Implementation of Internet of Things for Battery Room Monitoring and Controlling (Case Study PT. Telkom Indonesia-Malang)

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Abstract— **Batteries are capable of storing and conducting electric current, as a backup power supply source in the industry. Battery charging involves the conversion of electrical energy into chemical energy, and overcharging produces harmful hydrogen sulfide gas(H_2S), which is crucial for early risk identification. This study aims to develop a condition monitoring system using the Internet of Things in industrial areas. This research was developed in the battery room owned by Telkom Malang, adapted to the need to optimize the condition of the battery room. The research system integrates the mq136 sensor for detecting H_2S gas, DHT22 for temperature and humidity, and a voltage sensor that measures battery capacity. All data is processed by the ESP32 microcontroller, stored on Firebase, and displayed through the website to make it easier for officers to monitor and control the battery room. The result of DHT22 sensor accuracy for temperature is 98.82%, humidity is 98.83% and voltage sensor accuracy is 99.95%. As for the mq136 gas sensor, it has an accuracy value of 93.5%. The automatic fan control system has been effective in activating the fan when the battery chamber conditions indicate H_2S gas levels above 10 ppm and temperatures above 40°.**

Keywords*— *DHT22, Firebase, Hydrogen Sulfide, IoT, Lead-Acid Battery.

I. INTRODUCTION

In the current digital era, the information and communication technology industry continues to experience innovation and transformation, PT. Telkom Indonesia a pioneer provider of information and Communication Technology (ICT) services and telecommunications networks in Indonesia has the responsibility to provide the best service for its customers with the ability to adapt quickly to changes in the industry to improve customer satisfaction [1]. One of the important elements that contribute to quality service is an optimal charging system. No Break System was implemented by PT. Telkom Indonesia consists of three components: PLN as the main power supply system, Diesel Engine Generator (DEG) as the power supply system when the main source of interference. To prevent voids from occurring during the process of switching voltage sources, batteries are used [2] as intermediaries that supply current to telecommunications devices. One of the batteries used is a wet type of battery, requiring appropriate charging and good maintenance. Battery charging process involving the conversion of electrical energy into chemical energy, producing hydrogen gas(H2) derived from the battery electrolyte liquid containing sulfuric acid [3][4], under conditions of overcharging, can produce harmful gas hydrogen sulfide (H_2S), which has the potential to cause risks such as explosion or fire. In addition to the impact on the environment, high levels of H_2S gas can interfere with the health of maintenance personnel [5][6].

Based on previous research conducted by Lavanya, et al(2021)[7], monitoring air conditions in industrial areas can provide early warning for workers in the area. However, this system has not been implemented in the industrial device room, where maintenance personnel have a crucial task to ensure each telecommunications support device is functioning optimally, one of which is a wet battery. Other literature reviews provide knowledge in finding theoretical and conceptual foundations for solving the intended problems in research. This study aims to improve the safety of maintenance personnel while in the battery room and optimize the condition of the battery device room. This research is expected to contribute to maintaining worker safety and good environmental conditioning.

IoT enables devices and systems to communicate with each other and share data automatically over the internet, creating efficiency, real-time monitoring, and better decision-making. In healthcare, IoT is used for patient health monitoring, while in industry, IoT optimizes supply chains, production processes, and equipment monitoring. In the household, IoT provides convenience through connected smart devices. This utilization shows the significant potential of IoT in improving safety efficiency, operational and quality of life, as well as a contribution to the continuous development of Technology [8].

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Internet of Things (IoT) is a technology that uses the internet to connect, control, process, and monitor an object or device. IoT provides convenience in connecting the virtual world with objects in the real world through information technology [9]. This technology is supported by three main components, sensors as the eyes and ears of the object, which will collect data from its environment. Second is the internet connection, allowing the data to be transmitted to the data center. Third is the data center, where data is processed and analyzed. The results of the analysis are sent back to the device or user to take a specific action. This entire process occurs in real-time, enabling fast and efficient responses [10].

The literature review provides a perspective on previous research and development potential. Research integrates research methodologies and techniques to improve the validity and reliability of research. The first research title Monitoring Temperature, Humidity, and Gas Level in Industries Using IoT focuses on monitoring temperature, humidity, and gas levels in open industrial areas. The study developed a monitoring system using NodeMCU ESP8266 microcontroller, DHT11 gas sensor, and LPG. The results help maintain and provide workers with information about industrial conditions that may not be seen or felt, such as rapid temperature rise and gas leakage through applications [7].

The next study is the title application of Wireless Sensor Network for Environmental Monitoring using ESP-WROOM 32. Using a Wireless Sensor Network (WSN) system for environmental monitoring of community areas, with parameters such as CO, SO2, H2O, and CO2. Sensors used include MQ 135, DHT22 [11], and MQ 9. This study examines the location of sensors at various Node locations. The result of the sensor measurement will be displayed on the LCD and sent to the web server [12].

The next research is titled Air Quality Monitoring Device Design Using Mq135 Sensor based on Arduino Uno microcontroller. This study focuses on the development of a sensor monitoring system using an Arduino Uno microcontroller and mq135 sensor to measure air quality in a community environment. The results showed that air quality monitoring consistently showed readings below 0.5 ppm in three different locations, in accordance with Indonesian standards. However, this study has limitations, as it was conducted at a site with similar conditions and there were no sensor Efficiency Tests [13].

The research entitled Design of hydrogen sulfide Gas measuring instrument (H_2S) with mq136 sensor based on ATmega 16A-PU microcontroller, data collection using H_2S Gas detection sensor [14] and multimeter voltage measurement. Accuracy of gas sensor readings using a gas Detector. The Data was recorded using the BASCOM AVR program and the Delphi 7.0 program for real-time data analysis on a 16X2 LCD and Microsoft Excel. The tests were conducted at concentrations of 1 to 100 ppm, and the results showed that the detection of H_2S can be done effectively with the lowest concentration of 1,103 ppm and the highest concentration of 85,335 ppm [15].

The next study titled Internet of Things-Based Indoor Air Quality Monitoring System Design, this study took measurements in a room using mq135 sensors to detect air quality, MG-811 sensors to detect CO2, dust sensors to detect particles (PM2.5), mq2 sensors to detect smoke, MQ9 sensors detect CO, mq8 sensors detect H2. The microcontroller used in this study is ESP32. The accuracy of the sensor is carried out using a dust particle concentration measuring device, the HAZ Dust EPAM-5000. The shortcomings of this study did not include the area of the sensor coverage room and the measurement of sensor accuracy using only one measuring instrument [16].

The shortcomings of previous studies include measuring the area of sensor readings and the calibration process of the sensors used. With the use of the appropriate number of sensors in an area, it will produce more precise data information. Calibration on the sensor is done to determine the percentage of accuracy of the data produced compared to the tool made with factory standards.

Based on the review of previous studies, this study uses two sensor nodes to be able to provide precise measurement data information. It aims to cover a large area of battery space. Measurement accuracy of sensor data-sensors used in the study, to provide optimal measurement results. The process of excessive evaporation by the battery occurs during an increase in the flow of the flowing voltage, so the early identification of the flowing voltage in the battery can alert.

Sensors installed at several points in the room allow more optimal monitoring of conditions when evaporation occurs by the battery during its charging cycle. Ensuring that any potential risks can be dealt with immediately, maintaining the integrity of the device, and more importantly, the safety of the workers.

II. METHOD

A. System Planning

The type of research that will be conducted is research and development or Research and development (R&D) at PT. Telkom Malang to help solve existing problems. The study focuses on identifying the quality of the storage space conditions of battery devices, as part of the power supply system of the company's telecommunications devices. The research process begins with the design of the study to the analysis of research results. The design of the study begins with a literature review, which involves the review of literature from journals, articles, and dissertations related to the risks arising from the use of wet batteries in the power supply system of telecommunications equipment and their impact on the condition of the battery room. This is important to ensure the safety of maintenance personnel with the Internet of Things (IoT) technology approach [17]. Based on the understanding of the identified issues and needs, the design of Systematic Solutions is carried out. Hardware planning includes the design of a gas detection system, measurement of temperature, humidity, as well as battery voltage, as well as coordinated process control via the ESP32 microcontroller, with regulated fan control via relays. This solution facilitates monitoring and is an innovative response to the challenges of monitoring gas levels, temperature, and humidity in battery chambers [17]. The study integrates three sensors with different functions: the Mq136 Sensor to detect hydrogen sulfide (H_2S) gas levels, the DHT22 sensor for temperature and humidity, and a voltage sensor to monitor battery voltage. The existence of these sensors is essential in ensuring that the condition of the battery room remains optimal for the safety of officers. ESP32 microcontroller is adopted in the system to facilitate communication and data processing. Software system design involves the creation of a data store system, data communication system, and interface pages for officers. Furthermore, the manufacture of tools according to the design that has been made to be able to perform functional testing of the system. When the tool has worked well, further data collection can be done. Data analysis, involves data collected from the beginning of the design of the tool to the implementation of the tool, so as to obtain conclusions that answer the research problems.

The application of the Internet of Things System Design in helping to condition the optimal battery space will be achieved by meeting the needs of the system. Conducted a literature review to be able to produce a system of tools that are able to overcome existing problems. So it is able to define relevant parameters and identify important data in the research system. In this study, the monitoring will be done by measuring the levels of H_2S gas, temperature, humidity, and voltage flowing on the battery. The system will be depicted in the following block diagram consisting of two sensor nodes and one server node, which will perform data storage on a cloud database and can perform control via the website.

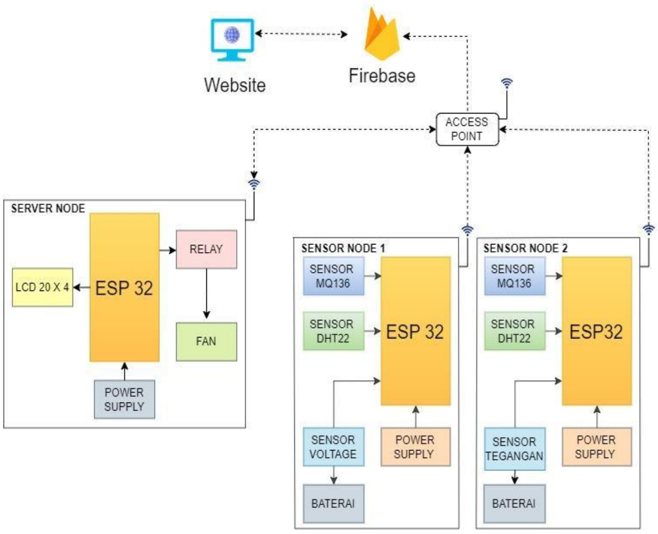

Figure 1. Block Diagram System

Figure 1 shows that the system is designed to work in a distributed manner. Consists of an ESP32 microcontroller that will process data processing results from sensor measurements, and then perform connectivity to storage on Firebase. Next, the data will be displayed on the officer interface page in the form of a website page. Send and receive process that occurs on the system using the internet network.

The design of the system uses two sensor nodes based on the coverage area of the battery room. Battery room owned by PT. Telkom with a length of 5.7 meters, 8.7 meters wide and, 5 meters high. The mq136 Sensor functions to detect H_2S gas, the DHT22 sensor functions to measure temperature and humidity in the battery compartment to determine the status of the condition. The Voltage Sensor measures the voltage flow on the battery. The power supply serves as a power source for operating the ESP32 microcontroller. The Firebase Cloud Database is used to store information generated by the system, as well as to communicate between nodes and websites.

The server Node will retrieve data from the Firebase database to display on the LCD [18] and perform processing related to the conditioning of the battery room so that it is safe for officers to perform battery maintenance in the room.

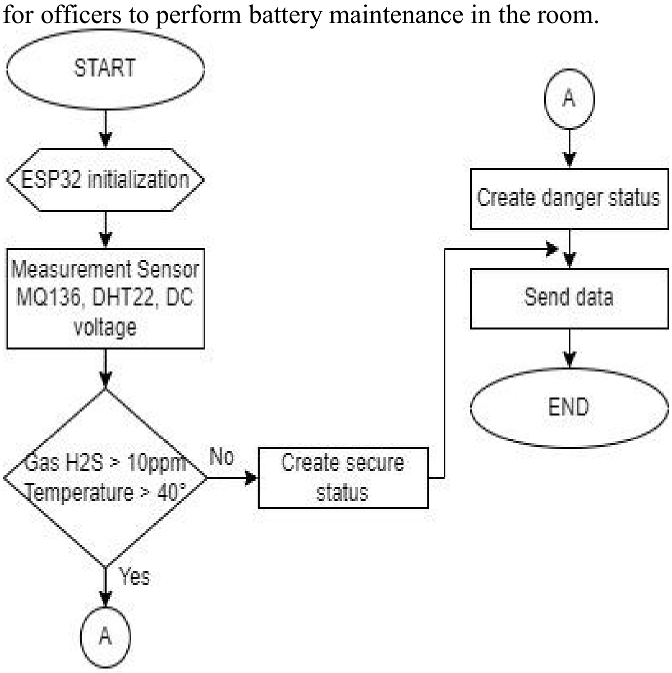

Figure 2. Sensor Node Device Flowchart

Figure 2 shows the flowchart of the sensor node, with an explanatory description, the system will start with initialization by ESP32, then perform measurements using H_2S gas sensor (MQ136), temperature and humidity (DHT22), and voltage sensors to determine the status of the battery chamber condition. This value is taken based on theoretical studies, in the process of charging the battery produces evaporation of H_2 gas which in conditions of overcharging the battery can experience excessive evaporation to produce H_2S gas. Increasing H_2S gas levels in the battery chamber will affect the increase in room temperature. It is known that the condition of charging by the battery affects the increase in the value of the voltage flowing from the battery, therefore, to obtain initial identification, measurements of the voltage flowing on the battery are carried out. Furthermore, the system will identify the condition, if the detected H_2S gas level has a value of more than 10 ppm and the temperature is above 40°C, the system will give a warning of dangerous conditions in the battery compartment. If the measurement result is below the limit value, the system will warn the safe condition of the battery compartment. The collected Data will be stored in Firebase as a storage location for the entire data. The use of these parameters is based on ACGIH's safety standards which state that H_2S gas levels in an industrial space must not exceed 10 ppm with a frequency of visits by humans under 20 minutes. The standard temperature value in the device chamber belongs to PT. Telkom Indonesia is below 40°C [19][20].

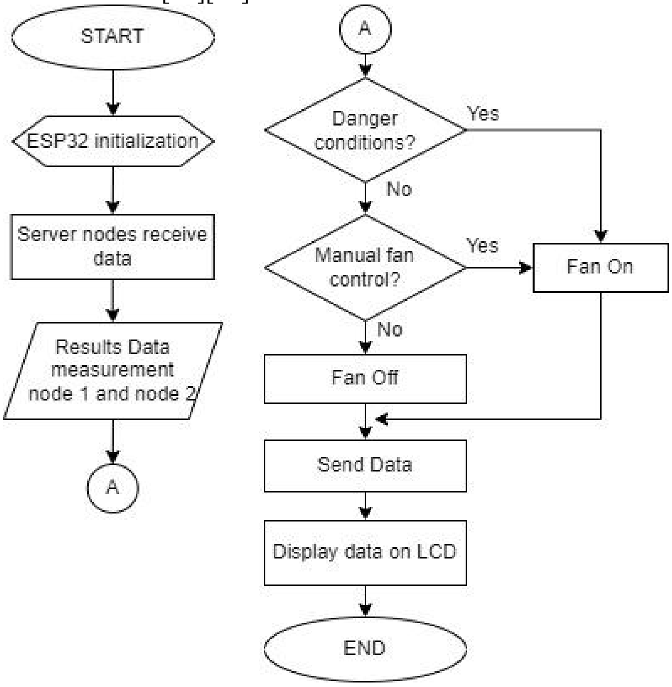

Figure 3. Server Node Device Flowchart

Figure 3 shows the flowchart of the server node, with a description of the explanation, the system starts by initializing the ESP32, then the system will receive data from the cloud database, then check the status of the measurement of the condition of each node whether the danger condition. If yes, then turn on the battery chamber fan. If not, then check if the fan control is done manually. If yes, then turn on the battery chamber fan. If not, then the fan will remain in the off-state. Data will be sent to a cloud database, then the data will be displayed by the LCD contained in the battery compartment.

Figure 4 shows the overall flowchart of the system, with an explanatory description, the system starts with the server node preparing to receive sensor node measurement data through the cloud database. Each sensor node will take measurements according to the specific capabilities of each sensor. The server Node will receive the results of sending information from the cloud database, and perform a condition measurement status check on each node whether the condition is in danger. If in dangerous conditions, then turn on the battery chamber fan. If not, then check if the fan control is manual. If yes, then turn on the battery chamber fan. If not, then the fan will remain in the off-state. Data sent to the cloud database will be displayed on the officer's website.

B. Design The Integration of The Entire Hardware System

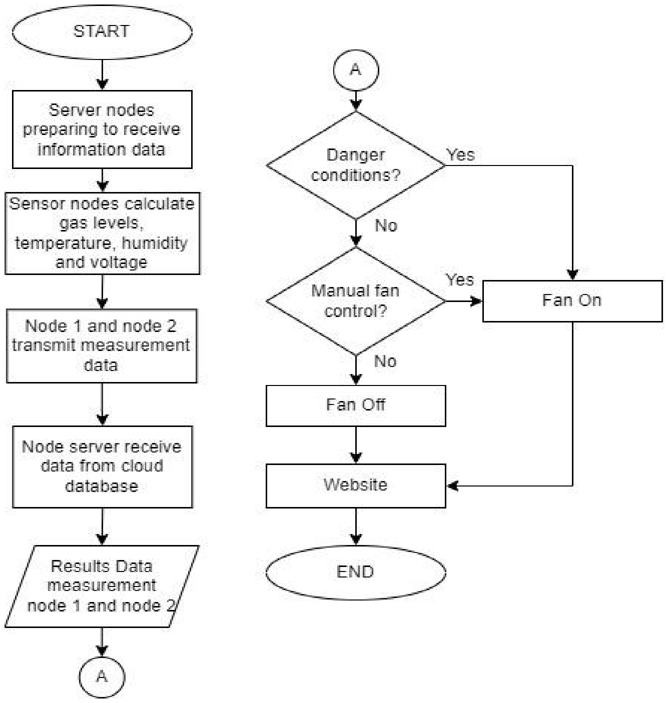

Figure 4. The Whole System Flowchart

Hardware system connection and Integration Design describes how hardware components interact and work together in a system. Through this design, relationships between modules, communication protocols, and operational parameters are determined with precision, ensuring optimal system performance and reliability of interaction between components. In this context, a systematic and analytical approach is required to ensure the efficiency and effectiveness of hardware integration.

Sensor node system design consists of ESP32 as a microcontroller that processes the work of the system. Based on the function of each pin on ESP32, the relationship between the sensor and ESP32 is shown in Figure 5, as follows:

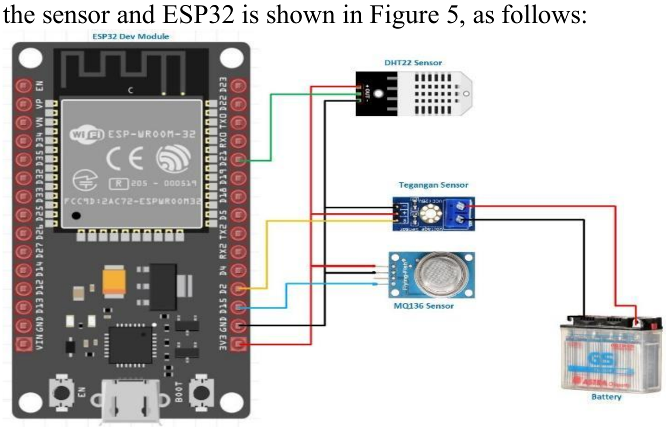

Figure 5. Sensor Node Connection Design

No	Pin Sensor DHT22	Pin ESP32
1	VCC	Vin (Input power)
2	GND	GND
3	OUT (Digital output)	22

No	Pin Sensor MQ136	Pin ESP32
1	VCC	Vin (Input power)
2	GND	GND
3	D0 (Digital output)	-
4	A0 (Analog output)	19
No	Pin Voltage DC	Pin ESP32
1	VCC	Vin (Input power)
2	GND	GND
3	S (Analog output)	21
4	+ (Positive terminal)	-
5	- (Negative terminal)	-
No	Battery	Voltage DC
1	Positive	+ (Positive terminal)
2	Negative	- (Negative terminal)

Server node system design consists of ESP32 as a microcontroller that processes the work of the system. Based on the function of each pin on ESP32, the relationship between the sensor and ESP32 is shown in Figure 6, as follows:

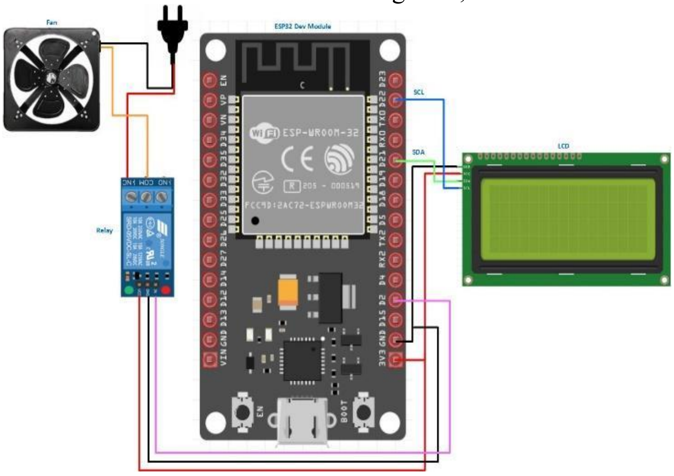

Figure 6. Server Node Connection Design

No	LCD	Pin ESP32
1	VCC	Vin (Input power)
2	GND	GND
3	SDA (Serial data)	21
4	SCL (Serial clock)	22

No	Relay	Pin ESP32	Fan
1	VCC	3.3V	-
2	GND	GND	-
3	IN (Digital input)	2	-
4	NO (Normally open)	-	-
5	COM (Contact center)	-	Positive
6	NC (Normally close)	-	-
No	Fan	Relay	Power Supply
1	Positive	COM (Contact center)	-
2	Negative	-	GND

Design node system as a whole consists of ESP32 as a microcontroller that processes the data communication of each node. Communication occurs using the internet network, the process is shown in Figure 7, as follows:

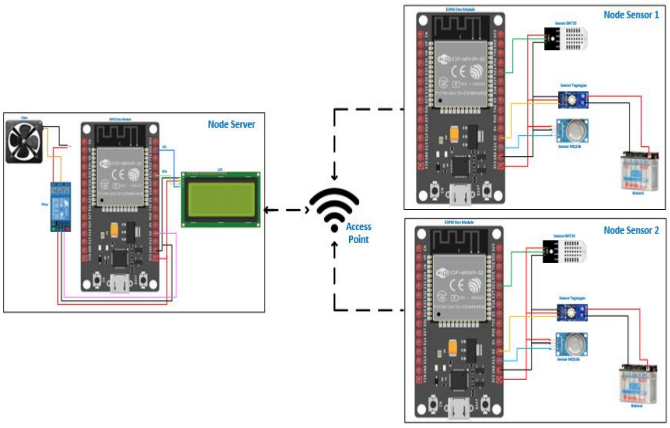

Figure 7. Integration Of The Entire Hardware System

III. RESULTS AND DISCUSSION

A. Node Design Results

The design of the sensor node is placed in a protective box, to keep the connection of the tool system installed properly.

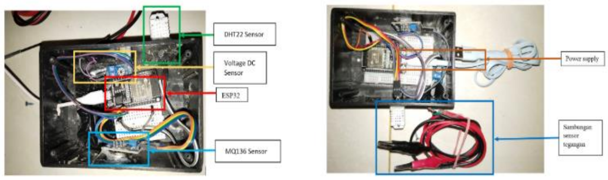

Figure 8. Sensor Node Design Results

Figure 8 (left) shows the sensor node consists of ESP32, mq136 sensor, DHT22 sensor, and DC voltage sensor. The placement of the mq136 gas sensor is embossed out of the box for easy identification of H_2S gas, as well as temperature and humidity sensors. Figure 8 (right) shows a jumper cable connection placed on the outside of the box to measure voltage.

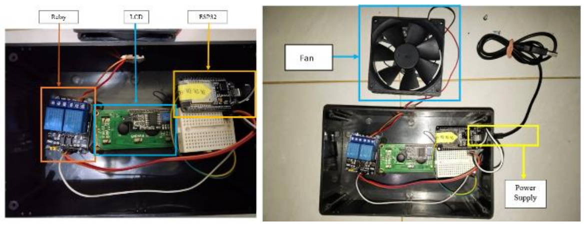

Figure 9. Server Node Design Results

Figure 9 (left) shows the inside of the server node box consisting of ESP32, relay, and LCD. Relay is used to control the work of the fan and the LCD will display the sensor readings. The server Node will receive sensor reading data information and battery room condition status to provide control of the fan and display the data on the LCD. Figure 9 (right) shows the fan mounted on the outside of the box.

B. Sensor Test Results

Component accuracy testing is a systematic evaluation process to determine the extent to which a particular component performs according to a specified specification or standard. Through careful testing procedures, the variability and potential faults of the components can be identified and analyzed, ensuring that performance is consistent so that the results obtained from the tool system are reliable.

Error percentage
= (Measuring instruments - Sensor) / Measuring instruments × 100%

Average error
= (Total error percentage) / Amount of data × 100%

To test the mq136 sensor using the BH-4s Bosean type H_2S gas detection gauge shown in Figure 10, an alternative method was used considering that H_2S gas has hazardous properties and is rarely found in the wild. Based on literature references and discussions with lecturers in Chemical Engineering, it was informed that organic compost has H_2S gas content. Taking this information into account, organic waste is collected in a large jar and left to ferment for one week. After a period of fermentation, H_2S gas was successfully detected, validating this approach as an effective method for generating H_2S gas sources for assay purposes.

Figure 10. Bosean BH-4S

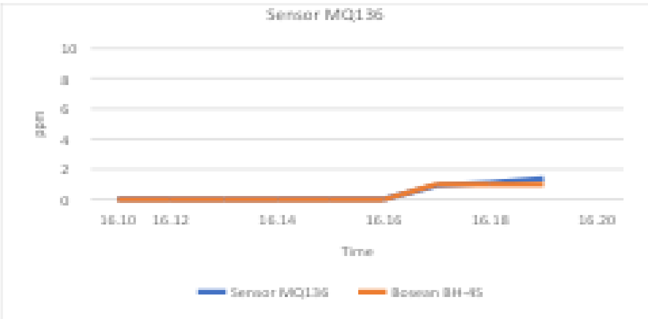

Figure 11. Sensor MQ136 Calibration

Based on Figure 11, the calibration results performed on the H_2S mq136 gas sensor, showing a graph identifying significant levels of H_2S gas, measurements were carried out in the same period. This shows the mq136 sensor readings that have been by the standard. The average reading error is 6.5%.

DHT22 sensor testing in detecting temperature and humidity is performed to assess the accuracy and consistency of measurements. The sensor calibration process is carried out by comparing the readings produced by the sensor and the readings of the HTC-1 Temperature gauge shown in Figure 12.

Figure 12. Temperature HTC-1

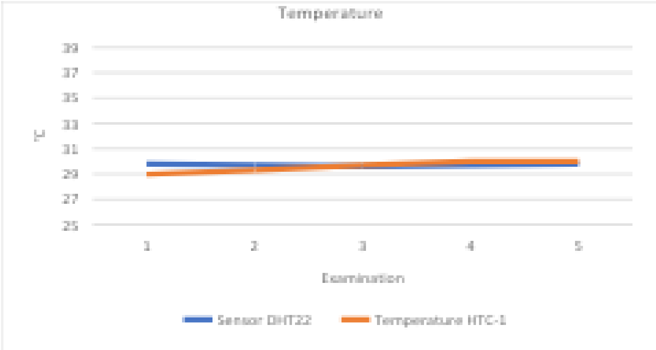

Figure 13. Sensor DHT22 (Temperature) Calibration

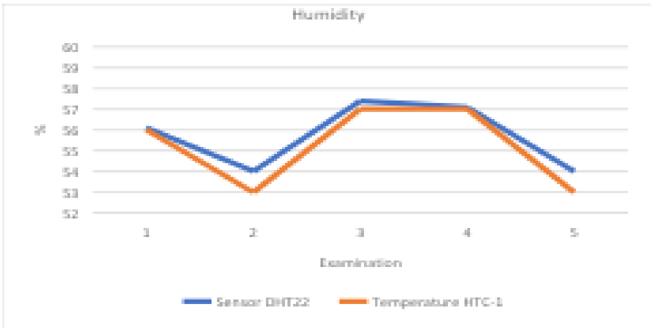

Figure 14. Sensor DHT22 (Humidity) Calibration

Based on Figure 13 and Figure 14 calibration results performed on the temperature and humidity sensor DHT22, the average value of the temperature reading error is 1.18% (sensor 1) and 1.17% (sensor 2) with the largest difference of 2.75 °C and the average value of the humidity reading error is 0.96% (sensor 1) and 1.37% (sensor 2) with the largest difference of 3.77%.

Testing of DC voltage sensors in detecting voltage values is carried out to assess the accuracy and consistency of measurements. The sensor calibration process is carried out by comparing the readings generated by the sensor and the readings of the multimeter measuring instrument in accordance with its manufacturer's specifications, which are shown in Figure 15.

Figure 15. Multimeter

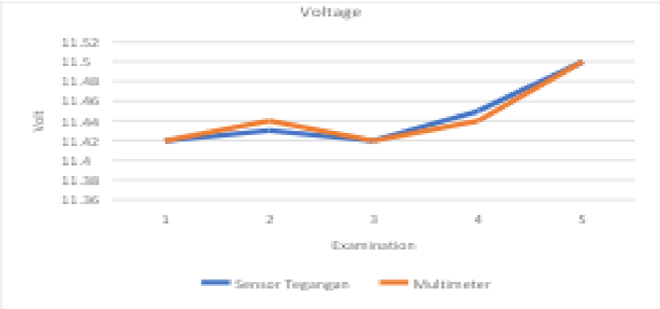

Figure 16. Sensor Voltage Calibration

Figure 16 shows the results of testing the accuracy of the voltage sensor obtained. The average error of the sensor node 1 is 0.032% with the largest difference is 0.01 V and the sensor node 2 is 0.068% with the largest difference is 0.17 V. The error value can be caused by the resistors that make up the voltage sensor, which have a tolerance value. The output value of the linear voltage sensor, the greater the voltage applied, the greater the voltage read by the voltage sensor.

C. Communication Node Test Results

The distance between node 1 and node 2 will be 3.8 meters, while the server node will be placed 3.1 meters below the room fan. This distance adjustment is to achieve optimal sensor measurement data, reduce the risk of sensor damage, and ensure optimal placement in reaching the internet. In the communication process, internet connectivity is essential. Therefore, the device should be placed at a location with optimal internet access for data transmission efficiency, as shown in Figure 17 and Figure 18.

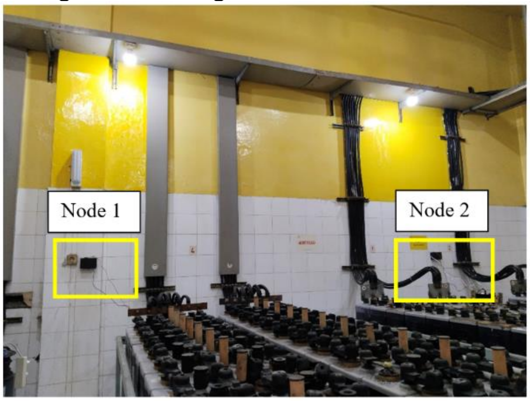

Figure 17. Installation Of Sensor Nodes

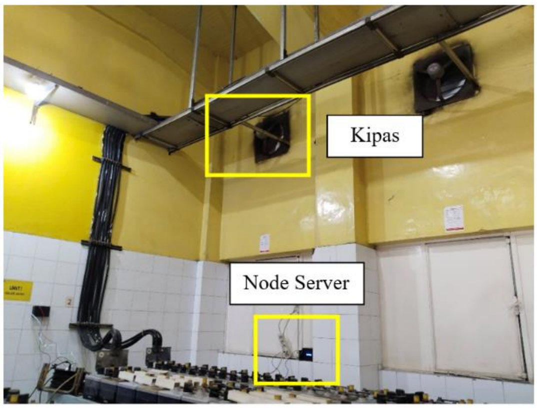

Figure 18. Installation Of Server Nodes

Two sensor nodes can transmit data information and communicate with the server over the internet, ensuring the data is stored on the website.

Figure 19. Firebase Firestore

Figure 19, Firebase Firestore will display storage information from the sensor node delivery, later this information will be displayed on the officer's website page. In addition, Firebase Firestore also stores a history of users who access the website, shown in Figure 20.

Figure 20. Firebase Auth

Figure 21 shows the officer's website page will display the results of information retrieved from Firebase.

Figure 21. Website

Storage Information data generated from sensor measurements will be stored in the Firebase Cloud Database, so it requires a connection to the internet network. Each node will be connected to the internet so that the data communication process occurs between nodes with Firebase and websites with Firebase. Interface page for officers in the form of a website, allows them to monitor the performance of the system and control the system. On the website page will be displayed the results of the data information of each sensor node, and control of the battery room fan. Manual control of the fan aims to condition the battery space so as to avoid the safety risks of the officer who will perform maintenance of the battery device. On the website page can also be displayed the overall results of system monitoring, making it easier for officers to conduct analysis.

D. Internet Of Things Implementation For Monitoring And Controlling

Functionality testing is performed to ensure that the system functions in accordance with the specifications or needs that have been determined. The purpose is to validate that each function of the system or tool is operating properly so that a safe battery room condition is achieved for maintenance personnel.

TABLE I
SENSOR NODE 1 TEST RESULT

No.	Temperature (°C)	Humidity (%)	H_2S (ppm)	Voltage (V)	Status	Fan
1	25.80	81.00	1.00	12.11	Aman	OFF
2	26.00	78.50	1.00	12.18	Aman	OFF
3	26.00	79.80	3.00	12.13	Aman	OFF
4	26.10	80.30	3.00	12.14	Aman	OFF
5	26.20	80.00	4.00	12.18	Aman	OFF
6	27.40	68.30	7.00	12.20	Aman	OFF
7	27.80	71.40	10.00	12.30	Bahaya	ON
8	28.00	67.20	6.00	12.29	Aman	OFF
9	28.10	67.00	3.00	12.15	Aman	OFF
10	28.30	66.10	6.00	12.19	Aman	OFF
11	28.30	66.40	7.00	12.27	Aman	OFF

TABLE II
SENSOR NODE 2 TEST RESULT

No.	Temperature (°C)	Humidity (%)	H_2S (ppm)	Voltage (V)	Status	Fan
1	26.50	61.40	1.00	12.14	Aman	OFF
2	26.50	61.40	3.00	12.13	Aman	OFF
3	26.40	61.80	4.00	12.14	Aman	OFF
4	26.50	61.50	2.00	12,11	Aman	OFF
5	26.50	61.60	5.00	12.10	Aman	OFF
6	26.50	61.60	10.00	12.22	Bahaya	ON
7	25.40	57.60	10.00	12.20	Bahaya	ON
8	25.40	57.60	7.00	12.15	Aman	OFF
9	24.90	59.10	7.00	12.16	Aman	OFF
10	24.80	58.90	8.00	12.23	Aman	OFF
11	25.40	58.00	6.00	12.17	Aman	OFF

In Table 1 and Table 2, shows that the tool system has been able to work properly, this is indicated by a fan that has been able to work automatically. At a safe voltage value of 12.11 V, H_2S gas levels of 1.00 ppm, and room temperature of 25.80°C, The Fan will not turn on. When there is a change in the condition of the battery room, where there is an increase in the voltage value that affects the increase in H_2S gas levels and temperatures in the room, based on the data obtained, the hazard conditions of the voltage value of 12.30 V, H_2S gas levels of 10.00 ppm, and room temperature of 27.80°C, The Fan will turn on to re-neutralize the room. This shows that the layout and use of ventilation in the battery room have been able to control the room temperature, which was not detected more than 40°C. The implemented tool system helps control H_2S gas levels in the battery chamber, and has worked in accordance with the goals to be achieved. Changes in H_2S gas levels that occur during testing of the appliance system are shown in the following graph:

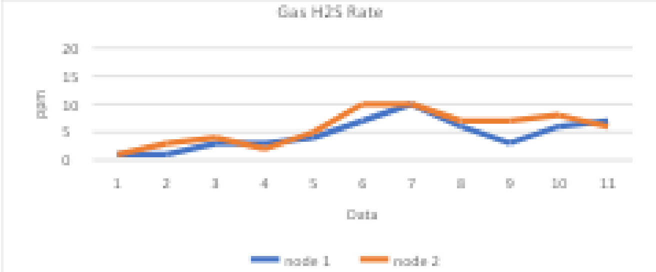

Figure 22. Indoor H_2S Gas Measurement Results

Based on Figure 22 it is shown that the detection of H_2S gas using node 1 and node 2, has been able to control the condition of the battery chamber. The difference between the reading of node 1 and node 2 occurs due to different installation locations.

After testing the working system of the tool, further testing of the results of measuring H_2S gas levels in the battery chamber before and after the implementation of the tool. Measurement using Bosean measuring instrument BH-4s. The initial measurement of H_2S gas levels was carried out on June 26, 2023, the second measurement was carried out after the implementation of the monitoring and controlling tool system in the battery room. Measurements were taken on August 21, 2023. The following comparison of the measurement results of H_2S gas levels is shown in Figure 22 (left) measurement before and Figure (right) after implementation, as follows:

Figure 23. Battery Chamber Condition Measurement Results

Based on Figure 23, it is shown that before the monitoring and controlling equipment in the battery room, the H_2S gas level identified was 19 ppm, after the implementation of the H_2S gas level device, it can be controlled at 0 ppm. The result is that the system has succeeded in reducing H_2S gas levels in the battery compartment, keeping the battery compartment always in a safe condition.

The implementation of the tool in the battery compartment is designed to be able to provide maximum solutions to the problems found. Conditioning the installation location of the sensor by considering the possibility of interference that can affect the results of the sensor readings, therefore the anticipation is done by placing the sensor node away from the air vent. This study provides ease of reading the condition of the battery room with the installation of LCD in the battery room, to reduce the risk that can be caused for officers who will enter the battery room, the need for readjustment to be able to put the LCD on the outside of the room, so that information can be more easily read.

IV. CONCLUSION

In creating an Internet of Things system for monitoring and controlling battery space, node 1 and 2 devices act as the initial entry point of the system, while the server node acts as the endpoint of the system. The sensor node is 1.25 meters from the base of the room, while the distance between the sensor nodes is 3.5 meters. These implementation conditions have given excellent results, by lowering the levels of H_2S gas detected in the battery chamber. By decreasing the H_2S gas level, it will affect the temperature in the battery chamber. From the tests that have been carried out on the quality of the battery room conditions, it was found that an increase in the voltage value will affect the increase in H_2S gas levels and temperatures in the room, based on the data obtained, the hazard conditions of the voltage value of 12.30 V, H_2S gas levels of 10.00 ppm, and room temperature of 27.80°C. under safe conditions, the voltage value is 12.11 V, H_2S gas content is 1.00 ppm and the room temperature is 25.80°C. Increased voltage flow in the battery will accelerate the evaporation process, the evaporation process by the excessive battery will form H_2S gas, and increased levels of H_2S gas in the room will affect the increase in temperature in the room.

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