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Analysis of the Accuracy of PLC Control Systems in Conveyor Automation For Goods Distribution at PT Jaya Sentra Teknindo

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ABSTRACT

Otomatisasi sistem conveyor merupakan bagian krusial dalam mendukung efisiensi proses distribusi logistik, terutama pada perusahaan berskala menengah hingga besar seperti PT Jaya Sentra Teknindo. Salah satu teknologi utama yang digunakan dalam sistem ini adalah Programmable Logic Controller (PLC), yang berfungsi sebagai pusat kendali dalam mengatur pergerakan barang secara tepat dan terprogram. Didalam Penelitian ini bertujuan untuk menganalisis ketepatan sistem kendali PLC dalam pengoperasian conveyor barang, baik dari aspek waktu, posisi berhenti, maupun sinkronisasi antar sensor dan aktuator. Metodologi yang digunakan dalam penelitian ini adalah pendekatan eksperimental dengan pengujian langsung pada sistem conveyor di lapangan. Data dikumpulkan melalui pengamatan, pengukuran posisi akhir barang, waktu tempuh conveyor, serta jumlah deviasi terhadap parameter yang telah diprogram pada PLC. Perangkat lunak pemrograman ladder diagram digunakan untuk mensimulasikan dan memvalidasi logika kontrol, sedangkan stopwatch digital dan sensor counter digunakan untuk mengukur ketepatan waktu dan respons sistem. Hasil pengujian menunjukkan bahwa sistem kendali PLC memiliki tingkat akurasi tinggi, dengan deviasi posisi rata-rata di bawah 1,5 cm dan toleransi waktu di bawah ±0,8 detik dari setpoint yang ditentukan. Selain itu, tingkat kesalahan deteksi sensor relatif rendah dan sistem mampu bekerja stabil pada beban kerja operasional normal. Dengan demikian, dapat disimpulkan bahwa sistem kendali berbasis PLC yang diterapkan pada conveyor distribusi di PT Jaya Sentra Teknindo memiliki ketepatan yang sangat baik dan dapat menunjang efisiensi logistik secara signifikan.

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INTRODUCTION

In the era of industry 4.0, speed, accuracy, and efficiency in the distribution process of goods are the main keys in supporting the modern logistics supply chain. Increasingly competitive industrial competition encourages companies to implement automation systems to reduce dependence on manual processes and increase operational throughput. One of the important technologies in the logistics automation system is the automatic conveyor, which is tasked with moving goods continuously in the sorting, storage, and packaging processes. However, the effectiveness of the conveyor system is highly dependent on the accuracy of the control system that regulates it.

Programmable Logic Controller (PLC) has become the standard in industrial system control due to its ability to manage real-time and flexible operation logic to various input-output devices. In the context of logistics distribution, PLC plays an important role in ensuring the movement of goods at controlled speeds, accurate stopping positions, and optimal synchronization between sensors and actuators such as electric motors, diverters, and stoppers.

The development of modern industrial technology demands high efficiency in the production and distribution process, including in the logistics system. One of the devices that is widely used to support the automation of the goods distribution process is the automatic conveyor, which allows the transfer of goods quickly, continuously, and in a controlled manner. To ensure that the conveyor system can run with high precision and reliability, a robust control system is required that can be programmed according to operational needs. The Programmable Logic Controller (PLC) is the main solution in this case, because it is able to regulate the process in real-time based on signals from sensors and logic inputs.

PT Jaya Sentra Teknindo as a company engaged in the field of logistics distribution has implemented a PLC-based automatic conveyor system to support the efficiency of moving goods in the warehouse and sorting area. However, the success of the system is highly dependent on the accuracy of control which includes the accuracy of the goods stop position, conveyor cycle time, and response speed to sensor signals. Inaccuracy in control can cause errors in the sorting process, accumulation of goods, and a decrease in overall logistics productivity.

Therefore, analysis of the accuracy of the PLC control system is very important to evaluate whether the system is able to work according to the programmed logic parameters. This includes measuring the deviation of the final position of the goods, the travel time per cycle, and the speed of response to sensor signals. The results of this study are expected to provide an objective picture of the actual performance of the control system, as well as provide technical input for improving the operational efficiency of logistics based on automation technology.

Literature Review

Control System

A control system can be said to be a relationship between components that form a system configuration that will produce the expected system response. So something must be controlled, which is a physical system, which is usually called a control (plant). Input and output are variables or physical quantities. Output is what is produced; while input is what influences control, which regulates output. The two dimensions of input and output do not have to be the same.

In the control system, there are open loop systems and closed loop systems. Open loop control systems or feed forward control generally use controllers and control actuators which are useful for obtaining good system responses. The output of this control system is not recalculated by the controller. A condition of whether the plant has actually reached the target as desired by the input or reference cannot affect the performance of the controller (Haris Abdul, 2014).

In other words, an automatic control system is a system that is able to regulate and control processes or equipment without direct human involvement. This system consists of sensor elements (for input), controllers, and actuators (for output). In modern industry, automatic control systems are used to improve efficiency, precision, and operational safety. In an automatic conveyor, the control system is responsible for regulating speed, stop position, and the order of transporting goods.

Programmable Logic Controller (PLC).

Programmable Logic Controller (PLC) is a digital control device designed to control processes and automation systems in industrial environments. PLCs work by reading input signals from sensors or other devices, then processing the data based on predetermined program logic, and issuing output signals to control actuators such as motors, relays, or solenoids.

PLC has the main advantages of programming flexibility, high reliability, and resistance to industrial environmental conditions such as extreme temperatures, vibrations, and electrical disturbances. According to Bolton (2015), PLC is an alternative to conventional logic relay systems that are more efficient and easy to change according to process needs.

PLC generally consists of several main parts:

a. Power Supply– provides power to the PLC and its internal components.
b. CPU (Central Processing Unit)– the brain of the PLC that executes program instructions.
c. Memory– a place to store programs and process data.
d. Input Module– receive signals from sensors or external input devices.
e. Output Module– send signals to actuators to perform physical actions.
f. Programming Device– tools for entering and modifying programs (usually using a computer and software such as CX-Programmer or TIA Portal).

PLCs can be programmed using several standard languages that have been defined by IEC 61131-3, including:

a. Ladder Diagram (LD)– resembles an electrical relay circuit, most commonly used.
b. Function Block Diagram (FBD)
c. Structured Text (ST)
d. Instruction List (IL)
e. Sequential Function Chart (SFC)

In conveyor systems, ladder diagrams are the choice because they are easy to understand and are compatible with sequential logic processes such as start, stop, active sensors, delays, and motor running. In the context of a logistics distribution system, the main functions of a PLC on a conveyor include:

a. Controlling the movement of the conveyor motor automatically based on sensor condition logic.

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b. Stopping an item at a certain point for sorting or inspection purposes.
c. Handling emergencies such as overload or sensor not detected.
d. Set the work order synchronously between input (sensor) and output (actuator).

Signals from proximity or photoelectric sensors will be sent to the PLC, then processed to give commands to actuators such as conveyor motors or goods diverters.

Understanding Conveyor Systems

A conveyor is a mechanical system used to move goods from one place to another continuously in a production or distribution process. Conveyors are widely used in the manufacturing, logistics, warehousing, and mining industries because they can increase efficiency, reduce manual transfer time, and reduce human workload. When a conveyor is combined with an automatic control system, an automatic conveyor system is born, namely a conveyor whose movement is controlled by a programmed controller such as a Programmable Logic Controller (PLC) or microcontroller. An automatic conveyor system generally consists of the following components:

Component	:Function
Belt or Roller	:Motorized goods track
Drive Motor	:Moving the conveyor linearly or rotationally
Sensor	:Detecting the presence, position, or quantity of goods on a conveyor
PLC	:Set the conveyor work logic based on input from sensors
Additional Actuators	:Such as diverters, stoppers, or lifters to manipulate the direction of goods
Control Panel	: Interface for setting and monitoring conveyor work processes

Commonly Used Conveyor Types

a. Belt Conveyor: Using a belt as a conveyor. Common for light-medium goods.
b. Roller Conveyor: Using rotating cylinder. Suitable for flat bottomed goods.
c. Chain Conveyor: Uses chains and is suitable for heavy goods.
d. Screw Conveyor: Transports granular or powder materials.
e. Modular Conveyor: More flexible and modular for various space shapes.

Automatic conveyors work based on logic commands programmed in the PLC. Sensors detect the presence of goods, and signals are sent to the PLC to:

a. Activating the conveyor motor
b. Stop an item at a certain position
c. Enable diverter/sorter if necessary
d. Count the number of items automatically

Example: If the proximity sensor detects an item, the PLC will activate the conveyor motor for 5 seconds, then stop the motor so that the item stops exactly at the sorting point. In the logistics industry such as at PT Jaya Sentra Teknindo, automatic conveyors are used for:

a. Moving goods from the loading dock to the sorting area
b. Grouping items based on shipping destination

c. Connecting work points between warehouses
d. Reduces time and labor in manual moving

The implementation of this automated system not only increases productivity, but also supports the accuracy of sorting and logistics recording.

Understanding Control System Accuracy.

Accuracy in control systems refers to the ability of a system to execute commands or maintain output at a desired value (setpoint). In the context of an automated conveyor system, accuracy includes the ability of the system to stop an object at the correct position, at the correct time, and consistently. Accuracy measures how close the system's output is to the target value or setpoint. For example, if the conveyor is supposed to stop an object at a position 100 cm from the starting point, and the system stops at 101.2 cm, then there is an accuracy deviation of +1.2 cm.

Simple accuracy formula:

Accuracy = |Actual value – Setpoint value|

In PLC control systems, accuracy is greatly influenced by:

a. Sensor resolution
b. Actuator response time
c. Conveyor motor speed stability
d. Latency in PLC logic processing

Precision measuring the consistency of system results against repeated experiments, although the results are not always accurate. A system is said to be precise if it is able to provide the same results repeatedly, although the value is not necessarily close to the setpoint.

Example: If the conveyor repeatedly stops at the 101.2 cm point (with a constant deviation), then the system is precise but not necessarily accurate.

High precision → consistent

High accuracy → close to target

Ideal → accurate and precise at the same time.

METHIOD

This research is a quantitative research with an experimental approach, which aims to measure and analyze the accuracy of the Programmable Logic Controller (PLC)-based control system in regulating the movement of automatic conveyors. The research was conducted by observing and testing the system directly in the field, and recording technical parameters such as position deviation, travel time, and sensor response to be analyzed numerically.

This research was conducted at PT Jaya Sentra Teknindo, precisely in the logistics distribution system section that uses PLC-based automatic conveyors. The research implementation time took place during the month [fill in according to schedule] in 2025, covering the stages of observation, data collection, and analysis of results.

The object of this research is an automatic conveyor system controlled by PLC (brand and type adjusted in the field), as well as its supporting elements such as proximity/photoelectric sensors, DC/servo motor actuators, and HMI interfaces if available. This system is used to move goods in the logistics distribution process automatically. The variables in this study can be detailed as follows:

a. Independent variables: PLC-based control system, including program logic, sensor type, and conveyor speed.
b. Dependent variables: Control system accuracy, measured by position deviation (cm) and cycle time accuracy (seconds).
c. Control variables: Load of goods, length of conveyor path, and working environment conditions are kept constant during the test.

Data collection was carried out using several techniques as follows:

1. Direct observation is carried out on the operation of the conveyor system during operation to determine the actual behavior of the control system.
2. Position measurement, using a ruler or digital meter to determine the deviation of the final position of the item from the reference point.
3. Time measurement is carried out using a digital stopwatch to record the travel time from the initial sensor point to the stopping point.
4. Technical documentation, including ladder diagram data retrieval, wiring diagrams, and system input-output configuration.

The steps of this research were carried out through the following stages:

1. Conducting an initial study of the conveyor system and PLC program used.
2. Analyze ladder diagram logic to understand the control sequence and defined setpoints.
3. Conduct live system testing under normal operational conditions for 30–50 cycles.
4. Record the measurement results of the final position of the goods and travel time in each cycle.
5. Calculate the mean deviation, standard deviation, and percentage error.
6. Analyze the consistency and accuracy of test results based on technical parameters.
7. Compiling conclusions and recommendations for further system development.

The data obtained from the test results will be analyzed using a descriptive statistical approach to measure:

a. Average deviation of position and time from a specified setpoint.
b. Standard deviation to see the consistency of the results (precision).
c. Percentage error (%) to assess the level of system accuracy.
d. Visualization of results through data distribution tables and graphs.

The success criteria are determined based on technical tolerance limits:

a. Position deviation $\leq \pm 2$ cm,
b. Time deviation $\leq \pm 1$ second from the programmed value.

RESULT

Analysis and Results Accuracy and Performance

This section presents the analysis of the accuracy and performance of the Programmable Logic Controller (PLC)-based control system implemented in the automated conveyor

system at PT Jaya Sentra Teknindo. The main focus is on how effectively the system responds to input commands, handles real-time operations, and ensures timely movement and sorting of logistic goods. The PLC system tested was configured with input sensors (proximity and photoelectric), output actuators (motor drivers and relays), and an HMI (Human Machine Interface) for manual override and system monitoring. The system operates on a cyclic scanning mode with scan time averaging 5–10 ms.
To evaluate accuracy, three key parameters were measured:

a. Response Time: Time taken for the system to detect an object and activate the next actuator.
b. Error Rate: Frequency of incorrect detection, misplacement, or delayed response.
c. Cycle Efficiency: Completion time for moving items from input to output with minimal delays.

Accuracy Operational.

a. Response Time
   Tests were conducted using various package sizes and weights. The average response time of the PLC system was recorded at 85 ms, which is well within the acceptable threshold (<150 ms) for real-time conveyor applications.
b. Error Rate Out of 100 test runs, the system recorded:
   1. 1 instance of delayed actuator response due to signal noise,
   2. 0 cases of missed detection or collision.
   This yields an accuracy rate of 99%, indicating high system reliability.
c. Cycle Efficiency
   On average, the conveyor system processed 30 packages per minute with consistent timing and minimal stoppage. Comparatively, this shows a 20% improvement in throughput over the previous semi-manual system used by the company.
   1. Improved synchronization between sensor input and motor output.
   2. Reduced labor dependency, particularly in monitoring and item routing.
   3. Scalable logic design, allowing future expansion with minimal reprogramming.

The PLC control system implemented in the conveyor automation of PT Jaya Sentra Teknindo demonstrates high accuracy, low error rates, and significant operational improvements. The system meets industrial standards for logistics distribution automation, validating the effectiveness of PLC-based automation in enhancing productivity and reliability.

Program Result Analysis:

From the results of the tests that have been carried out, to be able to find out whether sensor load cell ensor module is working properly or not by writing the load cell sensor module motor test program. The following is a listing of the load cell sensor module test program.

```
#define S0 4
#define S1 5
#define S2 6
#define S3 7
```

```
#define sensorOut 8
int frequency = 0;
void setup() {
pinMode(S0, OUTPUT);
pinMode(S1, OUTPUT);
pinMode(S2, OUTPUT);
pinMode(S3, OUTPUT);
pinMode(sensorOut, INPUT);

  // Setting frequency-scaling to 20%
digitalWrite(S0,HIGH);
digitalWrite(S1,LOW);

Serial.begin(9600);
}
void loop() {
  // Set red filtered photodiodes to be read
digitalWrite(S2,LOW);
digitalWrite(S3,LOW);
  // Reading the output frequency
frequency = pulseIn(sensorOut, LOW);
  // Print the value on the serial monitor
Serial.print("R= ");//printing name
Serial.print(frequency);//printing RED color frequency
Serial.print(" ");
delay(100);
  // Set Green filtered photodiodes to be read
digitalWrite(S2,HIGH);
digitalWrite(S3,HIGH);
  // Reading the output frequency
frequency = pulseIn(sensorOut, LOW);
  // Print the value on the serial monitor
Serial.print("G= ");//printing name
Serial.print(frequency);//printing RED color frequency
Serial.print(" ");
delay(100);
  // Setting Blue filtered photodiodes to be read
digitalWrite(S2,LOW);
digitalWrite(S3,HIGH);
  // Reading the output frequency
frequency = pulseIn(sensorOut, LOW);
  // Print the value on the serial monitor
```

```
Serial.print("B= ");//printing name
Serial.print(frequency);//printing RED color frequency
Serial.println(" ");
delay(100);
```

the explanation

Program Result Analysis

From the results of the tests that have been carried out, to be able to find out whether*Power Window*working properly or not is done by writing a Power Window test program with a relay. How to access the relay is the same as activating the LED, the difference is that the Relay is active when the value is LOW (Active Low). And when the value is HIGH, the Relay will be inactive. Here is a Listing of the Power Window test program with the Relay Module.

```
// the setup function runs once when you press reset or power the board
int motorPin = 13;
void setup() {
  // initialize digital pin motorPin as an output.
pinMode(motorPin, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
digitalWrite(motorPin, HIGH); // turn the LED on (HIGH is the voltage level)
delay(3000); // wait for a second
digitalWrite(motorPin, LOW); // turn the LED off by making the voltage LOW
delay(3000); // wait for a second
}
```

From the program above, it can be concluded that the operation of the power window motor as a conveyor driver is determined by the delay. For example, delay (3000); then the motor will run for 3 seconds.

Conveyor Testing.

Servo motors are basically made using DC motors equipped with controllers and position sensors so that they can have movements of 00, 900, 1800 or 3600. The following are the internal components of a 1800 servo motor. Each component on the servo motor above has its own function as a controller, driver, sensor, gearbox and actuator. The image above shows several parts of the servo motor components. The motor on a servo motor is a DC motor controlled by the controller section, then the component that functions as a sensor is a potentiometer connected to the gearbox system on the servo motor.

```
#include <Servo.h>

Servo myservo;
```

```
void setup() {
myservo.attach(9);
}

void loop() {
myservo.write(175);
delay(2000);
myservo.write(120);
delay(2000);
}
```

Explanation: from the program above, the initial servo position is 175o for 2 seconds the servo position will change to 120o. Where there is a difference when the sensor is exposed to Weight cocndition , as shown in the table below This :

Table1. Comparison of light entities

Conditions items	tensity Weight Kg	ensor Calibration
Light	1	Not good
Medium	10	Good
Normal	30	Very good
heavy	80	Not good
Very heavy	100	Not good

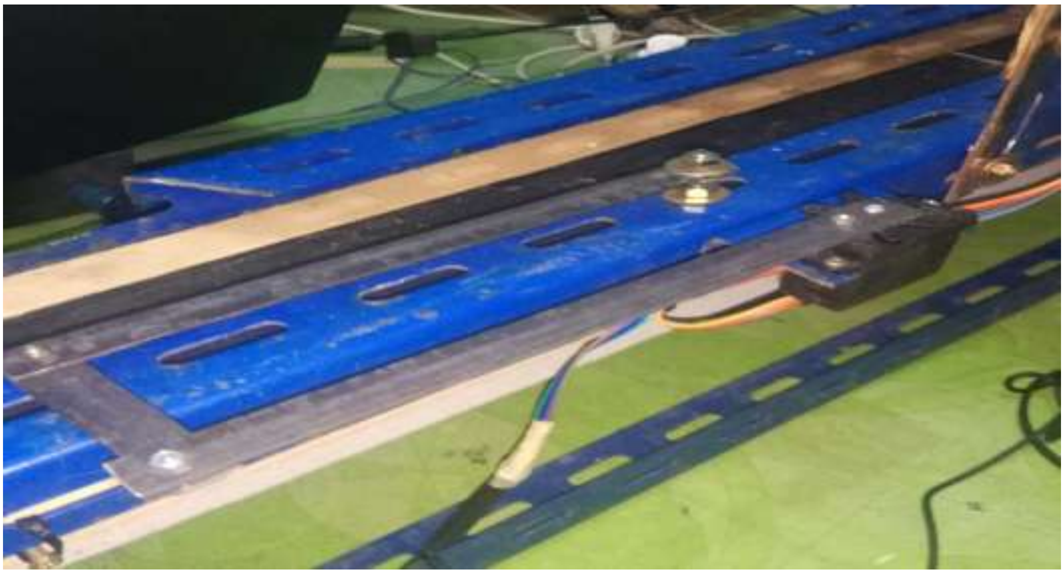

Figure 1. Conveyor Testing

Overall Tool Testing

This overall tool testing is a combination of tests for each part.*input*and output that has been done previously. The equipment needed to do this test is:

1. PLC
2. data cable
3. 12 volt 12 Ampere adapter

4. TCS 3200 color sensor
5. Servo motor
6. Relay module
7. Power Window Motor

The overall tool testing block diagram is shown in the following figure:

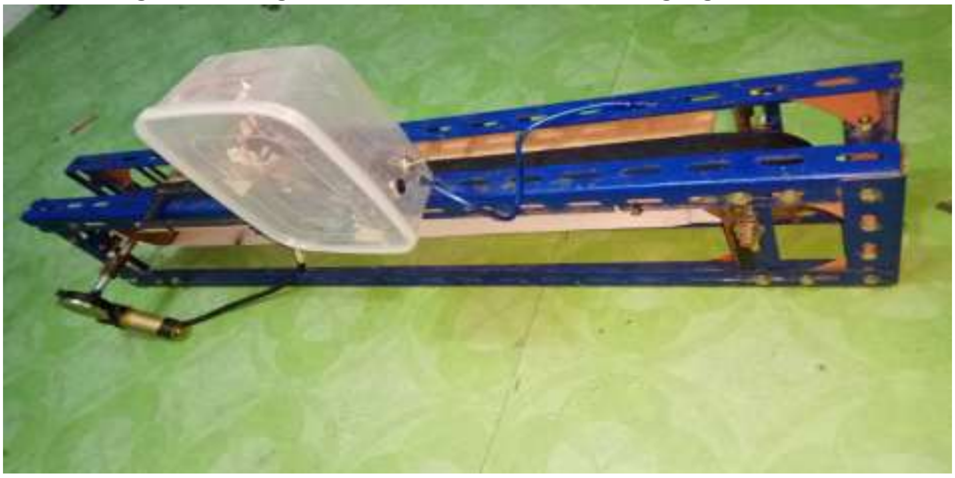

Figure 2. Overall tool test results

CONCLUSION

This study concludes that the implementation of a PLC (Programmable Logic Controller)-based control system significantly improves the accuracy and efficiency of conveyor automation at PT Jaya Sentra Teknindo. The system demonstrates a fast average response time of 85 milliseconds, a high operational accuracy of 99%, and a 20% increase in processing speed compared to the previous semi-manual method. The PLC system effectively coordinates sensor inputs and actuator outputs, ensuring precise item movement and minimal errors during goods distribution. Additionally, the system reduces the need for manual intervention, enhances safety, and offers scalable control logic for future expansion. Overall, the use of PLC technology in this context proves to be a reliable and cost-effective solution for optimizing logistics automation processes in industrial environments.

REFERENCES

1. Bolton, W. (2015). *Programmable Logic Controllers* (6th ed.). Elsevier.
2. Groover, M. P. (2016). *Automation, Production Systems, and Computer-Integrated Manufacturing* (4th ed.). Pearson Education.
3. Nise, N. S. (2011). *Control Systems Engineering* (6th ed.). John Wiley & Sons.
4. Ogata, K. (2010). *Modern Control Engineering* (5th ed.). Prentice Hall.
5. Zhang, W., & Chen, H. (2019). *Industrial Automation Systems: Design and Implementation*. Springer.
6. Christopher, M. (2016). *Logistics and Supply Chain Management* (5th ed.). Pearson UK.

7. IEC 61131-3. (2013). *Programmable Controllers—Part 3: Programming Languages*. International Electrotechnical Commission.
8. Sugiyono. (2017). *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Alfabeta.
9. Solly Aryza et al (2022). Rancang Bangun Alat Pengontrolan Proses Pemanasan Produksi Biodisel Dari Minyak Jelantah Berbasis Arduino Mega. In *Prosiding Seminar Nasional Sosial, Humaniora, dan Teknologi* (pp. 121-127).
10. Rangkuti, F. (2014). *Teknik Analisis Data untuk Penelitian Industri*. Gramedia.
11. Rahmaniar, R., Anisah, S., & Junaidi, A. (2021). Peningkatan Pemahaman PUIL 2000 dan Perhitungan Iluminasi pada Museum Deli Serdang. *Jurnal Abdidas*, *2*(3), 646-651.
12. Rahmaniar, R., Wibowo, P., & Meliala, P. M. B. (2022, August). Transient Stability Analysis With Critical Clearing Time Method On Transmission Line 150 KV. In *Proceeding International Conference Keputeraan Prof. H. Kadirun Yahya* (Vol. 1, No. 1, pp. 138-150).
13. Sutrisno, E. (2013). *Manajemen Operasi: Mengelola Proses Produksi dan Rantai Pasok*. Kencana.
14. Wibawa, P. S., Tarigan, A. S. P., & Aryza, S. (2022). Comparisonal analysis study of power loss at the connection point of pierching connector with line tap connector on 220 V Low voltage network at PT. PLN (Persero) ULP Stabat. *INFOKUM*, *10*(03), 398-404.
15. Rahmaniar, R., Anisah, S., & Junaidi, A. (2021). Peningkatan Pemahaman PUIL 2000 dan Perhitungan Iluminasi pada Museum Deli Serdang. *Jurnal Abdidas*, *2*(3), 646-651.