International Journal Publishing
INFLUENCE: International Journal of Science Review
Volume 8, No. 3, 2026
https://influence-journal.com/index.php/influence/index

Development and Performance Testing of a PLC and HMI Based Automatic Cable Cutting Machine

Sarah Chairul Annisa[1], Peni Asmawati[2], Fithri Muliawati[3], Joki Irawan[4], Muhidin[5]
[1,2,3,4,5]*Universitas Ibn Khaldun Bogor, Indonesia*
Email: peniasmawati@yahoo.co.id

Abstract. The system was developed to improve cutting accuracy and efficiency compared to the manual method currently used by PT. PLN (Persero), Bogor Barat Customer Service Unit. The device utilizes a Delta DVP14SS211R PLC as the main controller, a DOP-103BQ HMI for inputting the cutting length, a proximity sensor to detect cable movement, and a pneumatic actuator for the cutting mechanism. The test results show that the automatic cutting system provides better accuracy than the manual method. For a target length of 1600 cm, the automatic system produced an average cut length of 1640 cm (+2.5% deviation), while the manual method produced 1680 cm (+5% deviation). Thus, the automatic system reduced material waste by 2.5%. In terms of processing time, the automatic cutting process required 800 seconds for 1600 cm and 2177 seconds for 3200 cm, whereas the manual method required only 10 seconds and 20 seconds, making the automatic process 78–105 times slower. Electrical energy consumption, calculated using the formula $W = V \times I \times t$ ranged from 740,960–769,120 Joules (0.206–0.214 Wh) for 1600 cm and 2,016,337–2,092,968 Joules (0.560–0.581 Wh) for 3200 cm.

Keywords: *Programmable Logic Controller (PLC), Human Machine Interface (HMI), Proximity Sensor, Pneumatic Actuator, NFA2X 2×10 MM² Cable, Automation.*

A. INTRODUCTION

PT PLN (Persero), West Bogor Customer Service Unit, routinely carries out cable-cutting activities, particularly for NFA2X 2 × 10 mm² cables. This type of cable is an insulated aerial cable commonly used for service connections, functioning to connect the low-voltage distribution network (LV network) on utility poles to customers' kWh meters. Cable-cutting activities are conducted to support new service connections and network maintenance. Currently, the cable-cutting process is still performed manually using conventional cutting tools operated by technicians (Prayogo & Hartayu, 2023).

The manual cutting method has two major limitations. First, the accuracy of the cable length depends heavily on measurement precision and operator performance, which may result in significant deviations from the specified dimensions. Second, the process may require considerable time, particularly when handling a high volume of work, which can directly affect operational productivity and costs. Inaccurate cable lengths may lead to material waste and potentially affect the speed of customer service delivery (Berlianti & Nasrul, 2020; Direktorat Pembinaan Sekolah Menengah Kejuruan, Kementerian Pendidikan dan Kebudayaan, 2013; Sehr et al., 2020; Siemens, 2021). To address these challenges, a technological solution is required to improve the accuracy and consistency of cable cutting (Ramalho et al., 2024). The implementation of an automation system based on a *Programmable Logic Controller* (PLC) and a *Human–Machine Interface* (HMI) offers a potential solution for controlling the cable-cutting process in a precise and repeatable manner (Direktorat Pembinaan Sekolah Menengah Kejuruan, Kementerian Pendidikan dan Kebudayaan, 2013; Bolton, 2015; Wahani et al., 2026).

Several previous studies have demonstrated the effectiveness of PLC- and HMI-based automated systems in improving the accuracy and operational performance of cable-cutting processes (Prayogo & Hartayu, 2023; Berlianti & Nasrul, 2020; Direktorat Pembinaan Sekolah

Menengah Kejuruan, Kementerian Pendidikan dan Kebudayaan, 2013; Sehr et al., 2020; Siemens, 2021; Groover, 2015; Da Costa et al., 2024). Prayogo & Hartayu (2020), in their study entitled *"Design and Control of an Automatic Cable-Cutting Machine with the Implementation of a Stepper Control Program Using PLC,"* successfully developed an automatic cable-cutting system using an Omron CP1E PLC, an OP320 HMI, and a stepper motor. Their system achieved a very low cutting error rate, ranging from 0% to 0.8%, with a cutting time of approximately 5 seconds for a cable length of 1,000 mm (Prayogo & Hartayu, 2023).

Furthermore, a study conducted by Rahmi & Nasrul (2020), entitled *"Design of an Automatic Cable Cutting Machine Based on a Programmable Logic Controller with an NB7W-TW00B HMI,"* demonstrated that an automated cable-cutting system for NYA 2.5 mm² cables could operate effectively according to the specified cutting length (Berlianti & Nasrul, 2020). Previous studies have indicated that the use of PLC and HMI technologies can improve the accuracy, consistency, and operational performance of cable-cutting processes compared with conventional manual methods. The novelty of the present study lies in the application of an automated cutting system for NFA2X 2 × 10 mm² cables, which have larger and more rigid physical characteristics than the cables examined in previous studies. In addition, this study provides a comparative analysis of cutting accuracy and processing time between the automated system and the manual method currently used at PT PLN (Persero), West Bogor Customer Service Unit. This study is expected to develop an automated cable-cutting system that provides improved precision and is suitable for operational requirements in the field. The findings are expected to contribute to improvements in the quality and consistency of technical work processes at PLN.

B. METHOD

The research method employed in this study was an engineering research approach, which focuses on the design, development, and testing of a technological product or system. This approach was selected because the study aimed to develop a PLC-based automatic cable-cutting machine capable of effectively cutting NFA2X 2 × 10 mm² cables with precise and consistent dimensions. The research flowchart for the design and development of the automatic cable-cutting machine is presented in Figure 1. Based on Figure 1, the research methodology consisted of the following stages:

1. Problem Identification and Research Objectives
   The first stage involved identifying the main problems associated with the conventional manual cable-cutting process, particularly its limited accuracy and potential operational risks. The objective of this study was to design and develop a PLC- and HMI-based automatic cable-cutting machine to improve the precision, safety, and consistency of the cable-cutting process.
2. Literature Review
   A literature review was conducted using various theoretical and scientific sources related to automated control systems employing PLCs, HMIs, proximity sensors, pneumatic actuators, stepper motors, and ladder diagram programming. These concepts served as the theoretical and technical foundation for the design and development of the proposed system.
3. System Design
   The system design stage consisted of two main activities:

a. Conceptual Design
The conceptual design involved developing the operating mechanism of the machine to measure and automatically cut cables according to the specified length entered through the HMI.

b. Component Selection
The required system components were selected based on the operational requirements of the proposed machine. The main components included a PLC, proximity sensor, HMI, stepper motor, pneumatic cylinder, compressor, and power supply.

4. System Implementation
The system design was subsequently implemented as a physical prototype through several stages. First, the mechanical and electrical components were assembled to construct the proposed system. Second, the wiring process was conducted by connecting all components according to the electrical wiring diagram. Finally, the PLC control logic was programmed using WPLSoft software to enable the system to perform the cable-cutting process automatically.

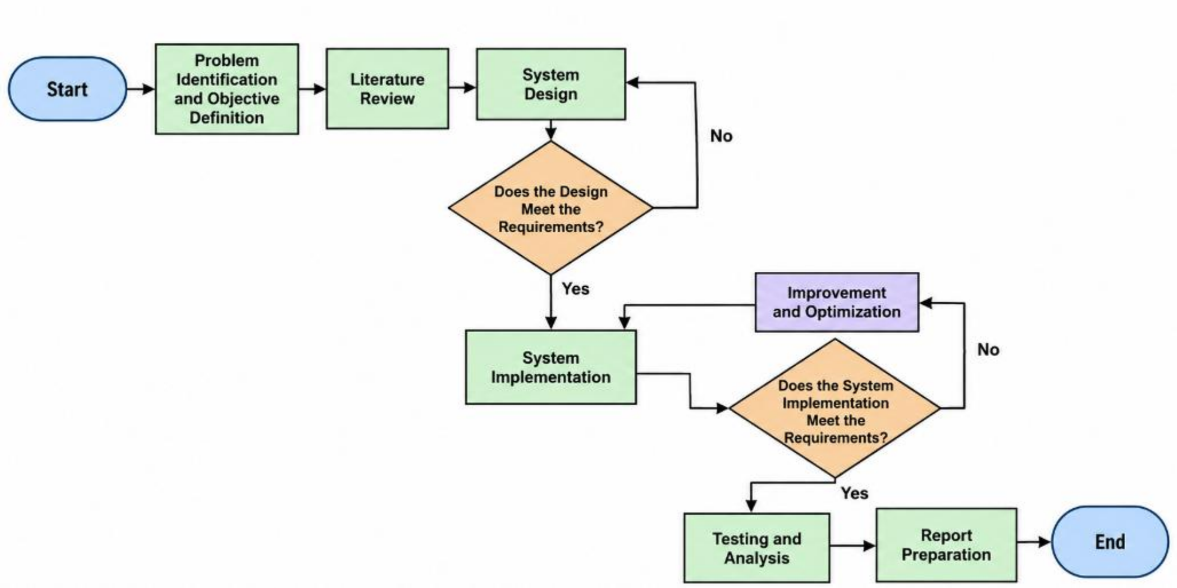

Figure 1. Research Flowchart for the Development of the PLC- and HMI-Based Automatic Cable-Cutting Machine

5. Improvement and Optimization
Adjustments were made to the control program, sensor position, and air-pressure settings when errors or performance issues were identified during testing. This stage aimed to improve the stability, accuracy, and operational performance of the proposed machine.

6. Testing and Analysis
The system functionality and the accuracy of the cable-cutting results were tested and evaluated. The experimental data were analyzed to determine the cutting error, processing speed, and overall performance of the system.

7. Report Preparation
The research report was prepared based on all stages of the study, including the system design, implementation, testing, analysis, and conclusions. The report serves as documentation and provides a basis for future system development and improvement.

The operational flowchart of the PLC- and HMI-based automatic cable-cutting machine is presented in Figure 2. The flowchart illustrates the overall sequence of system operations, starting from user input until the machine completes its operation. At the initial stage, the system is started by ensuring that all components are properly connected and ready for operation. The operator then enters the desired cable length through the *Human–Machine Interface* (HMI). In this study, one counter unit represents a cable length of 25 cm.

Next, the Delta *DVP14SS211R* PLC receives the input data from the HMI and processes it through the automated control system. The PLC activates the stepper motor to pull the cable from the reel according to the specified length. As the cable moves, the proximity sensor detects the rotation of the roller and sends pulse signals to the PLC. These signals are used to calculate the length of the cable being pulled. The PLC then performs a decision-making process by comparing the measured cable length, based on the signals received from the proximity sensor, with the length specified through the HMI. If the measured cable length has not yet reached the specified value, the stepper motor continues pulling the cable until the desired length is achieved. Once the required length has been reached, the PLC stops the operation of the stepper motor.

Subsequently, the PLC activates the solenoid valve to supply compressed air to the pneumatic cylinder. The movement of the pneumatic cylinder drives the cable-cutting mechanism, allowing the cable to be cut automatically. This process is performed according to the cable length specified through the HMI.bAfter the cutting process is completed, the system returns to its initial condition and becomes ready to process the next command. If the required number of cable cuts has been completed, the system automatically stops. Overall, the operational flowchart demonstrates how the coordination between the PLC, HMI, stepper motor, proximity sensor, solenoid valve, and pneumatic cylinder enables an automated and programmable cable-cutting system.

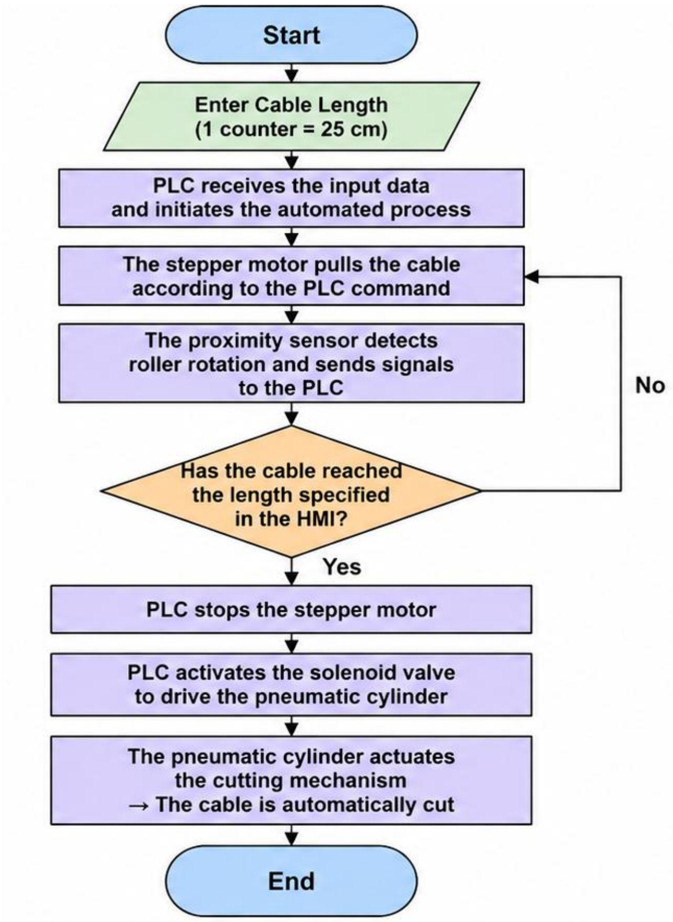

Figure 2. Operational Flowchart of the PLC- and HMI-Based Automatic Cable-Cutting Machine for NFA2X 2 × 10 mm² Cables

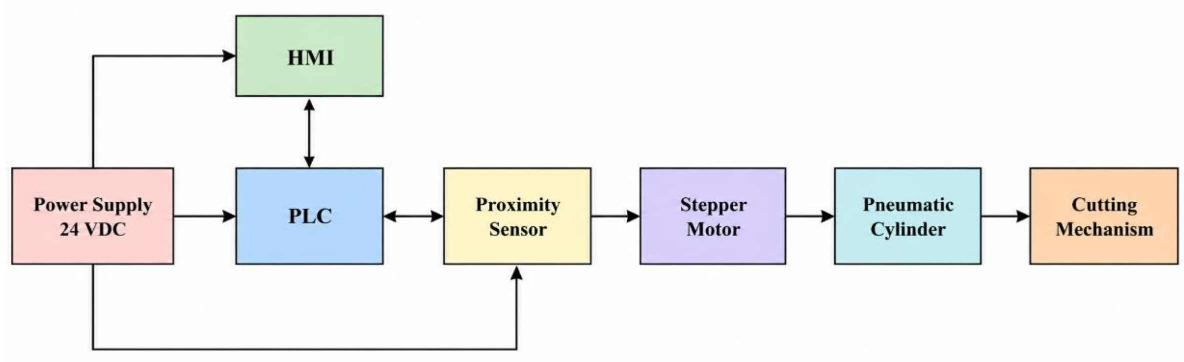

Figure 3. Circuit Block Diagram

Based on Figure 3, it can be explained that the integration of various electronic modules and components was carried out in accordance with the research objectives and methodology. The subsequent stage involved conducting a requirements analysis for the hardware used as research components, as well as for other supporting components.

C. RESULTS AND DISCUSSION

1. Evaluation of System Performance and Data Collection

This stage aimed to evaluate the extent to which the automatic cable-cutting system could operate according to the proposed design. The testing was conducted to evaluate the accuracy of the cable-cutting length, the operational speed of the system, and the performance of the automation components, including the stepper motor, proximity sensor, and pneumatic cylinder.

a. System Performance Testing

The system performance test was conducted by operating the machine through the HMI, where the operator entered the desired cable length and the required number of cuts. The PLC then controlled the stepper motor to pull the cable, while the proximity sensor counted the number of roller rotations as an indicator of the cable length. Once the specified length was reached, the PLC activated the pneumatic cylinder to perform the cutting process. The entire process was observed to ensure that the system operated automatically, accurately, and consistently without significant signal delays or mechanical errors. Each testing cycle was repeated several times to obtain consistent and reliable results.

b. Data Collection Using the Cable-Cutting Machine

The experimental data were obtained by measuring the length of the cut NFA2X 2 × 10 mm² cables using a measuring tape and comparing the results with the cable length entered through the HMI. The tests were conducted using several variations in cutting length and counter values.

The data collection results are presented in Table 2, while the comparison between the target cable length and the actual cutting length produced by the automatic cable-cutting machine is presented in Figure 4.

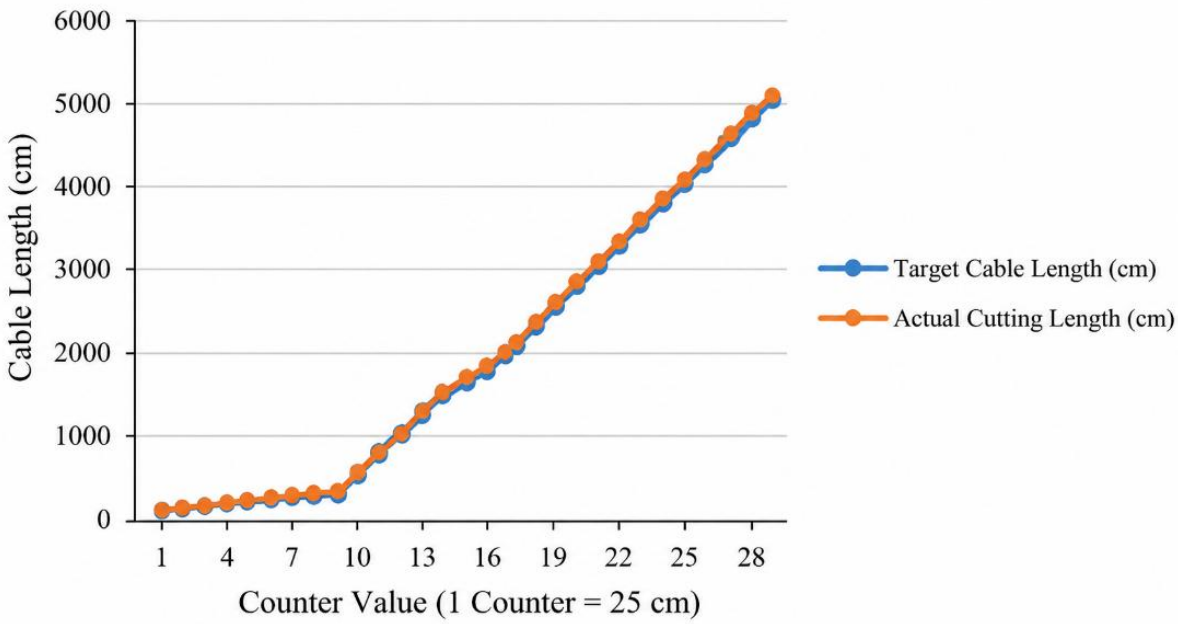

Figure 4. Comparison of the Target Cable Length and the Actual Cutting Length Using the NFA2X 2 × 10 mm² Cable-Cutting Machine

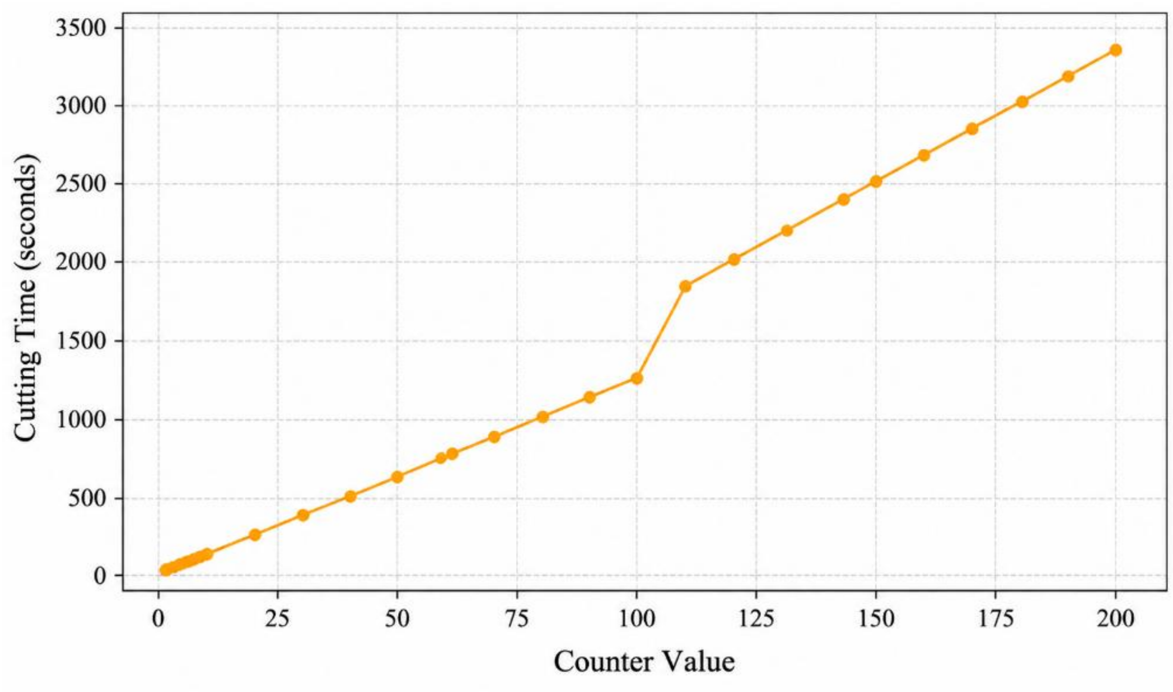

Figure 5. Graph of Counter Value versus Cutting Time

The graph presented in Figure 5 illustrates the relationship between the counter value and the required cutting time. As the counter value increases, the cutting time also increases gradually. This indicates that the PLC- and HMI-based automatic cable-cutting system operates consistently according to the specified counter value. The approximately linear pattern of the graph suggests that an increase in the counter value results in a relatively consistent increase in processing time. This finding indicates that the system demonstrates stable and predictable performance during the cable-feeding and cutting process.

Furthermore, data from the manual cutting of NFA2X 2×10 mm² cables were collected by field personnel by measuring the length of the cut cables using a measuring tape. These data were used to compare the results obtained from manual cutting with those produced by the automatic cable-cutting machine in order to evaluate the cutting accuracy and operational performance of the proposed system. The manual cable-cutting process performed by field personnel and the automated cable-cutting process are illustrated in Figures 6 and 7, respectively. Meanwhile, a graphical comparison of the cable lengths obtained from manual cutting and those produced by the automatic cable-cutting machine is presented in Figure 8.

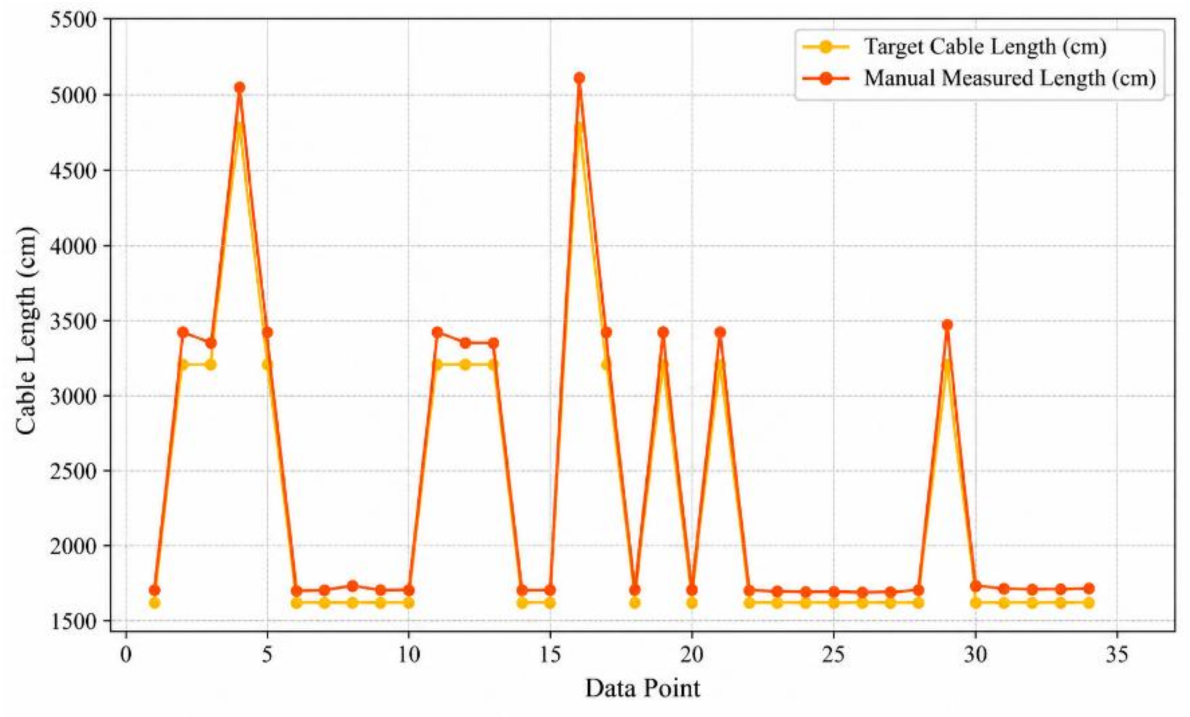

Figure 6. Graph of Manual Retrieval of NFA2X 2x10 MM² Cables by Personnel

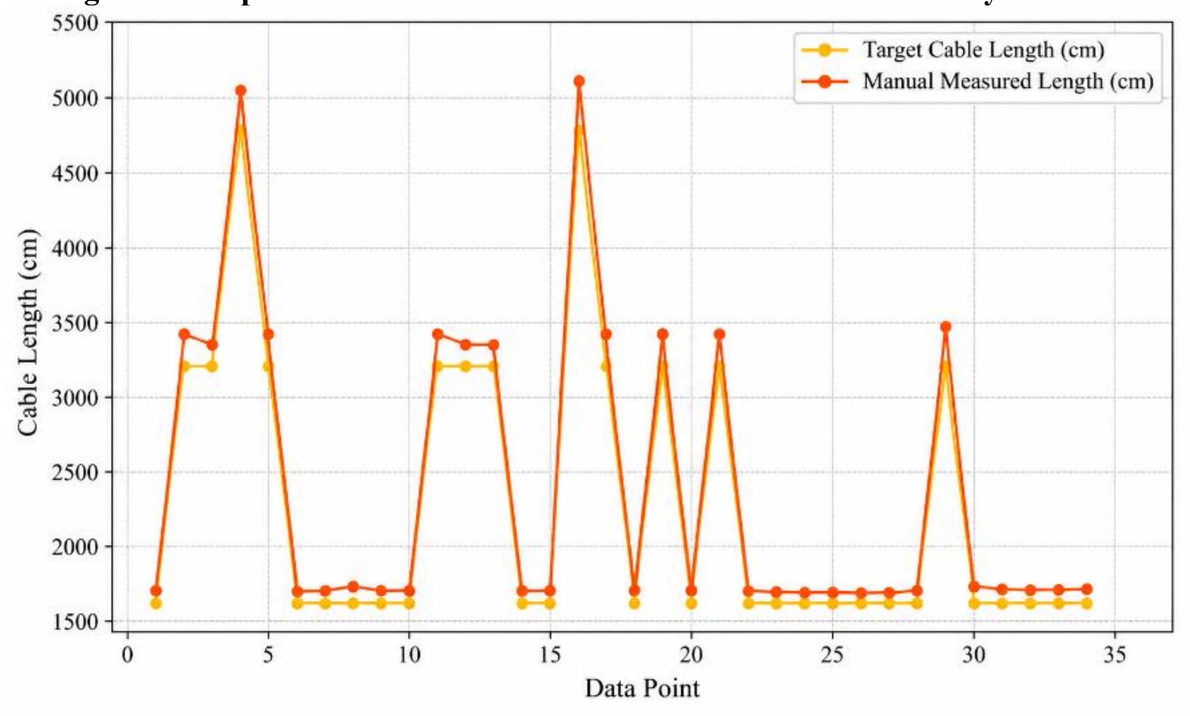

Figure 7. Graph of Manual NFA2X 2x10 mm² Cable Retrieval Using the Tool

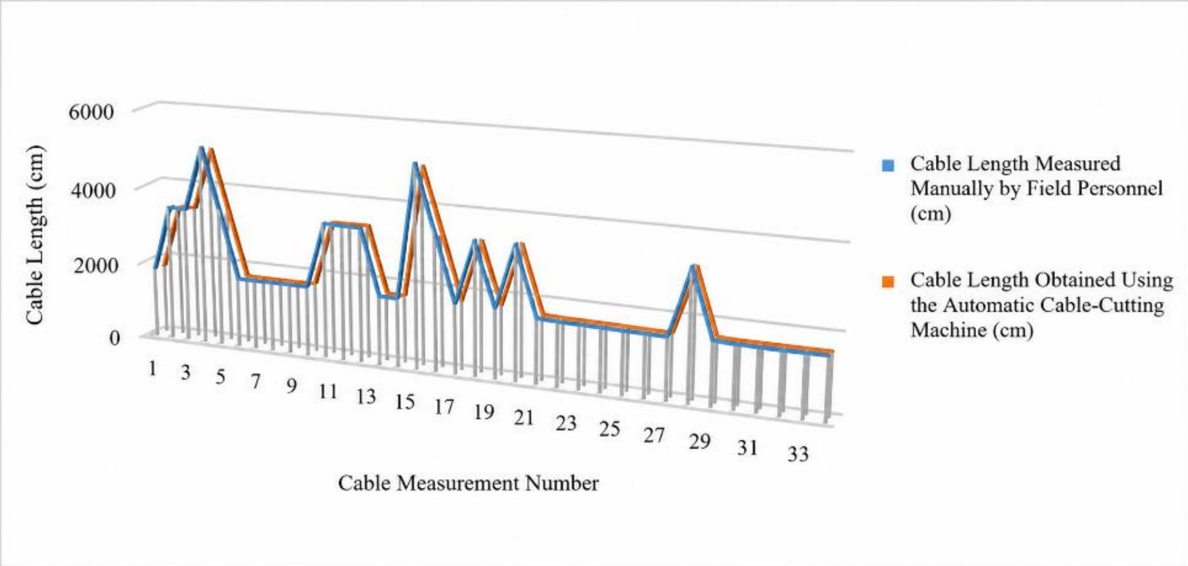

Figure 8. Graph Comparing Cable Lengths Resulting from Manual Cutting by Personnel Versus Cutting Using a Cable Cutting Machine

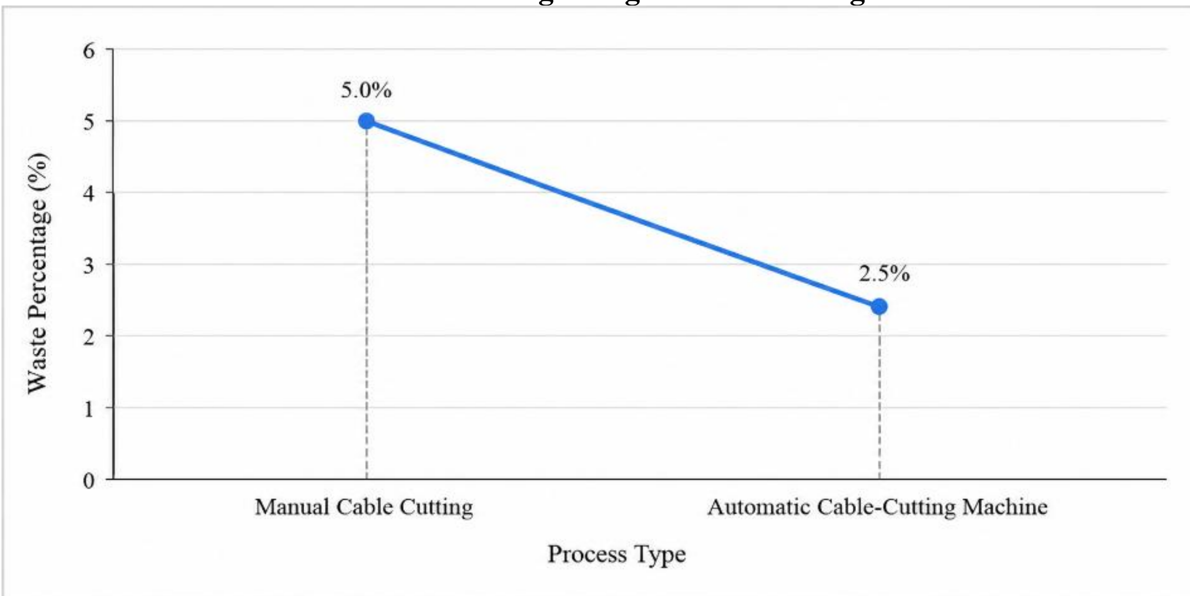

Figure 9. Comparison Graph of the Difference in Cutting Waste Between Manual Methods and the Use of a Tool

Figure 10. Comparison Graph of Manual Cutting Time Versus Cutting Using an Automatic Cable Cutter

Based on Figure 9, the average cable waste resulting from the manual cable-cutting process was 5.0%, whereas the use of the automatic cable-cutting machine reduced cable waste to 2.5%. This difference can be attributed to the presence of human error in the manual process, including inaccuracies in measurement and cutting. In contrast, the automated system operates according to the PLC control program and provides greater consistency in achieving the specified cable length. Furthermore, as shown in Figure 10, the manual cable-cutting process required significantly less time than the PLC- and HMI-based automatic cable-cutting machine. For a cable length of 1,600 cm, the average manual cutting time was 10 seconds, whereas the automatic cable-cutting machine required 800 seconds. The time ratio was calculated using the following formula:

$$\text{Time Ratio} = \frac{\text{Automatic Cutting Time}}{\text{Manual Cutting Time}}$$

For a cable length of 1,600 cm:

$$\text{Time Ratio} = \frac{800}{10} = 80$$

This result indicates that the automatic cable-cutting system required 80 times more processing time than the manual method. For a cable length of 3,200 cm, the manual cutting process required 20 seconds, whereas the automatic cable-cutting machine required approximately 2,100 seconds. The time ratio was calculated as follows:

$$\text{Time Ratio} = \frac{2100}{20} = 105$$

The calculation indicates that, for the same cable length, the automated system required approximately 105 times more processing time than the manual cutting process. Therefore, in terms of processing speed and time performance, the manual cable-cutting method was substantially faster than the proposed automated system. However, despite its longer processing time, the automatic cable-cutting machine provided advantages in terms of cutting-length consistency, reduced cable waste, and measurement accuracy. Therefore, the automated system demonstrated better performance in terms of material utilization and cutting accuracy, although further optimization is required to improve its processing speed.

2. Electrical Current Consumption of the Automatic Cable-Cutting Machine

Electrical load measurements were conducted to determine the amount of electric current consumed by the automatic cable-cutting machine under various operating conditions. The measurements were intended to analyze the system's electrical power consumption, both during standby conditions and full operation. The results of the electrical current measurements are presented in Table 1.

Table 1. Electrical Current Measurements of the Automatic Cable-Cutting Machine

No.	Test Condition	Current (A)	Description
1	Machine idle	0.08	Standby condition; only the PLC and power supply are active
2	Machine operating without load	0.25	The system is active without performing the cutting process
3	Compressor operating without cable cutting	4.24	The compressor operates to maintain air pressure
4	Compressor operating while the machine is running	4.37	Full operating condition during the cable-cutting process
5	Compressor off while the machine is running	4.21	Cable-cutting operation without air replenishment

Based on the measurement results presented in Table 1, the highest current consumption occurred when the compressor was operating while the machine was running, reaching 4.37 A. In contrast, the lowest current consumption was recorded when the machine was idle, at 0.08 A. These results indicate that the compressor was the component with the highest electrical power demand in the system. The initial compressor charging process, which involved increasing the air pressure from zero to the required operating pressure, required 1 minute and 15 seconds. Meanwhile, the compressor recharge time after operation required 33 seconds. These results indicate that the pneumatic system was able to restore the required air pressure relatively quickly during the cable-cutting operation.

Table 2. Electrical Energy Consumption During the Cable-Cutting Process

No.	Cable Length (cm)	Time (s)	Voltage (V)	Current (A)	Energy Calculation (J)	Energy (Wh)
Condition: Compressor Operating and Machine Running						
1	1,600	800	220	4.37	769,120	0.214
2	3,200	2,177	220	4.37	2,092,968	0.581
Condition: Compressor Off and Machine Running						
1	1,600	800	220	4.21	740,960	0.206
2	3,200	2,177	220	4.21	2,016,337	0.560

As presented in Table 2, the electrical energy consumption during the cable-cutting process was calculated based on the relationship: $E = V \times I \times t$ where the electrical energy consumption is influenced by voltage, electric current, and operating time. Under the condition in which the compressor was operating while the machine was running, cutting a 1,600 cm cable required 769,120 Joules (0.214 Wh), whereas cutting a 3,200 cm cable required 2,092,968 Joules (0.581 Wh). Meanwhile, when the compressor was not operating while the machine continued to perform the cable-cutting process, the energy consumption for cutting a 1,600 cm cable was 740,960 Joules (0.206 Wh), while cutting a 3,200 cm cable required 2,016,337 Joules (0.560 Wh). Based on these results, the system consumed more electrical energy when the compressor was operating than when the compressor was not operating. In addition, longer cable lengths required greater electrical energy consumption because of the longer operating time required for the cable-feeding and cutting processes.

D. CONCLUSION

The automatic cable-cutting machine was successfully designed and implemented using a Delta DVP14SS211R PLC as the main controller and a Delta DOP-103BQ HMI as the user input interface. The system was capable of feeding the cable, measuring its length using a proximity sensor, and performing automatic cutting through a pneumatic actuator according to the developed ladder logic program.

The machine demonstrated accurate and stable performance based on the performance testing results. At a target cable length of 1,600 cm, the automatic system produced an average cutting length of 1,640 cm, corresponding to a deviation of +2.5%. In comparison, the manual method produced an average length of 1,680 cm, corresponding to a deviation of +5.0%. Therefore, the automated system was able to reduce cable material waste compared with the manual cutting method.

In terms of processing time, the automated system required substantially more time than the manual method. The automatic cable-cutting process required 800 seconds for a cable length of 1,600 cm and 2,177 seconds for a cable length of 3,200 cm. In comparison, the manual method required only 10 seconds and 20 seconds, respectively. These results indicate that although the automated system provided greater cutting precision, it required a longer processing time because the cable-feeding and cutting mechanisms were controlled sequentially through the PLC and pneumatic actuator.

The electrical energy consumption of the system was calculated based on voltage, current, and operating time. Based on the current measurements under the tested operating conditions, the energy consumption ranged from 740,960 to 769,120 Joules (0.206–0.214 Wh) for cutting a 1,600 cm cable and from 2,016,337 to 2,092,968 Joules (0.560–0.581 Wh) for cutting a 3,200 cm cable. These results indicate that longer cable lengths require greater electrical energy consumption because of the increased operating time.

REFERENCE

Agnihotri, S. P., & Joshi, M. P. (2024). Alternating current servo motor and programmable logic controller coupled with a pipe cutting machine based on human-machine interface using dandelion optimizer algorithm-attention pyramid convolution neural network. *AIMS Electronics & Electrical Engineering*, *8*(1), 1.

Berlianti, R., & Nasrul, N. U. (2020). Perancangan Alat Pemotong Kabel Otomatis Berbasis Programmable Logic Controller dengan HMI NB7W-TW00B. *Jurnal Teknologi Manufaktur*, *12*(1).

Bolton, W. (2015). *Programmable Logic Controllers*. Oxford: Newnes/Elsevier.

Da Costa, T. P., da Costa, D. M. B., & Murphy, F. (2024). A systematic review of real-time data monitoring and its potential application to support dynamic life cycle inventories. *Environmental Impact Assessment Review*, *105*, 107416.

Direktorat Pembinaan Sekolah Menengah Kejuruan, Kementerian Pendidikan dan Kebudayaan. (2013). *Perekayasaan Sistem Kontrol Kelas X Semester 1*. Jakarta: Kementerian Pendidikan dan Kebudayaan.

Groover, M. P. (2015). *Automation, Production Systems, and Computer-Integrated Manufacturing*. New Jersey: Pearson.

Nandi, A., Emon, M. M. H., Azad, M. A., Shamsuzzaman, H. M., & Md Mahfuzur Rahman, E. (2024). Developing an extruder machine operating system through PLC programming with HMI design to enhance machine output and overall equipment effectiveness (OEE). *International Journal of Science and Engineering*, *1*(03), 1-13.

Prayogo, H., & Hartayu, R. (2023). Design and control of an automatic cable-cutting machine with the implementation of a stepper control program using PLC. *Gema Wiralodra*, *14*(3), 1281-1291.

Ramalho, P. M. S., Campilho, R. D. S. G., Silva, F. J. G., Pedroso, A. F. V., & Sales-Contini, R. C. M. (2024). Productivity improvement of control cable manufacturing machine for the automotive industry. *Mechanics Based Design of Structures and Machines*, *52*(12), 9717-9740.

Sehr, M. A., Lohstroh, M., Weber, M., Ugalde, I., Witte, M., Neidig, J., ... & Lee, E. A. (2020). Programmable logic controllers in the context of industry 4.0. *IEEE Transactions on Industrial Informatics*, *17*(5), 3523-3533.

Shaheed, B. N., & Selman, N. H. (2023). Developing the control system for the old indus-trial machines using PLC and IIOT. *Int J Circuit Comput Networking*, *4*(2), 13-20.

Siemens, A. G. (2021). *Real Time Automation and Control Systems: Industrial Implementation Guide*. Siemens Industry.

Syufrijal, S., Rif'an, M., Prabumenang, A. W. R., & Wicaksono, R. (2021, March). Design and implementation of pipe cutting machine with AC servo motor and PLC based on HMI. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1098, No. 4, p. 042082). IOP Publishing.

Tomar, A., Sood, Y. R., & Tomar, D. S. (2014). An efficient scheme of automation and control for conventional cable manufacturing industry. *IEEE Transactions on Industrial Informatics*, *11*(1), 132-140.

Wahani, R. R., Kimbal, M. E. G., Tumembow, M. N., & Siwi, H. (2026). Programmable Controller and Human-Machine Interface Retrofit for Sheet-Metal Cutting Control. *Educatione*, 731-746.