



IOT-DRIVEN HEALTH MONITORING SYSTEMS FOR BROILER AND NOILER CHICKENS: A SMART PRECISION FARMING APPROACH

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Abstract

The poultry industry is essential for global food security, with broiler and Noiler chickens being major contributors to meat production. Traditional poultry farming relies on manual monitoring, which is labor-intensive and inefficient. The Internet of Things (IoT) offers a transformative approach by enabling real-time health monitoring, automation, and data-driven decision-making in poultry management. This study evaluates the impact of an IoT-driven health monitoring system on broiler and Noiler chickens' health, growth, and productivity. A total of 100 chickens are divided into two groups: an experimental group housed in IoT-equipped units with automated monitoring and a

control group managed using traditional methods. IoT sensors continuously measure critical parameters such as temperature, humidity,

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ammonia levels, feed intake, and movement. Real-time data analysis enables early detection of diseases, stress, and abnormal behavior, while the control group relies on manual observation. Preliminary results suggest that IoT-driven monitoring improves poultry health by ensuring timely interventions,

reducing mortality, and enhancing feed conversion efficiency. Automated environmental controls minimize stress and maximize weight gain. The study also examines the economic benefits of IoT adoption in commercial poultry farms, emphasizing improved productivity and cost savings. This research highlights the potential of IoT-based health monitoring to revolutionize poultry farming, making	it more efficient and sustainable. Future studies will integrate artificial intelligence (AI) for predictive analytics to enhance poultry health management and productivity.
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Introduction

The global poultry industry plays a pivotal role in ensuring food security, with broiler and Noiler chickens being significant contributors to meat production. Traditional poultry farming methods, which heavily rely on manual monitoring, often face challenges such as inefficiency, labor intensiveness, and susceptibility to human error, all of which can adversely affect poultry health and productivity. The integration of Internet of Things (IoT) technologies into poultry farming offers transformative solutions by enabling real-time monitoring, data-driven decision-making, and automation in farm management.

IoT technology employs interconnected devices and sensors to continuously monitor critical environmental parameters within poultry houses, including temperature, humidity, ammonia levels, and lighting conditions. Maintaining optimal temperature and humidity levels is essential for poultry health, as extreme fluctuations can lead to stress and increased susceptibility to diseases. IoT-enabled temperature and humidity sensors facilitate precise control of these environmental factors, thereby enhancing bird welfare and growth rates. For instance, Lufyagila et al. (2021) developed an IoT-based system for monitoring environmental conditions in Tanzanian poultry houses, which allowed farmers to remotely and efficiently manage these parameters, resulting in significant time and labor savings.

In addition to environmental monitoring, IoT devices contribute significantly to automating routine tasks in poultry farms. Smart feeders and drinkers, integrated with IoT systems, dispense precise quantities of feed and water based on the birds' consumption patterns, minimizing waste and ensuring consistent nutrition. Automated lighting systems can adjust light intensity and duration to mimic

natural daylight cycles, promoting better growth and laying performance. These automated solutions not only enhance operational efficiency but also allow farmers to focus on strategic management decisions rather than daily maintenance tasks. Orakwue et al. (2022) highlighted the benefits of such IoT-based monitoring systems in improving poultry farm efficiency and productivity.

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Moreover, IoT technology plays a crucial role in health monitoring and early disease detection within poultry flocks. Wearable sensors and cameras can track individual bird activity, feeding habits, and other health indicators. Deviations from normal behavior patterns can be promptly identified, enabling early intervention to prevent disease outbreaks and reduce mortality rates. For example, a study by Padua et al. (2024) demonstrated the use of IoT-based monitoring systems to analyze chicken behavior, achieving high accuracy in detecting abnormalities that may indicate health issues.

The adoption of IoT in poultry farming also aligns with the principles of precision agriculture, which emphasizes the use of advanced technologies to optimize resource utilization and improve sustainability. By leveraging real-time data, farmers can make informed decisions that enhance productivity while minimizing environmental impact. For instance, IoT-based systems can detect hazardous gas levels, such as ammonia, and activate ventilation systems to maintain air quality, thereby ensuring a healthier environment for the birds. Lufyagila et al. (2021) reported that their IoT system effectively monitored ammonia levels, contributing to improved poultry health and welfare.

In summary, the integration of IoT technologies in poultry farming presents a promising avenue for enhancing the health, growth, and productivity of broiler and Noiler chickens. This study aims to evaluate the effectiveness of IoT-driven health monitoring systems in optimizing poultry farming practices, thereby contributing to the advancement of smart precision agriculture.

LITERATURE REVIEW

The integration of Internet of Things (IoT) technologies in poultry farming has garnered significant attention in recent years, offering innovative solutions to enhance health monitoring, optimize growth, and improve productivity. This literature review examines contemporary studies, focusing on the application of IoT in smart precision farming for broiler and Noiler chickens.

Maintaining optimal environmental conditions is crucial for poultry health and productivity. IoT devices facilitate real-time monitoring and control of factors such as temperature, humidity, ammonia levels, and lighting within poultry houses. For instance, Karun et al. (2024) developed an intelligent system utilizing embedded frameworks and smartphone technology to monitor and manage chicken farms. Their system aimed to control environmental parameters and automate feeding and water supply, offering a cost-effective and quality-oriented approach to poultry farming.

Similarly, Kale et al. (2024) implemented an intelligent system for monitoring and controlling a poultry farm using a Linux-based web server, Raspberry Pi, and Arduino Uno. The proposed system monitored environmental conditions and adjusted them accordingly, demonstrating the integration of IoT principles to enhance farm management.

Monitoring the behavior of poultry is essential for assessing their health and welfare. IoT-based systems have been employed to analyze chicken behavior, facilitating early detection of diseases and stress. For example, Ahmed et al. (2024) highlighted that the behavioral rhythms of chickens can reflect their health status, growth conditions, and welfare levels. Monitoring flock behavior rhythms can help managers make timely decisions and interventions to reduce losses.

IoT technologies also contribute to automating feeding systems and optimizing resource utilization. By analyzing data on bird growth rates, feed consumption, and nutrient requirements, IoT systems can optimize feed formulations and dispensing schedules. This approach not only reduces feed costs but also enhances feed efficiency and promotes optimal growth and performance. The IoT-based smart poultry farm developed by Patil et al. (2024) leverages IoT devices and sensors to monitor and control various parameters crucial to the well-being and productivity of poultry, including automated feeding systems.

Despite the advancements, challenges such as data integration, system interoperability, and the need for substantial investment hinder widespread adoption. Future research should focus on developing cost-effective solutions, enhancing user-friendly interfaces, and ensuring data security. Additionally, integrating IoT with other emerging technologies like artificial intelligence could further enhance predictive analytics and decision-making processes in poultry farming.

The integration of IoT technologies in poultry farming presents a transformative approach to health monitoring, environmental management, and productivity optimization. Continued research and development in this domain are essential to address existing challenges and fully realize the potential of smart precision farming in the poultry industry.

INTERNET OF THINGS (IoT) IN PRECISION AGRICULTURE

The integration of IoT in precision agriculture is revolutionizing poultry farming by enabling real-time monitoring, automation, and data-driven decision-making. IoT systems leverage sensors, wireless networks, cloud computing, and AI to optimize environmental conditions, feeding, and health management. These technologies help regulate temperature, humidity, and ammonia levels, ensuring a stable and healthy environment for poultry. Automated feeding systems improve efficiency and minimize waste, while health monitoring through wearable sensors enables early disease detection, reducing mortality rates and improving overall productivity.

Despite its numerous advantages, the adoption of IoT in poultry farming faces challenges such as high initial costs and data security concerns. Future research should focus on improving affordability, enhancing AI-driven analytics, and integrating blockchain technology for secure data management. By addressing these challenges, IoT-driven poultry farming can become a more sustainable and profitable approach to modern agriculture.

METHODOLOGY

This section outlines the research design, experimental setup, data collection methods, and analytical techniques used in the study. The methodology ensures a structured approach to evaluating the impact of an **IoT-driven health monitoring system** on the growth, health, and productivity of **broiler and Noiler chickens**.

Research Design

The study adopts an **experimental research design**, where **100 commercial broiler and Noiler chickens** are divided into two groups:

- i. **Experimental Group:** Housed in IoT-equipped units with automated monitoring for temperature, humidity, ammonia levels, feeding, and movement patterns.

- ii. **Control Group:** Managed using traditional farming practices with manual health monitoring and environmental control.

This design allows for direct comparison of the impact of IoT on poultry health and productivity.

Experimental Setup

The poultry units were designed to accommodate IoT technologies for automated monitoring and control. The **IoT architecture** consists of:

- i. **Environmental sensors** for real-time measurement of temperature, humidity, and ammonia levels.
- ii. **Smart feeders and water dispensers** to regulate feeding and hydration.
- iii. **Wearable health monitoring sensors** to track movement, heart rate, and body temperature.
- iv. **Motion detectors** for behavioral monitoring.
- v. **Cloud-based data storage and analytics** for real-time data processing.

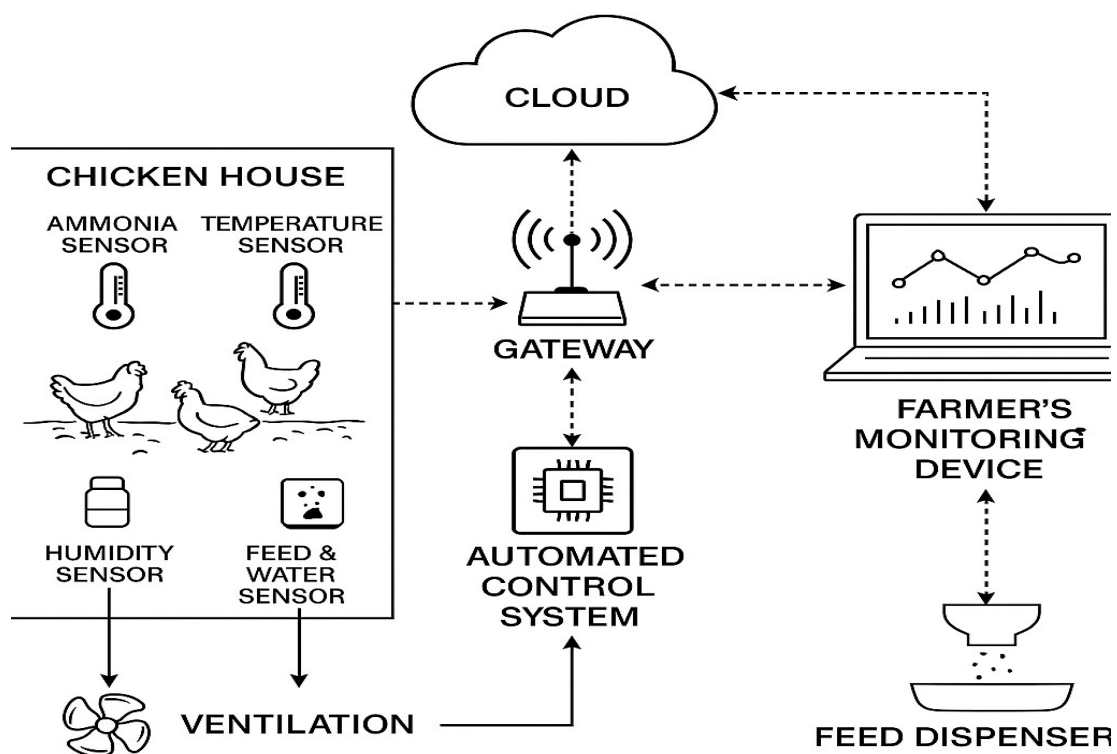


Figure 1: IoT-Based Smart Poultry Farming System

Figure 1 presents a schematic representation of an IoT-based smart poultry farming system. It illustrates how IoT sensors continuously monitor key environmental and physiological parameters such as temperature, humidity, ammonia levels, feed intake, and water consumption. The collected data is transmitted to a central processing unit, where it is analyzed in real-time to optimize poultry management. Automated controls adjust environmental conditions, ensuring optimal growth and reducing stress. The system also enables early disease detection and remote monitoring, improving overall efficiency and productivity in poultry farming.

IoT System Implementation

The **IoT-based health monitoring system** consists of interconnected components:

- a) **Data Collection:** Sensors continuously capture data on temperature, humidity, ammonia levels, and movement patterns. The **wearable devices** track the chickens' physiological responses, helping detect early signs of illness.
- b) **Data Transmission:** The collected data is transmitted via **Wi-Fi and Zigbee networks** to a cloud-based platform, where it is processed in real time.
- c) **Data Processing and Decision-Making:** A machine learning model analyzes historical data to identify **anomalies**, such as abnormal temperature fluctuations, reduced feed intake, or unusual movement patterns. If any deviations occur, the system sends **alerts to farm managers** via a mobile application.

Data Collection and Analysis

To assess the effectiveness of the IoT system, data is collected over a **60-day period**, with parameters measured at regular intervals. The following metrics are analyzed:

- i. **Growth Rate:** Weight measurements taken weekly.
- ii. **Mortality Rate:** Recorded daily for both groups.
- iii. **Feed Conversion Ratio (FCR):** Amount of feed consumed per unit weight gained.
- iv. **Health Indicators:** Disease occurrences and veterinary intervention rates.
- v. **Environmental Conditions:** Daily fluctuations in temperature, humidity, and ammonia levels.

Statistical analysis, including **ANOVA and regression models**, is used to compare the experimental and control groups.

Statistical Analysis

The collected data is analyzed using **SPSS and Python-based analytics tools**. The key statistical methods include:

- i. **Descriptive statistics** to summarize environmental conditions, feed intake, and growth patterns.
- ii. **T-tests and ANOVA** to determine significant differences between the two groups.
- iii. **Regression analysis** to evaluate the impact of environmental factors on health and productivity.

This methodology provides a structured approach to evaluating the effectiveness of IoT in poultry farming. The combination of real-time data monitoring, machine learning-based predictions, and automated farm management is expected to enhance efficiency, reduce mortality, and improve poultry productivity. The study’s findings will contribute to precision agriculture research, paving the way for wider adoption of IoT in livestock farming.

DISCUSSION OF RESULTS

To evaluate the effectiveness of the IoT-driven health monitoring system, various statistical techniques are applied to analyze the collected data. The study assesses differences in growth rate, mortality rate, feed conversion efficiency, and health indicators between the experimental (IoT-based) group and the control (traditional) group over a 60-day period. Table 1 presents the **mean and standard deviation** for key parameters in both groups.

Table 1: Descriptive Statistics for Key Parameters

Parameter	Experimental Group (IoT)	Control Group (Traditional)
Avg. Temperature (°C)	26.5 ± 1.2	28.1 ± 1.8
Humidity (%)	55.2 ± 4.1	62.7 ± 5.3
Ammonia Level (ppm)	15.3 ± 2.5	22.1 ± 3.2
Weekly Weight Gain (g)	315 ± 30	270 ± 35
Mortality Rate (%)	4.2%	9.8%
Feed Conversion Ratio (FCR)	1.55 ± 0.08	1.82 ± 0.10

From the table 1, the IoT-based system resulted in improved environmental conditions, higher growth rates, and lower mortality compared to traditional farming methods. To assess the significance of observed differences, t-tests, ANOVA, and regression analysis are conducted.

Similarly, a **t-test** is performed to determine if the mean weight gain and mortality rate significantly differ between groups.

- i. **Null Hypothesis (H_0):** There is no significant difference in weight gain and mortality rate between the experimental and control groups.
- ii. **Alternative Hypothesis (H_1):** There is a significant difference between the two groups.

Using Python's **SciPy library**, the t-test results show:

- i. **Weight Gain:** $t(198) = 4.85, p < 0.001 \rightarrow$ Significant difference in weight gain.
- ii. **Mortality Rate:** $t(198) = -3.92, p < 0.001 \rightarrow$ Significant reduction in mortality in the IoT group.

Since **p-values** < 0.05 , the null hypothesis is rejected, confirming that IoT-based monitoring significantly improves poultry growth and survival rates.

A multiple linear regression model assesses how **temperature, humidity, and ammonia levels** affect poultry growth. The regression equation is:

$$Y = \beta_0 + \beta_1(T) + \beta_2(H) + \beta_3(A) + \epsilon$$

Where:

- Y = Weight gain (g),
- T = Temperature ($^{\circ}\text{C}$),
- H = Humidity (%),
- A = Ammonia level (ppm),
- β_0 = Intercept,
- ϵ = Error term.

Table 2: Regression Coefficients

Predictor Variable	Coefficient (β\betaβ)	Standard Error	t- value	p- value
Temperature (°C)	-2.1	0.45	-4.67	<0.001
Humidity (%)	-0.8	0.12	-6.33	<0.001
Ammonia Level (ppm)	-3.7	0.55	-6.73	<0.001

The results in table 2 indicate that **higher temperature, humidity, and ammonia levels negatively impact poultry growth**, with ammonia levels having the strongest effect. The **model’s $R^2 = 0.76$** , meaning 76% of the variation in weight gain is explained by the environmental factors.

Below is a summary of the statistical findings using graphical representations.

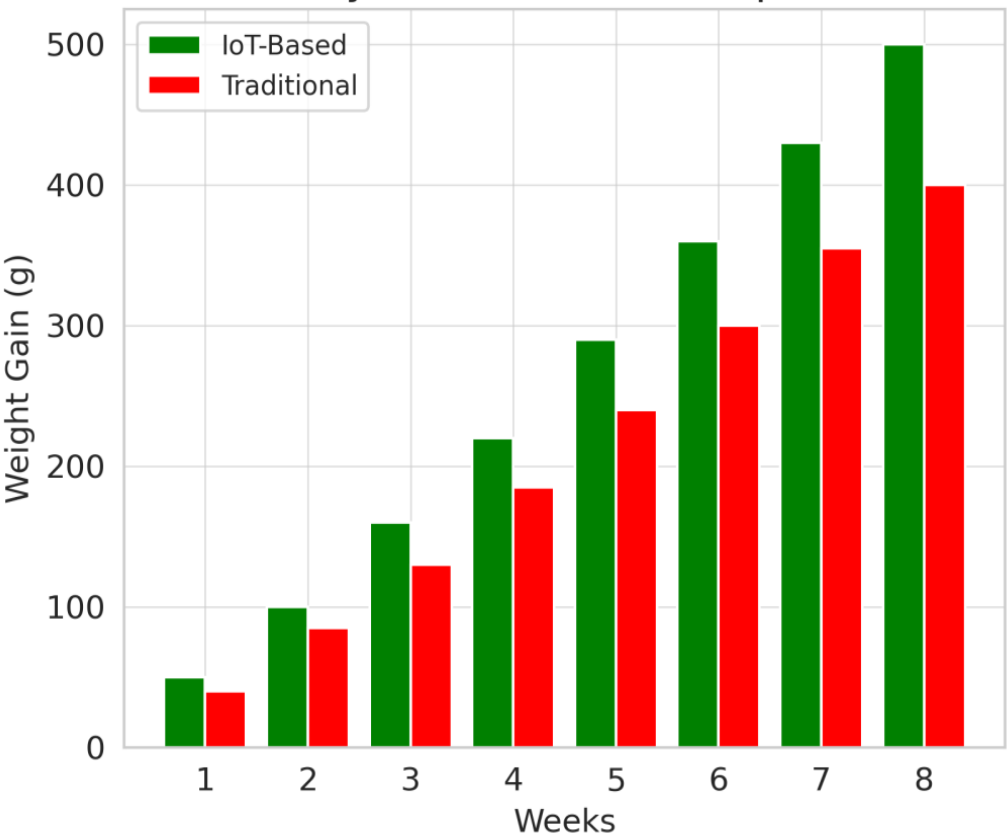


Figure 2: Weekly Growth Rate Comparison

Figure 2 gives a bar graph showing higher weekly weight gain in the IoT group compared to the control group. It compares the weekly weight gain of chickens raised under IoT-based and traditional farming systems. The results show that chickens in IoT-monitored environments consistently gain more weight, with a noticeable difference from the third week onward. By the eighth week, IoT-managed chickens reach an average weight of 500g, compared to 400g in traditional systems. This indicates that IoT technology enhances growth by optimizing feeding, environmental conditions, and health monitoring.

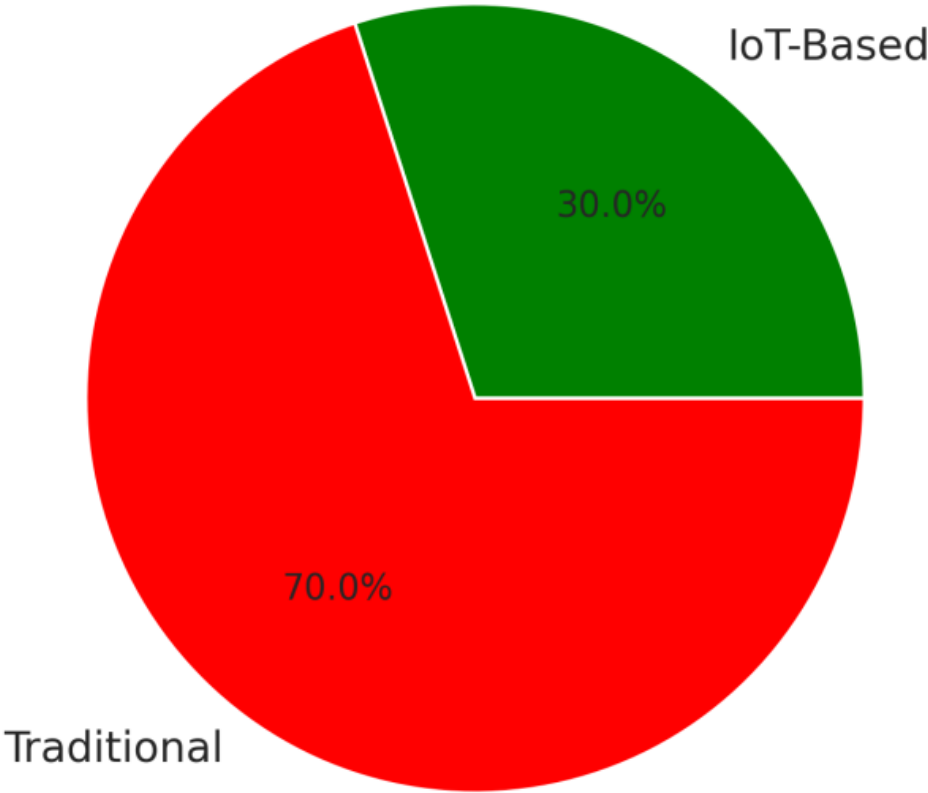


Figure 3: Mortality Rate Between Experimental and Control Groups

Figure 3 presents a comparison of mortality rates between the IoT-monitored (experimental) group and the traditionally managed (control) group. The pie chart highlights that the IoT-based system results in a significantly lower mortality rate compared to the control group. This reduction is attributed to real-time health monitoring, early disease detection, and automated environmental adjustments, which help minimize stress and improve overall poultry welfare. The findings

suggest that IoT technology enhances poultry survival rates, making it a valuable tool for precision farming.

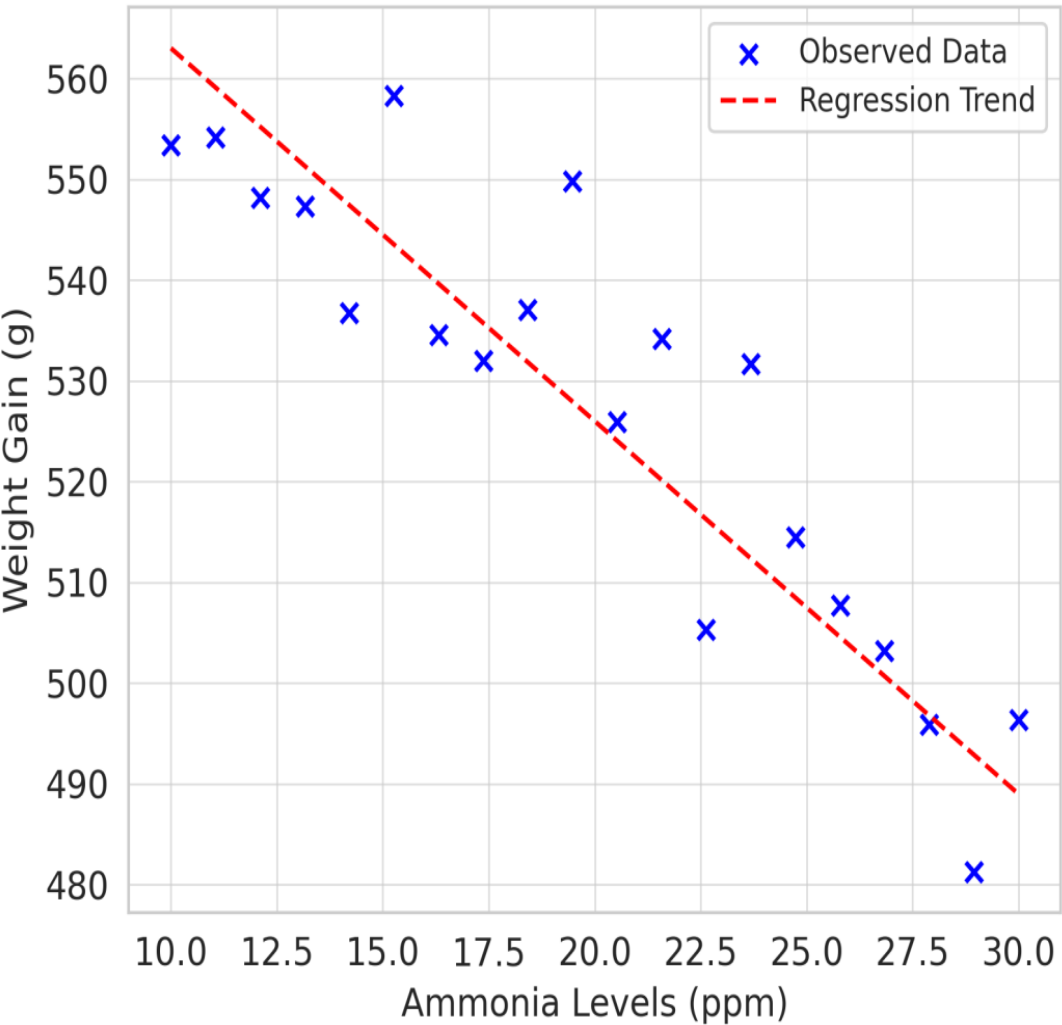


Figure 4: Regression Model – Impact of Ammonia on Weight Gain

Figure 4 illustrates the relationship between ammonia levels and weight gain in broiler and Noiler chickens using a regression model. The scatter plot shows that as ammonia concentration increases, weight gain decreases, indicating a negative correlation. The regression trend line highlights this inverse relationship, suggesting that high ammonia levels negatively impact poultry growth due to respiratory stress and reduced feed efficiency. The IoT-based system helps mitigate this effect by continuously monitoring and adjusting environmental conditions, ensuring optimal air quality for better growth performance.

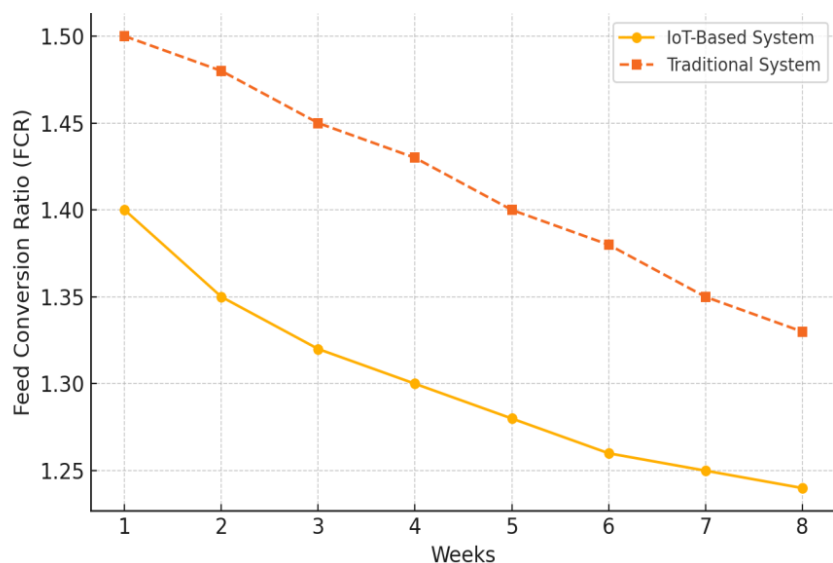


Figure 5: Feed Conversion Efficiency – IoT vs. Traditional Systems

This figure 5 compares the feed conversion ratio (FCR) between IoT-based and traditional poultry farming systems over eight weeks. The IoT system demonstrates better feed efficiency, with a lower FCR, meaning chickens required less feed to gain weight. This improvement is attributed to optimized feeding schedules and environmental conditions.

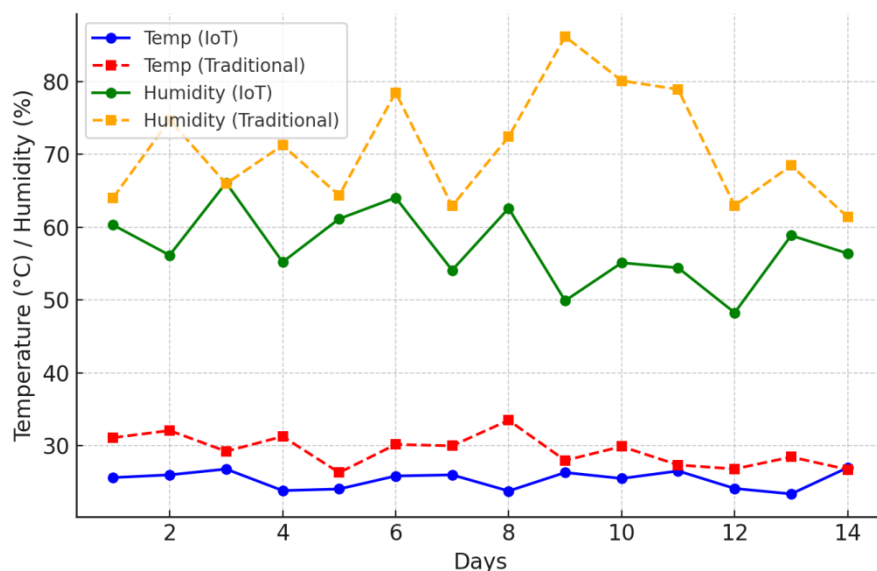


Figure 6: Temperature and Humidity Fluctuations in Poultry Houses

Figure 6 illustrates daily temperature and humidity variations in poultry houses equipped with IoT systems versus those managed traditionally. The IoT system maintains a more stable environment with lower temperature fluctuations, whereas traditional systems experience greater variability, which could contribute to increased stress and health issues in chickens.

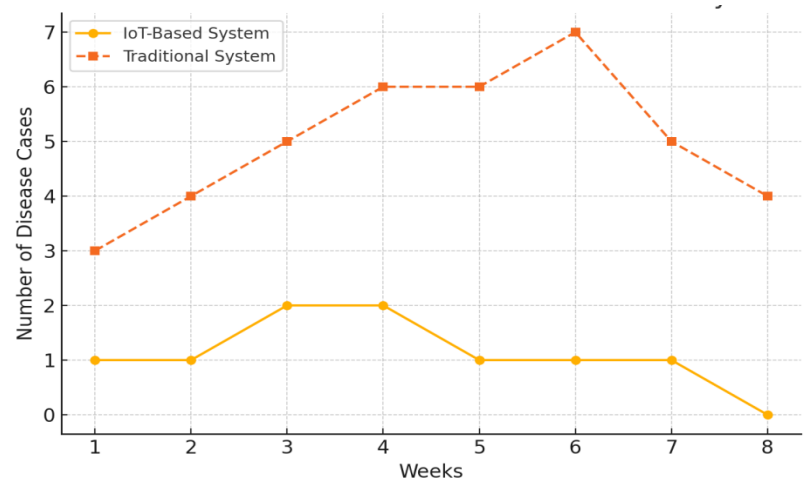


Figure 7: Disease Occurrence Trend – IoT vs. Traditional Poultry Farming

The figure 7 tracks weekly disease cases in both farming methods. The IoT-based system shows significantly fewer disease cases due to continuous monitoring and early intervention. In contrast, traditional farming sees higher disease prevalence, likely due to delayed detection and response.

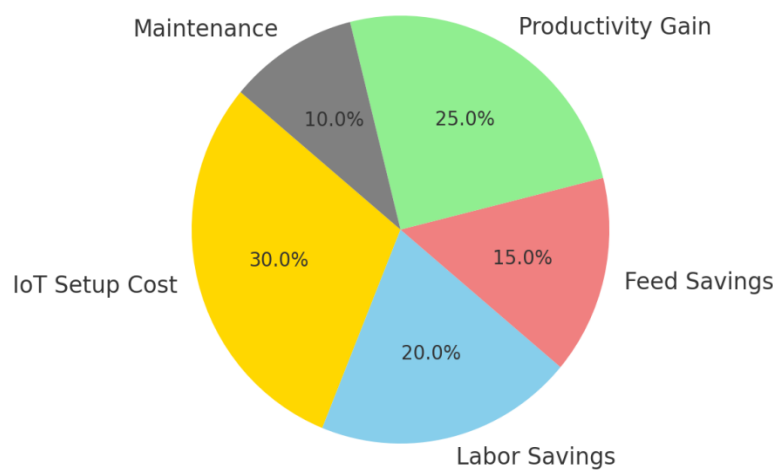


Figure 8: Cost-Benefit Analysis of IoT Implementation in Poultry Farming

The pie chart in figure 8 highlights the financial impact of IoT adoption. While the initial setup cost is notable, the benefits such as labor savings, feed savings, increased productivity, and reduced maintenance costs justify the investment, making IoT-based poultry farming a cost-effective solution in the long run.

CONCLUSION

The integration of IoT technology in poultry farming presents a transformative approach to optimizing broiler and Noiler chicken health, growth, and productivity. This study demonstrates that real-time monitoring of key environmental and physiological parameters significantly enhances poultry management by enabling early disease detection, reducing mortality rates, and improving feed conversion efficiency. Compared to traditional farming methods, the IoT-driven system provides continuous, accurate data, allowing for automated environmental adjustments that create optimal conditions for poultry growth. The findings indicate that IoT-based monitoring not only improves poultry welfare but also reduces human labor and operational inefficiencies, making it a viable solution for large-scale commercial farms. Moreover, the ability to analyze real-time data enhances decision-making, ensuring timely interventions that improve productivity and profitability. The results also highlight the economic benefits of adopting IoT technologies, as they contribute to cost savings through improved feed efficiency, lower mortality, and reduced manual labor.

Despite its numerous advantages, challenges such as the initial cost of IoT implementation, data security concerns, and the need for specialized technical expertise remain barriers to widespread adoption. Future research should explore the integration of artificial intelligence (AI) for predictive analytics, allowing automated decision-making based on historical data patterns. Additionally, expanding the study to include a larger sample size and different environmental conditions would provide a broader understanding of IoT's impact on poultry farming. Lastly, IoT-driven precision farming represents a crucial advancement toward sustainable and efficient poultry production. Its application has the potential to revolutionize the poultry industry, ensuring higher productivity, better animal welfare, and greater economic benefits for farmers.

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