



An Automated Feeding System Model to Improve Production Efficiency in Laying Hens

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Abstract

The poultry industry continues to seek technological innovations to improve production efficiency and reduce operational costs. One critical aspect in poultry farming is feed management, which significantly influences productivity and farm sustainability. Manual feeding systems often lead to feed waste, labor inefficiency, and inconsistent feeding schedules. This study aims to develop an automated feeding system model to improve production efficiency in laying hens through the integration of Internet of Things (IoT) technology and real-time monitoring systems. The research employed a system development approach combining microcontroller-based automation, sensor monitoring, and scheduling mechanisms using real-time clock modules. Data were analyzed by comparing feeding accuracy, labor efficiency, and feed utilization before and after system implementation. The results demonstrate that the proposed automated feeding model improves feeding accuracy and reduces feed waste while maintaining optimal feeding intervals. The integration of sensors and IoT monitoring also enables real-time control and improved farm management. The findings indicate that automated feeding technology contributes significantly to enhancing production efficiency and sustainability in poultry farming. This study provides a practical model that can be implemented in small- and medium-scale poultry farms to support modern poultry management systems.

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Introduction

The poultry industry plays a strategic role in global food security by providing a reliable source of animal protein through egg and meat production. Laying hen farming is particularly important because eggs are widely consumed and relatively affordable compared to other animal protein sources. As the demand for eggs continues to increase, poultry farmers are required to improve production efficiency while maintaining animal welfare and cost control. One of the most critical factors affecting poultry productivity is feed management. Feed accounts for the largest proportion of production costs in poultry farming and significantly influences the growth, health, and egg production performance of laying hens

(Purnamasari et al., 2022). Inefficient feeding practices may lead to feed waste, irregular feeding schedules, and increased operational costs, which ultimately reduce the overall efficiency of poultry farm management.

Effective feed management requires consistency in feeding schedules, accurate feed distribution, and continuous monitoring of feed consumption. In many small and medium poultry farms, feeding operations are still conducted manually. Manual feeding often depends on human labor and is vulnerable to inconsistencies caused by human error, fatigue, or time constraints. Such conditions may lead to irregular feeding intervals, uneven feed distribution, and difficulties in monitoring feed utilization. These issues can negatively affect laying hen productivity and increase production costs. Therefore, improving feeding management through technological innovation has become an essential strategy to support sustainable poultry farming systems.

Technological advancements in agriculture have encouraged the development of automated systems that improve efficiency and reduce reliance on manual labor. In poultry farming, automation technologies have been applied to several operational aspects, including feeding systems, environmental monitoring, and production management. Automated feeding systems are designed to distribute feed at predetermined intervals and quantities using microcontrollers, sensors, and mechanical actuators. These systems allow farmers to maintain consistent feeding schedules and reduce feed wastage. Research conducted by Chinaeke-Ogbuka et al. (2024) demonstrated that automated poultry feeding systems can improve feeding precision and reduce human labor while maintaining optimal feeding conditions for poultry.

The integration of Internet of Things (IoT) technology has further enhanced the capability of automated poultry farming systems. IoT enables communication between devices, sensors, and monitoring platforms through internet connectivity, allowing real-time data collection and remote control of farm operations. Automated feeding systems equipped with IoT technology can monitor feed levels, feeding schedules, and equipment performance simultaneously. Priyadarshini et al. (2022) developed an IoT-based poultry feeding automation system that allows farmers to control feed distribution and monitor feed availability remotely. The system improved operational efficiency and provided farmers with real-time information about feeding activities.

Several studies have also investigated sensor-based technologies to improve poultry feeding management. Sensors such as ultrasonic sensors, load cells, and temperature sensors can monitor feed availability, feed weight, and environmental conditions inside poultry houses. These technologies allow automated systems to distribute feed based on predefined parameters and environmental conditions. Safputra et al. (2023) reported that IoT-based monitoring systems integrated with sensors can improve feeding control and enable farmers to track farm conditions more efficiently. Similarly, Ihsanudin and Suharjo (2025) developed a feeding system using load cell sensors and IoT technology to ensure accurate feed distribution in poultry farms.

The implementation of automated feeding technology has also been supported by research on real-time monitoring systems for poultry production. Monitoring technologies provide detailed information about feed intake, growth performance, and poultry behavior. Peng et al. (2022) introduced a real-time automated monitoring system that measures feed intake and body weight of chickens in group housing systems. The study demonstrated that automated monitoring systems provide valuable insights for improving feeding strategies and optimizing poultry production management.

In addition to feeding automation, technological innovation in poultry farming has expanded to include computer vision and data analysis technologies. These technologies allow farmers to analyze poultry production performance using digital monitoring tools. For instance, Jiang et al. (2025) developed a computer vision-based method to measure egg weight accurately in laying hen farms. Accurate

monitoring of egg weight helps farmers evaluate feed conversion efficiency and adjust feeding strategies to improve production outcomes.

Despite the growing availability of smart farming technologies, the adoption of automated feeding systems in many developing regions remains limited. Poultry farmers in these areas often face constraints such as limited access to technology, lack of technical knowledge, and high initial investment costs. As a result, manual feeding practices continue to dominate poultry farming operations. These traditional practices may limit productivity improvements and reduce the competitiveness of poultry farms in the modern agricultural sector. Studies have indicated that integrating automation and intelligent monitoring technologies into poultry farming can significantly improve productivity and resource utilization (Landge et al., 2024).

The concept of smart poultry farming emphasizes the use of intelligent systems to optimize production efficiency and farm management. Automation technologies can improve feeding accuracy, reduce feed waste, and enhance decision-making through data-driven management. Leong et al. (2025) highlighted that intelligent manufacturing technologies in poultry farming can improve production efficiency by integrating automation, monitoring systems, and digital control mechanisms. Such technologies support the development of modern agricultural systems that are more efficient, sustainable, and responsive to market demands.

Previous studies have demonstrated the potential benefits of automated feeding systems in improving poultry farm management. However, many existing systems focus on specific technological components without providing a comprehensive model that integrates feeding automation, sensor monitoring, and real-time scheduling mechanisms. In addition, some automated feeding technologies are designed for broiler chickens rather than laying hens, which have different feeding requirements and production characteristics (Sukri et al., 2023). Therefore, further research is needed to develop a feeding system model specifically designed to support production efficiency in laying hen farming.

Another important aspect that requires attention is the integration of automated feeding systems with simple and cost-effective technologies that can be implemented by small and medium poultry farms. Many advanced automation systems require sophisticated equipment and high investment costs, which may limit their adoption in developing countries. Developing a practical and scalable automated feeding model is therefore essential to ensure that technological innovations can be implemented in real farming environments.

Based on these challenges, this study proposes an automated feeding system model designed to improve production efficiency in laying hens. The proposed model integrates microcontroller-based automation, sensor monitoring, and real-time scheduling mechanisms to ensure consistent feed distribution and efficient feed management. The system is designed to support accurate feed delivery, minimize feed waste, and improve farm operational efficiency.

This research contributes to the development of a practical technological model that supports modern poultry farming practices. By integrating automation and IoT-based monitoring technologies, the proposed system aims to improve feeding management and production efficiency in laying hen farms. The findings of this study are expected to provide valuable insights for poultry farmers, researchers, and agricultural technology developers in implementing automation technologies to support sustainable poultry production systems.

Methods

Research Design

This study applied a system development research approach to design and evaluate an automated feeding system model intended to improve production efficiency in laying hens. The research focused on

developing a prototype system that integrates microcontroller-based automation, sensor monitoring, and Internet of Things (IoT) communication. The objective of the system was to regulate feed distribution automatically according to predetermined feeding schedules while ensuring accurate feed quantities and consistent feeding intervals.

The system development process consisted of four main stages: system design, hardware implementation, system testing, and performance evaluation. The design stage involved determining the architecture of the automated feeding system, including the selection of sensors, control units, communication modules, and feed dispensing mechanisms. The implementation stage focused on assembling hardware components and integrating them with the control program. The testing stage was conducted to ensure that the system operated according to the predefined feeding schedule and feed quantity parameters. The final stage evaluated system performance by measuring feeding accuracy and operational efficiency.

Research Location and Time

The research was conducted in a poultry farming simulation environment that represents typical small-scale laying hen farm conditions. The system prototype was developed and tested over a four-month period from January to April 2025. This time frame allowed sufficient testing of the automated feeding schedule, sensor performance, and communication reliability of the IoT-based monitoring system.

System Architecture and Instrumentation

The automated feeding system was designed using a microcontroller-based architecture integrated with sensors and a feed dispensing mechanism. The central control unit consisted of a NodeMCU microcontroller that functions as the primary processor responsible for controlling feeding operations and managing communication with the IoT monitoring platform.

Several sensors were integrated into the system to support automated feed monitoring and distribution. An ultrasonic sensor was used to detect feed level conditions inside the feed container, enabling the system to identify when feed levels were low. A load cell sensor was implemented to measure the weight of feed distributed during each feeding cycle. The load cell allowed the system to ensure that feed quantities corresponded to the programmed feeding parameters. Previous research has demonstrated that sensor-based feeding systems can improve feed distribution accuracy in poultry farms (Ihsanudin & Suharjo, 2025).

A real-time clock (RTC) module was incorporated into the system to control feeding schedules precisely. The RTC module ensured that feeding events occurred at consistent intervals regardless of system restarts or power interruptions. Automated feeding based on real-time scheduling has been shown to improve feeding consistency and operational efficiency in poultry farms (Prihantoro et al., 2021).

The feed dispensing mechanism used a servo motor connected to a feed gate that regulates feed flow from the container to the feeding tray. The servo motor was controlled directly by the microcontroller, allowing the system to open or close the feed gate based on programmed feeding parameters. This mechanism ensured that feed was distributed only when the feeding schedule was triggered.

IoT Monitoring System

The automated feeding system was integrated with an IoT communication module to enable remote monitoring of feeding operations. The NodeMCU microcontroller transmitted sensor data and feeding status information to an online monitoring platform through a wireless internet connection. The transmitted data included feed levels, feed distribution quantities, and system operation status.

The IoT monitoring platform allowed users to access real-time information regarding the feeding process through a web-based interface. Farmers could observe system performance and verify that

feeding operations occurred according to the predefined schedule. IoT-based monitoring systems have been widely implemented in smart poultry farm applications to improve farm management and operational control (Safputra et al., 2023).

Data Collection

Data collection was conducted to evaluate the operational performance of the automated feeding system and its impact on feeding efficiency. The evaluation focused on three main indicators: feeding accuracy, feed utilization efficiency, and labor efficiency.

Feeding accuracy was measured by comparing the programmed feed quantity with the actual feed weight delivered by the dispensing system during each feeding cycle. The load cell sensor recorded the amount of feed released during each feeding event. Feed utilization efficiency was evaluated by observing the consistency of feed distribution and the reduction of feed waste during system operation.

Labor efficiency was assessed by comparing the level of human involvement required for feeding operations before and after the implementation of the automated system. In manual feeding systems, farm workers typically distribute feed multiple times per day. The automated system aimed to minimize this manual intervention by performing feeding tasks automatically according to the programmed schedule.

Data Analysis

The collected data were analyzed using descriptive statistical methods to evaluate the performance of the automated feeding system. The analysis focused on identifying improvements in feeding accuracy, feed utilization efficiency, and operational efficiency after the implementation of the automated feeding model.

The evaluation also considered system reliability and the consistency of feeding schedules controlled by the real-time clock module. Automated feeding technologies have been shown to improve operational efficiency and reduce feeding errors in poultry farms when supported by reliable scheduling mechanisms and sensor-based monitoring (Priyadarshini et al., 2022).

The results of the analysis were then interpreted to assess the effectiveness of the proposed automated feeding system model in improving production efficiency in laying hen farming systems. The findings also provide insight into the potential application of IoT-based automation technologies in modern poultry farm management.

Results and Discussion

The evaluation of the automated feeding system focused on three operational indicators: feeding accuracy, feed utilization efficiency, and labor efficiency. System testing demonstrated that the automated model successfully maintained consistent feeding schedules and controlled feed distribution according to the programmed parameters. The integration of the real-time clock module ensured that feeding events occurred at predetermined intervals without deviation caused by human error. Similar findings have been reported in automated poultry feeding research where RTC-based control improves feeding consistency and operational stability (Prihantoro et al., 2021). Consistent feeding intervals are essential in laying hen production because irregular feeding schedules can negatively affect egg production performance and feed conversion efficiency.

Another important result of the system evaluation relates to feed distribution accuracy. The integration of a load cell sensor allowed the system to measure feed output during each feeding cycle and ensure that the feed quantity matched the programmed feeding parameters. Sensor-based monitoring significantly reduced feed waste compared with traditional manual feeding practices. Research on automated poultry feeding technologies indicates that load-cell-based systems are effective in controlling

feed quantities and improving feeding precision (Ihsanudin & Suharjo, 2025). The use of automated dispensing mechanisms also ensured that feed was distributed evenly to the feeding tray, reducing feed spillage and improving feed utilization.

The automated system also demonstrated improvements in operational efficiency. Manual feeding requires workers to distribute feed several times per day, which increases labor requirements and operational costs. With the implementation of the automated feeding system, feeding activities were executed automatically by the microcontroller-controlled mechanism. This reduced the level of human intervention required during daily feeding operations. Similar outcomes have been observed in IoT-based poultry farm automation systems where automated feeding significantly reduces labor dependency and improves farm productivity (Priyadarshini et al., 2022; Surahman et al., 2021).

The integration of IoT monitoring provided additional benefits for farm management. Through the monitoring platform, users could access real-time information regarding feed levels, system status, and feeding schedules. The monitoring interface allowed farmers to observe system performance remotely and identify potential operational issues. IoT-based monitoring systems have been widely recognized as an important component of smart poultry farming because they provide real-time operational data that supports better decision-making (Safputra et al., 2023). This capability allows farmers to respond quickly to system alerts, such as low feed levels or device malfunction.

Overall, the implementation of the automated feeding model contributes to improved feeding management and production efficiency in laying hen farms. The system combines automated feed dispensing, sensor monitoring, and IoT communication to support a more controlled and reliable feeding process. These results are consistent with previous research highlighting that automation technologies can improve production efficiency and sustainability in poultry farming (Landge et al., 2024; Leong et al., 2025). The findings indicate that integrating microcontroller-based automation with IoT monitoring provides a practical solution for improving feeding management in small and medium poultry farms.

Performance Indicators of the Automated Feeding System

Indicator	Manual Feeding System	Automated Feeding System	Supporting Literature
Feeding schedule consistency	Dependent on worker availability	Controlled automatically using RTC module	Prihantoro et al., 2021
Feed quantity control	Estimated manually	Measured using load cell sensor	Ihsanudin & Suharjo, 2025
Feed waste level	Higher due to uneven distribution	Reduced due to controlled dispensing	Priyadarshini et al., 2022
Labor involvement	High	Low	Surahman et al., 2021
Monitoring capability	Direct visual observation	Real-time monitoring via IoT platform	Safputra et al., 2023

Functional Components of the Automated Feeding System

System Component	Function	Operational Contribution
NodeMCU Microcontroller	Controls feeding operations	Executes automated feeding logic
Ultrasonic Sensor	Detects feed level	Prevents empty feed containers
Load Cell Sensor	Measures feed weight	Ensures accurate feed distribution
Real-Time Clock (RTC)	Controls feeding schedule	Maintains consistent feeding intervals
Servo Motor	Operates feed gate	Regulates feed flow
IoT Monitoring Platform	Displays system data	Enables remote monitoring

Conclusion

This study developed an automated feeding system model designed to improve production efficiency in laying hens through the integration of microcontroller-based automation, sensor monitoring, and Internet of Things (IoT) communication. The system was designed to regulate feed distribution automatically based on predefined feeding schedules while ensuring accurate feed quantities and consistent feeding intervals. The implementation of a real-time clock module enabled the system to maintain stable feeding schedules, while load cell sensors ensured that feed distribution matched the programmed parameters.

The results indicate that the automated feeding system improves feeding management by reducing feed waste, increasing feeding accuracy, and minimizing manual labor requirements. The integration of IoT monitoring also enables real-time observation of feeding activities and system performance, allowing farmers to monitor feed levels and system conditions remotely. These capabilities support more efficient and responsive farm management practices.

The findings confirm that automation technologies can significantly enhance operational efficiency in poultry farming, particularly in feed management, which represents a major component of production costs. By combining automated dispensing mechanisms, sensor-based monitoring, and IoT communication, the proposed system provides a practical technological solution for improving the efficiency of laying hen production systems.

This research contributes to the development of smart poultry farming technologies that are applicable to small and medium poultry farms. The proposed model demonstrates that relatively simple automation technologies can improve feeding consistency and production efficiency. Future studies may focus on improving system scalability and integrating additional monitoring parameters to further support data-driven poultry farm management.

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