

# The Prototype of An Automated Temperature Control System for Broiler Chicken Coops Based on Arduino and The Internet of Things (IoT)

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**Abstract**—This study aims to design and implement an Internet of Things (IoT)–based automated temperature control prototype for broiler chicken housing using an Arduino Uno and ESP32 microcontroller architecture. The proposed system integrates a DHT22 temperature–humidity sensor, relay modules, a cooling fan, and a heating lamp to regulate the coop microclimate based on predefined temperature thresholds. The Arduino Uno functions as the primary data acquisition and control unit, reading environmental parameters and executing actuator control logic, while the ESP32 handles wireless communication by transmitting sensor data to a MySQL database via WiFi at a configurable interval of 5 seconds. A simple yet effective control algorithm is applied, in which the fan is activated when the temperature exceeds 30.8 °C, while the heating lamp operates based on a scheduled brooding cycle. Experimental results demonstrate that the system is capable of reading temperature data in real time, responding appropriately to environmental changes, and reliably storing data in the database. The main contribution of this research lies in the development of a low-cost, dual-microcontroller IoT prototype that combines real-time monitoring, automatic temperature control, and flexible data logging, making it suitable for small to medium scale broiler farming applications and serving as a foundation for future enhancements involving humidity-based control.

**Keywords:** Arduino Uno; ESP32; IoT; Broiler Chicken; Temperature Control.

## 1. INTRODUCTION

Broiler production in tropical regions is often limited by environmental stressors, particularly elevated ambient temperatures, which can prevent birds from achieving their optimal growth performance. In many cases, broilers are reared in facilities without adequate temperature regulation. Such conditions are further exacerbated during hot and humid seasons, when ambient temperatures may reach up to 38°C, thereby intensifying thermal stress and reducing productivity [1]. However, the optimal temperature range that enables broilers to effectively regulate their body temperature has been reported to be 18–24°C [2], [3]. However, although the general thermal comfort range for mature broilers is reported to be 18–24°C, newly hatched broiler chicks during the brooding phase require significantly higher temperatures to support thermoregulation and early growth.

The brooding stage represents a highly sensitive period in broiler production, as chicks at this phase possess underdeveloped physiological and immune systems, incomplete feather coverage, and limited ability to regulate body temperature. As a result, they are extremely susceptible to environmental fluctuations, particularly in temperature and humidity. Poor environmental management during this phase can trigger stress, respiratory complications, dehydration, and increased mortality, all of which contribute to substantial economic losses for poultry farmers [4].

Traditional temperature management practices, often used by smallholder farmers, rely on simple observations such as monitoring chick behavior in relation to heat sources like lamps. Such methods are inefficient and make it difficult to maintain the recommended thermal comfort zone. Ideally, chicks require a temperature of around 95 °F (35°C) during the first week and 90 °F (32.2°C) in the second week, with relative humidity maintained between 50–70%. Deviations from these ranges, whether too high or too low, can negatively affect chick health [4]. Similarly, studies have reported that the temperature and humidity requirements of broilers during the brooding period range from 29 °C to 35 °C, with relative humidity between 60% and 70% [5], [6].

In the era of Industry 4.0, the Internet of Things (IoT) has emerged as one of the key enabling technologies. IoT applications span various sectors of human life, including industry, business, healthcare, agriculture, infrastructure, communication, and household activities [7], [8]. Fundamentally, IoT facilitates interconnectivity and data exchange among diverse devices and objects, such as computers, smartphones, vehicles, and even agricultural facilities like mushroom houses. Through this connectivity, environmental conditions can be monitored and controlled remotely in real time, provided that internet access and an adequate power supply are available [7].

As an initial step toward the sustainability of the broiler poultry industry, this research holds significant potential in promoting more efficient and sustainable farming practices. Technology and innovation will continue to serve as key instruments for maximizing production outcomes, ensuring animal welfare, and maintaining environmental balance. Many studies have employed the DHT22 sensor because it is capable of directly measuring both temperature and humidity [9], [10], [11], [12], [13]. The DHT22 sensor provides high accuracy in measuring both temperature and humidity [14]. In this context, the implementation of the DHT22 temperature sensor and IoT-based automation systems is not only a practical approach but also a tangible step toward a responsible, competitive, and sustainable broiler poultry industry that contributes to the increasing demand for animal protein. Building upon this foundation, the present study aims to develop a prototype utilizing the DHT22 sensor based on Arduino Uno, integrated with IoT, to provide a clearer

understanding of its potential contributions in realizing more efficient and sustainable poultry management. Recent advances in the Internet of Things (IoT) have further strengthened the relevance of such sensor-based systems by enabling the development of intelligent environmental monitoring platforms capable of real-time data acquisition and automated control. Low-cost microcontrollers such as the ESP32 have been widely adopted to enhance the reliability and connectivity of poultry monitoring systems. Several studies have demonstrated that ESP32-based solutions can effectively measure and transmit environmental parameters—including temperature, humidity, and air quality—supporting improved decision-making and early detection of thermal stress in broiler houses. For example in [15], integrated sensor-based data collection with IoT and automation models to advance precision livestock farming, highlighting the importance of continuous monitoring for maintaining bird welfare. Similarly, in [13], [16] research on precision poultry management emphasized the effectiveness of ESP32/ESP8266 platforms combined with sensors such as DHT22 or DHT11 and MQ-135 to assess microclimate conditions and detect harmful gases, enabling remote supervision and rapid intervention [16].

Other implementations have emphasized the development of practical prototypes aimed at supporting farm-level deployment. Ezema *et al* [17] introduced an ESP32-based smart embedded controller for regulating poultry house microclimates, demonstrating its effectiveness in automating ventilation and heating systems in response to environmental fluctuations. Complementing this work, the IoT-enabled monitoring system developed by West Science Interdisciplinary Studies [18] integrates ESP32 with sensors such as DHT22, MQ-135, and BH1750, enabling multi-parameter tracking through a mobile dashboard that is suitable for small-scale poultry operations. Additional studies [19] further highlight the popularity of ESP32 due to its built-in Wi-Fi, low energy consumption, and seamless compatibility with diverse environmental sensors, making it a preferred platform for smart poultry farming applications. In line with this development, Syam *et al.*[20] and Farhan *et al.* [21] demonstrated a dual-microcontroller architecture in which the Arduino Uno serves as a stable data-acquisition unit for the DHT22 sensor, while the ESP32 manages wireless communication and real-time data transmission—providing strong evidence of the practicality and effectiveness of combining Arduino Uno, ESP32, and DHT22 in integrated environmental monitoring systems.

Collectively, previous studies demonstrate that IoT-based monitoring systems using ESP32 and environmental sensors are effective for observing poultry house conditions and supporting decision-making in broiler production. However, most existing works primarily emphasize monitoring functions, multi-parameter sensing, or cloud-based visualization, while the practical implementation of a simple yet reliable temperature control mechanism during the brooding phase remains limited, particularly in low-cost systems designed for smallholder farmers. In addition, many studies rely on a single microcontroller architecture, which may reduce system stability when sensor reading, actuator control, and wireless communication are handled simultaneously.

To address these limitations, the present study proposes a dual-microcontroller architecture that integrates an Arduino Uno and an ESP32 with a DHT22 sensor to achieve stable data acquisition, temperature-based control, and real-time IoT data transmission. Unlike previous studies that focus mainly on monitoring, this research emphasizes the implementation and validation of a simple control algorithm that regulates fan and heating lamp operation based on temperature thresholds relevant to broiler brooding conditions, while simultaneously storing environmental data in a database for remote access. Therefore, this study contributes a practical, low-cost, and experimentally validated prototype that bridges the gap between environmental monitoring and automated temperature control for broiler chicken housing in tropical environments. Based on the identified challenges and research gaps, this study adopts a structured methodology to design and evaluate an IoT-based temperature control prototype for broiler housing.

## 2. RESEARCH METHODOLOGY

This study employs a structured and systematic research methodology consisting of several sequential stages, namely literature-based qualitative data collection, prototype design and development, system implementation, experimental testing, and data analysis. The qualitative stage focuses on reviewing relevant journals and previous studies to identify optimal environmental parameters for broiler chickens, which serve as the basis for system design. These findings are then applied in the prototype development stage, where hardware and software components are integrated to form an IoT-based temperature control system. The developed system is subsequently tested to evaluate its ability to acquire real-time environmental data, control actuators, and transmit data to a database reliably. Finally, the collected data are analyzed to assess system performance, stability, and feasibility for practical application in broiler housing environments. The overall research procedure and the relationship between each stage are summarized in the flowchart presented in **Figure 1**.

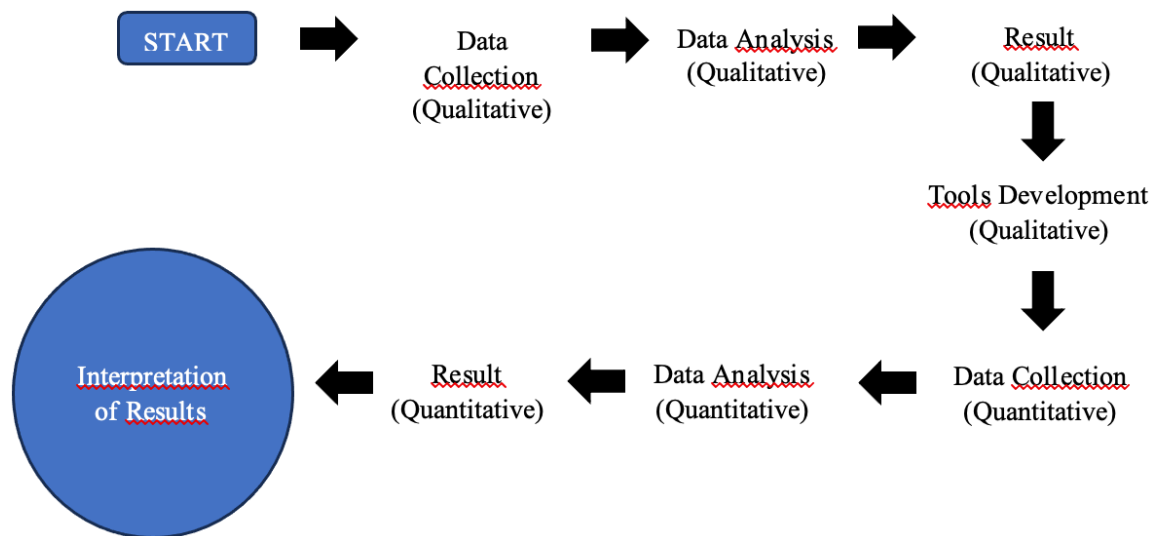


Figure 1. Reserach Flowchart

This study adopts a rule-based temperature control approach, where predefined temperature thresholds derived from literature are used as decision rules to activate or deactivate environmental control devices, such as fans and heating lamps. The control logic is implemented on the Arduino Uno, while data transmission and remote monitoring are handled by the ESP32 module. The initial stage involves qualitative data collection, which focuses on gathering information related to the optimal temperature and humidity conditions required for broiler chicken growth. This information was obtained through an extensive review of relevant journals, scientific articles, and previous studies on broiler management and environmental control systems.

Subsequently, the qualitative data analysis stage was conducted by analyzing and synthesizing the findings from the collected literature to identify suitable environmental parameters for broiler chickens. From this analysis, the result of the qualitative phase was obtained, concluding that the optimal temperature range for broiler chickens during the brooding phase is approximately 30 – 32 °C, with relative humidity levels between 60–70%. These parameters serve as the reference values for designing the proposed control system and defining the temperature threshold used in the prototype.

Based on these findings, the study proceeded to the tools development stage, which involved designing and assembling the hardware and software components required to build the IoT-based prototype. This stage includes integrating the DHT22 temperature and humidity sensor, Arduino Uno microcontroller, ESP32 communication module, relay module, fan, heating lamp, and LCD display. The actual circuit configuration is illustrated in **Figure 2**, while the pin assignments used for data communication and control are summarized in Tables 1–3. In this stage, the Arduino Uno functions as the main data acquisition and control unit, whereas the ESP32 is responsible for wireless data transmission to the database.

The control algorithm implemented in this system follows a rule-based approach derived from the qualitative analysis results. The Arduino continuously reads temperature data from the DHT22 sensor and compares the measured value with a predefined threshold of 30.8 °C, which was selected for experimental validation. When the measured temperature exceeds the threshold, the relay activates the fan to reduce the ambient temperature; otherwise, the fan is deactivated to prevent excessive cooling. The heating lamp operates based on a predefined time schedule. This simple algorithm enables automatic environmental regulation while maintaining system reliability and ease of implementation.

The next phase is quantitative data collection, where the developed system is tested to ensure its capability to read temperature data in real time using the DHT22 sensor. During this phase, the measured temperature simulates environmental conditions within a broiler chicken coop. The sensor data are transmitted from the Arduino to the ESP32 via serial communication and subsequently sent to a MySQL database over a WiFi connection. This stage also evaluates whether the fan is activated appropriately in response to changes in ambient temperature. Following this, quantitative data analysis is performed to assess system performance, including data transmission stability, responsiveness of the relay control, and suitability of data logging intervals. In this study, data are stored in the database every 5 seconds to validate real-time monitoring performance. However, the analysis also considers longer intervals (e.g., 60-300 seconds) for practical deployment to improve database efficiency during long-term monitoring.

Finally, the results and interpretation stage integrates findings from all previous phases to evaluate the effectiveness and feasibility of the proposed system. The results demonstrate that the system operates reliably, accurately monitors environmental conditions, and successfully controls the fan and heating lamp based on temperature thresholds. Therefore, the proposed IoT-based prototype is considered feasible for implementation in broiler chicken housing environments and provides a foundation for future enhancements, such as incorporating humidity-based control strategies.

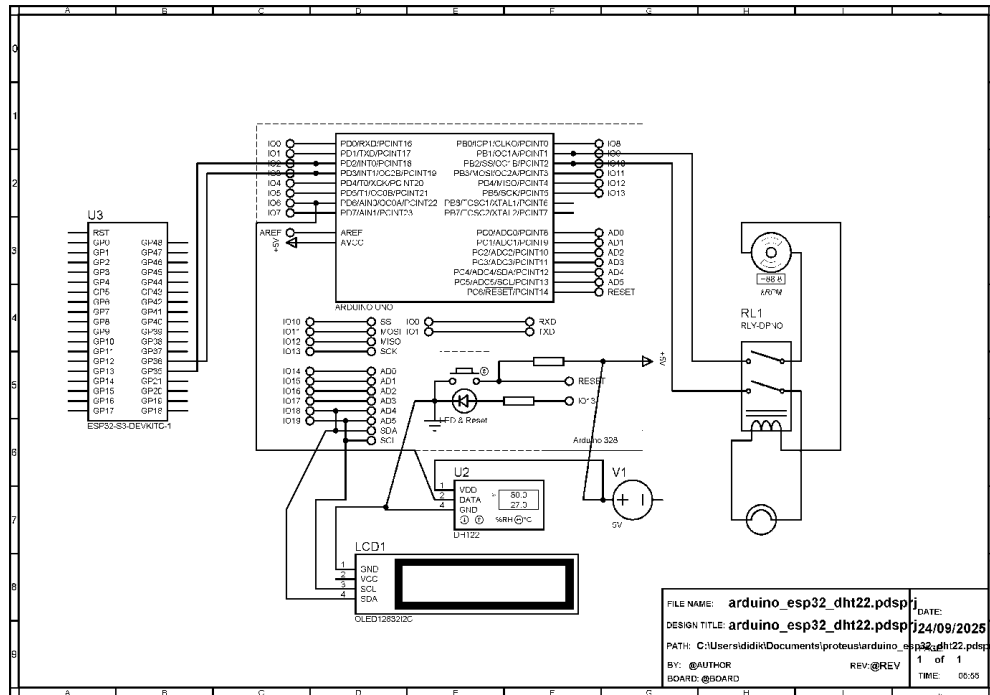


Figure 2. Circuit diagram of the Arduino, ESP32, DHT22, and LCD.

Based on the circuit diagram shown in **Figure 2**, the Arduino Uno functions as the primary data acquisition unit. The DHT22 sensor is interfaced with the Arduino Uno, where its data pin is connected to a digital input pin, while the VCC and GND pins are supplied with 5 V and ground, respectively. The LCD module is connected using the I<sup>2</sup>C communication protocol, with the SDA and SCL pins linked to the corresponding pins on the Arduino Uno to enable real time visualization of temperature and humidity readings. Serial communication between the Arduino Uno and the ESP32 is established via the RX and TX pins, allowing sensor data collected by the Arduino to be transmitted to the ESP32. The ESP32 subsequently manages wireless communication and transmits the data to the database through a WiFi connection. In addition, a relay module is connected to the Arduino’s digital output pins to control the fan and heating lamp based on predefined temperature thresholds. This integrated hardware configuration enables coordinated sensing, local display, actuation, and remote monitoring, forming the basis for system testing and performance evaluation in the subsequent research stages.

### 3. RESULTS AND DISCUSSION

#### 3.1 Application of the Control Method and Algorithm

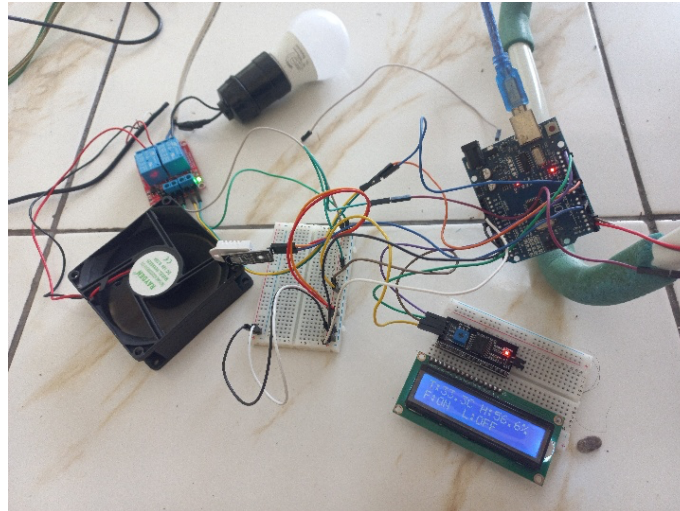
Based on the qualitative data collection and analysis stages, information obtained from various journals and previous studies indicates that broiler chicken require a stable environmental temperature in the range of 30 – 32°C and relative humidity of around 60–70%. These findings form the theoretical foundation for the control strategy implemented in this study. The identified temperature range is used as the primary reference for designing the environmental control logic applied in the proposed system.

The developed system applies a rule-based control algorithm, which is categorized as a simple threshold-based method. This algorithm is selected due to its suitability for real-time embedded systems, low computational complexity, and ease of implementation on microcontroller-based platforms. In this approach, sensor readings are continuously compared with predefined threshold values to determine the appropriate control actions. The algorithm is implemented primarily on the Arduino Uno, which functions as the main control unit. The Arduino reads temperature and humidity data from the DHT22 sensor at regular intervals. The measured temperature value is then evaluated against a predefined threshold of 30.8 °C. If the measured temperature exceeds this threshold, the system activates the cooling mechanism by switching the relay that controls the fan. Conversely, when the temperature falls below the threshold, the relay is deactivated, and the fan is turned off. This logic is intended to prevent excessive heat while also avoiding overcooling, both of which could negatively affect broiler chick growth.

In addition to temperature-based control, a time-based control mechanism is applied to the heating lamp. The lamp is programmed to operate for 22 hours and turn off for 2 hours each day, following standard brooding management practices commonly used in poultry farming. This time-based scheduling ensures adequate warmth for broiler chicks while allowing short rest periods for energy efficiency and system stability.

### 3.2 Hardware Implementation and Data Flow

The practical implementation of the proposed method is realized through the prototype shown in **Figure 3**. The system employs a dual-microcontroller architecture, where the Arduino Uno and ESP32 perform distinct but complementary roles. The Arduino Uno is responsible for data acquisition, local display, and actuator control, while the ESP32 manages wireless communication and data transmission to the database.



**Figure 3.** Circuit diagram of the Arduino, ESP32, DHT22, and LCD.

**Figure 3** shows the actual hardware circuit of the proposed system, which appears relatively cluttered because it represents a physical prototype. Since the system employs two microcontrollers, separate programs are developed for each device. The Arduino is responsible for acquiring temperature and humidity data from the DHT22 sensor and displaying the readings on the LCD. Meanwhile, the ESP32 processes the data received from the Arduino and transmits it to the database for storage and further analysis. The LCD display shown in **Figure 3** is interpreted as follows: ‘T’ represents temperature, ‘H’ denotes humidity, ‘F’ indicates the fan status, and ‘L’ refers to the lamp status. **Table 1** shows the pins used in the actual circuit configuration.

**Table 1.** Pin Connections Between the Arduino Uno and the ESP32 in Actual Hardware

Arduino Uno	ESP32
2 (RX)	35 (TX)
3 (TX)	34 (RX)

Serial communication between the Arduino and the ESP32 requires the use of the RX and TX pins. In this configuration, the RX pin of the Arduino is connected to the TX pin of the ESP32, while the TX pin of the Arduino is connected to the RX pin of the ESP32, ensuring proper bidirectional data transmission between the two microcontrollers. The connection between the Arduino and the DHT22 is presented in **Table 2**.

**Table 2.** Pin Connections Between the Arduino Uno and the DHT22 in Actual Hardware

Arduino Uno	DHT22
GND	- (GND)
5V	+ (VCC)
6	out (Data)

In principle, the data (output) pin of the DHT22 sensor can be connected to any available input pin on the Arduino; however, in this study, pin 6 was selected for the connection. The connection between the Arduino and the relay is presented in **Table 3**.

**Table 3.** Pin Connections Between the Arduino Uno and the Relay in Actual Hardware

Arduino Uno	Double Relay
- (B)	GND
9 (A)	IN1 (FAN)
10 (A)	IN2 (LAMP)
+ (B)	VCC

As with the DHT22, pins 9 and 10 were selected for this connection in the system configuration.

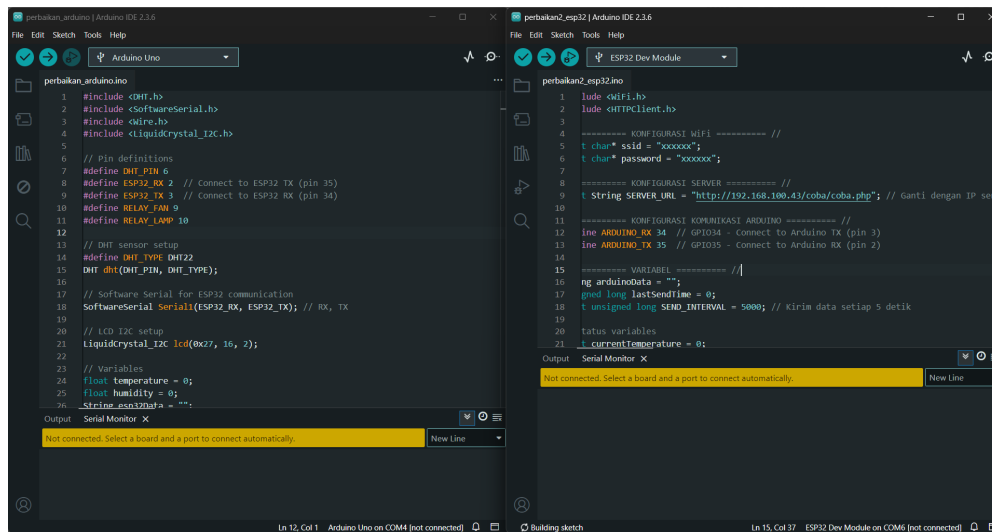


Figure 4. Separate Programs for Arduino and ESP32.

In Figure 4, the image on the left shows the program developed for the Arduino Uno, while the image on the right shows the program developed for the ESP32. The pins used in Tables 1 to 3 are clearly reflected in the Arduino and ESP32 programs.

### 3.3 Experimental Result and System Response

Figure 5 presents an example of the database records generated by the system. The recorded temperature value of 33.1 °C exceeds the predefined threshold of 30.8 °C, which results in the activation of the cooling fan while the heating lamp remains off. This behavior demonstrates that the control algorithm responds correctly to environmental changes. The threshold value of 30.8 °C was intentionally selected for experimental purposes to facilitate relay testing and system validation under actual field conditions. System testing was conducted in a non-air-conditioned environment to better approximate real poultry house conditions.

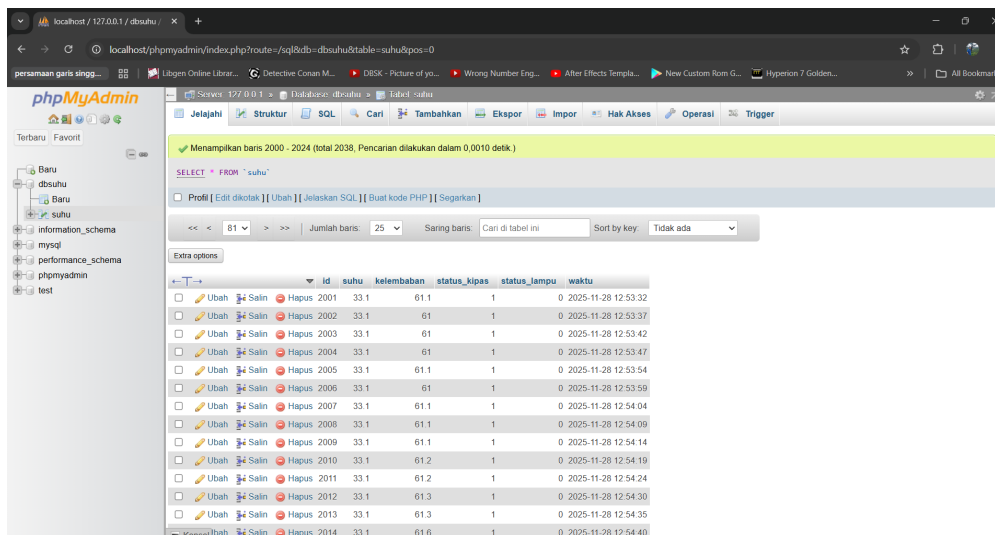


Figure 5. Database Display

In Figure 5, the database field *status\_kipas* with a value of 1 indicates that the relay controlling the fan is in the active (ON) state. Although the condition when the fan is turned OFF is not explicitly shown in Figure 5, the experimental results confirm that the relay operates correctly. This is evidenced by the successful activation of the fan when the measured temperature exceeds the predefined threshold of 30.8 °C. The correct switching behavior demonstrates that the relay control logic implemented in the Arduino program functions as intended, enabling reliable temperature-based control of the cooling mechanism within the system.

Figure 6 illustrates the Arduino IDE program used to implement the control logic. The code explicitly defines the temperature threshold, relay switching conditions, and lamp scheduling parameters. This implementation demonstrates the practical application of the proposed algorithm in controlling physical devices based on real-time sensor data. This device implements a simple algorithm that controls the hardware operation based on temperature readings and time. The algorithm functions as follows:

- a. If the coop temperature exceeds 30.8 °C, the system activates the fan to cool the environment when excessive heat is detected.
- b. If the coop temperature falls below 30.8 °C, the system turns off the fan to prevent overcooling, which could negatively affect broiler chicks.
- c. The heating lamp is programmed to operate for 22 hours and turn off for 2 hours each day, following the typical brooding schedule in poultry housing.

```
113 void controlRelays() {
114     if (temperature > 30.8) {
115         digitalWrite(RELAY_FAN, LOW);
116         digitalWrite(RELAY_LAMP, LOW); // Lampu MATI ketika suhu tinggi
117         Serial.println(" 🌀 Fan ON, Lamp OFF - Temperature high");
118     } else {
119         digitalWrite(RELAY_FAN, HIGH);
120         digitalWrite(RELAY_LAMP, HIGH); // Lampu NYALA ketika suhu normal
121         Serial.println(" 🌀 Fan OFF, Lamp ON - Temperature normal");
122     }
123 }
```

**Figure 6.** Arduino IDE Screenshot for Fan and Lamp Control.

**Figure 6** illustrates the control logic implemented in the system. The current system controls only the fan and lamp based on temperature thresholds, while humidity has not yet been incorporated as a control parameter. This limitation may serve as a direction for future research, enabling environmental regulation based on both temperature and humidity simultaneously.

### 3.4 Data Transmission and Monitoring Efficiency

The system is designed to transmit and store temperature and humidity data at configurable time intervals. During the experimental phase, data were recorded every 5 seconds to closely observe system responsiveness and verify real-time operation. This short interval allowed the researchers to confirm that sensor readings, data transmission, and database storage were functioning correctly and consistently. However, for long-term implementation in an actual poultry housing environment, a data transmission interval of 5 seconds may be excessively frequent and lead to rapid growth of the database size, resulting in inefficient storage usage and increased server load. Since environmental conditions in broiler houses generally change gradually rather than instantaneously, such high-frequency data logging is not always necessary. Therefore, the data transmission interval can be adjusted to longer durations, such as every 60 seconds or 120 seconds, depending on monitoring needs.

For practical farm-scale monitoring, a more efficient approach would be to configure the system to record data at longer intervals, such as every 5 minutes (300 seconds). This interval is sufficient to capture meaningful environmental trends while significantly reducing database storage requirements and improving overall system efficiency. Consequently, the flexibility to modify data transmission intervals represents an important feature of the proposed IoT-based monitoring system, allowing it to be adapted for both experimental testing and long-term operational deployment in poultry housing environments.

### 3.5 Discussion of System Limitations

Although the system successfully demonstrates temperature-based environmental control, several limitations were identified during testing. First, humidity is currently monitored but not yet incorporated as a control parameter. Environmental regulation based solely on temperature may be insufficient in certain conditions, particularly in tropical climates where humidity plays a significant role in broiler comfort and health. Incorporating humidity-based control represents a promising direction for future research.

Another issue encountered in this study was related to controlling the relay module. During testing, the fan was activated regardless of whether the control signal was set to HIGH or LOW, which created confusion during system debugging. This behavior is generally caused by differences in relay module design, some modules are active HIGH, while others are active LOW meaning that the relay may turn on when the input signal is LOW instead of HIGH. Additionally, noise, improper wiring, or the absence of a proper grounding reference between the Arduino and the relay module can also contribute to unexpected switching behavior. This issue requires careful identification of the relay type and verification of its input logic to ensure correct operation within the intended control system.

Another issue encountered in this study concerns the durability of the hardware components used. Since the system is intended to operate continuously for nearly 24 hours, long-term reliability becomes a critical consideration. During testing, the circuit operated for approximately one hour without major issues, and the data were successfully transmitted to the database. However, the LCD display eventually began to malfunction, with the characters becoming unclear or distorted. Although this malfunction does not significantly affect system performance because the primary requirement is that the data are successfully stored in the database and accessible through the web interface this finding highlights a limitation in the durability of the display component. The relay was also found to be easily damaged due to physical vibrations. This was concluded after observing that the system, when moved between locations, sometimes failed to

activate the fan. Based on these findings, it can be inferred that the relay lacks sufficient durability for continuous operation in practical field conditions.

### 3.6 Overall Discussion

Overall, the results demonstrate that the proposed IoT-based system successfully implements a temperature control method using a simple yet effective threshold-based algorithm. The system is capable of real-time data acquisition, actuator control, and remote monitoring through a database. Despite its limitations, the prototype provides a solid foundation for further development, including humidity-based control, improved hardware durability, and enhanced data visualization. These improvements will support the practical implementation of intelligent environmental control systems in broiler chicken housing.

## 4. CONCLUSION

Based on the results of data processing, system implementation, and experimental testing, this study demonstrates that the proposed Arduino, ESP32 based IoT system is capable of monitoring and controlling the environmental conditions of a broiler chicken house in an automatic and reliable manner. The system successfully integrates temperature and humidity sensing, local actuation using relays, and wireless data transmission to a database, enabling continuous environmental supervision without direct human intervention. The application of a simple yet effective control algorithm, particularly the activation of the cooling fan when the temperature exceeds a predefined threshold, proved sufficient to maintain environmental conditions within the recommended range for broiler chick development. In addition, the use of IoT technology allows environmental data to be accessed remotely via a web interface, thereby increasing flexibility and operational efficiency for poultry farmers. The experimental results indicate that the system responds appropriately to changes in ambient temperature, confirming its functional stability and practical feasibility. Overall, the proposed prototype provides a cost-effective and scalable foundation for smart poultry house management, and it can be further enhanced in future work by incorporating humidity-based control strategies and long-term durability improvements for field deployment. Finally, the findings of this study also highlight the feasibility of implementing simple, low-cost IoT-based control systems as an initial step toward precision poultry farming in tropical environments.

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