of access on each network				1	4
10	Trainer performance			1		3
11	Ease of operation / use of trainer				1	4
Media Compatibility with Job sheet						
1	The suitability of the trainer with the module material				1	4
2	Practicum activities with a trainer in accordance with those contained in the module				1	4
	Total					54

REFERENCES

[1] E. Kamel, K., & Kamel, *Programmable logic controllers*. New York: Mc Graw Hill Education, 2014.

[2] A. G. A. Obeng, H. K, E. O. Amponsah-Abu, "Failure Mode and Effect Analysis for a Programmable Logic Controller-Based Control Unit for a Miniature Neutron Source Reactor Pneumatic Transfer System," *J. Electr. Comput. Eng.*, 2021.

[3] K. Underman, "Playing doctor: Simulation in medical school as affective practice," *Soc. Sci. Med.*, vol. 136, pp. 180–188, 2015.

[4] K. Halverson, E. R., & Sheridan, "The maker movement in education," *Harv. Educ. Rev.*, vol. 84, no. 4, pp. 495–504, 2014.

[5] E. Blackwell, C. K., Lauricella, A. R., & Wartella, "Factors influencing digital technology use in early childhood education," *Comput. Educ.*, vol. 77, pp. 82–90, 2014.