Confluence University Journal of Science and Technology
Journal of the Confluence University of Science and Technology,
Osara, Kogi State
Journal Homepage: www.cujostech.com.ng
CUJoSTech

A Review on Development of an IoT-Based System for Enhancing Yield in Poultry Farming

*[1]AMBAFI J.G., [1]HARIS Y.M., [1]AHMAD A.S., [1,2]OHIZE H.O., [1]DAUDA U.S., [3]MUSA J.J.
[1]Department of Electrical & Electronics Engineering, Federal University of Technology, Minna, Nigeria.
[2]Department of Electrical & Electronics Engineering, Confluence University of Science and Technology, Osara, Nigeria.
[3]Department of Agriculture & BioResources Engineering, Federal University of Technology, Minna, Nigeria.
*ambafi@futminna.edu.ng

DOI: https://doi.org/10.5455/CUJOSTECH.2504

Review Article

Abstract

The emergence of the Internet of Things (IoT) has transformed traditional poultry farming practices in addressing productivity challenges, animal health, and sustainability. This paper provides a review of the development and application of IoT-based systems to improve productivity and enhance operational efficiency in poultry farming by integrating sensors, actuators, microcontrollers, cloud platforms, and mobile applications. IoT systems enable real-time monitoring and control of environmental conditions such as temperature, humidity, and concentration of harmful gases. The system also supports health monitoring, automatic feeding and watering systems, and data-driven decision-making. The review identified key challenges in adopting IoT-based systems, such as the high starting cost, lack of technical expertise, and data security concerns. The review also discussed potential solutions such as training programs, availability of affordable devices, and robust security measures.

Keywords: *IoT, Poultry, Farming, Gases, Technology, Environment.*
Article History: *Received: 10 March 2025; Accepted:26 June 2025; Published: 27 June 2025*

1. Introduction

Technological advancements continue to reshape agriculture, enhancing productivity, sustainability, and efficiency [1]. Among these innovations, the Internet of Things (IoT) stands out as a transformative force, enabling precision agriculture, data-driven decision-making, and automation through interconnected devices and systems [2]. In the livestock sector, poultry farming has especially benefited from IoT integration, addressing persistent challenges such as disease control, resource management, and environmental monitoring [3]. As global demand for poultry products rises, farmers must boost productivity while ensuring animal health, ecological sustainability, and meeting market demands, as traditional methods often fail to meet these goals due to their labor-intensive and inefficient nature. Environmental factors like temperature, humidity, and air quality critically impact poultry health and growth, reinforcing the need for advanced monitoring systems [4]. IoT facilitates this by using sensors to collect real-time data on environmental conditions, bird behavior, and resource usage [3]. These insights allow for informed decision-making and automation of tasks such as feeding, watering, and ventilation, ultimately increasing efficiency and profitability [5][6]. Beyond productivity, IoT supports sustainability by reducing resource waste, maintaining optimal living conditions, and improving animal welfare [7]. It also aids in early disease detection through analytics, minimizing economic losses and safeguarding livestock health [8].

This paper explores the integration of IoT in poultry farming, focusing on system components, practical applications, and their impact. Special attention is given to environmental control, automated feeding, and health monitoring, highlighting IoT's role in revolutionizing poultry farming practices. A general outline of the rest of this article is provided below. Section 2 presents a review of related literature on IoT-based poultry management systems. Section 3 outlines the methodology adopted in the survey work. Section 4 introduces IoT technologies used in poultry systems, leveraging the traditional IoT-based architecture. The significant impacts of IoT-based solutions on poultry management are discussed in Section 5. Finally, Section 6 presents the conclusion and outlines possible future directions.

2.0 Related Works

The application of IoT technologies in poultry farming has been widely studied, with numerous works highlighting their impact on yield optimization, health monitoring, and farm automation. A systematic review of these studies offers valuable insights into existing innovations, methodologies, and challenges. This subsection examines key scholarly reviews and research efforts focused on sensor technologies, data analytics, wireless communication, and cloud integration in poultry farming. Several studies have evaluated the effectiveness of environmental sensors, wearable devices, and machine learning models in enhancing poultry production. Commonly identified challenges include high implementation costs, data security risks, and the need for real-time predictive analytics. This review synthesizes these findings, outlining major trends, gaps, and future research directions for IoT-based poultry systems.

The role of smart sensors, big data analytics, and IoT systems in improving production efficiency, while also addressing data management, security, and cost concerns was examined, including how precision livestock farming and automation contribute to increased productivity [9].

Another study [10] reviewed advancements in AI-powered IoT systems for poultry health monitoring. It covered aspects from sensor and hardware design to AI-based image, video, and sound analysis for diagnosing poultry health. Faysal et al. [11] analyzed the evolution of poultry farming in Bangladesh, emphasizing IoT and computer vision technologies. Their review also highlighted the potential of blockchain and machine learning to boost farm productivity, while noting barriers such as poor internet access, high device costs, and limited technical expertise. Additionally, [6] provided a comprehensive overview of AI-enabled IoT applications aimed at improving poultry welfare in which the study discussed key innovations, associated challenges, and proposed a structured framework for implementing welfare-enhancing technologies.

3.0 Methodology

This systematic review analyzed existing literature on IoT-based systems aimed at enhancing poultry yield, following the PRISMA guidelines to ensure a rigorous and transparent process [59]. The flow of the review process is illustrated in Figure 1, which provides how a comprehensive search was conducted across major databases—including Google Scholar, Springer, Scopus, ScienceDirect, PubMed, MDPI, and IEEE Xplore—for articles published between 2013 and 2024. The search strategy incorporated keywords related to IoT in poultry farming, smart and automated systems, wireless technologies (such as, LoRaWAN, ZigBee, Bluetooth), AI, big data analytics, cloud integration, environmental monitoring, smart feeding, disease detection, and common challenges such as cost, cybersecurity, and implementation barriers.

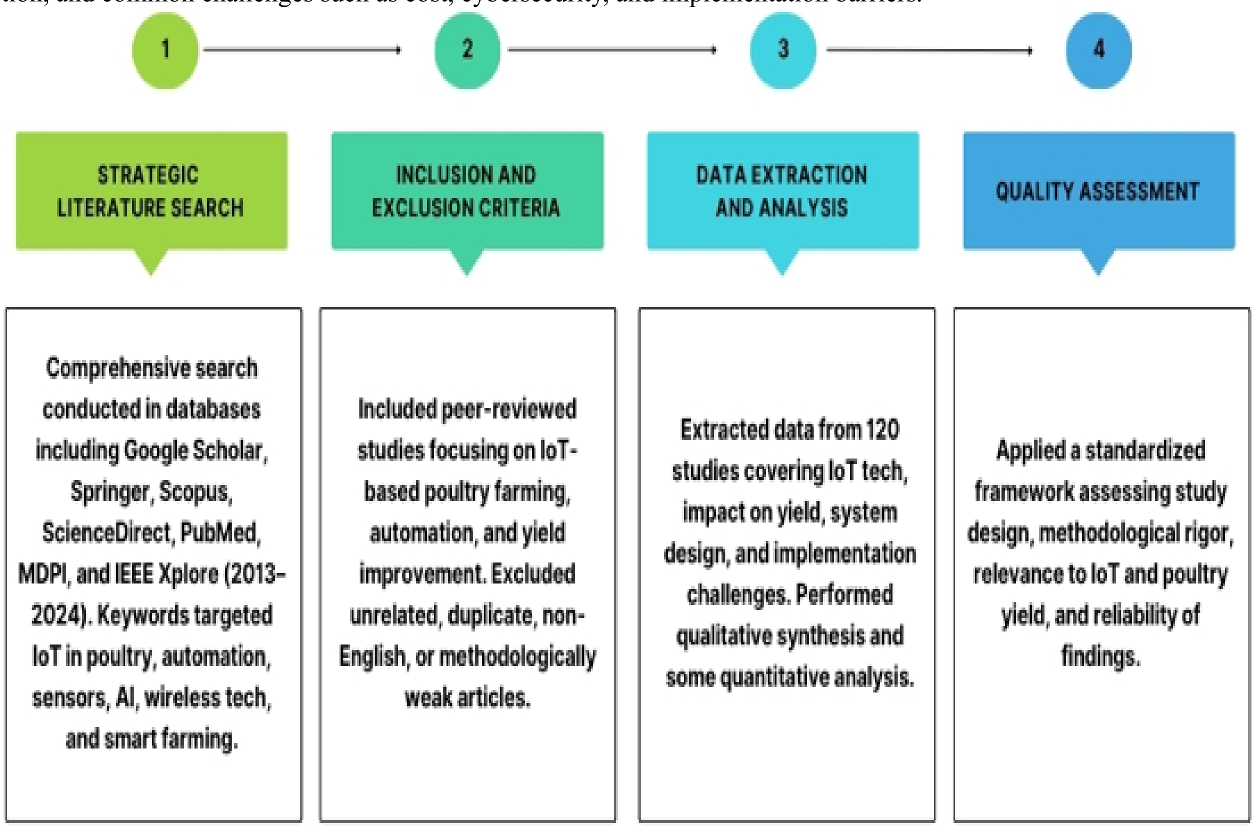

Figure 1: Survey methodology

Following the search, predefined inclusion and exclusion criteria were applied in alignment with established PRISMA-based protocols [Check]. Relevant data were extracted and analyzed, with studies evaluated for methodological rigor, relevance to poultry yield enhancement, reproducibility, and reliability of findings.

4.0 IoT Technologies in Poultry Farming

This section explores the key IoT technologies used in poultry farming, including sensor-based monitoring systems, wearable and embedded IoT devices, wireless communication networks, and AI-driven analytics. Figure 2 is an Internet of Things (IoT) based poultry farming architecture, which is a collection of devices, software, and services that can network and exchange information [1]. The core concept of IoT is integrating sensors into objects and using connectivity to aid the exchange of information between objects. The architecture of an IoT-based management system in poultry farming is designed to monitor, control, and optimise the processes within the poultry farm. It consists of several key components that interact to collect and process information and make informed decisions.

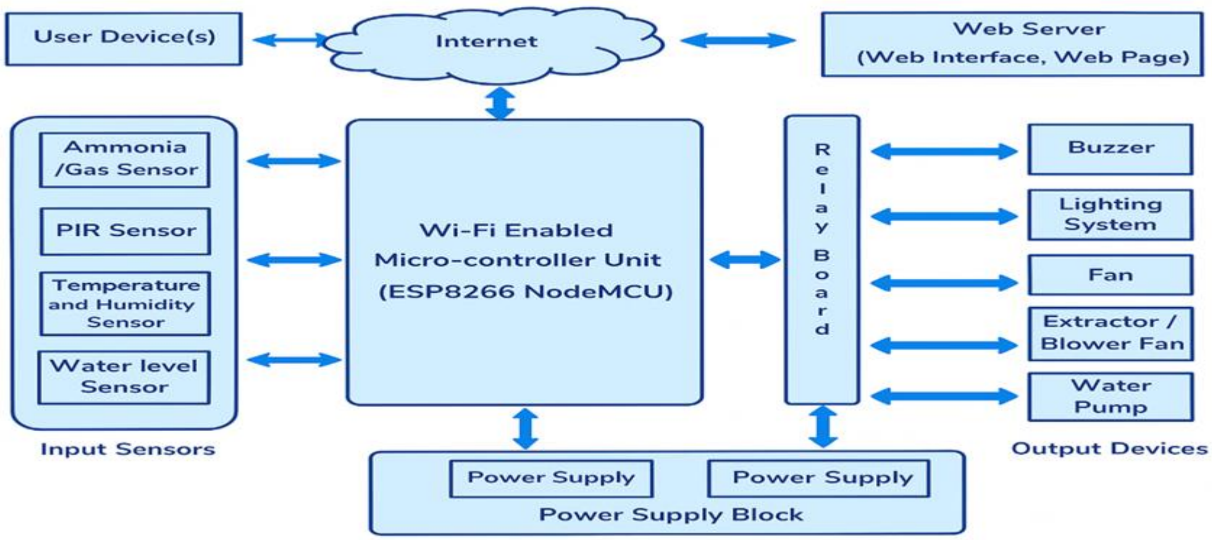

Figure 2: management system

An IoT-based system for poultry farming typically includes the following components in Table 1, whose technologies leverage IoT solutions in poultry farming to enhance bird welfare, reduce mortality rates, and maximise yield.

Table 1: IoT poultry farm components whose technologies leverage IoT solutions

Component	Function
Sensors	These devices monitor environmental parameters such as temperature, humidity, ammonia levels, and light intensity.
Actuators	Control devices like feeders, water dispensers, ventilation systems, and lighting
Microcontrollers	Process data from sensors and communicate with the central system.
Cloud Platform	Store and analyse data, providing insights and predictive analytics.
Applications	Enable remote monitoring and control via user-friendly interfaces.

4.1 Sensor-Based Monitoring Systems

Sensor-based monitoring systems are essential in modern poultry farming, providing real-time data on environmental and physiological conditions that affect bird health and productivity. Traditional methods rely on manual observation and periodic checks, often delaying the detection of issues such as temperature fluctuations, high ammonia levels, or abnormal bird behaviour [13]. IoT-enabled sensors overcome these limitations by continuously tracking key parameters like temperature, humidity, air quality, light intensity, and bird health metrics [14] as this supports optimal living conditions, improves feed conversion, reduces mortality, and enhances overall yield.

By integrating various sensors—environmental, biometric, and motion—farmers can make data-driven decisions and automate farm operations. For example, temperature and humidity sensors control climate systems to prevent heat stress and respiratory issues, while gas sensors detect harmful emissions like ammonia and CO_2 to ensure proper ventilation. Wearable sensors monitor heart rate and body temperature, enabling early disease detection. This real-time monitoring reduces manual labour, improves animal welfare, and promotes sustainable poultry farming.

4.1.1 Environmental-Based Sensors

Environmental sensors are critical to IoT-based poultry farming, ensuring that birds are raised in optimal health, growth, and productivity conditions. Poultry birds are susceptible to environmental changes [2], and even slight temperature, humidity, air quality, or lighting fluctuations can impact their well-being. Traditional monitoring methods often fail to provide real-time insights, leading to delayed responses and increased risks of disease outbreaks, heat stress, or poor feed conversion. Farmers can continuously track and regulate key parameters by integrating IoT-enabled environmental sensors, reducing mortality rates, and improving overall yield. These sensors provide automated ventilation, heating, and lighting control, creating a stable and comfortable bird environment.

Different types of environmental sensors serve distinct purposes in poultry farming, as shown in Table 2. Temperature and humidity sensors help maintain appropriate thermal conditions, preventing heat stress or cold exposure. Gas sensors detect harmful emissions such as ammonia (NH_3), carbon dioxide (CO_2), and hydrogen sulfide (H_2S), which, if left unchecked, can lead to respiratory diseases and reduced bird performance. Light sensors are crucial in optimizing photoperiods, regulating the birds' circadian rhythm, and influencing feed intake and egg production. By leveraging real-time data from these sensors, poultry farmers can implement precision farming techniques, reducing losses and enhancing productivity through proactive management.

Table 2: Common Sensors for IoT in Poultry Farming

Sensor name (Manufacture)	Measured Output	Output Type	Operating Voltage (DC)	Range	Accuracy
DHT11 (Aosong)	Temperature and Humidity	Digital	+3.5-5.5V	0°-50° C/ 20-90%	±2°C/ ±5%
DHT22 (Aosong)	Temperature and Humidity	Digital	+3.5-5.5V	-40° - 80°C / 0-100%	± 0.5°C / ±2%
LM35 (National Semiconductor)	Temperature	Analog	+4-30V	-50° - 150°C	±0.5°C
SHT75 (Sensiron)	Temperature and Humidity	Digital	+2.4-5.5V	-40° - 123.8°C / 0-100%	±0.4°C/ ±3%
GM-HT-01(Gemo)	Temperature and Humidity	Digital	-	-19.9 - +800°C / 5 - 95%	± 1 °C/ ± 3 %
AM2315 (Aosong)	Temperature and Humidity	Digital	+3.3-5.5V	-40°-125°C/ 0 - 99.9%	± 0.2°C / ±2%
HX71-V1 (Omega)	Humidity	Analog	+8-12V	5 - 95%	±4%
SY-HS-220 (Syhitech)	Humidity	Analog	+5V	30-90%	±5%
HIH4030 (Honeywell)	Humidity	Analog	+4-5.8V	0-100%	±3.5%
MQ2 (Hanwei)	Methane, Butane, LPG, Propane, Smoke, Hydrogen	Digital	+5V	200ppm 5,000ppm (LPG & Propane)	α ≤ 0.6
MQ5 (Hanwei)	Natural gas, LNG, LPG	Digital	+5V	200ppm 10,000ppm (LPG & LNG)	α ≤ 0.6
MQ6 (Hanwei)	LPG, butane	Digital	+5V	200ppm 10,000ppm	α ≤ 0.6
MQ7 (Hanwei)	Carbon Monoxide	Digital	+5V	10ppm 10,000ppm	α ≤ 0.6
MQ135 (Hanwei)	Air Quality	Digital	+5V	10ppm-300ppm (NH3)	α ≤ 0.65
MQ136 (Hanwei)	Hydrogen Sulfide gas	Digital	+5V	1ppm-100ppm	α ≤ 0.65
MQ137 (Hanwei)	Ammonia	Digital	+5V	1ppm-200ppm	α ≤ 0.65
TGS4161(Figaro)	Carbon Dioxide	Analog	+5V	350ppm 10,000ppm	±20%
HC-SR04 (Cytron Technologies)	Water Level	-	+5V	2cm-400cm	0.3cm
02-LDR1 (NTE Electronics)	Light Intensity	Analog	Max +150V	Light Resistance (50-100K)	γ = 0.8
SKU114990100 (Seed Studio)	Weight sensor/Load Cell	Analog	+10-15V	0-50KG	Class C2=±0.30 (% R.O.)

Lashari et al [16] developed an IoT-based system using sensor nodes and Raspberry Pi with GSM modules to monitor poultry house conditions—such as temperature, humidity, O_2, CO_2, and NH_3—in real time, enabling remote access and alerts via SMS and email. Orakwue et al [17] designed a smart monitoring system using an ESP32 microcontroller, DHT11, PIR, and MQ135 sensors, along with a buzzer and lamp control to regulate conditions and alert farmers of intrusions. Similarly, [18] implemented a Wireless Sensor Network (WSN) with a star topology for monitoring temperature and humidity, demonstrating reliable sensor performance and energy efficiency, though limited by battery life and communication range. Studies [19] and [20] used DHT22 sensors to automate environmental control via buzzers, fans, and lamps, significantly improving poultry conditions and productivity. Praveena et al [21] focused on gas monitoring (NH_3, CO_2, H_2S), emphasizing the risks of harmful emissions from bird litter. Supporting studies [22–25] highlighted the health, environmental, and economic impacts of gas accumulation. To address these, [21] proposed an automated system integrating gas detection with ventilation and purification to ensure air quality, improve bird health, and reduce operational risks.

Table 3 reviewed literature highlights the growing adoption of IoT-based technologies for environmental monitoring in poultry farming, of which various studies have demonstrated the effectiveness of wireless sensor networks, cloud-based data management, and automated control systems in maintaining optimal conditions for poultry health and productivity.

Table 3: IoT-based Poultry Environment Monitoring Related Studies

Ref	Year	Country	Key hardware used	Key Functions	Alert method
[3]	2018	Pakistan	Raspberry Pi, SIM900 GSM SIM module	Monitoring air temperature, air humidity, oxygen (O_2) levels, carbon dioxide (CO_2) concentration, and ammonia (NH_3) concentration in real-time.	SMS & E-mail
[4]	2019	India	Arduino Uno, DHT22 sensor, Ultrasonic sensor	Temperature monitoring for sprinkler control	Buzzer
[5]	2020		DHT11 sensor, Arduino microcontrollers	• Temperature and humidity monitoring of the chicken cage • Provision of a web application for result display	Smartphone alerts and buzzers
[6]	2020	Bangladesh	DHT11 sensor	• Real-time measurement of temperature and humidity • Transmission of results to a cloud-based server for continual analysis against threshold levels	Alert message via smartphone and triggering of the buzzer
[7]	2020	Malaysia	DHT22 sensor	• Environmental parameter measurements for automatic transmission to a central database • Automatic control of the light bulb and fan for adjusting temperature and humidity levels	Notification via the cloud-based monitoring system
[8]	2020	Brunei		• Regulate temperature, humidity, air quality, and food supply efficiently • Carry out corrective measures when parameters exceed safe limits • Web-based interface for remote monitoring and visualization.	SMS, Email, WhatsApp, and remote monitoring from a web-based interface.
[9]	2022	Malaysia	Raspberry Pi, DHT11 sensor	• Monitoring of temperature and humidity	Telegram
[10]	2023	India	Node MCU, Servo Motor, DHT11, IR sensor, piezoelectric buzzer	• Monitoring of house temperature and humidity, along with lighting and water level • Monitoring of chicken presence (entering and leaving the coop)	Results display on a Cloud-based application

The findings suggest IoT integration enhances environmental stability and reduces mortality rates and labour requirements. These insights provide a strong foundation for further advancements in smart poultry farming systems, emphasizing the need for improved sensor accuracy, energy efficiency, and scalability in future implementations.

4.1.2 Health and Biometric Monitoring

IoT-enabled health and biometric sensors have transformed poultry farming by enabling continuous, real-time monitoring of individual bird health, behaviour, and physiology, allowing early disease detection and improved welfare as reported [10]. Devices such as RFID tags, smart leg bands, microchips, and infrared thermometers offer automated data collection and, when integrated with cloud analytics and AI, support optimized vaccination, feeding, and mortality reduction [31].

Research by [32] evaluated an RFID-based system with data mining and K-means clustering to classify birds based on behaviour and weight, showing strong potential for large-scale disease detection. Similarly, Iowa State University researchers [33] developed a UHF RFID system to monitor feeding and nesting behaviours, using real-time data from antennas and load cells to assess individual hen activity. These systems support non-intrusive, automated tracking for data-driven decisions, enhancing productivity, welfare, and resource allocation in precision poultry farming.

4.2 Wearable and Embedded IoT Devices

Wearable and embedded IoT devices have transformed poultry farming by enabling real-time monitoring of bird health, behaviour, and environmental conditions [34]. Technologies such as smart sensors, RFID tags, and microcontroller systems collect continuous data on parameters like body temperature, movement, and stress levels, supporting data-driven decisions to enhance productivity and welfare [35], [32]. Wearable devices (such as RFID leg bands [32]) enable individualized tracking, while embedded systems (such as smart feeders [36] and climate controllers [37, 38]) maintain optimal living conditions. Integration with cloud computing and AI further improves monitoring, prediction, and traceability. Despite these benefits, challenges remain. High initial costs limit adoption for small-scale farmers [39], while ongoing maintenance requires technical expertise. Also, data overload, cybersecurity threats [40, 41], and potential discomfort to birds from poorly designed devices raise concerns about large-scale implementation [34].

4.3 Wireless Communication and Cloud Integration

The integration of wireless communication and cloud computing in poultry farming has significantly transformed traditional farming methods into highly efficient, automated, and data-driven systems. These technologies play a crucial role in enhancing real-time monitoring, remote farm management, and decision-making, ensuring improved poultry health, optimized production, and better resource utilization. Wireless communication allows for the seamless transmission of data from IoT-enabled devices to cloud platforms, where advanced analytics processes the information to provide actionable insights.

Cloud integration further enhances poultry farming by providing secure data storage, advanced analytics, and AI-driven decision-making tools [11]. By leveraging cloud-based platforms, farmers can monitor temperature, humidity, feed intake, and disease outbreak trends, allowing for predictive maintenance, automated interventions, and optimized resource allocation. Additionally, cloud integration supports multi-farm connectivity, enabling large-scale poultry operations to centralize data from multiple locations for better efficiency, traceability, and biosecurity [12]. The combination of wireless communication and cloud computing ensures that poultry farmers can make faster, more informed decisions, leading to higher productivity, reduced losses, and improved animal welfare.

4.3.1 Wireless Communication Technologies in Poultry Farming

Wireless communication is essential to IoT-based poultry farming, enabling real-time data transmission without extensive wiring. Key technologies include:

i. Wi-Fi (IEEE 802.11 standards): Supports high-speed data transfer for monitoring environmental and operational parameters. IEEE 802.11ah (HaLow) offers extended range, low power use, and efficient sensor connectivity, ideal for IoT applications [44, 45].
ii. Bluetooth and BLE: Used for short-range communication between wearable devices and gateways. BLE is energy-efficient and cost-effective, operating in network structures like Pico-net and Scatter-net for expanded connectivity [44, 46].
iii. LoRa and Zigbee: LoRa supports long-range, low-power transmission via LoRaWAN in a star topology, ideal for large-scale farms [47]. Zigbee, based on IEEE 802.15.4, supports low-power, short-range communication with star, P2P, and mesh topologies, ensuring reliable, efficient data routing [44, 48].
iv. Cellular Networks (3G/4G/5G): Enable farm-wide and remote access to data. 5G offers ultra-fast connectivity, supporting video surveillance and AI integration.
v. RFID and NFC: Used for tracking bird health, movement, and feed intake. RFID can be integrated with other wireless systems for enhanced farm management.

These technologies collectively enhance real-time monitoring, automation, and decision-making in modern poultry farming. Table 4 summarises the wireless networks for IoT.

Table 4: Wireless Networks for IoT

	Zigbee	Bluetooth	LoRa	Wi-Fi
Standard	IEEE 802.15.4	IEEE 802.15.1	IEEE 1451.5.5	IEEE 802.11a, b, g
Industry Organizations	Zigbee Alliance	Bluetooth SIG	LoRa Alliance	Wi-Fi Alliance
Topology	Mesh, star, tree.	Star	Star-of-stars	Star
RF Frequency	868/915 MHz, 2.5 GHz	2.4 GHz	863-870/873 MHz (Europe), 915-928 MHz (South America), 902-928 MHz (North America), 865-867 MHz (India), 915-928 MHz (Asia)	1GHz, 2.4GHz, 5.8GHz
Data rate	250 kbits/s	723 kbits/s		11 to 105 Mbits
Range	10 to 300 m	10 m		10-100 m
Power	Very low	Low		Low/High
Nodes	65,000	8		32

4.3.2 Cloud Integration for Smart Poultry Farming

Cloud computing plays a crucial role in smart poultry farming by enabling efficient data storage, analysis, and remote access. It supports real-time monitoring and alerts, notifying farmers via mobile apps or SMS when parameters like temperature or ammonia levels exceed safe limits [49]. Through advanced analytics and AI integration, cloud platforms help predict disease outbreaks, feed consumption, and growth trends, enhancing resource and vaccination management [9, 50]. Remote access and multi-farm connectivity allow centralized oversight of multiple farms from any location, improving coordination and biosecurity [51]. Cloud systems also enable automated reporting and compliance, simplifying record-keeping and meeting regulatory requirements, as demonstrated in Hongqian et al.'s work on egg-laying hen farms [52]. Furthermore, cloud platforms integrate with smart automation units to adjust feeding, ventilation, and climate control systems automatically, minimizing manual effort.

4.3.3 Challenges of Wireless Communication and Cloud Integration in Poultry Farming

Despite the numerous advantages, the integration of wireless communication and cloud computing in poultry farming presents several challenges:

i. High Initial Costs: Setting up IoT sensors, wireless networks, and cloud infrastructure can be expensive, making it less accessible for small-scale farmers.
ii. Connectivity Issues in Remote Areas: Some poultry farms are located in rural areas with poor internet connectivity, which can hinder real-time data transmission and cloud access [13].
iii. Cybersecurity Risks: Cloud-based systems are vulnerable to cyberattacks, data breaches, and hacking, which could compromise farm data and operational security.
iv. Data Overload and Management: The large volume of real-time data generated by IoT sensors may lead to data overload, requiring efficient data storage, processing, and filtering mechanisms [14].
v. Technical Expertise Requirements: Farmers may require training and technical support to effectively use cloud platforms, IoT devices, and wireless communication systems.

Despite challenges such as cost, connectivity issues, and cybersecurity concerns, the adoption of these technologies is steadily increasing, paving the way for a more efficient, sustainable, and data-driven poultry industry.

5.0 Impact of IoT in Poultry Yield Enhancement

This section explores how IoT impacts poultry yield enhancement through precision farming, optimized feeding and water management, disease detection and prevention, environmental control, and overall farm efficiency.

5.1 Precision Farming and Smart Data Utilisation

IoT enhances poultry yield through precision farming by using sensor networks, automation, and data analytics to monitor factors like temperature, humidity, air quality, feed, water intake, and bird movement [37]. Cloud-based AI tools help predict health issues and optimize operations. RFID systems track individual birds to monitor feeding, behaviour, and growth, enabling early illness detection and feed adjustments. Computer vision technologies also assess bird behaviour to identify stress or aggression that could affect productivity.

5.2 Optimized Feeding and Water Management

IoT-powered automated feeding and watering systems enhance poultry yield by delivering precise nutrition and hydration, reducing feed waste, and improving growth efficiency [54]. Smart dispensers and water monitors enable farmers to regulate feed based on individual bird consumption [55], track water intake to prevent dehydration and disease [56], and adjust feed composition using real-time analytics tailored to bird age, weight, and health [57]. AI-integrated weighing sensors further optimize feeding schedules based on growth and feed conversion ratios, boosting productivity.

5.3 Disease Detection and Prevention

[10] researched on disease IoT-based biometric and health monitoring systems which help combat disease outbreaks in poultry farming by enabling early detection and timely intervention. Smart sensors, thermal cameras, and respiratory monitors track vital signs like body temperature, heart rate, and movement patterns to identify signs of illness. Integrated with AI-driven diagnostics, these systems alert farmers to potential outbreaks before symptoms worsen, allowing for quick responses. Additionally, IoT-enabled vaccination systems automate precise vaccine dosing, reducing human error and supporting consistent disease prevention.

5.4 Environmental Control for Optimal Growth Conditions

Environmental conditions like temperature, humidity, ventilation, and air quality greatly influence poultry productivity, with poor conditions leading to stress, illness, and reduced feed intake [15]. IoT-based climate control systems address these challenges by using smart sensors to monitor environmental parameters, automatically adjusting ventilation and cooling systems, and detecting harmful gases to activate purifiers or fans. For instance, automated cooling systems in hot climates and smart heating in cold areas help maintain optimal conditions, prevent stress, and support consistent poultry growth.

5.5 Reduction in Mortality and Losses

High IoT-based monitoring systems help reduce poultry mortality and losses by enabling real-time health monitoring, automated emergency responses (such as alerts for temperature shifts, fires, or gas leaks), and improved biosecurity through RFID access controls [17, 28, 58]. These technologies facilitate rapid intervention, limit disease spread, and enhance farm efficiency, leading to higher survival rates and increased yield per production cycle.

5.6 Cost Efficiency and Sustainable Farming Practices

IoT improves poultry farming by enhancing yield, cost efficiency, and sustainability through precision feeding, automation, and optimized climate control systems [17]. It reduces feed and water wastage, lowers labour and energy costs, and minimizes environmental impact, promoting a more resource-efficient and sustainable farming model.

6.0 Conclusion and Future Directions

IoT systems are transforming poultry farming by improving productivity, efficiency, and sustainability through real-time monitoring, automation, and data analytics. These systems—comprising sensors, actuators, microcontrollers, cloud platforms, and mobile apps—enable smart control of farm operations. However, challenges such as high costs, limited farmer expertise, and data security remain. Future research should focus on affordable solutions, AI-driven disease prediction, and standardizing IoT devices for better interoperability.

Acknowledgements

The authors wish to appreciate TETFUND and FUT-Minna for providing Institutional Based Research Funding: TETFUND/FUTMINNA/2024/004, which aided in the development of this paper.

Conflict of interest:

The authors declare no conflicting interest

Authors' contributions:

Conceptualization, methodology, formal analysis, investigation, AMBAFI J.G. & HARIS Y.M; writing—original draft preparation, result interpretation, writing—review and editing, AMBAFI J.G., AHMAD A.S., & OHIZE H.O. Result interpretation, project administration, review and original draft preparation: review and editing: were carried out by AMBAFI J.G., DAUDA U.S., and Musa J.J.

References

1. Wu, D., Cui, D., Zhou, M. and Ying, Y., 2022. Information perception in modern poultry farming: A review. Computers and Electronics in Agriculture, 199, p.107131.
2. Alahmad T, Neményi M, Nyéki A. Applying IoT sensors and big data to improve precision crop production: a review. Agronomy. 2023 Oct 12;13(10):2603.
3. Vinueza-Naranjo PG, Nascimento-Silva HA, Rumipamba-Zambrano R, Ruiz-Gomes I, Rivas-Lalaleo D, Patil NJ. IoT-Based smart agriculture and Poultry farms for environmental sustainability and development. InInformation and Knowledge in Internet of Things 2021 May 5 (pp. 379-406). Cham: Springer International Publishing.
4. M. H. Lashari, S. Karim, M. Alhussein, A. A. Hoshu, K. Aurangzeb, and M. S. Anwar, "Internet of Things-based sustainable environment management for large indoor facilities," PeerJ Computer Science, vol. 9, p. e1623, 2023.
5. Ali M, Imran M, Baig MS, Shah A, Ullah SS, Alroobaea R, Iqbal J. Intelligent Control Shed Poultry Farm System Incorporating With Machine Learning. IEEE Access. 2024 Apr 22.
6. Ojo RO, Ajayi AO, Owolabi HA, Oyedele LO, Akanbi LA. Internet of Things and Machine Learning techniques in poultry health and welfare management: A systematic literature review. Computers and Electronics in Agriculture. 2022 Sep 1;200:107266.
7. Bist RB, Bist K, Poudel S, Subedi D, Yang X, Paneru B, Mani S, Wang D, Chai L. Sustainable poultry farming practices: A critical review of current strategies and future prospects. Poultry Science. 2024 Sep 4:104295.
8. Benos L, Tagarakis AC, Dolias G, Berruto R, Kateris D, Bochtis D. Machine learning in agriculture: A comprehensive updated review. Sensors. 2021 May 28;21(11):3758.
9. Astill J, Dara RA, Fraser ED, Roberts B, Sharif S. Smart poultry management: Smart sensors, big data, and the internet of things. Computers and Electronics in Agriculture. 2020 Mar 1;170:105291.
10. Singh M, Kumar R, Tandon D, Sood P, Sharma M. Artificial intelligence and iot based monitoring of poultry health: A review. In2020 IEEE International Conference on Communication, Networks and Satellite (Comnetsat) 2020 Dec 17 (pp. 50-54). IEEE.
11. Faysal MA, Ahmed MR, Rahaman MM, Ahmed F. A Review of groundbreaking changes in the poultry industry in Bangladesh using the internet of things (IoT) and computer vision Technology. In2021 International Conference on Automation, Control and Mechatronics for Industry 4.0 (ACMI) 2021 Jul 8 (pp. 1-6). IEEE.
12. Mouha RA. Internet of things (IoT). Journal of Data Analysis and Information Processing, vol. 9, no. 02, 2021, (pp. 77).

13. Lamping C. Dealing with uncertainty: Deep learning for robust animal monitoring in uncontrolled environments, Wageningen University and Research, 2024.
14. Goyal V, Yadav A, Mukherjee R. A Literature Review on the Role of Internet of Things, Computer Vision, and Sound Analysis in a Smart Poultry Farm. ACS Agricultural Science & Technology. 2024 Mar 11;4(4):368-88.
15. Nawab A, Ibtisham F, Li G, Kieser B, Wu J, Liu W, Zhao Y, Nawab Y, Li K, Xiao M, An L. Heat stress in poultry production: Mitigation strategies to overcome the future challenges facing the global poultry industry. Journal of thermal biology. 2018 Dec 1;78:131-9.
16. Lashari MH, Memon AA, Shah SA, Nenwani K, Shafqat F. IoT based poultry environment monitoring system. In2018 IEEE International Conference on Internet of Things and Intelligence System (IOTAIS) 2018 Nov 1 (pp. 1-5). IEEE.
17. Orakwue SI, Al-Khafaji HM, Chabuk MZ. IoT Based smart monitoring system for efficient poultry farming. Webology. 2022 Jan;19(1):4105-12.
18. Wicaksono D, Perdana D, Mayasari R. Design and analysis automatic temperature control in the broiler poultry farm based on wireless sensor network. In2017 2nd International conferences on Information Technology, Information Systems and Electrical Engineering (ICITISEE) 2017 Nov 1 (pp. 450-455). IEEE.
19. Mitkari S, Pingle A, Sonawane Y, Walunj S, Shirsath A. IoT based smart poultry farm. Eng., Agricultural Food Sciences, Comput. Sci., Environmental Sci. 2019 Mar.
20. Malika NZ, Johar MG, Alkawaz MH, Hajamydeen AI, Raya L. Temperature & humidity monitoring for poultry farms using IOT. In2022 IEEE 12th Symposium on Computer Applications & Industrial Electronics (ISCAIE) 2022 May 21 (pp. 76-81). IEEE.
21. Praveena NG, Basha SH, Dinesh S, Sankar C, Kumar A. Sensory Detector of Hazardous Gases in Poultry Farms. In2024 IEEE 4th International Conference on Applied Electromagnetics, Signal Processing, & Communication (AESPC) 2024 Nov 29 (pp. 1-6). IEEE.
22. Casey KD, Bicudo JR, Schmidt DR, Singh A, Gay SW, Gates RS, Jacobson LD, Hoff SJ. Air quality and emissions from livestock and poultry production/waste management systems, 2006.
23. Muley NS, Parihar RT, Student R, Malkapur VM. Corrosion in Agriculture Instruments and Equipments: Reasons and Solutions, (2022).
24. Saksrithai K, King AJ. Controlling hydrogen sulfide emissions during poultry productions. J Anim Res Nutr. 2018;3(1):2.
25. Al-Kerwi MS, Mardenli O, Jasim MR, Al-Majeed MA. Effects of harmful gases emitted from poultry houses on productive and health performance. InIOP Conference Series: Earth and Environmental Science 2022 Jul 1 (Vol. 1060, No. 1, p. 012082). IOP Publishing.
26. Paputungan IV, Al Faruq A, Puspasari F, Al Hakim F, Fahrurrozi I, Oktiawati UY, Mutakhiroh I. Temperature and humidity monitoring system in broiler poultry farm. InIOP Conference Series: Materials Science and Engineering 2020 Apr 1 (Vol. 803, No. 1, p. 012010). IOP Publishing.
27. Mondol JP, Mahmud KR, Kibria MG, Al Azad AK. IoT based smart weather monitoring system for poultry farm. In2020 2nd International Conference on Advanced Information and Communication Technology (ICAICT) 2020 Nov 28 (pp. 229-234). IEEE.
28. Hambali MF, Patchmuthu RK, Wan AT. IoT based smart poultry farm in Brunei. In2020 8th International Conference on Information and Communication Technology (ICoICT) 2020 Jun 24 (pp. 1-5). IEEE.
29. Shafie N, Zainab NA, Sam SM, Adam MZ, Azizan A. Real-Time Temperature and Humidity Monitoring Testing Approach in Poultry Farm. Open International Journal of Informatics. 2022 Dec 15;10(2):24-32.
30. Sasirekha R, Kaviya R, Saranya G, Mohamed A, Iroda U. Smart poultry house monitoring system using IoT. InE3S Web of Conferences 2023 (Vol. 399, p. 04055). EDP Sciences.
31. Gupta S. AI Applications in Animal Behavior Analysis and Welfare. InAgriculture 4.0 (pp. 224-244). CRC Press.
32. Feiyang Z, Yueming H, Liancheng C, Lihong G, Wenjie D, Lu W. Monitoring behavior of poultry based on RFID radio frequency network. International Journal of Agricultural and Biological Engineering. 2016 Dec 1;9(6):139-47.
33. Li L, Zhao Y, Oliveira J, Verhoijsen W, Liu K, Xin H. A UHF RFID system for studying individual feeding and nesting behaviors of group-housed laying hens. Transactions of the ASABE. 2017;60(4):1337-47.
34. Campbell DL, Erasmus MA. Poultry welfare monitoring: wearable technologies. InUnderstanding the behaviour and improving the welfare of chickens 2020 Sep 29 (pp. 149-176). Burleigh Dodds Science Publishing.
35. Ahmed G, Malick RA, Akhunzada A, Zahid S, Sagri MR, Gani A. An approach towards IoT-based predictive service for early detection of diseases in poultry chickens. Sustainability. 2021 Dec 3;13(23):13396.
36. Mahesh N, Prabhu K, Sudha G, Deepak K, Dharun S, Dinaker S. Implementation of Embedded System based Poultry Feeding Trolley Automation. In2024 5th International Conference on Smart Electronics and Communication (ICOSEC) 2024 Sep 18 (pp. 72-77). IEEE.
37. George AS, George AH. Optimizing poultry production through advanced monitoring and control systems. Partners Universal International Innovation Journal. 2023 Oct 25;1(5):77-97.
38. Kaimujjaman M, Hossain MM, Khatun MA. A Smart Automation System f or Controlling Environmental Parameters of Poultry Farms to Increase Poultry Production. InInternational Conference on Trends in Electronics and Health Informatics 2022 Dec 7 (pp. 79-92). Singapore: Springer Nature Singapore.

39. Leong WY, Leong YZ, San Leong W. Eco-efficient poultry farms: Leveraging IoT for sustainable production. In2024 9th International Conference on Applying New Technology in Green Buildings (ATiGB) 2024 Aug 30 (pp. 432-437). IEEE.
40. Wilkinson SJ. Big data for poultry–what is possible. InProceedings of the 29th Annual Australian Poultry Science Symposium, Sydney, Australia 2018 Feb (pp. 4-7).
41. Neethirajan S. Safeguarding digital livestock farming-a comprehensive cybersecurity roadmap for dairy and poultry industries. Frontiers in Big Data. 2025 Apr 16;8:1556157.
42. Manik A, Kuntoji A, Kumar D, Gupta S. Data Fusion and Integration Platforms for Smart Farming. InAgriculture 4.0 (pp. 169-184). CRC Press.
43. Basir MS, Buckmaster D, Raturi A, Zhang Y. From pen and paper to digital precision: a comprehensive review of on-farm recordkeeping. Precision Agriculture. 2024 Oct;25(5):2643-82.
44. Abbas A, Jilani MT, Khan MK. Comparative analysis of wireless technologies for internet-of-things based smart farm. Sci. Int. 2017;29(2):373-8.
45. Andrade N, Toledo P, Guimaraes G, Klimach H, Dornelas H, Bampi S. Low power IEEE 802.11 ah receiver system-level design aiming for IoT applications. InProceedings of the 30th Symposium on Integrated Circuits and Systems Design: Chip on the Sands 2017 Aug 28 (pp. 11-16).
46. Dahiya M. A short range wireless network: Bluetooth. International Journal of Advanced Research in Computer Science. 2017 Mar 15;8(3).
47. V. Goyal, Internet of things based smart poultry farm, Bennett university, 2024.
48. Ompal, Mishra VM, Kumar A. Zigbee internode communication and FPGA synthesis using mesh, star and cluster tree topological chip. Wireless Personal Communications. 2021 Jul;119(2):1321-39.
49. Danev V, Atanasova T, Dineva K. Multi-Sensor Platform in Precision Livestock Farming for Air Quality Measurement Based on Open-Source Tools. Applied Sciences. 2024 Sep 10;14(18):8113.
50. Leong WY, Leong YZ, San Leong W. System-on-chip Iot for smart poultry manufacturing. In2024 21st International SoC Design Conference (ISOCC) 2024 Aug 19 (pp. 348-349). IEEE.
51. Toth G, Szabo S, Haidegger T, Alexy M. Edge or Cloud Architecture: The Applicability of New Data Processing Methods in Large-Scale Poultry Farming. Technologies. 2025 Jan 1;13(1):17.
52. Hongqian C, Xin H, Guanghui T, Chaoying M, Xiaodong D, Taotao M, Cheng W. Cloud-based data management system for automatic real-time data acquisition from large-scale laying-hen farms. International Journal of Agricultural and Biological Engineering. 2016 Jul 31;9(4):106-15.
53. Antony AP, Leith K, Jolley C, Lu J, Sweeney DJ. A review of practice and implementation of the internet of things (IoT) for smallholder agriculture. Sustainability. 2020 May 6;12(9):3750.
54. Makkar HP. Smart livestock feeding strategies for harvesting triple gain–the desired outcomes in planet, people and profit dimensions: a developing country perspective. Animal Production Science. 2016 Feb 9;56(3):519-34.
55. Peng Y, Zeng Z, Lv E, He X, Zeng B, Wu F, Guo J, Li Z. A Real-Time Automated System for Monitoring Individual Feed Intake and Body Weight of Group-Housed Young Chickens. Applied Sciences. 2022 Dec 2;12(23):12339.
56. Batuto A, Dejeron TB, Cruz PD, Samonte MJ. e-poultry: An IoT poultry management system for small farms. In2020 IEEE 7th International Conference on Industrial Engineering and Applications (ICIEA) 2020 Apr 16 (pp. 738-742). IEEE.
57. Zuidhof MJ, Afrouziyeh M, van der Klein MS, and You J. Smart poultry nutrition in Smart Livestock Nutrition: Springer, 2023, pp. 201-225.
58. Onibonoje MO. IoT-based synergistic approach for poultry management system, in *2021 IEEE International IOT, Electronics and Mechatronics Conference (IEMTRONICS)*, 2021: IEEE, pp. 1-5.