JOSEIT JOURNAL OF SYSTEMS ENGINEERING AND INFORMATION TECHNOLOGY
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Monitoring System for Temperature and Humidity Sensors in the Production Room Using Node Red as the Back End and Grafana as the Front End

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Abstract

The client of the TRIAS project is faced with issues with a decrease in production quality or defective products. They require a temperature and humidity monitoring system in the production area that provides real-time notifications in case of any anomalies in temperature and humidity. However, the project has a limited budget, which poses a challenge to the contractor in developing a monitoring system that tracks temperature and humidity changes using temperature and humidity sensors as the data source. It should also provide alarms if the temperature and humidity values exceed the standard values for the room. Additionally, the pricing offer should be adjusted using information technology. The research methodology used in this study includes qualitative methods such as observation, literature review, and interviews to collect data on the mentioned issues. The SWOT method is used to analyze business process problems, while the Waterfall method is used for system development. Based on the research findings, the researcher concludes that this project requires a cost reduction in material usage and also needs a data visualization application for the mentioned sensors. The visualization application system utilizes Grafana as the front-end, chosen for its high flexibility in processing. The temperature and humidity data obtained from the sensors will be recorded by Node-Red as the back-end and synchronized on the server. The data stored on the server will be saved in a MySQL database. The data from the database will be synchronized with Grafana for processing and visualization, presenting the data in easily understandable graphical forms.

Keywords: Grafana, IoT, Monitoring, Node red, Temperature and Humidity

1. Introduction

A monitoring system is a system used to supervise and control work processes in a plant or facility. Such systems are widely used and implemented in the industrial world to assess the performance of a plant [1]. This research was carried out during a project activity in an electronic factory located in Cikarang, specifically in the production area where a clean environment, stable temperature, and sufficient air humidity are required. If the conditions in the production area do not meet the criteria established by the company, poor quality or non-functional products can be produced. Defective products can occur due to various reasons, and one of them is the inappropriate temperature and humidity in the production area [1] [2].

There is already a monitoring system in place, but it is still conventional. Production users rely on a hygrothermograph device that reads the display on the instrument. The readings are taken three times a day during the morning, afternoon, and night shifts. However, the hygrothermograph is a conventional measuring device that is susceptible to vibrations and shocks, leading to inaccurate measurements. Additionally, manual temperature and humidity checks by human operators are prone to reading and writing errors. The production area is only checked three times a day, while the sensor devices are positioned at different locations. If some production areas deviate from the specified conditions, it becomes difficult to control and the materials in the production area may corrode if the conditions in the room are not corrected within two hours, resulting in decreased material quality or even damage. Customers will not accept low-quality products. The delay in handling temperature and humidity problems, the lack of early warning within the production area, and the lack of information contribute to the problem [1].

To address these issues in the production area, PT. Tri Agung Sinergi can provide a solution using sensors, PLC, and HMI. Temperature and humidity sensors are connected to the PLC, where the data are processed and presented on the HMI as a user interface. Users require real-time notifications or alarms in case of temperature and humidity anomalies in the area. Although there is already a monitoring system, the challenge lies in the budget constraints for this project. Since this project falls under the medium-sized category in terms of hardware devices such as PLC and HMI, the customer's requirement is relatively simple, and they have not allocated a large budget for this project. However, this customer has the potential to undertake other projects to monitor production areas and transition to a smart factory 4.0. Therefore, PT Tri Agung Sinergi needs to reduce material costs to provide a more affordable offer that fits the customer's budget [2].

Accepted by editor: 12-08-2023 | Final revision: 17-09-2023 | Online publication: 17-09-2023

In this research, the author upgrades the existing monitoring system by incorporating information system technology [3]. This is achieved using open-source applications such as Grafana for data visualization / display [4] - [7], MySQL as a database [8], and Node-Red as a tool to connect sensor data to the computer. PT. Tri Agung Sinergi is a company involved in contracting, automation consulting, and IT consulting. They have experience in handling these fields. Therefore, PT. Tri Agung Sinergi has provided an opportunity for the author to conduct research in his facility, allowing him to gain practical experience and knowledge that cannot be obtained solely through academic education [2].

Based on the analysis of previous research through a literature review from various journals, it was found that the Node-RED system as the back end and Grafana as the front end are highly recommended to support company management [8] - [9]. This can be observed from several journals, mentioning that Node-RED and Grafana greatly assist companies in visualizing data extracted from real-time object data, such as sensor data, and processing them into information to support decision making. Moreover, this application is cost-effective as it is free and can also enhance the utilization of company assets[10]-[11].

The Monitoring System, using the Node-RED and Grafana concepts, also helps companies adapt to changing times and current technologies, which in turn encourages continuous development of their technological infrastructure and information. It facilitates the integration between existing services. Lastly, it is important to keep track of technological advancements and evaluate them because through such evaluations, companies can determine the importance of staying up-to-date with information technology and make improvements to existing IT services. This helps companies control IT service processes and provides an overview of the expected conditions in the future. This study aims to complement and further develop previous research, particularly in the field of advancements in information systems technology [12]-[14].

Based on the description provided in the background, the issues that need to be addressed in this document are as follows. The need for real-time data regarding the conditions of the production area as the fundamental information used by the user. The need for a dashboard to display data from multiple temperature and humidity sensors and provide real-time alarm notifications to the user. The importance of achieving cost efficiency by replacing devices with more affordable specifications and making modifications to the monitoring system. This will allow the project to fit within the customer's budget.

Then, the questions are as follows:

a. Can this research create a monitoring system that displays data directly from sensors without any intervention from humans or users?
b. Can this research create a monitoring system to display only one dashboard to view data from multiple temperature and humidity sensors, and provide warnings or alarms as real-time notifications to the user?
c. Can this research provide a solution to replace hardware devices to reduce material requirements and lower material costs?

2. Method

2.1 Data Source Description.

Research data are obtained through observations, literature reviews, and interviews with project users in the production area of the Cikarang factory. The literature review is conducted to analyze the information technology requirements in the specific case study location. System development utilizes the Software Development Life Cycle (SDLC) methodology. SDLC is a process of creating and modifying systems, as well as the models and methodologies used to develop software engineering systems [15].

2.2 Data collection techniques

The methodology in this research is classified into data collection methods and system development methods.

a. Data collection
   Review of the literature: study of various online resources, e-books, journals, and other literature related to the topic of this final project.
   Observation: Observation and study of various projects, software tools, and previous research related to the topic of this final project.
   The collection of research data is carried out using a quantitative method. The author collects data through observations, reviews of the literature, and interviews. Observation is the process of acquiring primary data by observing people and locations involved in the research.
b. System development
   In research, the waterfall model is used for system development. This method allows departmentalization and control as the development process progresses in a phased manner, minimizing potential errors. Development moves from concept to design, implementation, testing, installation, problem solving and concludes with

operation and maintenance. This methodology is more suitable for projects that are not too large and do not require continuous changes.

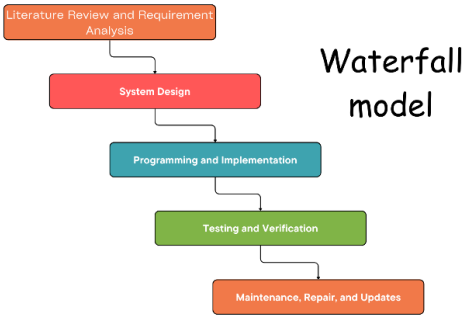

Figure 1. Waterfall Model

The stages of system development using the waterfall model are as follows.

a. Review of the literature and analysis of requirements
b. System Design
c. Programming and Implementation
d. Testing and Verification
e. Maintenance, repair and updates

2.3 Research flowchart

The data collection method is shown in the following research flow chart.

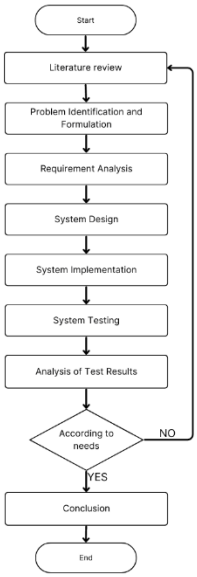

Figure 2. Research flow chart

Explanation of the Research Flowchart:

a. Review of the literature
   At this stage, the author searches for a suitable research location. Eventually, the author decides to conduct research on the Smart Industry Project at PT Tri Agung Sinergi.
b. Identification and formulation of problems
   In this stage, the author identifies the problems and discovers the issues within the project.
c. Requirement analysis
   At this stage, the author collects data using quantitative methods such as observation, review of the literature, and interviews with the project users.
d. System Design
   In this stage, the author creates a system design that is suitable for solving the problems within the project.

e. System Implementation
At this stage, the author implements the designed system with the help of the waterfall SDLC method.
f. System testing
In this stage, the author tests the system to meet the problem requirements of the Project, discussing with the users what needs to be displayed and the notifications required.
g. Analysis of test results
At this stage, the author analyzes the implemented system to ensure its suitability and alignment with the objectives.
h. Conclusions
At this stage, the author draws conclusions about the effectiveness of the research.

3. Results and Discussion

3.1 Initiation

In this section, the author obtains information on what the development of information technology can be for the current research project and what the organization expects for its future.

Overview of the problem

There is a high demand for automation and improvement in ships and factories, which requires the development of modern technology to assist technicians in their work and reduce maintenance costs.

Objectives

In this subsection, the researcher conducts a case study on the temperature and humidity monitoring project for a customer of PT Tri Agung Sinergi located in Cikarang. The customer requires a temperature and humidity monitoring system in the production area due to indications of product defects caused by abnormal humidity. PT Tri Agung Sinergi can fulfill the request, but they encounter a budget mismatch due to the high cost of automation equipment and future system development. Although they can build a monitoring system, presenting information from complex sensor data in an easily understandable manner becomes a challenge. The objective is to provide a solution using information technology for this project.

Goals

In this subsection, the researcher designs a complex dashboard application to display easily understandable information from sensor data. The application should alert users to temperature and humidity anomalies in the production area and strive to minimize the budget for the Temperature and Humidity Monitoring Project.

Strategic Plan

In this subsection, the researcher plans to use Node-Red as the backend, the open-source Grafana platform as the frontend, and MySQL as the database. Wireless and wired router communication will be used, using Ethernet cables and the TCP/IP protocol. This combination helps reduce the estimated budget for the monitoring application, since it utilizes free/open-source components. Moreover, this application has the potential for further development in future projects. Additionally, the monitoring application can be used with sensors other than temperature and humidity, as long as the sensor can send text data as input to the database. This requires the use of a converter device for the sensor and an appropriate data communication protocol.

3.2 Information Technology Governance Competence in Information Technology Governance

In this subsection, the research explains the architecture used in the study, namely:
a. Technology Architecture
b. Application architecture.
c. Data architecture.

Further details will be provided for each of these architectures.

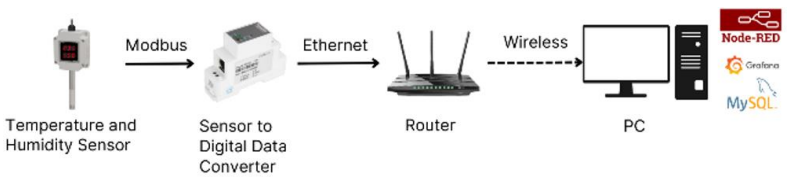

Figure 3. Technology Architecture

a. Sensor: Acts as a data source, and the data is processed into information to identify the source or point of problem [16].
b. Converter: Converts data between the sensor and the application. Sensor data are transformed into text format and sent to the application [17].
c. Router: Wirelessly connects sensor data to the application on the computer [18].
d. PC: Used to process data and display information from the application.

Application Architecture

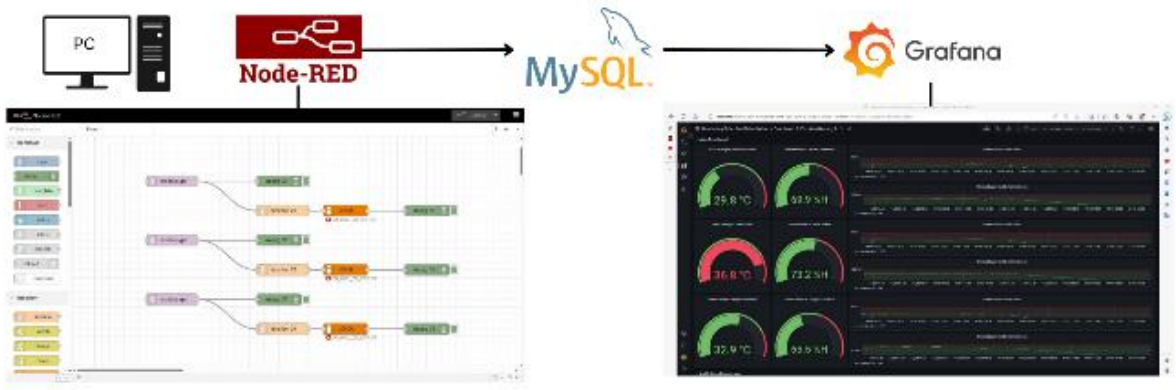

Figure 4. Application Architecture

a. Node-Red: Serves as the back-end system to read data sent by the converter and store it in the database.
b. MySQL: Acts as a database for storing sensor data, which will be processed as information using the Grafana application.
c. Grafana: Serves as the front-end system to visualize the collection of database data into information in the form of gauges, graphs, or tables, customized to meet specific needs.

Data architecture

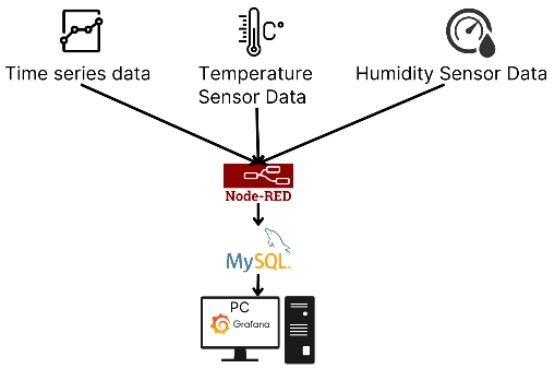

Figure 5. Data Architecture

a. Timeseries: Initial data used to display time-related information.
b. Temperature Sensor Data: Initial data used to display the temperature values in the room.
c. Humidity Sensor Data: Initial data used to display humidity values in the room.

3.3 Proposed business process

This subsection describes the proposed business process that can maximize information technology and suggests ways to optimize the material budget.

The suggested business process is as follows:

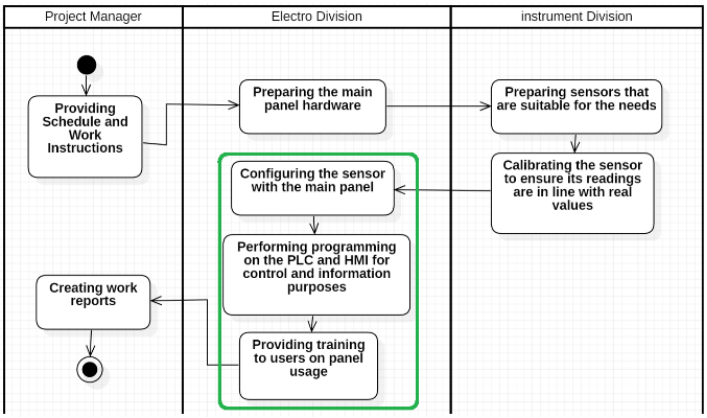

Figure 10. Current proposed business process

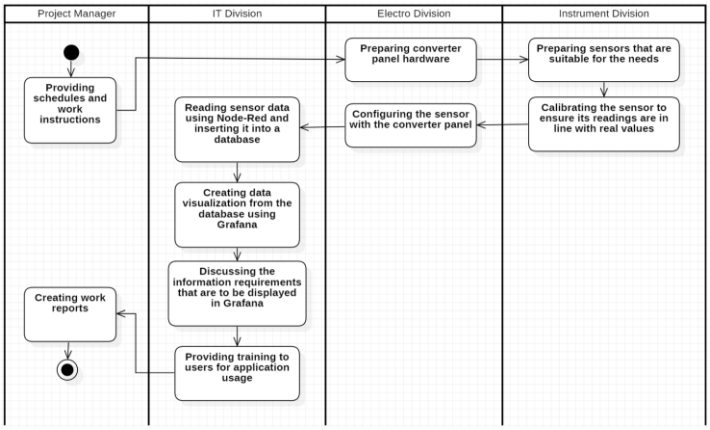

Figure 6. New Proposed Business Process

3.4 Application Implementation

Implementation of the Temperature and Humidity Sensor Monitoring System Application:

Backend Application Using Node-Red

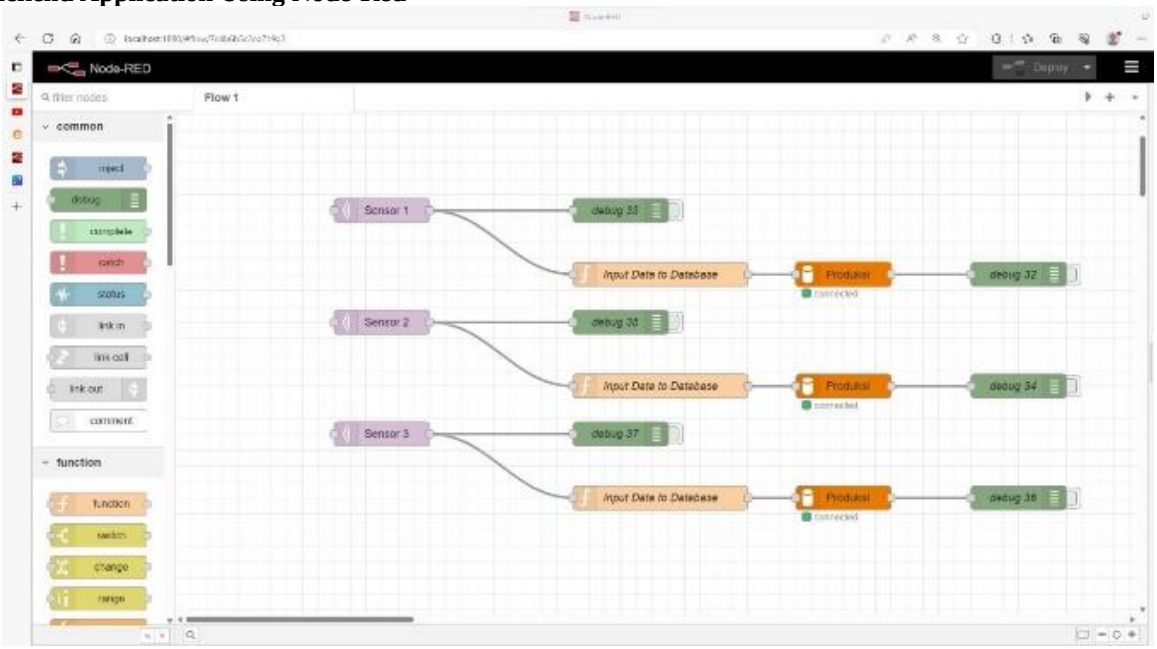

Figure 7. Node-Red backend

Node Red is used as the back-end to read sensors that have been converted by the converter and transmitted by the repeater router in IP mode. The sensors in this case are temperature and humidity sensors, combined as one device with three placement points in the production area. These data are entered into the Trias database. The data is directed to the database, which has been adjusted to the expected data. Before receiving the data, Node-Red searches for sensor data by identifying the IP sent by the converter. Using wireless communication on the router, the IP is read in Node-Red and entered into the respective fields.

MySQL Database

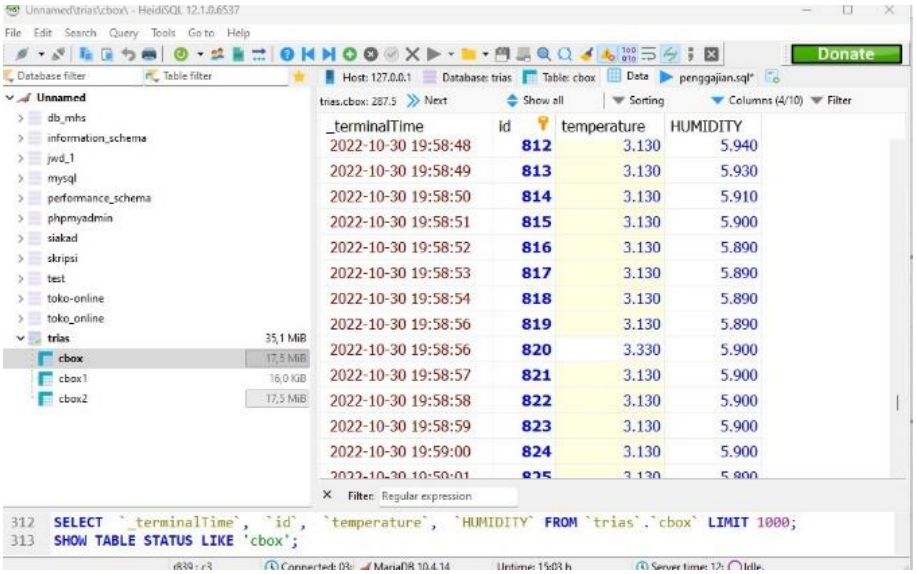

Figure 8. MySQL database

MySQL is used to receive and store data from temperature and humidity sensors. It is used to process and display the data using the Grafana open-source data visualization application. In the MySQL database, there is a database named "trias" with attributes such as "cbox" to store data for sensor 1, "cbox1" for sensor 2, and "cbox2" for sensor 3. These fields contain "_terminalTime," "id," "temperature," and "humidity" to indicate which data should be displayed in the data visualization, such as barometers or graphs.

Front-end application using Grafana Monitoring System

In this view, a list of dashboards available for display will appear, and users can choose one from the list.

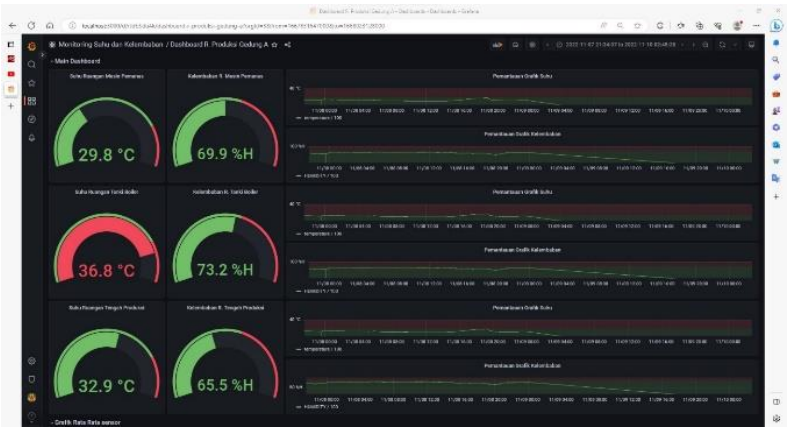

Figure 9. Main dashboard of the Temperature and Humidity Monitoring Application

This image shows the main dashboard of the temperature and humidity monitoring system. This dashboard provides real-time information on temperature and humidity conditions, displayed through gauges and graphs. This information helps users analyze the source of temperature and humidity changes in the production area, providing data for discussions or meetings with leaders and other employees present in the production area.

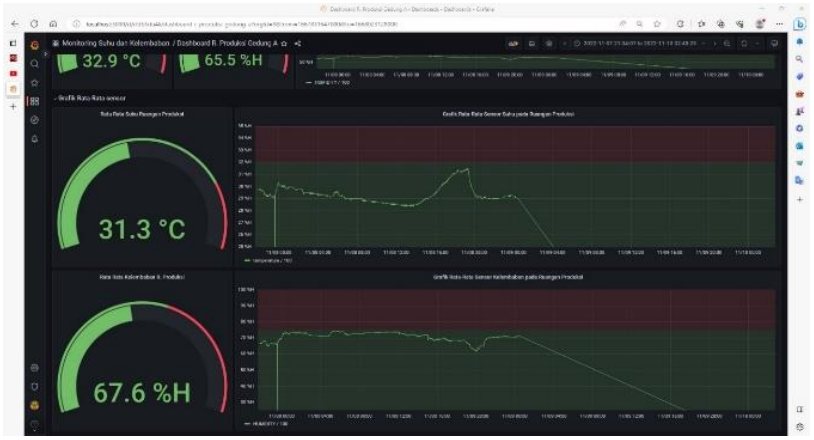

Figure 10. Support Dashboard of the Temperature and Humidity Monitoring Application

3.5 Gap analysis

In this subsection, an analysis of the gaps between actual performance and expected potential performance is conducted. Here are the results of the gap analysis which may reveal hidden or undetected issues in the current business process.

a. Lack of competent human resources in the field of automation and IT within the company.
b. Device-related challenges can arise if they do not meet the requirements. For example, router specifications should be considered to ensure effective data transmission, especially in environments with interference from materials such as iron or machinery that can disrupt signal communication.
c. Proper planning is necessary for computer devices, considering factors such as duration and capacity of usage. As data are sent periodically, the accumulated data volume over time can cause a decreased response capability or system hang-ups, negatively impacting the performance of application users.
d. The quality and performance of the converter devices, including the sensors used, should also be carefully evaluated to ensure compliance with industrial standards.

4. Conclusions

Based on the analysis explained in Chapters I-IV regarding "Monitoring System for Temperature and Humidity Sensors in Production Rooms Using Node Red as Backend and Grafana as Frontend," the researcher can conclude the following. Obtained a monitoring system that can display real-time data and provide alarm notifications as warnings for anomalies in the production room conditions, allowing identification of the specific areas contributing to humidity problems. Possesses an application that can serve as an IT asset and be further developed into a more complex and useful monitoring system by adding the necessary sensors and integrating them. This would enable the presentation of more abundant and accurate information about production rooms. Provides a solution for budget efficiency by replacing PLC and HMI hardware with a computer and this Monitoring System application. This allows for the best possible offer tailored to the needs and budget of PT Tri Agung Sinergi customers.

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