# Prototype of IoT-Based Temperature and Humidity Monitoring and Controlling System for Broiler Chicken Coops

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***Abstract***

*Temperature and humidity are critical factors that influence the health and productivity of broiler chickens. Manual monitoring and control of coop conditions are often ineffective and inefficient, leading to a decline in production quality. This research aims to develop a prototype IoT-based monitoring and controlling system for temperature and humidity in broiler chicken coops. The system employs a DHT22 sensor to measure temperature and humidity, a Wemos D1 R1 microcontroller for data processing, and the Blynk application as a user interface for real-time monitoring and notifications. The Evolutionary Prototyping method is applied in the development of this system to allow gradual adjustments based on user needs. Testing results show that the prototype can monitor temperature and humidity in real-time and automatically activate fans or lights when the temperature is outside the optimal range. With this system, farmers can monitor coop conditions remotely, simplifying farm management.*

***Keywords***— IoT, monitoring system, environmental sensor, Wemos D1, automation

## 1. INTRODUCTION

Broiler chickens are widely consumed in Indonesia due to their affordability and accessibility [1]. Their role in the national animal protein supply sector is significant, serving as one of the primary drivers in providing animal protein nationwide [2]. Maximizing this opportunity, particularly in empowering rural farmers through the optimization of resources and local chicken farming, can improve living standards and become a source of income for families [2]. However, challenges in broiler chicken maintenance, especially in managing coop temperature and humidity, often become significant obstacles to chicken productivity and welfare.

In managing chicken coops, farmers must consider several crucial factors, with temperature and humidity being among the most critical ones affecting chicken health [3]. The optimal temperature range for raising broiler chickens aged 9 to 33 days is between 26°C and 29°C [4]. Environmental temperature fluctuations can lead to reduced feed intake or illness, potentially resulting in chicken mortality and decreased farm income [5]. Similarly, changes in coop humidity can affect temperature [6], potentially disrupting chicken activities and overall well-being. The optimal temperature range is between 26°C to 29°C, while the humidity should range from 50% to 70%. [29]. Therefore, temperature and humidity control are vital aspects of coop management.

Based on an interview with Alexander, who has operated a chicken farming business for eight years, maintaining broiler chickens presents several challenges in their care process. One significant challenge is maintaining appropriate coop temperature and humidity to prevent illness [4]. Consequently, farmers must ensure optimal temperature and humidity levels in chicken coops to maintain chicken health and productivity.

Temperature serves as a crucial indicator in broiler chicken coop management. Interview findings revealed that broiler chicken coop temperature measurements are still conducted manually using thermometers [4]. Coop attendants cannot continuously monitor the indoor conditions, resulting in unmonitored temperature changes. Therefore, an automatic system for monitoring coop temperature and humidity is needed, where IoT technology enables various sensor devices to connect through the internet [7]. These sensors can collect temperature and humidity data and send notifications based on this information. Thus, IoT will be implemented in this research to develop a prototype system for automatic monitoring of broiler chicken coop temperature and humidity.

Previous studies have implemented IoT technology to monitor broiler chicken coop temperature and humidity, such as research conducted by [8], [9], and [10]. However, these studies revealed limitations in the field implementation of this technology. Most research utilized the DHT11 sensor, which has lower measurement accuracy compared to the DHT22 sensor [7]. Therefore, this research will further explore the use of the DHT22 sensor, which offers higher measurement accuracy. The implementation of the DHT22 sensor is expected to provide more accurate monitoring results of broiler chicken coop temperature and humidity, thereby assisting farmers in maintaining optimal coop conditions.

## 2. RESEARCH METHOD

### *2.1. Theoretical Framework*

This study employs the Prototyping method as the system development approach. This method was chosen because it allows for gradual and iterative system development, enabling the system to be adjusted according to user needs that may evolve during the development process [28]. As illustrated in Figure 1, the main stages of this method include:

1. *Communication*: Conduct interviews and direct observations with broiler chicken farmers to understand the problems they face, their needs, and their expectations for the system to be developed.
2. *Quick Design*: Develop an initial system design based on the information gathered. This design includes system architecture sketches, data flow diagrams, and specifications for the hardware and software components to be used.
3. *Construction of Prototype*: Implement the initial design into a functional prototype. At this stage, hardware components such as the DHT22 sensor, Wemos D1 microcontroller, fan, and lamp are assembled according to the predefined schematic. The program code is written using the Arduino IDE and uploaded to the microcontroller.
4. *Development, Delivery, and feedback*: The built prototype is tested to ensure that all components function as intended. The testing includes measuring sensor accuracy, evaluating the system's responsiveness in activating actuators, and verifying its ability to send data and notifications through the Blynk application.

   The development process is considered complete when all stages have been carried out and the necessary adjustments have been made following the research objectives.

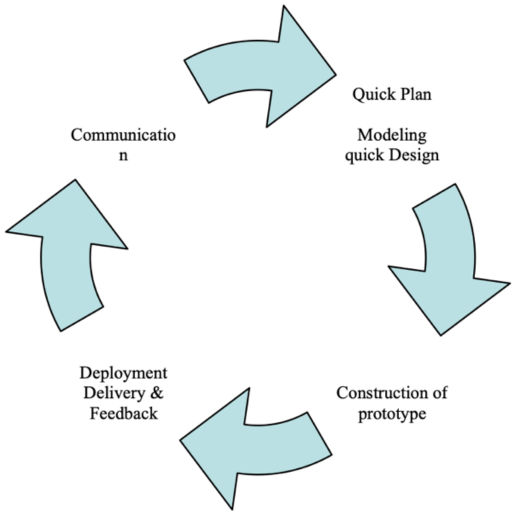


*Figure 1. Prototyping Model [28]*

### *2.2. Broiler Chicken Coop Environment*

Broiler chicken coops serve as protective shelters from direct sunlight and rain while supporting the chicken rearing process. Proper coop design must account for critical environmental factors, including temperature, humidity, ventilation, and solar radiation exposure [11]. Inadequate environmental control can lead to heat stroke in chickens, particularly when combined with poor management practices such as overcrowding, insufficient ventilation, or excessive protein feed that generates ammonia and heat [12]. Temperature and humidity fluctuations in broiler chicken coops can significantly impact chicken welfare and productivity. Uncontrolled temperatures can induce heat stress, resulting in reduced feed intake, stunted growth, and potential mortality [13]. Similarly, improper humidity levels can lead to respiratory infections and other health issues [8].

### *2.3. Microcontroller*

The system employs a Wemos D1 microcontroller, which features an ESP8266-based module capable of WiFi connectivity. This microcontroller can function independently in processing input codes and includes both digital and analog pins configurable for input/output operations [20].

### *2.4. Environmental Sensor*

The DHT22 sensor is used for temperature and humidity measurements. This digital sensor combines a capacitive humidity sensor with a thermistor, providing a digital signal output. The DHT22 offers higher responsiveness and faster sensing capabilities compared to conventional temperature measuring devices [22, 23].

### *2.5. IoT Platform*

The system utilizes the Blynk IoT platform, which enables hardware monitoring and control through smartphone interfaces. Blynk provides real-time sensor data monitoring, control commands for output components, and notification capabilities for specific conditions [24].

Several studies on IoT-based environmental detection and monitoring systems [25-27] discuss IoT platforms, hardware design, monitoring processes, and notifications to users. A study developed an indoor air quality detector using Wemos, MQ135, and ThingSpeak[25] also there is a study that designed an IoT-based broiler monitoring with DHT11, ESP8266, and Firebase[26]

This research uses Blynk's IoT platform, Blynk Apps, to monitor the temperature and humidity of broiler cages via Android smartphones in real-time. A similar system has been implemented by Junior et al. [8] with NodeMCU and Blynk, and Try Hadyanto et al. [9] who used DHT11, solid-state relay, and NodeMCU ESP32 to automate temperature and humidity monitoring.

### ***2.6.*** *Research Instrumentation*

#### *2.6.1 Data*

The data obtained in this research consists of two main types:

1. Primary Data: Obtained through interviews and observations with chicken coop owners, this data provides direct information about the operational conditions of the coop and specific needs related to temperature and humidity monitoring.
2. Secondary Data: Obtained from a literature review related to the use of IoT technology in farming, particularly for temperature and humidity monitoring. The secondary data sources include scientific journals, articles, books, and relevant case studies.

#### *2.6.2 Data collection technique*

The data collection techniques used in this research are:

1. Literature Study: Conducting a comprehensive review of existing literature to gather data related to temperature and humidity monitoring systems using IoT technology. Sources such as scientific journals, articles, books, and other relevant documents serve as the primary references.
2. Interview: Conducting interview sessions with chicken coop owners to gain a deeper understanding of the practical needs in the development of the monitoring system.
3. Observation: Conducting direct observations at broiler chicken coop locations to gather data on environmental conditions, daily operations, and farmer interactions with the coop environment. These observations help identify environmental factors affecting temperature and humidity, ensuring that the system design developed aligns with real-world conditions in the field.
4. Data Analysis: Collecting and analyzing data obtained from literature studies, interviews, and observations to determine the specifications and design of an effective monitoring system.

### ***2.7*** *Conceptual Framework*

The system design phase is a crucial process that aims to visualize the structure and working mechanism of a system. This phase includes mapping a series of operational stages that form the overall system framework. The resulting design will provide a comprehensive overview of various user interactions, system workflows from start to finish, and present a detailed explanation of the proposed system architecture.

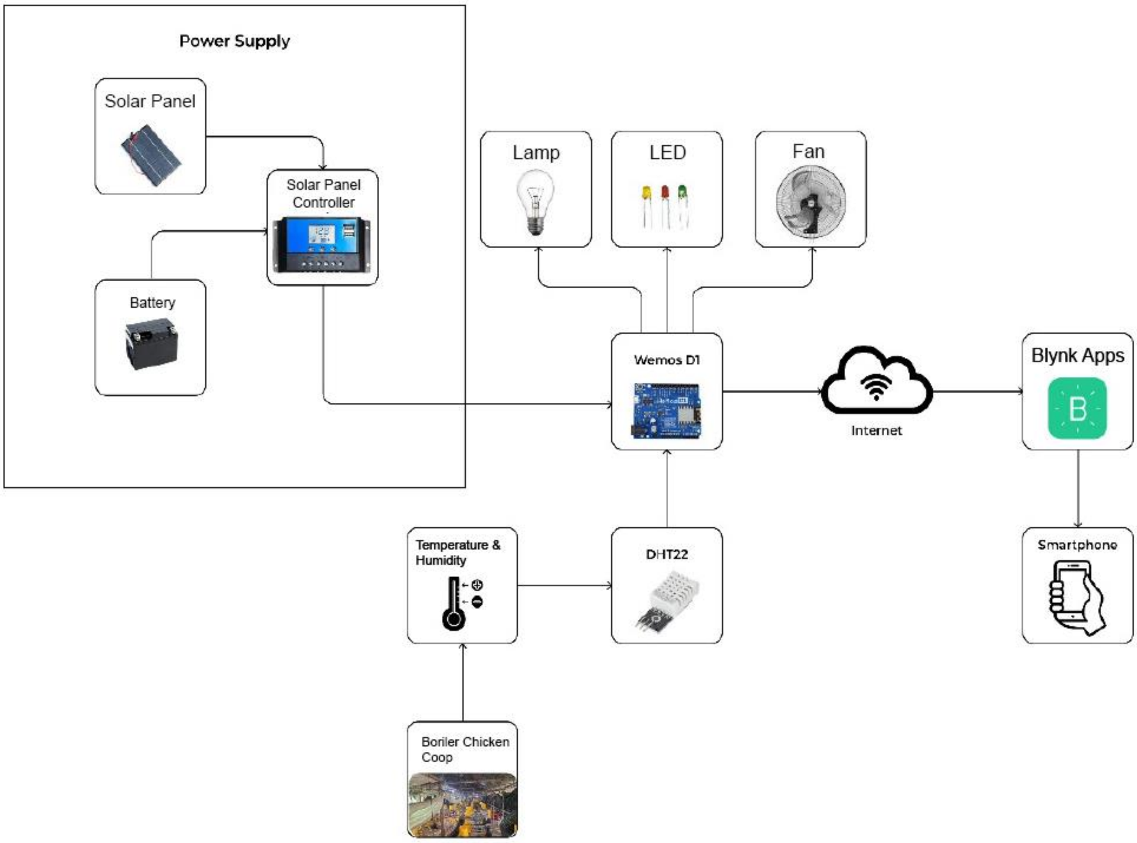


*Figure 2. Conceptual Framework*

- The DHT22 sensor detects the temperature and humidity inside the broiler cage.
- When the DHT22 Sensor successfully detects temperature and humidity, the data will be sent to the Wemos D1.
- Wemos D1 is connected to the internet.
- Wemos D1 sends detection results to the Blynk application
- Blynk notifies the smartphone
- Wemos D1 provides real-time output in the form of LEDs, where if the temperature in the cage is too hot, then the red LED will light up, while if the temperature is too cold, then the yellow LED will light up. As long as the temperature is normal, the green LED will continue to light up.
- Wemos D1 also provides a reaction to the detection results of the DHT22 sensor where when the temperature in the cage is too hot, the fan will be turned on to reduce the temperature in the room, while when the temperature in the cage is too cold, the lights will be turned on to increase the temperature in the cage to become normal again.
- The power source used is a solar panel connected to a battery and a solar panel controller.

### *2.8 Testing Environment*

The system testing was conducted in a broiler chicken cage owned by Mr. Alexander Febrian, located at Tandu, Trans Sulawesi Road, Inobonto Village, Bolaang District, North Sulawesi, Indonesia. The cage operates as a closed house system, measuring 12x68 meters, and houses 700 broiler chickens aged 23 days. This controlled environment provides a realistic operational scenario for evaluating the system's performance under actual conditions.

### *2.9 Testing Methods*

The testing process involved two primary methods:

1. Function Testing
   Functional testing was conducted to verify that all system components operate as expected. This included testing the DHT22 sensor for accurate temperature and humidity detection and evaluating the functionality of actuators such as fans, lamps, and mist makers. The results ensured that the system could effectively read environmental data and control the actuators based on predefined logic.
2. Performance Testing
   Performance testing focused on evaluating the system's responsiveness under operational conditions. The key metric assessed was the response time in processing sensor data and activating or deactivating actuators. This testing method ensured that the system could promptly adapt to environmental changes in real-time.

## 3. RESULT AND DISCUSSION

### *3.1 System Design*

The system design phase is a crucial process that aims to visualize the structure and working mechanism of a system. This phase includes mapping a series of operational stages that form the overall system framework. The resulting design will provide a comprehensive overview of various user interactions, system workflows from start to finish, and present a detailed explanation of the proposed system architecture.

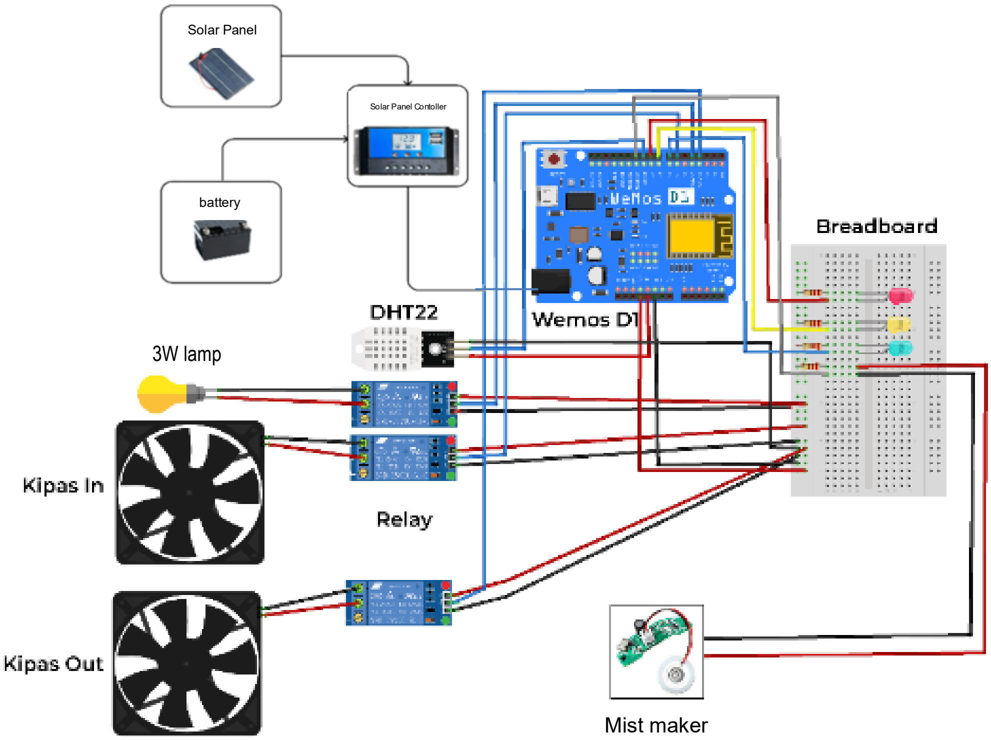


*Figure 3. IoT-based Broiler Cage Temperature and Humidity Monitoring and Controlling Hardware Schematic*

Figure 3 illustrates the hardware schematic of the IoT-based prototype system for monitoring and controlling temperature and humidity in broiler chicken cages. This schematic represents the relationship and interconnections among the hardware components. The DHT22 sensor, connected to pin D8 on the Wemos D1 microcontroller, measures temperature and humidity in real-time. The Wemos D1 microcontroller processes the data received from the sensor, controls the actuators, and transmits the data via WiFi to the Blynk application. Relays are used to manage the actuators, where fans connected to D4 and D1 are activated to lower high temperatures, the lamp connected to D2 is used to raise low temperatures, and the mist maker connected to D9 is activated to increase humidity when it falls below optimal levels. LED indicators, connected to D5 (red), D6 (green), and D7 (yellow), provide visual feedback on temperature status, displaying whether conditions are normal, too high, or too low. The solar panel controller regulates power from the solar panel to the 12V battery, ensuring a continuous power supply to the system. Overall, this system effectively integrates sensors and actuators with real-time monitoring and control functionalities through the Blynk application, enabling efficient environmental management for broiler chicken cages. Pins D1 and D4 are used for fans, D2 for the heating lamp, and D9 for the mist maker (humidifier). The LED indicators (D5=Red, D6=Green, D7=Yellow) provide visual feedback for temperature status: Green = Normal (26–29°C), Red = Too Hot (>29°C), Yellow = Too Cold (<26°C). Researchers use solar panels as a power source, because it is suitable for chicken coops so as not to depend on home electricity, then there are additional batteries to store the power obtained from solar panels.

In summary, D1 and D4: used to control the fan (Fan In and Fan Out); D2: used to control the Heating Lamp; D9: used for the mist maker (humidifier); D5 (Red), D6 (Green), D7 (Yellow); Temperature indicator LED. All of these pins are digital I/O pins from the Wemos D1 (ESP8266) board that are programmed as actuator control outputs.

### *3.2 System Testing Result*

The temperature and humidity monitoring and controlling system for broiler chicken coops based on IoT was tested in real conditions at a broiler chicken farm owned by a farmer in Inobonto Village. The testing was conducted to evaluate the reliability and accuracy of the prototype. The monitoring from the Blynk Apps is illustrated in Figure 4.

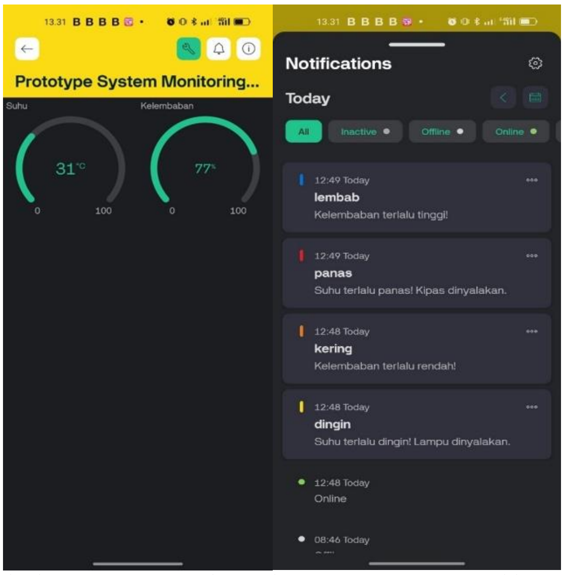


*Figure 4. A view of the Blynk app on a smartphone showing temperature and humidity monitoring (left) and notifications related to temperature and humidity conditions (right).*

#### *3.2.1 DHT22 Sensor Testing*

The DHT22 sensor was used to monitor the temperature and humidity of the coop in real-time. Table 1 presents the results of temperature and humidity measurements during the testing. The test results show that the DHT22 sensor is capable of providing accurate data, with an optimal temperature range of 26°C–29°C and humidity between 50%–70%.

*Table 1. DHT22 Sensor Testing Results in the cage*

| **Time** | **DHT22 Temperature($^0$C)** | **DHT22 Humidity (%)** | **Optimal Temperature ($^0$C)** | **Optimal Humidity(%)** | **Measurement Status** |
|---|---|---|---|---|---|
| 08:00 | 26.4 | 60 | 26-29 | 60-70 | Success |
| 08:30 | 26.6 | 63 | 26-29 | 60-70 | Success |
| 09:00 | 26.4 | 62 | 26-29 | 60-70 | Success |
| 09:30 | 27.3 | 64 | 26-29 | 60-70 | Success |
| 10:00 | 26.9 | 63 | 26-29 | 60-70 | Success |
| 10:30 | 27.3 | 61 | 26-29 | 60-70 | Success |
| 11:00 | 27.6 | 63 | 26-29 | 60-70 | Success |
| 11:30 | 28.2 | 65 | 26-29 | 60-70 | Success |
| 12:00 | 28.9 | 63 | 26-29 | 60-70 | Success |
| 12:30 | 29.3 | 62 | 26-29 | 60-70 | Success |
| 13:00 | 30.3 | 62 | 26-29 | 60-70 | Success |
| 13:30 | 30.5 | 61 | 26-29 | 60-70 | Success |
| 14:00 | 30.4 | 62 | 26-29 | 60-70 | Success |
| 14:30 | 29.6 | 60 | 26-29 | 60-70 | Success |
| 15:00 | 28.1 | 63 | 26-29 | 60-70 | Success |
| 15:30 | 27.5 | 64 | 26-29 | 60-70 | Success |
| 16:00 | - | - | 26-29 | 60-70 | Fail |
| 16:30 | - | - | 26-29 | 60-70 | Fail |
| 17:00 | 25.6 | 67 | 26-29 | 60-70 | Success |
| 17:30 | 25.3 | 71 | 26-29 | 60-70 | Success |
| 18:00 | 25.2 | 75 | 26-29 | 60-70 | Success |

The test results show that the DHT22 sensor successfully detected the temperature and humidity inside the coop. However, data retrieval failures were observed between 15:00 and 15:30. This was caused by a network quality decline due to a sudden rainfall.

### *3.2.2 Actuator Testing*

The system is able to control the fan, lights, and misting device based on temperature and humidity data. When the temperature exceeds the 29°C threshold, the fan is activated to lower the temperature. Conversely, when the temperature drops below 26°C, the lights are turned on to raise the temperature.

*Table 2. Testing Results of Fan, Light, and Mist Maker Controls*

| Time | DHT22 Temperature ($^0$C) | DHT22 Humidit y (%) | Fan Status | Lamp Status | Mist maker | Indicator LED | Temperature Condition | Humidity Temperature | Measuremen t Status |
|---|---|---|---|---|---|---|---|---|---|
| 08:00 | 26.4 | 60 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 08:30 | 26.6 | 63 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 09:00 | 26.4 | 62 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 09:30 | 27.3 | 64 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 10:00 | 26.9 | 63 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 10:30 | 27.3 | 61 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 11:00 | 27.6 | 63 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 11:30 | 28.2 | 65 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 12:00 | 28.9 | 63 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 12:30 | 29.3 | 61 | ON | OFF | ON | Red | Too Hot | Normal | Success |
| 13:00 | 30.3 | 58 | ON | OFF | ON | Red | Too Hot | Too Dry | Success |
| 13:30 | 30.5 | 54 | ON | OFF | ON | Red | Too Hot | Too Dry | Success |

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|---|---|---|---|---|---|---|---|---|---|
| 14:00 | 30.4 | 58 | ON | OFF | ON | Red | Too Hot | Too Dry | Success |
| 14:30 | 29.6 | 60 | ON | OFF | OFF | Red | Too Hot | Too Dry | Success |
| 15:00 | 28.1 | 63 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 15:30 | 27.5 | 64 | OFF | OFF | OFF | Green | Normal | Normal | Success |
| 16:00 | - | - | OFF | OFF | OFF | - | - | - | Fail |
| 16:30 | - | - | OFF | OFF | OFF | - | - | - | Fail |
| 17:00 | 25.6 | 67 | OFF | ON | OFF | Yellow | Too Cold | Normal | Success |
| 17:30 | 25.3 | 71 | OFF | ON | OFF | Yellow | Too Cold | Too Humid | Success |
| 18:00 | 25.2 | 75 | OFF | ON | OFF | Yellow | Too Cold | Too Humid | Success |

The test results indicate that the system is capable of automatically detecting changes in temperature and humidity, as well as controlling the fan, lights, and misting device according to the detected conditions. During high temperatures (12:30 to 14:30), the fan and misting device were activated, while during low temperatures (17:00 to 18:00), the lights were turned on to raise the temperature. The test was conducted on an operational day.

However, although the devices successfully responded according to the set rules, the fan, lights, and misting device did not have a significant impact on temperature and humidity, as seen from the very small changes before and after the devices were activated. Under normal conditions (08:00 to 12:00), the devices remained inactive, with the green LED indicator showing that the conditions were safe.

The measurement failure between 16:00 and 16:30 indicates the need for a more reliable device connection. Overall, the system functions according to the set rules, but the hardware needs to be improved to have a more significant impact on the environmental conditions of the broiler chicken coop.

#### *3.2.3 Field Testing*

The testing process for the IoT-based prototype system is designed to monitor and control temperature and humidity in broiler chicken cages. The purpose of the testing is to ensure that the system operates according to the specified requirements and meets the predetermined objectives. The system testing was conducted in a broiler chicken cage located at Tandu, Trans Sulawesi Road, Inobonto Village, Bolaang District, North Sulawesi, Indonesia. The cage operates as a closed house system, measuring 12x68 meters, and houses 700 broiler chickens aged 23 days. This controlled environment provides a realistic operational scenario for evaluating the system's performance under actual conditions, as we can see from Figure 5.

*Figure 5. Prototype Testing Monitoring System in Broiler Cage*

## 4. CONCLUSION

### *4.1 Conclusion*

1. An IoT-based temperature and humidity monitoring and control system for broiler chicken cages has been successfully created and is functioning well.
2. Using the DHT22 sensor, the system is able to monitor temperature and humidity in real-time with high accuracy.
3. The system provides notifications to the user when the temperature or humidity is outside the optimal range, helping farmers maintain ideal coop conditions without the need for continuous manual supervision.
4. The use of the Wemos D1 and Blynk platform enables monitoring through a smartphone, enhancing the efficiency of coop management.
5. The use of solar panels as the primary power source makes the system more sustainable and environmentally friendly, making it suitable for areas with limited access to electricity.

### *4.2 Future Studies*

1. The addition of extra sensors, where the integration of air quality and light sensors monitors other environmental factors that affect the health of broiler chickens.
2. Adding an automatic water spraying system to more effectively control humidity.
3. Considering the use of additional power reserves to anticipate adverse weather conditions or power failures in the solar panels..
4. Developing the prototype to be applicable for large-scale or multi-location chicken coops with centralized control.
5. Optimizing the placement of devices:
   - Place the sensor in the center of the coop inside a transparent protective box with ventilation for measurement accuracy and protection from the chickens.
   - Place the fan and lights in strategic positions to ensure even airflow and heat distribution.
   - Store the microcontroller in a dust and humidity-proof box in a safe area to prevent damage.

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