Journal of Information System Research (JOSH)
Volume 6, No. 1, Oktober 2024, pp 108−116
ISSN 2686-228X (media online)
https://ejurnal.seminar-id.com/index.php/josh/
DOI 10.47065/josh.v6i1.5920

Real-Time Integration of PLC and ERP Odoo for Enhanced Production Monitoring Using OEE in a Bottle Sorting Plant

Mashudi Asnawi[1], Tri Siwi Agustina[1], Muhammad Mustajib[1], Muhammad Rafi Solakhudin[2,*]

[1]Management Department, Airlangga University, Surabaya
Jl. Keputih Tegal No.52, RT.001/RW.06, Keputih, Kec. Sukolilo, Surabaya, Jawa Timur, Indonesia
[2]Automation Engineering, Shipbuilding Institute of Polytechnic Surabaya, Surabaya
Jl. Keputih Tegal No.52, RT.001/RW.06, Keputih, Kec. Sukolilo, Surabaya, Jawa Timur, Indonesia
Email: [1]mashudi.asnawi75@gmail.com, [2]siwi@feb.unair.ac.id, [3]ajibmustajib14@gmail.com, [4,*]m.rafisolakhudin@gmail.com
Correspondence Author Email: m.rafisolakhudin@gmail.com
Submitted: **15/09/2024;** Accepted: **09/10/2024;** Published: **14/10/2024**

Abstract−The integration of Operational Technology (OT) and Information Technology (IT) plays a pivotal role in optimizing enterprise-level decision-making, improving company efficiency and productivity. In this research, a software connector was designed to link Programmable Logic Controllers (PLCs) with Odoo's Enterprise Resource Planning (ERP) system, facilitating real-time data acquisition from industrial machines. The integration supports communication protocols such as Modbus TCP/IP, Ethernet IP, and Profinet, enabling seamless data flow between OT and IT systems. To demonstrate this integration, a bottle sorting plant controlled by a PLC was developed, with production data transmitted in real-time to Odoo ERP. The Overall Equipment Effectiveness (OEE) method was employed within a custom-built manufacturing module in Odoo to monitor key performance metrics, including Availability, Performance, and Quality. Results of the OEE analysis were cross-verified with manual calculations, showing a 0% discrepancy, thus ensuring accuracy. In addition, the OEE metrics were visualized in Grafana, where real-time monitoring revealed the sorting machine's OEE at 85.7%, placing it in the world-class category. Availability reached 96.67%, Performance was at 92.53%, and Quality measured at 95.7%. This system not only streamlined production processes but also provided actionable insights, enabling the company to make data-driven improvements. The findings of this research highlight the benefits of IT-OT integration, improving machine performance and serving as a vital tool for evaluating production efficiency at the enterprise level.

Keywords: Integration; Software Connector; OEE

1. INTRODUCTION

The rapid evolution of industrial automation systems since the early 20th century has forced companies to continuously improve their production efficiency and effectiveness to remain competitive, particularly with the rise of Industry 4.0[1]. In this new era, digital transformation has become essential, integrating digital technologies into all aspects of company operations to ensure timely and accurate data reporting[2]. However, many manufacturing companies still rely on manual data input and reporting, which not only increases the likelihood of human error but also introduces data inconsistencies between departments, potentially leading to costly mistakes in decision-making[3].

The growing complexity of modern production lines, which are integral to generating products, combined with the increasing use of machinery, makes the risk of performance degradation a critical issue[4]. This decline in machine performance can negatively impact both productivity and product quality over time. Therefore, implementing a robust monitoring system that tracks machine efficiency and performance is crucial. The Overall Equipment Effectiveness (OEE) method is recognized as a highly effective tool for evaluating production line performance and identifying areas for improvement[5].

To address the limitations of manual data reporting and to enhance production monitoring, an innovative approach that integrates Operational Technology (OT) and Information Technology (IT) is proposed. OT systems, such as SCADA, PLCs, sensors, and motors, manage production equipment, while IT systems, including ERP platforms like Odoo and monitoring tools like Grafana, handle business and production data. By integrating OT and IT, companies can streamline data flow from the factory floor to enterprise-level applications, eliminating manual data entry and improving decision-making based on real-time information[6].

This integration is achieved through the development of a software connector that links data from PLCs to Odoo ERP[7]. The system supports multiple communication protocols, including Modbus TCP/IP, Ethernet IP, and Profinet, ensuring compatibility with various PLC brands. A prototype bottle sorting system was designed to validate the proposed integration, capturing operational data such as machine run-time and bottle volume, which was then analyzed using the OEE method within the Odoo ERP. This data was also visualized in real-time using Grafana, enabling efficient and informed decision-making[8].

Previous studies have focused on individual aspects of IT or OT, such as ERP module development or basic SCADA integration, but have not addressed the full potential of IT-OT integration[9]. This research aims to bridge that gap by designing a comprehensive IT-OT integration system, offering a more advanced solution for monitoring and improving production processes in industrial environments[10]. By ensuring real-time, accurate data reporting, this system represents a significant advancement in the drive toward achieving greater production efficiency and quality in Industry 4.0[11].

Journal of Information System Research (JOSH)
Volume 6, No. 1, Oktober 2024, pp 108−116
ISSN 2686-228X (media online)
https://ejurnal.seminar-id.com/index.php/josh/
DOI 10.47065/josh.v6i1.5920

2. RESEARCH METHODOLOGY

In this research, the Overall Equipment Effectiveness (OEE) method is implemented in a bottle sorting plant to monitor total production output and duration, particularly within the Quality Control (QC) section. The plant operates with a Schneider PLC using the Modbus protocol, which collects production data via a software connector and transmits it to the Odoo ERP system for OEE analysis[12] [13]. To ensure the software connector's capability to gather data through multiple protocols, a dummy program was developed on a Siemens PLC utilizing the Profinet protocol and an Allen Bradley 1756-L62 PLC employing Ethernet/IP. This integration allows users to automatically assess machine effectiveness and efficiency based on established OEE standards, facilitating enhanced monitoring of the bottle sorting process[14].

2.1 The Overall System Design

This research is structured around four key components: hardware, API service, Odoo ERP, and Grafana. The hardware includes a bottle sorting plant and a control panel equipped with both a PLC and Arduino. As illustrated in Figure 1, the data flow begins with input and output signals from sensors and actuators integrated into the bottle sorting plant, which is managed by a Siemens PLC. The collected data is transmitted via an API service to the Odoo ERP system, where it is processed and subsequently displayed on Grafana. Additionally, the system architecture can be divided into three main sections: hardware, software connector, and Odoo ERP. The hardware setup involves the bottle sorting plant and a control panel containing the PLC, while dummy production data is provided by a Siemens PLC and an Allen Bradley PLC for validation purposes. This data is transmitted to the Odoo ERP using the software connector and API service for further analysis [15][16].

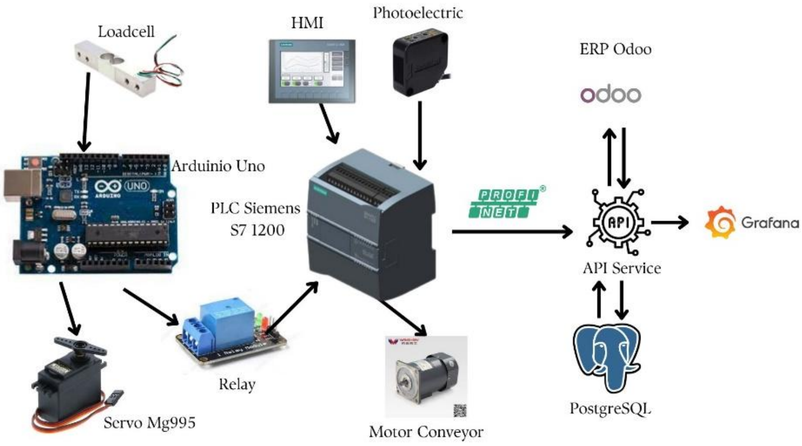

Figure 1. Diagram Block System

2.2 Hardware Design

The hardware in this research consists of the bottle sorting plant and workflow process, as shown in Figures 2 and 3. The bottle sorting plant is equipped with 2 photoelectric sensors to differentiate between good and bad products and to trigger the rejector, 2 proximity sensors to measure cycle time and count the actual output, and a push-pull type solenoid actuator to reject bad products. The plant also includes push buttons to control the conveyor operation and indicator lights to signal the conveyor's status. Clear bottles are categorized as good products, while black bottles are categorized as bad products[15][17].

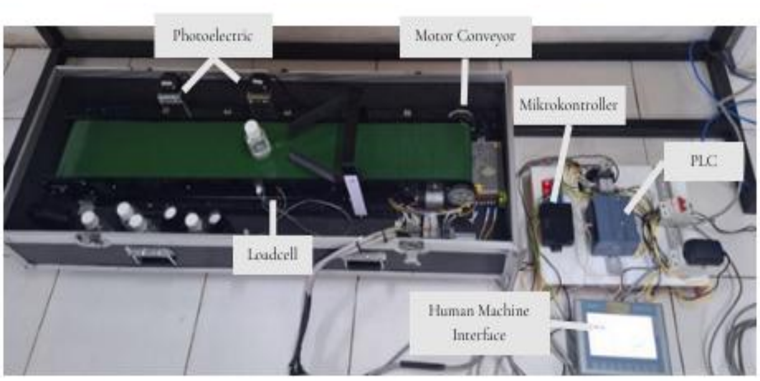

Figure 2. Bottle Sorting Plant

Journal of Information System Research (JOSH)
Volume 6, No. 1, Oktober 2024, pp 108−116
ISSN 2686-228X (media online)
https://ejurnal.seminar-id.com/index.php/josh/
DOI 10.47065/josh.v6i1.5920

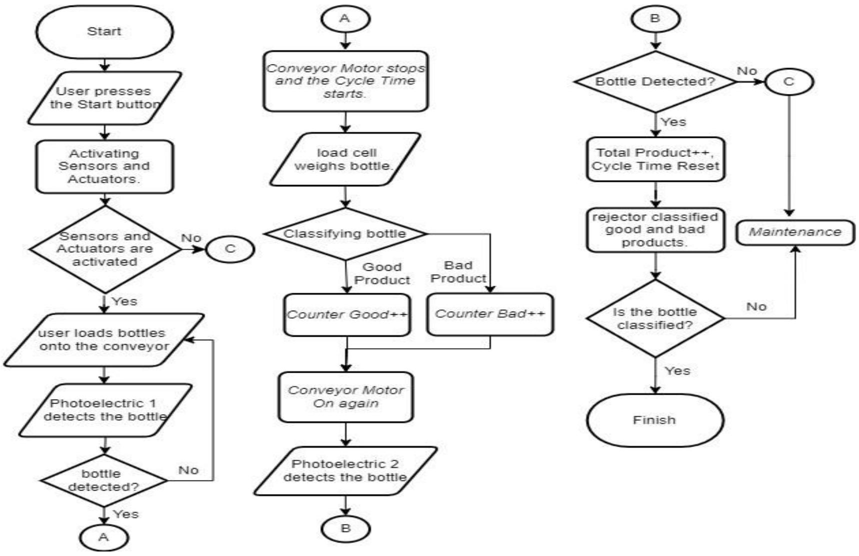

Figure 3. Workflow bottle sorting plant

The control panel itself consists of a Schneider PLC, a Siemens PLC, and an Allen Bradley PLC. For controlling the bottle sorting plant, I/O mapping is required for the sensors and actuators. In this research, only digital input and digital output channels are used. Table 1 shows the I/O mapping used in the Schneider PLC[18].

Table 1. Mapping I/O PLC Schneider

No	PLC	Hardware	Address
1	I0	Sensor Photoelectric 1	%I0.0
2	I1	Sensor Photoelectric 2	%I0.1
3	I2	Push Button Start	%I0.2
4	I3	Push Button Stop	%I0.3
5	I4	Proximity Sensor 1	%I0.4
6	I5	Proximity Sensor 2	%I0.5
7	Q0	Conveyor	%Q0.0
8	Q1	Rejector	%Q0.1
9	Q2	Lamp Indicator ON	%Q0.2
10	Q3	Lamp Indicator OFF	%Q0.3

2.3 Software Connector Design

The design of the software connector in this research is based on a use case, as illustrated in Figure 4. The development process begins by assessing user requirements and identifying necessary features. To build the connector, VS Code is used as the debugger, CodeIgniter as the framework, MariaDB as the database system, and Node.js to acquire data from the PLC and send it to Odoo ERP. The software system consists of three main components: the API service, ERP Odoo, and Grafana. The API service was developed using VS Code and Node.js to retrieve data from the Siemens PLC via the Profinet protocol. This data is stored in PostgreSQL, which serves as the database for ERP Odoo, where the OEE method is applied to analyze bottle production results. For monitoring purposes, data from PostgreSQL is sent to Grafana, where it is visualized through graphs, bar charts, and pie charts, showcasing the three key OEE indicators: Availability Ratio, Performance Rate, and Rate of Quality.[7][19].

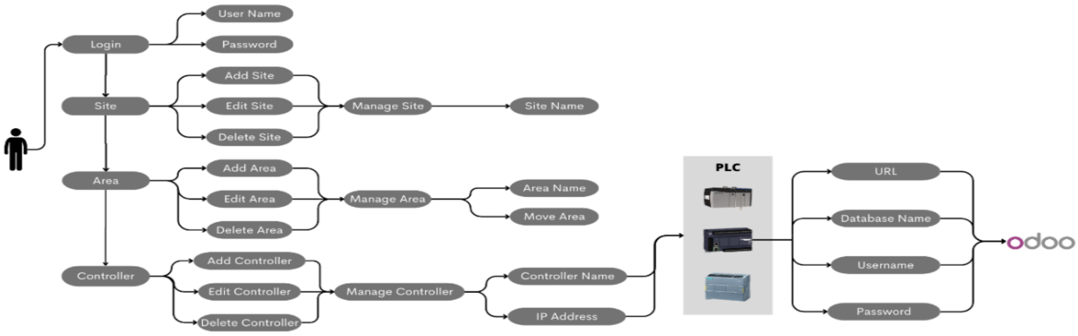

Figure 4. Use Case Software Connector

Journal of Information System Research (JOSH)
Volume 6, No. 1, Oktober 2024, pp 108−116
ISSN 2686-228X (media online)
https://ejurnal.seminar-id.com/index.php/josh/
DOI 10.47065/josh.v6i1.5920

2.4 ERP Odoo Module Design

The ERP Odoo, OEE analysis will be performed on the bottle sorting plant. The testing process is conducted by accessing the database utilized by Odoo itself, namely PostgreSQL. The data sent from the Siemens PLC will be obtained by the API Service. After that, the data will be stored in the database. Furthermore, it will be processed in the Odoo backend using the OEE calculation formula. This backend data will then be displayed in Grafana in the form of tables and charts.[20].

3. RESULT AND DISCUSSION

In this chapter, the discussion will focus on the results of the research and the testing that has been conducted. The testing covers hardware, the software connector, and Odoo ERP.

3.1 Hardware Testing

The hardware testing was carried out to assess the success of integrating the PLC, Arduino, and the bottle sorting plant. The Arduino was programmed to process reading the data from photoelectric and load cell sensors to detect incoming products and activate an actuators to dispose any defect items. The sensor data readings by Arduino was transmitted using relays through the digital inputs available on the PLC. The success of this integration was confirmed by the bottle status readings displayed on the HMI, as shown in Figure 5.

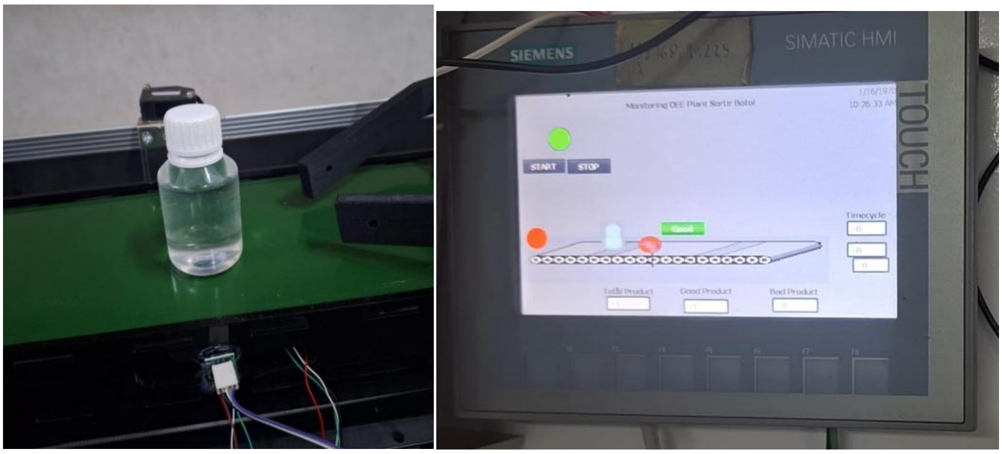

Figure 5. Integration Between PLC and Bottle Sorting Plant

3.2 Software Connector Testing

The testing of the software involves embedding the node.js logic into an executable (.exe) file. During the acquisition process, configuration of the PLC's IP Address, port, rack and slot used in the Profinet protocol is required. The .exe file will execute its logic by retrieving values from the PLC. Parameters that are read on the PLC including the actual output, good product, bad product, planned time, and downtime are used for OEE analysis. The acquired values will then be stored in a PostgreSQL database and processed through ERP Odoo. The following is display of the PLC data acquisition. In addition, it is necessary to configure the data transmission trigger, which can be based on time intervals or sent when only there is incoming data

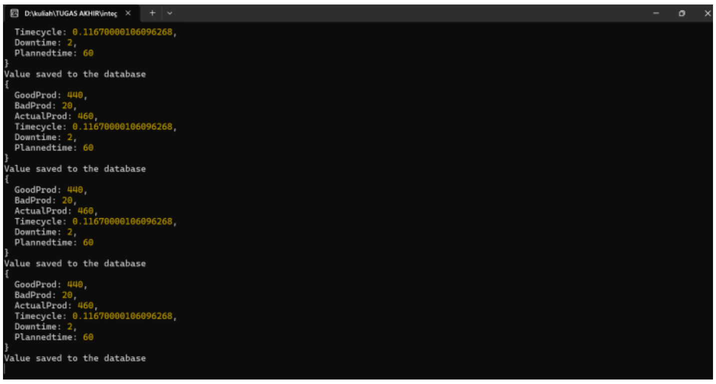

Figure 6. Data Acquisition from Schneider PLC

Figure 6 shows the data acquisition results from Schneider PLC using the Modbus protocol. Parameters read from this PLC include actual output values, good product counts, planned time, and downtime, which are

Journal of Information System Research (JOSH)
Volume 6, No. 1, Oktober 2024, pp 108−116
ISSN 2686-228X (media online)
https://ejurnal.seminar-id.com/index.php/josh/
DOI 10.47065/josh.v6i1.5920

used for OEE analysis. The values obtained are real data from the bottle sorting plant. The acquisition process requires configuring the PLC's IP Address and the Modbus protocol port, as well as setting the data acquisition interval according to requirements.

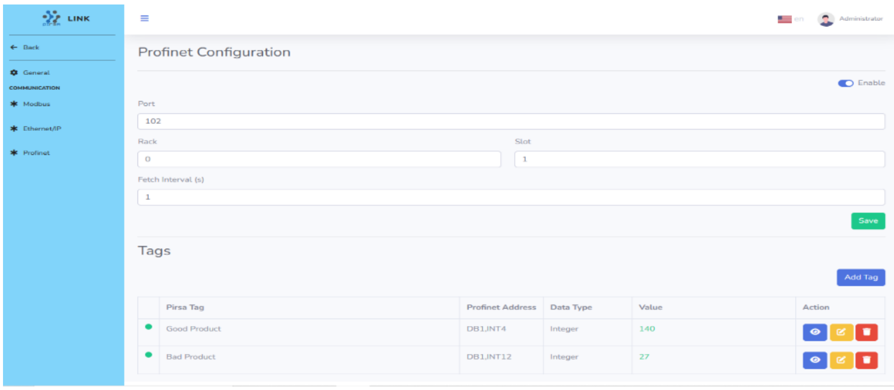

Figure 7. Data Acquisition from Siemens PLC

The results of data acquisition from the Siemens PLC are shown in Figure 7, where dummy data is generated using timer and counter commands. This dummy data simulates reading one good product every 2 seconds, and after 5 good products, the system reads one bad product, repeating this pattern in a loop. The software connector displays both good and bad product counts. For configuring the Profinet protocol, settings such as IP Address, protocol port, PLC rack and slot, and data acquisition interval are required.

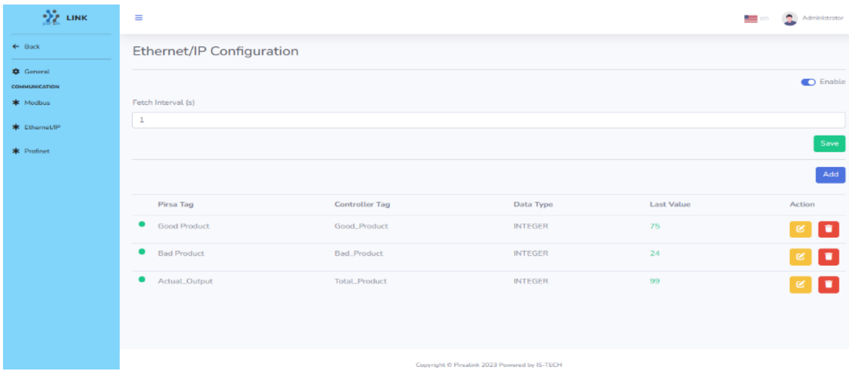

Figure 8 Data Acquisition from Allen Bradley PLC

Figure 8 presents data acquisition from an Allen Bradley PLC using the Ethernet/IP protocol. Similarly, dummy data is used here, with the system simulating a good product reading every 4 seconds. After 3 good products are read, 1 bad product is recorded, and this sequence repeats. The configuration for this protocol is simpler, only requiring the IP Address and data acquisition interval, as the Allen Bradley PLC offers a user-friendly setup.

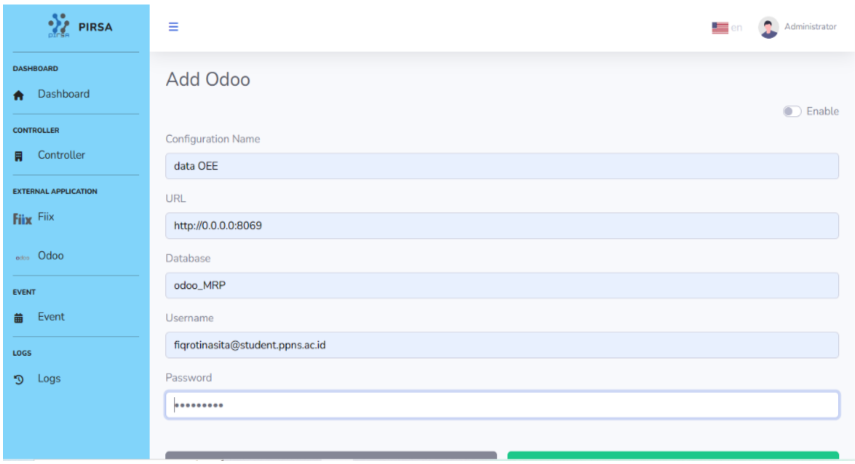

Figure 9. Odoo ERP Account Configuration

Once data has been successfully retrieved from the PLC, the next step involves configuring the Odoo ERP account to receive the production data, as demonstrated in Figure 9.

Journal of Information System Research (JOSH)
Volume 6, No. 1, Oktober 2024, pp 108−116
ISSN 2686-228X (media online)
https://ejurnal.seminar-id.com/index.php/josh/
DOI 10.47065/josh.v6i1.5920

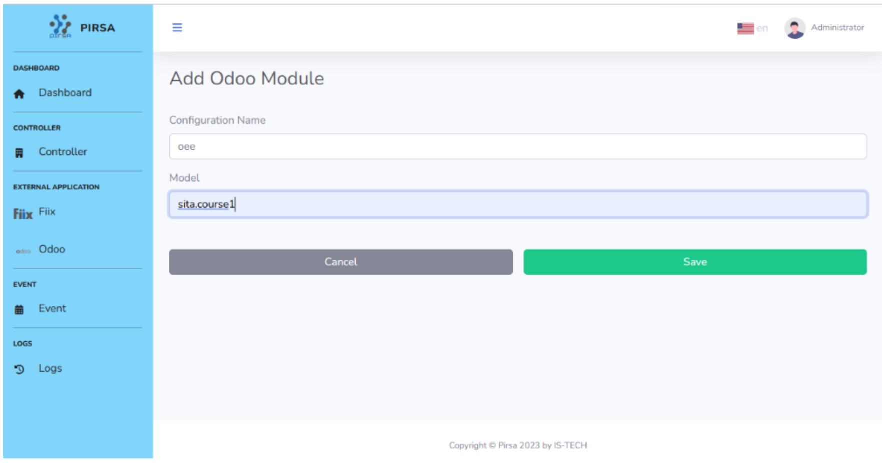

Figure 10. ERP Odoo Module Configuration

Figure 10 shows the setup required to initialize the module where production data will be stored.

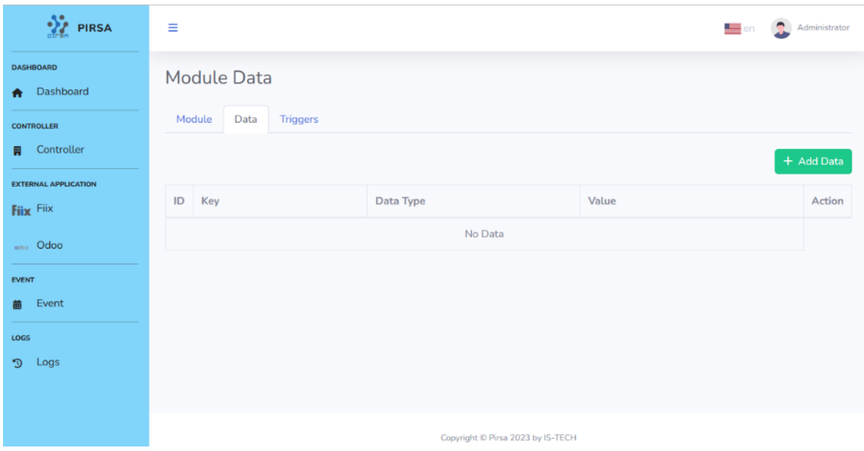

Figure 11. Configuration of Data to be Sent to Odoo ERP

The final step in sending data to Odoo ERP involves specifying details such as the data source, which may come from a Schneider, Siemens, or Allen Bradley PLC, and including the relevant PLC address. Additionally, configurations must be set for triggering data transmission, which can be based either on time intervals or on incoming data events.

3.3 Testing of the ERP Odoo Manufacturing Module

The ERP Odoo, OEE analysis will be performed on the bottle sorting plant. The testing process is conducted by accessing the database utilized by Odoo itself, namely PostgreSQL. The data sent from the Siemens PLC will be obtained by the API Service. After that, the data will be stored in the database. Furthermore, it will be processed in the Odoo backend using the OEE calculation formula. This backend data will then be displayed in Grafana in the form of tables and charts.

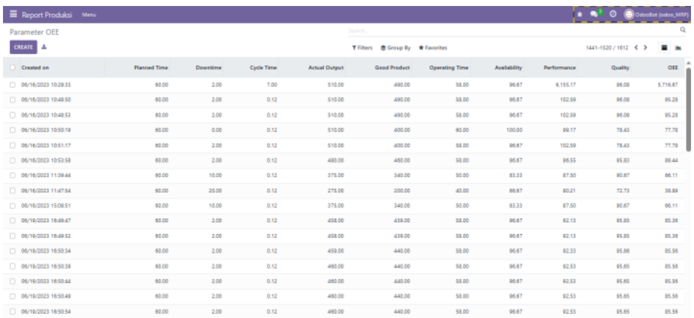

Figure 12. OEE Analysis Results

Figure 12 shows the frontend view of the little MRP manufacturing module displaying real-time production data, including planned time, downtime, actual output, good product, and cycle time. Additionally, OEE analysis results are displayed, including Availability, Performance, Quality, and total OEE.

Journal of Information System Research (JOSH)
Volume 6, No. 1, Oktober 2024, pp 108−116
ISSN 2686-228X (media online)
https://ejurnal.seminar-id.com/index.php/josh/
DOI 10.47065/josh.v6i1.5920

3.3 Grafana Testing

In order to facilitate the process of monitoring the OEE analysis results, a dashboard is created as shown in the image. The dashboard displayed a gauge chart and a bar chart of the OEE calculation results, making it easier to monitor OEE based on real-time data and shift data.

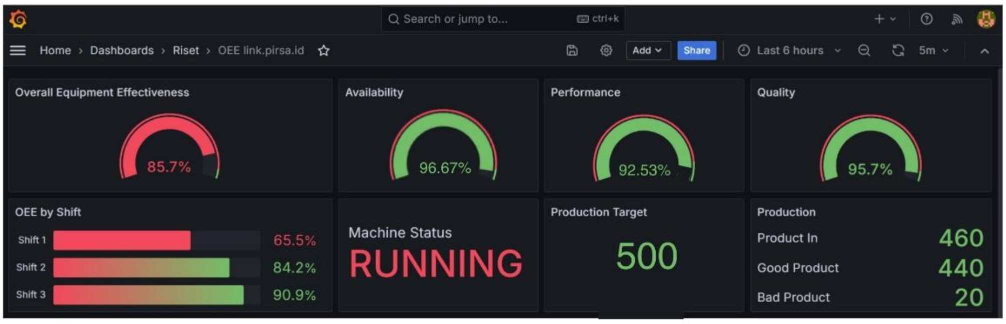

Figure 13. OEE dashboard results on Grafana

3.4 OEE Analysis Result

Data collection from the bottle sorting plant is conducted every hour, reflecting periodic data gathering in the industry corresponding to each shift. The data collected includes the number of good products produced, the number of bad products, downtime duration, production time (Loading Time), and cycle time. The production results are shown in Table 2[4].

Table 2. Data Production Result for OEE Analysis

Data Ke-	Data				
	Loading Time(Menit)	**Cycle Time(Menit)**	**Downtime(Menit)**	**Good Product**	**Actual Output**
1	60	0,116666667	2	440	460
2	60	0,116666667	10	375	340
3	60	0,116666667	20	275	200

Here are the results of the manual calculations of the production data presented in Table 2:

$$A\ (\%) = \frac{\text{Operating Time}}{\text{Loading Time}} \text{ x } 100\ \% \qquad (1)$$

$$= \frac{60-2}{60} \text{ x } 100\ \%$$

$$= 96{,}67\%$$

$$P\ (\%) = \frac{\text{Cycle Time x Actual Output}}{\text{Operating Time}} \text{ x } 100\ \% \qquad (2)$$

$$= \frac{0{,}116666667 \text{x } 460}{60-2} \text{ x } 100\ \%$$

$$= 92{,}53\ \%$$

$$Q\ (\%) = \frac{\text{Good Product}}{\text{Actual Output}} \text{ x } 100\ \% \qquad (3)$$

$$= \frac{440}{460} \text{ x } 100\ \%$$

$$= 95{,}65\ \%$$

After determining the final results for the three OEE variables—Availability, Performance, and Quality—the OEE value based on this data is:

OEE (%) = A x P x Q
= 0,9667 x 0,9253 x 0,9565
= 0,8556
= 85,56 %

Data ke-2:

A (%) = Operating TimeLoading Time x 100 %
= 60-1060 x 100 %
= 83,33%

P (%) = Cycle Time x Actual OutputOperating Time x 100 %
= 0,116666667x 37560-10 x 100 %
= 87,50 %

Journal of Information System Research (JOSH)
Volume 6, No. 1, Oktober 2024, pp 108−116
ISSN 2686-228X (media online)
https://ejurnal.seminar-id.com/index.php/josh/
DOI 10.47065/josh.v6i1.5920

Q (%) = Good ProductActual Output x 100 %
= 340375 x 100 %
= 90,67 %

Once the final values for the three OEE variables—Availability, Performance, and Quality—are determined, the OEE value based on this data is:

OEE (%) = A x P x Q
= 0,8333 x 0,875 x 0,9067
= 0,6611
= 66,11 %

Data ke-3:

$$A\ (\%) = \frac{\text{Operating Time}}{\text{Loading Time}} \times 100\ \%$$
$$= \frac{60-20}{60} \times 100\ \%$$
$$= 66{,}67\%$$

$$P\ (\%) = \frac{\text{Cycle Time x Actual Output}}{\text{Operating Time}} \times 100\ \%$$
$$= \frac{0{,}116666667 \times 275}{60-20} \times 100\ \%$$
$$= 80{,}21\ \%$$

$$Q\ (\%) = \frac{\text{Good Product}}{\text{Actual Output}} \times 100\ \%$$
$$= \frac{200}{275} \times 100\ \%$$
$$= 72{,}73\ \%$$

Once the final values for the three OEE variables—Availability, Performance, and Quality—are determined, the OEE value based on this data is:

OEE (%) = A x P x Q
= 0,6667 x 0,8021 x 0,7273
= 0,3889
= 38,89 %

3.5 Comparison of Manual OEE with ERP Odoo

To validate that the integration system has been successful, a comparison is made between the OEE analysis results displayed in ERP Odoo, shown in Figure 17, and the manual calculations performed. The results of this comparison are presented in Table 3.

06/16/2023 11:47:54	60.00	20.00	0.12	275.00	200.00	40.00	66.67	80.21	72.73	38.89
06/16/2023 15:08:51	60.00	10.00	0.12	375.00	340.00	50.00	83.33	87.50	90.67	66.11
06/19/2023 16:49:47	60.00	2.00	0.12	458.00	439.00	58.00	96.67	92.13	95.85	85.36

Figure 14. OEE Result on ERP Odoo

Table 3. Result Comparison Between OEE Manual and ERP Odoo

Data ke-	OEE (Manual) (%)	OEE (ERP Odoo) (%)	Error (%)
1	85,56 %	85,56 %	0%
2	66,11 %	66,11 %	0%
3	38,89 %	38,89 %	0%

4. CONCLUSION

The successful integration of Information Technology (IT) and Operational Technology (OT) has been achieved through the development of a bottle sorting prototype, where a Siemens PLC utilizing the Profinet protocol serves as the control unit. Production data from this prototype is acquired via an Software connector, which transmits the information to Odoo ERP for analysis using the Overall Equipment Effectiveness (OEE) method. The results are then visualized in real-time on a Grafana dashboard, providing graphical and dashboard formats for better monitoring. This real-time data flow from the PLC to Odoo ERP significantly enhances operational efficiency, ensuring that production processes remain smooth and that product quality is maintained. To ensure the accuracy of the Software connector, a comparison was made between the OEE calculations from the system and manual calculations, resulting in no discrepancies and a 0% error rate. This confirms that the IT-OT integration system is both reliable and effective in its data acquisition and analysis functions. Data acquisition is facilitated by configuring the IP address and port of the PLC, followed by setting up the relevant data addresses and PostgreSQL database parameters. In this study, the Software connector successfully retrieved data from the Siemens PLC using Profinet, further validating the system's capabilities. Additionally, to test the software connector's compatibility with multiple protocols, dummy programs were created for two other PLC types: a Schneider PLC using Modbus

Volume 6, No. 1, Oktober 2024, pp 108−116
ISSN 2686-228X (media online)
https://ejurnal.seminar-id.com/index.php/josh/
DOI 10.47065/josh.v6i1.5920

and an Allen Bradley 1756-L62 PLC using the Ethernet/IP protocol. The successful data acquisition from all three PLCs demonstrates the software connector's versatility in handling different communication protocols. The transfer of production data from the PLC to Odoo ERP was achieved by configuring the necessary account details, such as the Odoo URL, database, username, and password. A custom module within Odoo was developed to store and process the acquired production data, enabling OEE analysis and displaying the results in graphical form. This IT-OT integration system enables real-time data transmission, providing companies with the tools to boost productivity and optimize production efficiency while maintaining high standards of product quality.

REFERENCES

[1] A. P. Teguh, "ANALISIS NILAI OVERALL EQUIPMENT EFFECTIVENESS (OEE) UNTUK MENINGKATKAN EFEKTIVITAS MESIN HEAVY DUTY DI PT. TEMBAGA MULIA SEMANAN, Tbk," J. Ilm. Teknol. dan Rekayasa, vol. 6, hal. 1–13, 2018.

[2] F. N. Asita, M. K. Hasin, Z. Maulana, dan A. Putra, "Pengiriman Data Realtime PLC ke ERP Odoo dengan Dilengkapi Analisa OEE," no. x, hal. 1–13, 2023.

[3] Muhammad Naufal 'Izzudin, "MESIN SAG-MILL MENGGUNAKAN SUPPORT VECTOR REGRESSION," 2023, [Daring]. Tersedia pada: https://repository.its.ac.id/104344/.

[4] M. Dipa, F. D. Lestari, M. Faisal, dan M. Fauzi, "Analisis Overall Equipment Effectiveness (Oee) Dan Six Big Losses Pada Mesin Washing Vial Di Pt. Xyz," J. Bayesian J. Ilm. Stat. dan Ekon., vol. 2, no. 1, hal. 61–74, 2022, doi: 10.46306/bay.v2i1.29.

[5] M. H. A. Soliman, "Overall Equipment Effectiveness Simplified: Analyzing OEE to Find the Improvement Opportunities," no. September, 2020, doi: 10.5281/zenodo.4274026.

[6] A. A. Pangestu et al., "MANAJEMEN PRODUKSI BERBASIS FUZZY TSUKAMOTO," 2022.

[7] B. M. Ridwan, "Penerapan Enterprise Architecture Pada Perusahaan Manufaktur Baja di Era Industri 4.0," JATISI (Jurnal Tek. Inform. dan Sist. Informasi), vol. 9, no. 3, hal. 2652–2663, 2022, doi: 10.35957/jatisi.v9i3.2000.

[8] P. Dix, "InfluxData (InfluxDB) | Time Series Database Monitoring & Analytics," InfluxData, Inc., vol. 12, no. 2, hal. 168–174, 2020, [Daring]. Tersedia pada: https://www.influxdata.com.

[9] R. T. Darmawan, "Implementasi Grafana untuk Auto-Scaling pada NGINX Web-Server di Lingkungan Docker Container," Pengemb. Teknol. Inf. dan Ilmu Komput., vol. 7, no. 7, hal. 3163–3167, 2023.

[10] A. S. George, "The Impact of IT / OT Convergence on Digital Transformation in Manufacturing Partners Universal International Innovation Journal (PUIIJ) The Impact of IT / OT Convergence on Digital Transformation in Manufacturing," no. March, 2024, doi: 10.5281/zenodo.10895704.

[11] L. Lukmandono, E. Sulistyowati, dan ..., "Pendekatan Overall Equipment Effectiveness Dan Response Surface Methodology Dengan Pertimbangan Root Cause Failure Analysis Untuk Meminimalkan Six Big …," Katalog Buku Karya …, hal. 70–112, 2020, [Daring]. Tersedia pada: http://ejurnal.itats.ac.id/buku/article/view/1439/0.

[12] M. Yusri, A. Maulana, A. Fitriati, dan M. Nur, "Rancang Bangun Sistem Sortir Ikan Berdasarkan Berat Berbasis Plc," MAPLE Mechatronics J. Prof. Enterp., vol. 4, no. 2, hal. 48–53, 2022, [Daring]. Tersedia pada: https://jurnal.politeknikbosowa.ac.id.

[13] Tri Baswara Ari Aji, Hamidillah Ajie, dan Murien Nugraheni, "Pengembangan Web Service Aplikasi Manajemen Aset Upt Tik Universitas Negeri Jakarta," PINTER J. Pendidik. Tek. Inform. dan Komput., vol. 6, no. 2, hal. 69–75, 2022, doi: 10.21009/pinter.6.2.9.

[14] R. O. Product et al., "Lembar data produk controller M221 16 IO relay Ethernet," 2023.

[15] R. M. W. N. Slamet Purwo Santosa, "RANCANG BANGUN ALAT PINTU GESER OTOMATIS MENGGUNAKAN MOTOR DC 24 V," J. Chem. Inf. Model., vol. 53, no. February, hal. 2021, 2021, [Daring]. Tersedia pada: https://doi.org/10.1080/09638288.2019.1595750%0Ahttps://doi.org/10.1080/17518423.2017.1368728%0Ahttp://dx.doi.org/10.1080/17518423.2017.1368728%0Ahttps://doi.org/10.1016/j.ridd.2020.103766%0Ahttps://doi.org/10.1080/02640414.2019.1689076%0Ahttps://doi.org/.

[16] F. Y. Hartawan dan M. Galina, "Implementasi Programmable Logic Control (Plc) Omron Cp1E Pada Sistem Kendali Motor Induksi Star-Delta Untuk Kebutuhan Industri," JTT (Jurnal Teknol. Ter., vol. 8, no. 2, hal. 98, 2022, doi: 10.31884/jtt.v8i2.409.

[17] R. Riyandar, M. Wildan, A. Goeritno, dan J. Irawan, "Pengembangan Embedded Device Berbasis PLC untuk Simulator Rejection System dengan Penambahan Human Machine Interface," J. RESTI (Rekayasa Sist. dan Teknol. Informasi), vol. 5, no. 6, hal. 1171–1181, 2021, doi: 10.29207/resti.v5i6.3641.

[18] Eko Saputro, "Perancangan Sistem Kontrol Penstabil Tegangan Menggunakan PLC M221 Pada PLMTH Bintang," J. Ekon. Vol. 18, Nomor 1 Maret201, vol. 2, no. 1, hal. 41–49, 2020.

[19] M. Ridwan, T. H. Sinaga, dan M. Elsera, "Penerapan Framework Codeigniter Dalam Perancangan Aplikasi Manajemen Iuran Perumahan Griya Mandiri," Djtechno J. Teknol. Inf., vol. 3, no. 1, hal. 49–58, 2022, doi: 10.46576/djtechno.v3i1.2196.

[20] I. V. Niţulescu dan A. Korodi, "Supervisory Control and Data Acquisition Approach in Node-RED: Application and Discussions," Internet of Things, vol. 1, no. 1, hal. 76–91, 2020, doi: 10.3390/iot1010005.