Progresif: Jurnal Ilmiah Komputer
Jl. Ahmad Yani, K.M. 33,5 - Kampus STMIK Banjarbaru
Loktabat – Banjarbaru (Tlp. 0511 4782881), e-mail: puslit.stmikbjb@gmail.com
e-ISSN: 2685-0877
p-ISSN: 0216-3284

Production Room Temperature and Humidity Sensor Monitoring System Using Node-Red and Grafana

(Sistem Monitoring Sensor Suhu dan Kelembaban Ruangan Produksi Menggunakan *Node-Red* dan *Grafana*)

Khoirul Anam[1], Difa Nur Rofi[2], Ruci Meiyanti[3*]
Sistem Informasi, Universitas Mercu Buana, Jakarta, Indonesia
*e-mail *Corresponding Author:* ruci@mercubuana.ac.id

Abstract

The clients of the TRIAS smart industry project are facing issues with a decline in the quality of their production output. They require a monitoring system capable of tracking temperature and humidity levels in the production area and providing real-time alarm notifications for both parameters. This poses a challenge for the contractors to develop a monitoring system for temperature and humidity changes using temperature and humidity sensors as the data source. The system should display the data and issue alerts while also reducing material costs. The research methodology used in this study includes qualitative methods, literature review, and the SDLC-Waterfall method. The research outcome is the development of a data visualization application for the sensors, which utilizes Grafana as the visualization tool. The temperature and humidity data collected by the sensors are recorded using Node-Red and synchronized to the server. This data is stored in a MySQL database within the server. The data from the database is then synchronized with Grafana to be processed and visualized in the form of easily understandable graphs, with the aim of reducing material costs.
Keywords: *Grafana; IoT; Monitoring; Node-Red; Temperature and Humidity*

Abstrak

Klien dari project TRIAS smart industry memiliki permasalahan pada hasil produksi yang mengalami penurunan kualitas, mereka membutuhkan sistem monitoring yang bisa memantau Suhu dan Kelembaban pada ruangan produksi, dan memberikan alarm notifikasi suhu dan kelembaban pada ruangan produksi secara realtime. Hal ini menjadi tantangan bagi kontraktor untuk membuat sistem monitoring perubahan suhu dan kelembaban menggunakan alat sensor suhu dan kelembaban sebagai data yang akan ditampilkan dan memberikan peringatan dan melakukan pengurangan biaya pada material. Metode yang digunakan pada penelitian ini adalah metode kualitatif, studi literatur, dan metode SDLC-Waterfall. Hasil penelitian ini membuat sistem aplikasi visualisasi data dari sensor, aplikasi visualisasi tersebut menggunakan Grafana. Data didapat dari sensor suhu dan kelembaban dicatat oleh Node-Red dan disinkronisasi pada Server. Data yang berada di dalam Server, disimpan pada database Mysql. Data dari database, disinkronisasi dengan Grafana untuk diproses dan divisualisasikan untuk menampilkan data berbentuk grafik yang mudah dipahami dengan memangkas biaya material.
Kata kunci: *Grafana; IoT; Monitoring; Node-Red; Suhu dan Kelembaban.*

1. Introduction

The monitoring system is used to supervise and control the work process in plant design. Systems like this are widely used and applied in the industrial world to determine the performance of a plan [1]. This research was conducted while carrying out project activities at an electronics factory located in Cikarang, precisely in the production room, where the production process requires a very clean room, stable temperature, and sufficient air humidity. If the condition of the production room does not meet the criteria set by the company, it will produce a product of poor quality and may not function at all. Defective products can occur due to several reasons, one of which is the inappropriate temperature and humidity in the production room [1]-[2].

There is already a monitoring system, but it is still conventional, using a hygrothermograph measuring instrument operated by production users who read the display on this instrument. Readings are taken three times a day during the morning shift, afternoon shift, and night shift. The hygrothermograph is a conventional measuring instrument that is highly susceptible to vibration and shock, resulting in inaccurate measurement results. Additionally, often the temperature and humidity checking in the production room is carried out by humans who are very vulnerable to reading and writing errors. Moreover, the monitoring of the production room is only conducted three times a day, while the sensor devices in the production room are positioned far apart. If the conditions of several production rooms deviate from the specified specifications, it will be difficult to control, and the material in the production room may corrode if the room conditions are not repaired within two hours. This can cause the quality of the material to decrease and even lead to material damage. Customers will not be willing to accept poor-quality products. The delay in handling room temperature and humidity, which are far from specifications, is due to the absence of early warning in the production room and delayed information [1].

In the problems experienced in this production room, PT. Tri Agung Sinergi can provide a solution to solve this problem, using Sensors, PLC, and HMI. The sensors used are temperature and humidity sensors connected to the PLC. The data is then processed and presented to be displayed on the HMI as a user interface. The users need notifications, such as alarms, to notify them in real-time or quickly if there is an anomaly in temperature and humidity in that area. Although there is already a monitoring system, the problem here is the budget mismatch for this project, as it falls under the medium-sized project category for hardware devices such as PLC and HMI, and the customer's needs are simple, so they don't allocate a big enough budget for this project. However, this customer has the potential to carry out other projects to monitor production rooms and transform into a smart factory 4.0. Therefore, PT. Tri Agung Sinergi needs to reduce capital on material costs to provide more affordable offers and meet the customer's budget [2].

In this study, the authors upgraded the monitoring system by adding Information System Technology [3] using an open-source application platform, namely Grafana, as a visual data/dashboard [4]-[7], MySql as a database [8], and Node-red as a tool to connect sensor data with a computer [9]. PT. TRI AGUNG SINERGI is a company engaged in the field of contractors, Automation consultants, and IT consultants with experience in handling their respective fields. Thus, PT. TRI AGUNG SINERGI provided the opportunity for the author to carry out research on-site, enabling the writer to gain experience and knowledge that may not be obtained in lectures [4].

2. Literature Review

Several studies related to the development of information systems for monitoring systems have been conducted. Randi Setiawan, Warsito, Junaidi, and Sri Wahyu Suciati conducted a study titled "Monitoring Data Perubahan Suhu, CO, dan CO2 Secara Real Time Menggunakan MySQL." This research is related to the creation of a system for real-time display of temperature, CO, and CO2 monitoring data using MySQL. The measuring devices used consist of an MQ-7 sensor to detect CO gas, an MQ-135 sensor to detect CO2 gas, a DHT-22 sensor to measure temperature, and a microcontroller as the control system. The study involved developing software, including the program interface, and using existing hardware developed by Pangestu (2019) with the mentioned sensors and microcontroller connected to Visual Basic 2010 for data display and storage in the MySQL database [8].

Esa Hayyu Wiguna and Arkhan Subari conducted a study titled "Rancang Bangun Sistem Monitoring Ketinggian Air Dan Kelembaban Tanah Pada Penyiram Tanaman Otomatis Dengan Hmi (Human Machine Interface) Berbasis Raspberry Pi Menggunakan Software Node-Red." This research is related to a system used to monitor and control work processes in plant design. Such systems are widely used and applied in the industrial world to assess the performance of a plant. The monitoring system uses Human Machine Interface (HMI) software, particularly Node-Red, to visualize data from Raspberry Pi on an LCD touch screen. The visualization is achieved by designing graphs using Node-RED [10].

Karolus Thias Widagdo, Teguh Indra Bayu, and Yeremia Alfa Susetyo conducted a study titled "Pemodelan Sistem Monitoring Sensor Curah Hujan Menggunakan Grafana." The research focuses on the utilization of rainfall sensors, aiming to enhance the efficiency of data reading and processing. The visualization system uses Grafana, an open-source platform, to display the data and assist analysts in reading and analyzing anomalies. The study employed the Network Development Life Cycle (NDLC) method to develop the computer network design [11].

Susilawati, Suseno, and Chaerur Rozikin conducted a study titled " Sistem Monitoring Suhu Dan Kelembaban Ruang Produksi Berbasis Wireless Sensor Network Pada Pt. Xxx Manufacturing Services Indonesia." This research aimed to prevent material damage in semiconductor component production due to temperature and humidity variations. They developed a monitoring system using internet of things (IoT) technology and sensor devices to measure temperature and humidity. Data collection was done through literature review and observation, and the hardware system was developed according to specific needs and functions [12].

Based on the analysis of previous studies through literature review from various journals, it is found that the combination of Node-RED as the backend and Grafana as the frontend is highly recommended to support company management. These systems facilitate the visualization of real-time data, such as sensor data, and process it into valuable information for decision-making. Moreover, this application is cost-effective, improves asset utilization, and enables companies to adapt to technological changes, promoting continuous development in their information technology infrastructure. The implementation of these systems in the Indonesian industrial world is still limited due to non-standardized devices. To address this, the researchers modified the system's concept, incorporating industry-standard devices while utilizing the monitoring system's previous research concepts. This included adding Node-Red as a communication bridge and data processor between sensor data and the MySQL database, along with using Grafana for visualization.

3. Methodology

The methodology in this research is divided into data collection method and system development method.

3.1 Data Collection

Literature Review: Studying various online sources, e-books, journals, and other literature related to the topic of this final project. Observation: Observing and studying various projects, software tools, and previous research related to the topic of this final project. Research data is obtained through observation, literature review, and interviews with project users in the production area of the Cikarang factory. Literature review is conducted to analyze the information technology needs in the specific case study location. The research data collection is conducted using a quantitative method.

3.2 System Development

The system development uses the Software Development Life Cycle (SDLC) methodology. SDLC is a process of creating and modifying systems, models, and methodologies used in developing software engineering systems [13]. In this research, the Waterfall model of SDLC is used for system development. This method allows for departmentalization and control, and the development process progresses phase by phase, minimizing possible errors. The development moves from concept, design, implementation, testing, installation, troubleshooting, and ends in operation and maintenance. This methodology is more suitable for projects that are not too large and do not require continuous changes.

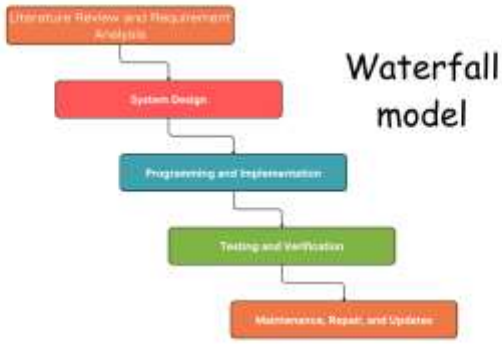

Figure 1. Waterfall Method

3.3 Technology Architecture

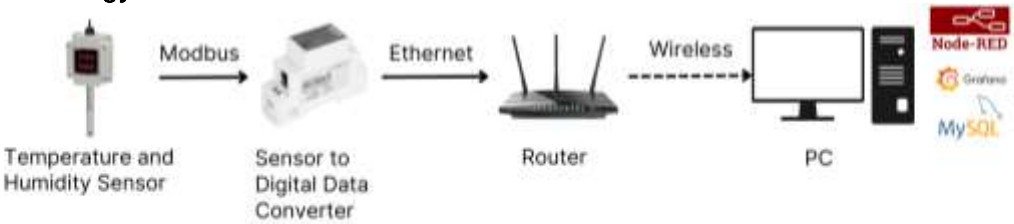

Figure 2. Technology Architecture

1) Sensor
   As a data source, sensors process data into information to identify the source points of existing issues [14].
2) Converter
   As a data converter between the sensor and the application, it transforms sensor data into text format and sends it to the application [15].
3) Router
   As a wireless connection between sensor data and the application on the computer [16].
4) PC
   As a tool for data processing and displaying information from the application.

3.4 Application Architecture

Figure 3. Application Architecture

1) Node-Red
   As the backend system to read data sent by the converter and store it in the database.
2) MySQL
   As the database for storing sensor data, which will be processed into information using the Grafana application.

3) Grafana
As the frontend system to visualize the collection of database data into information in the form of barometers, graphs, or tables, which can be customized according to needs.

3.5 Data Architecture

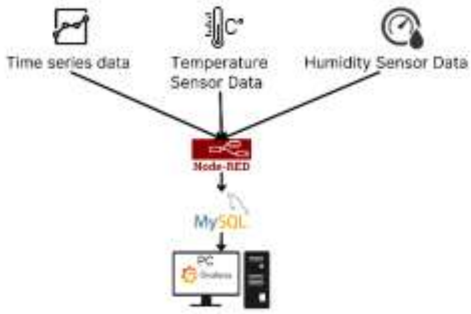

Figure 4. Data Architecture

1) Timeseries
As the initial data used to display time-related information.
2) Temperature Sensor Data
As the initial data used to display temperature values in the room.
3) Humidity Sensor Data
As the initial data used to display humidity values in the room.

3.6 Business Process Analysis

The Business Process Analysis for the project is explained in the Activity Diagram format as follows:

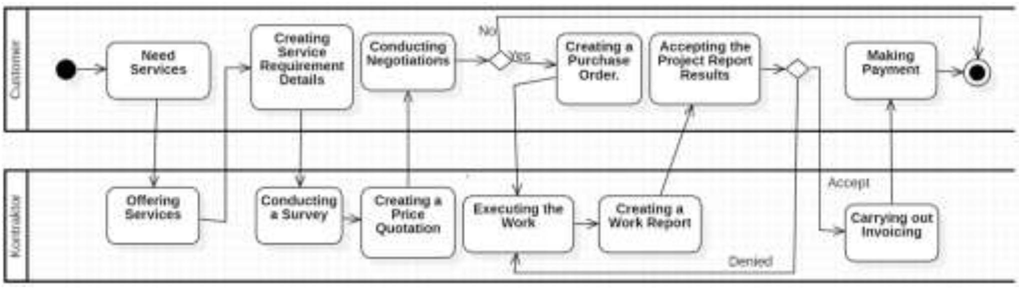

Figure 5. Research Business Process Analysis

Customer:
1) Identifies issues with the declining product quality in their company, which are traced back to the humid production rooms, necessitating a monitoring system.
2) Provides detailed problem and requirement descriptions to the Contractor.
3) Receives and negotiates the offered solutions.
4) Accepts the proposal if it meets the requirements and budget, then issues a Purchase Order (PO) as the work contract.
5) Reviews the work report to ensure it aligns with their expectations. If not, the customer can negotiate technical adjustments, such as alarm settings and sensor positioning.
6) Receives the invoice and proceeds with the payment for the completed work.

Contractor:
1) Offers services to address the customer's issues.
2) Conducts field surveys to understand difficulties and requirements, estimating the appropriate cost for the project.
3) Prepares a price quotation and explains it to the customer.
4) Engages in negotiations with the customer.

5) Receives the PO and arranges the necessary resources and equipment for the project.
6) Prepares a work report and explains the details to the customer.
7) Issues an invoice based on the PO and provides the invoice documentation to the customer.

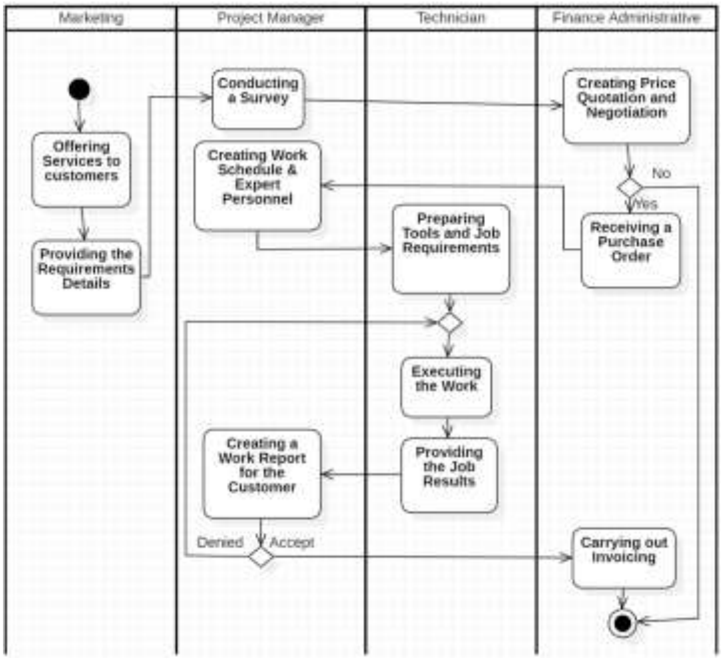

Figure 6. Contractor Business Process Analysis

Marketing:
1) Seeks potential customers in need of services and offers solutions.
2) Gathers detailed information about the customer's issues and explains them to the Head Technician.

Project Manager / Head Technician:
1) Conducts field surveys and explains the material and service requirements to the administrative finance department to create a tailored proposal.
2) Creates schedules and coordinates the ongoing work in the field.

Technicians:
1) Prepares tools and materials for the project.
2) Executes the project according to the schedule and guidance from the Head Technician.
3) Creates documentation of the completed work and submits it to the Head Technician.

Administrative Finance:
1) Generates proposals based on the material requirements provided by the Head Technician and presents them to the customer.
2) Engages in negotiations with the customer to obtain the best price offer.
3) Receives the PO and informs the Head Technician that the work can begin.
4) Issues invoices based on the PO and provides the necessary documentation.

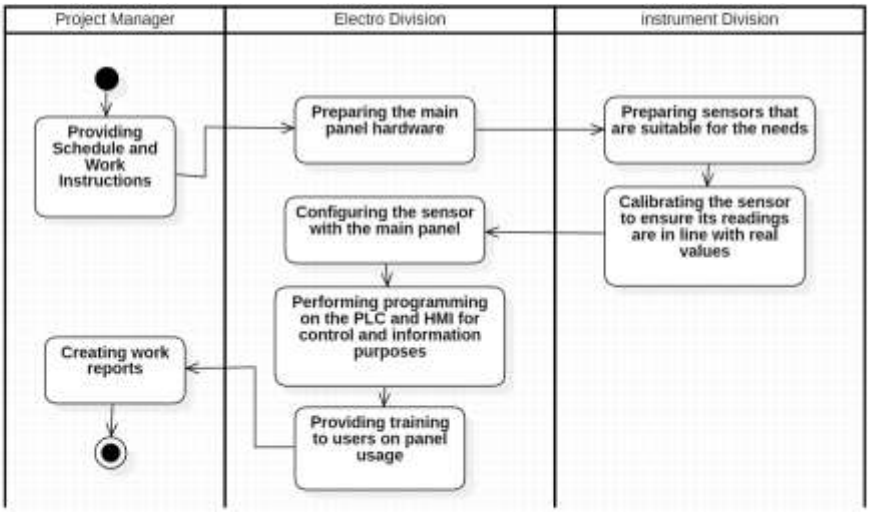

Figure 7. Research Business Process Analysis

Explanation of activities conducted by the Technicians:
Project Manager:
1) Provides schedules and activity details for the project.
2) Monitors and coordinates ongoing work in the field.
3) Adjusts and aligns the work documentation with the reports to be provided to the customer.

Electrical Division:
1) Assembles the main hardware panel.
2) Configures sensors with the main panel.
3) Programs the PLC and HMI devices within the main panel for control and information purposes.
4) Conducts training for users on how to use the main panel.

Instrumentation Division:
1) Prepares sensor specifications that match the main panel.
2) Calibrates the sensors to ensure accurate readings according to real conditions.

SWOT Analysis for PT Tri Agung Sinergi's Business Process:

Figure 8. SWOT analysis

Here are the results of the business process analysis using SWOT (Strengths, Weaknesses, Opportunities, and Threats) at PT Tri Agung Sinergi:

1) Strengths
   a). Successfully served numerous repair and automation projects for various large and startup clients.
   b). Experienced personnel in their respective fields.
   c). Several employees hold credible degrees and certifications.
   d). Flexible in adjusting their service rates.
2) Weaknesses
   a). Limited number of competent employees, leading to frequent overtime during simultaneous projects.
   b). Fast-paced culture requires employees to constantly adapt to new knowledge.
   c). Limited IT personnel to address projects requiring technology.
3) Opportunities
   Flexible rates greatly assist some clients in introducing contractor products and services to their superiors.
4) Threats
   a). Intense competition among automation consultants due to the many developed information technologies.
   b). Minimal competence in Automation SDM may lead to overtime in specific projects, particularly in the Digitalization Factory and Monitoring Factory projects.

Furthermore, the study will propose improvements to the Information Technology and suggest various measures to maximize material budget efficiency.
The proposed business processes are as follows:

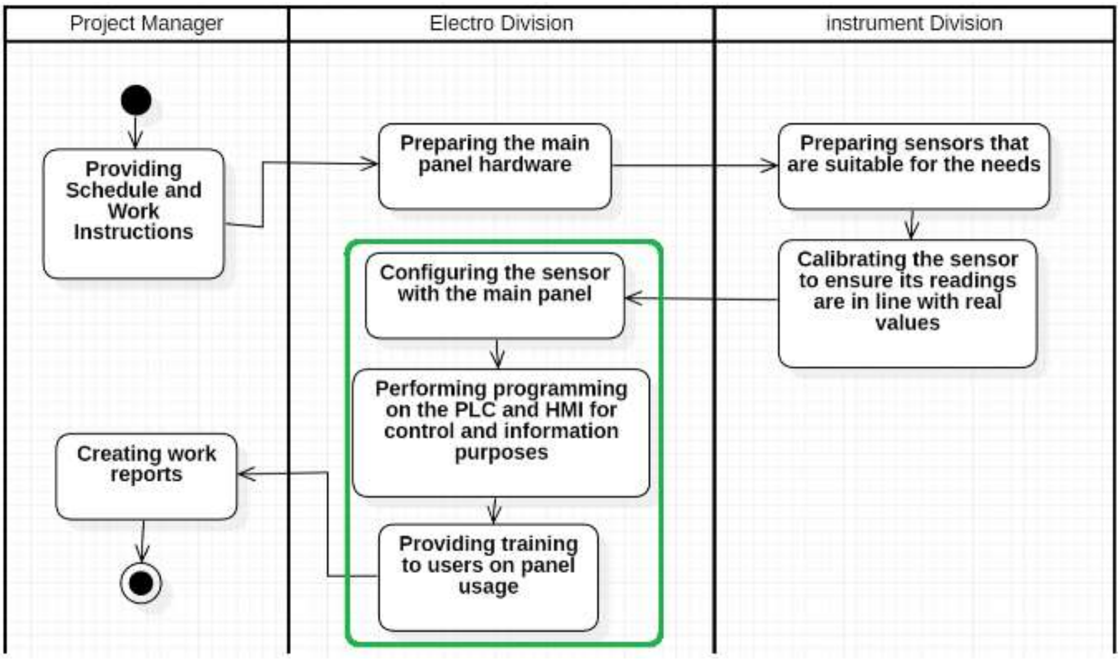

Figure 9. Current Proposed Business Process

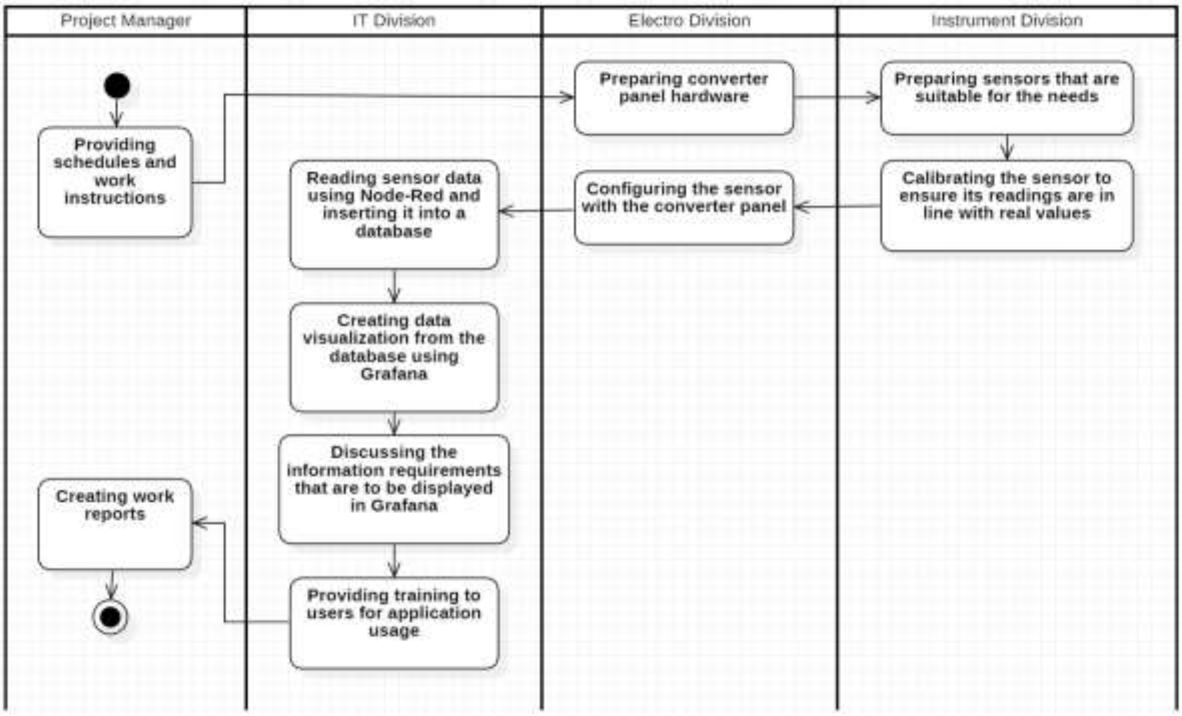

Figure 10. New Proposed Business Process

Explanation of the activities depicted in the images above:
Project Manager:
1) Provides schedules and activity details for the project.
2) Monitors and coordinates ongoing work in the field.
3) Adjusts and aligns the work documentation with the reports to be provided to the customer.

IT Division:
1) Reads sensor data from the panel into the computer and processes it into a database.
2) Creates data visualizations such as barometers/gauges and graphs from the collected database data.
3) Designs and adapts the data visualization dashboard according to user needs.
4) Conducts training on how to use the temperature and humidity monitoring system to users.

Electrical Division:
1) Assembles the main hardware panel.
2) Configures sensors with the main panel.

Instrumentation Division:
1) Prepares sensor specifications that match the main panel.
2) Calibrates the sensors to ensure accurate readings according to real conditions.

Implementation of hardware changes on the main panel and changes in budget efficiency estimations [17]-[18].

Tabel 1. Old Material Details

No.	Material Description	Unit	Type	Price	Total
1	PLC Omron CP1E	1	Pcs	9.000.000	9.000.000
2	HMI Omron 10 Inchi	1	Pcs	15.000.000	15.000.000
3	Communication Cable	150	Meters	15.000	2.250.000
					26.250.000

Here is the description of the item before the existence of the application [19]:

Tabel 2. New Material Details

No.	Material Description	Unit	Type	Price	Total
1	Converter	3	Pcs	700.000	2.100.000
2	Set Mini PC i7	1	Pcs	8.000.000	8.000.000
3	Router	4	Pcs	500.000	2.000.000
4	Ethernet Cable Cat 6	2	Meters	8.000	16.000
					12.116.000

Reduction in budget estimation for material costs = Rp.26.250.000 – Rp.12.116.000
Reduction in budget estimation for material costs = Rp.**14.134.000**
With this, the proposed offer can become more affordable and meet the budget requirements of the customer's issues.

4. Results and Discussion

In this section, the author obtained information on what can be the development of information technology for the current research project and what is expected from the organization for the future.

4.1 Application Implementation

The implementation of the Temperature and Humidity Sensor Monitoring System application is as follows:

4.1.1 Application of Backend Monitoring System - Node-Red

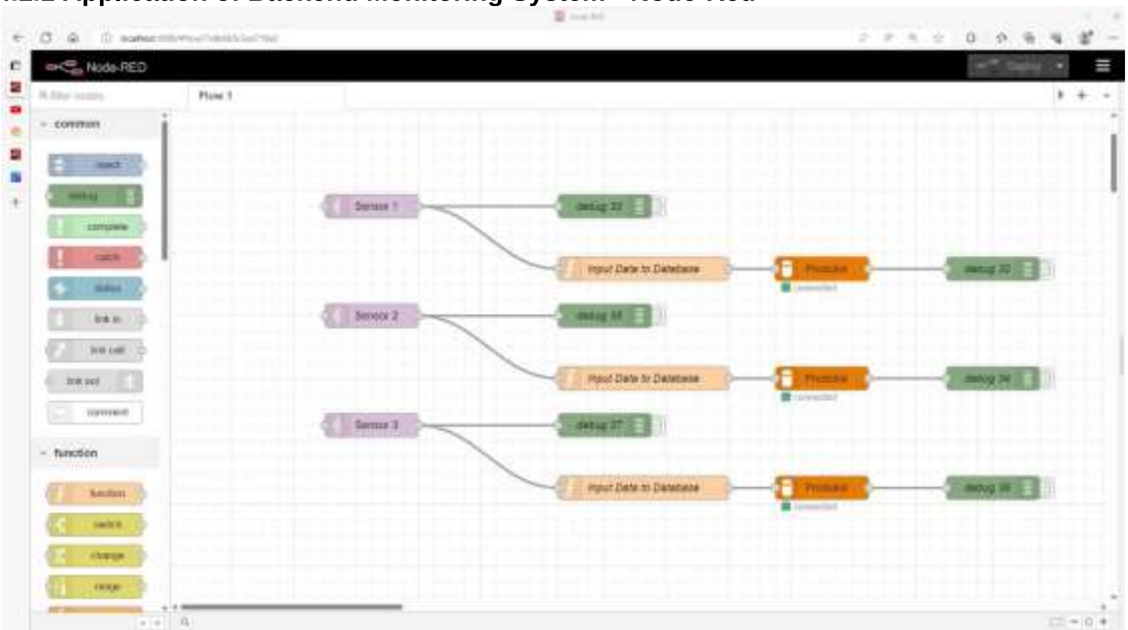

Figure 11. Node-Red Backend

Node-Red is used as the backend to read data from the sensors that have been converted by the converter and transmitted by the router in repeater mode in the form of IP. The sensors here include Temperature and Humidity sensors, with 3 placement points in the production room. The data is then entered into the "trias" database. Before receiving data, Node-Red searches for sensor data by identifying the IP sent by the converter. With wireless communication on the Router, the IP is read in Node-Red and inserted into their respective fields.

4.1.2 MySQL Database

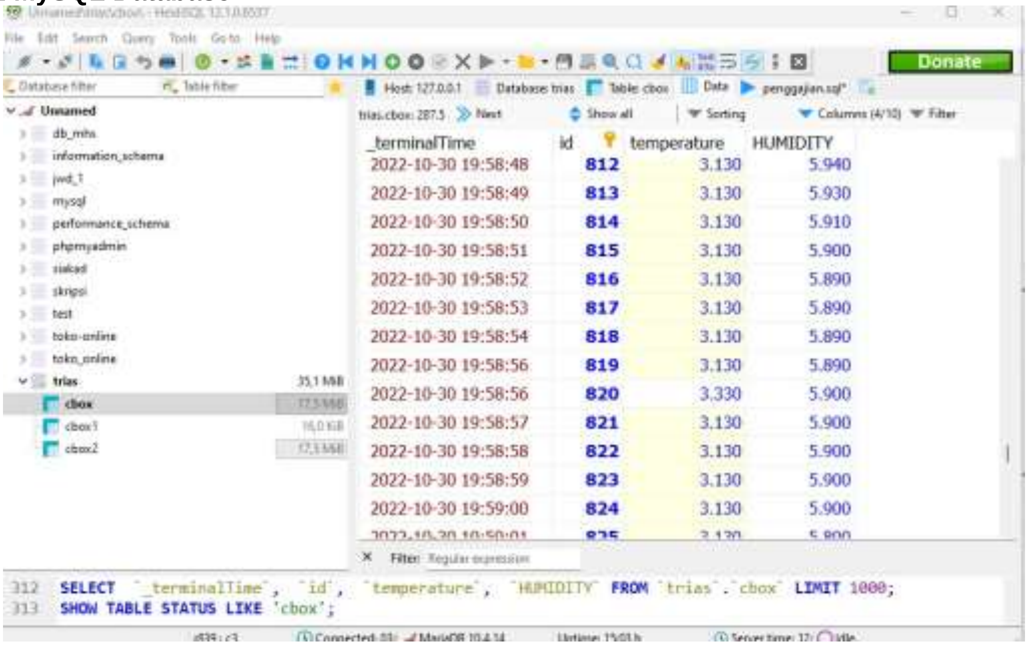

Figure 12. MySQL Database

MySQL is used to receive and store data from temperature and humidity sensors and is used to process and display it using the Grafana data visualization application. In MySQL, there is a database named "trias," and its attributes include "cbox" to store data from sensor 1, "cbox1" for data from sensor 2, and "cbox2" for data from sensor 3. The fields include "_terminalTime," "id," "temperature," and "humidity," used to indicate which data is to be displayed in the data visualization in the form of barometers or graphs.

4.1.3 Application of Frontend Monitoring System - Grafana

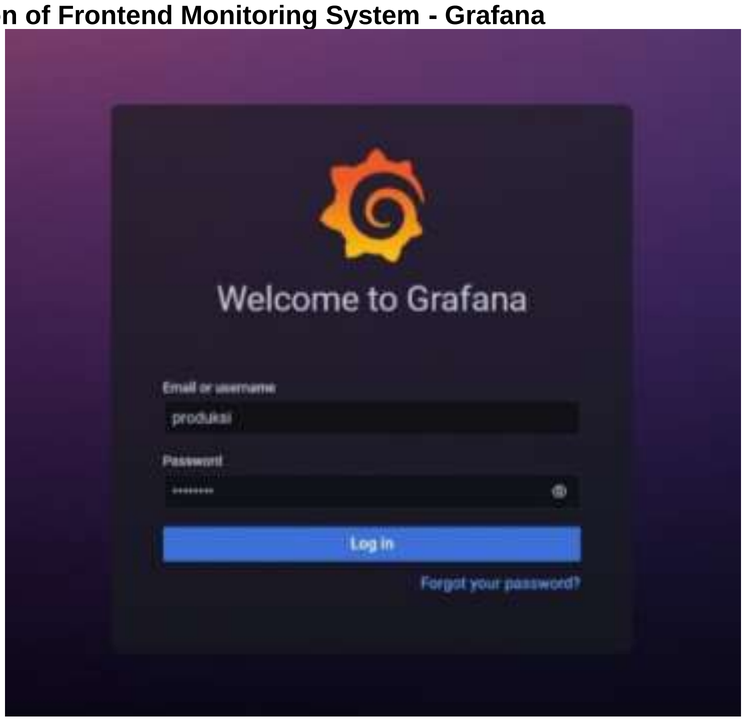

Figure 13. Temperature and Humidity Monitoring Application Login

The above figure is the initial display of the Grafana application. Users can enter the username "produksi" and password "produksi" to view the dashboard of the temperature and humidity monitoring system.

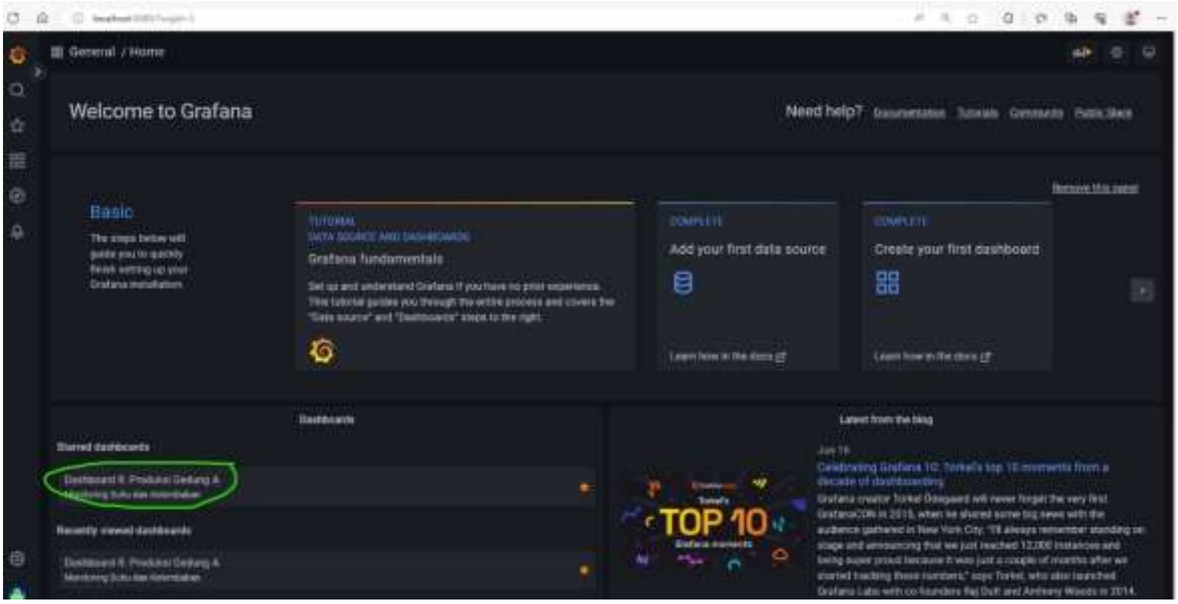

Figure 14. Initial View of the Temperature and Humidity Monitoring Application

In the second display, users must select which dashboard to be shown. As there is currently only one dashboard, users can click "Dashboard R. Produksi Gedung A." If the dashboard does not appear as shown above, users can see the panel on the side and find this icon and click on it. Then the display will appear as shown below.

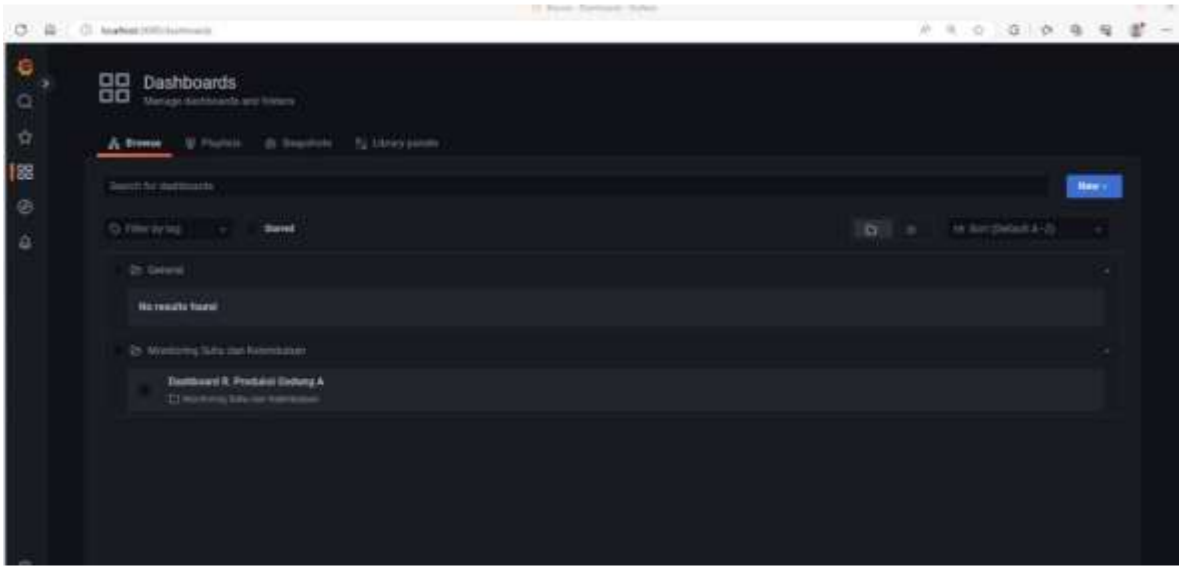

Figure 15. Main Dashboard of the Temperature and Humidity Monitoring Application

In the above display, there will be a list of dashboards to choose from, and users can select one from the list.

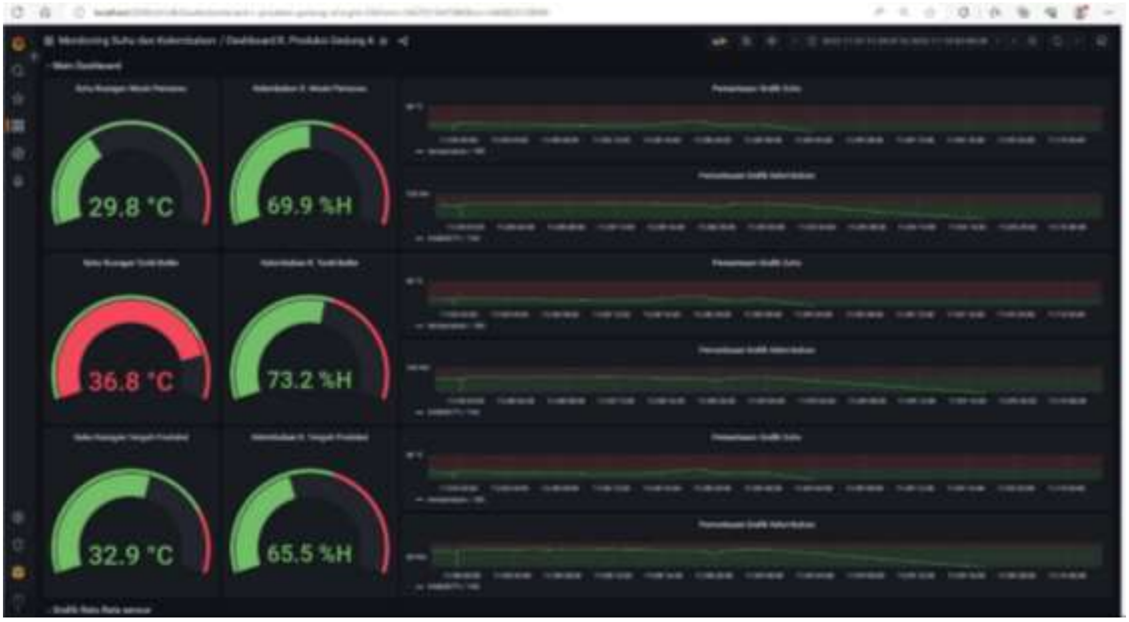

Figure 16. Main Dashboard Aplikasi Monitoring Suhu dan Kelembaban

The above figure is the main dashboard of the Temperature and Humidity Monitoring System. This main dashboard can display real-time temperature and humidity conditions using gauge and graph indicators. This information can help users analyze the sources of temperature and humidity fluctuations in the production room and provide data for discussions or meetings among management and other employees in the production room.

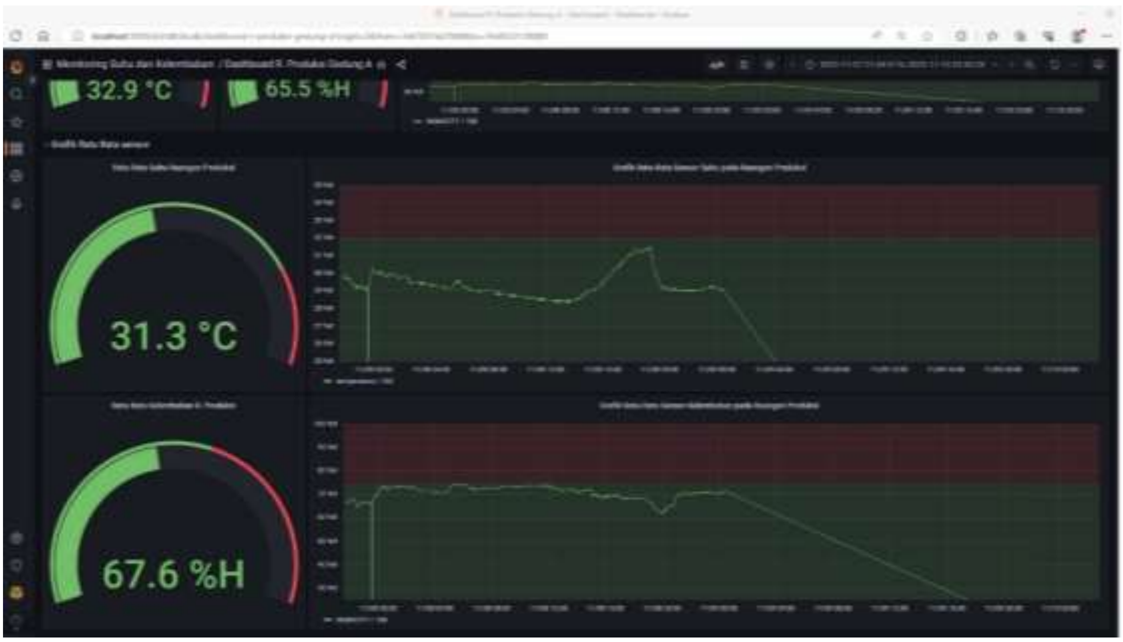

Figure 17. Support Dashboard of the Temperature and Humidity Monitoring Application

The above figure shows the average dashboard of the three sensors displayed in real-time using gauges and graphs. This display was created based on user requests and provides information about the average temperature and humidity of all sensors installed in the production room.

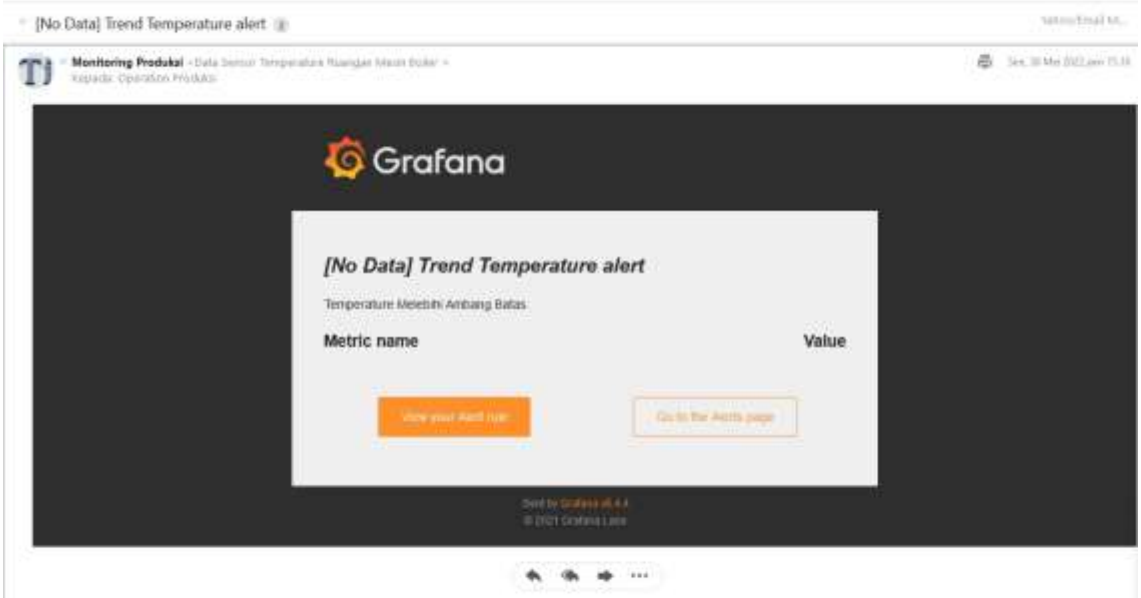

Figure 18. Temperature and Humidity Monitoring System Alarm Notification

The above figure shows the warning or notification that the sensor has detected an anomaly, indicating that the temperature in the boiler room, where the sensor has been installed, has exceeded the set limit. This notification applies to all sensors integrated into this temperature and humidity monitoring application.

For Article Review/Analysis:

In this subsection, the author provides comments on the ongoing research and related previous studies and concludes as follows:

In previous research, the author referred to journal articles titled "Monitoring Data Perubahan Suhu, CO, dan CO2 Secara Real Time Menggunakan MySQL" and "Pemodelan Sistem Monitoring Sensor Curah Hujan Menggunakan Grafana." However, the implementation of these systems in the industrial world in Indonesia is still rare and not well-developed, despite the significant need to address these issues. Therefore, it is necessary to develop the concept of such systems and utilize devices that comply with industrial standards [8], [11]. The author has modified the use of devices to meet industrial standards and has combined the monitoring system concepts from previous research. This includes adding Node-Red as a communication bridge and data processor between sensor data and the MySQL and Grafana databases.

5. Conclusion

Based on the analysis described from Chapter I to Chapter IV regarding "Temperature and Humidity Sensor Monitoring System Using Node-Red as Backend and Grafana as Frontend," the researcher can conclude that the system provides real-time data display and alarm notifications for anomalies in the production room. It is an information technology asset that can be further developed into a more complex and useful monitoring system by adding required sensors and integrating them into this application, presenting more abundant and accurate information for the production room. The system also offers budget efficiency for materials by replacing PLC and HMI hardware with computers and this Monitoring System application, providing the best proposal in line with the customer PT Tri Agung Sinergi's needs and budget.

Reference

[1] S. Susilawati, S. Suseno, and C. Rozikin, “Sistem Monitoring Suhu Dan Kelembaban Ruang Produksi Berbasis Wireless Sensor Network Pada Pt. Xxx Manufacturing Services Indonesia,” JUST IT *J. Sist. Informasi, Teknol. Inf. dan Komput.*, vol. 10, no. 2, pp. 136-143, 2020, doi: 10.24853/justit.10.2.136-143.

[2] TRIAS Group, "Company Profile PT TRI AGUNG SINERGI," https://trias-group.co.id/, 2018.
[3] A. M. Bilal, "Observability Of Industrial Data Using An Analytics And," no. October, 2021.
[4] Grafana Labs, "Grafana Labs. Dashboard overview.," grafana.com. https://grafana.com/docs/grafana/latest/dashboards/
[5] Grafana Labs, "Grafana Labs. Dashboard JSON model.," grafana.com. https://grafana.com/docs/grafana/latest/dashboards/json-model/
[6] Grafana Labs, "Grafana Labs, Visualization panels," grafana.com. https://grafana.com/docs/grafana/latest/visualizations/
[7] Grafana Labs, "Grafana Labs, Grafana alerts," grafana.com. https://grafana.com/docs/grafana/latest/alerting/#alerting
[8] R. Setiawan, W. Warsito, J. Junaidi, and S. W. Suciyati, "Monitoring Data Perubahan Suhu, CO dan CO2 Secara Real Time Menggunakan MySQL," J. Energy, Mater. Instrum. Technol., vol. 1, no. 2, pp. 75–80, 2020, doi: 10.23960/jemit.v1i2.25.
[9] S. Mulyono, M. Qomaruddin, and M. Anwar, "Penggunaan Node-RED pada Sistem Monitoring dan Kontrol Green House berbasis Protokol MQTT," *J. Transistor Elektro dan Inform*. (TRANSISTOR EI, vol. 3, no. 1, pp. 31–44, 2018.
[10] K. Thias Widagdo, I. Bayu, and Y. A. Susetyo, "Pemodelan Sistem Monitoring Sensor Curah Hujan Menggunakan Grafana," *Indones. J. Model. Comput*., vol. 2, pp. 1–8, 2018.
[11] E. H. Wiguna and A. Subari, "Rancang Bangun Sistem Monitoring Ketinggian Air Dan Kelembaban Tanah Pada Penyiram Tanaman Otomatis Dengan Hmi (Human Machine Interface) Berbasis Raspberry PI Menggunakan Software Node-Red," *Gema Teknol*., vol. 19, no. 3, pp. 1-12, Oct. 2017, doi: 10.14710/gt.v19i3.21878.
[12] S. Susilawati, S. Suseno, and C. Rozikin, "Sistem Monitoring Suhu Dan Kelembaban Ruang Produksi Berbasis Wireless Sensor Network Pada PT. XXX Manufacturing Services Indonesia," *JUST IT J. Sist. Informasi, Teknol. Inf. dan Komput*., vol. 10, no. 2, pp. 136-145, Jun. 2020, doi: 10.24853/justit.10.2.136-143.
[13] W. Nugraha, M. Syarif, and W. S. Dharmawan, "Penerapan Metode Sdlc Waterfall Dalam Sistem Informasi Inventori Barang Berbasis Desktop," *JUSIM (Jurnal Sist. Inf. Musirawas*), vol. 3, no. 1, pp. 22–28, 2018, doi: 10.32767/jusim.v3i1.246.
[14] T.W. Alhidayatuddiniyah, "Pengujian Karakteristik Termistor PTC Dengan Menggunakan Sensor Suhu LM35". *KoPeN: Konferensi Pendidikan Nasional*, vol. 3, no. 2, pp. 71-76, 2021.
[15] A. Dwiyanti, "Simulasi Buck Converter Pada Rangkaian Controller Turbin Angin the Sky Dancer 500 Di Pt Lentera Bumi Nusantara". *Buana Ilmu*, vol. 6, no. 2, pp. 44-62, 2022.
[16] D. Heryanto and Salma Azizah, "Application of Access Control List for Network Security At Cisco Router As a Firewall," OISAA J. Indones. Emas, vol. 2, no. 2, pp. 71–76, 2019, doi: 10.52162/jie.2019.002.02.3.
[17] D. Yuhendri, "Penggunaan PLC Sebagai Pengontrol Peralatan Building Automatis," JET (Journal Electr. Technol., vol. 3, no. 3, pp. 121–127, 2018, [Online]. Available: https://jurnal.uisu.ac.id/index.php/jet/article/view/952
[18] H. Haryanto and S. Hidayat, "Perancangan HMI (Human Machine Interface) Untuk Pengendalian Kecepatan Motor DC," Setrum Sist. Kendali-Tenaga-elektronika-telekomunikasi-komputer, vol. 1, no. 2, pp. 58-68, 2016, doi: 10.36055/setrum.v1i2.476.
[19] M. J. F. Arifianto and L. Prasetyani, "Sistem Pemantauan dan Kontrol Energi Listrik Menggunakan Platform Node-RED, Influxdb dan Grafana melalui Jaringan WiFi dan Lora," J. Fokus Elektroda Energi List. Telekomun. Komputer, Elektron. dan Kendali), vol. 7, no. 1, pp. 61-72, 2022, doi: 10.33772/jfe.v7i1.23440.