The Smart Coop: Revolutionizing Chicken Care With Automation

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Abstract

This study presents "The Smart Coop" to innovate chicken farming in Malaysia by addressing challenges like resource scarcity and high operational costs. Using automated systems, it aims to improve livestock conditions and implement machine learning for eco-friendly food production. Broiler farming in closed systems faces issues like increased costs, storm damage vulnerability, and disease outbreaks, worsened by poor waste management. "The Smart Coop" proposes autonomous monitoring of various factors and integrating air filters for better environmental quality. The project seeks to create a smart chicken coop monitoring and controlling various aspects, incorporating eco-friendly elements like air filters and rainwater collection, and evaluating the system's reliability. The research methodology includes a literature review, case studies, and practical implementation with Arduino UNO. Performance testing involves temperature control, safety measures, and feeding automation. Findings indicate the smart coop maintains optimal conditions for chicken welfare. Sensors regulate temperature and ensure security, while automated systems promote healthy growth. The air filter eliminates odors, and the air cooler maintains a comfortable environment. While the cleaning system needs improvement, the coop overall meets its objectives. "The Smart Coop" shows potential in improving chicken welfare, reducing environmental impact, and supporting sustainable poultry farming in Malaysia, with suggestions for further optimization.

1. Introduction

The global demand for chicken products is rapidly increasing, necessitating technological advancements to optimize inputs for sustainable production. Key issues in chicken farming include health and nutritional needs.

which influences profitability based on input costs each cycle. To achieve continuous earnings, chicken producers must use efficient alternatives to traditional inputs such as protein, energy sources, plant extra cts for medicine, and brooding materials. The research discovered that poultry farming products, such as eggs, meat, and manure, are enhancing the overall social and economic welfare of farmers, through improvements in food and nutrition security, higher earnings and savings, and the creation of job opportunities for farmer's families [1]. There is a system that is developed as a temperature and humidity monitoring and control system to ensure that the ideal parameters required by a chicken coop are met, thereby increasing chicken productivity [2]. Instead of autonomously monitoring and controlling the temperature and humidity inside the chicken coop, other researchers believe that adding load cell sensors could allowthe farmer to identify the chicken broiler growth in the coop [3].

1.1 Problem Statement and Objectives

According to the findings, an automated temperature and humidity monitoring system in a chicken coop can improve livestock quality of life, while integrating machine learning and deep learning to produce healthful food on a large scale in an environmentally friendly manner. However, broiler farming is challenging, especially when using a closed livestock system with automatic feeding, drinking, and lighting, which may increase costs. Additionally, storms can cause significant damage, and there are risks of losses due to bird flu virus transmission and chicken death. Although technology can enhance chicken products such as eggs and meat, poor waste management can lead to unpleasant smells, the appearance of flies, and concerns about the spread of the bird flu virus. To address these issues, The Smart Coop: Revolutionizing Chicken Care with Automation is proposed. This system can autonomously monitor and control temperature, humidity, food supply, drinking, and manure cleaning, while integrating air filters to release fresh air into the environment. The objectives of this project are to develop a smart chicken coop that constantly monitors and controls light, humidity, temperature, food supply, drinking, and manure cleaning. Additionally, the project aims to integrate eco-friendly features such as air filters and rainwater collection systems, and to evaluate the reliability of the developed smart chicken coop system through comprehensive testing.

1.2 Literature Review

The traditional method of chicken farming, commonly used in village areas, is designed for personal use and involves minimal commercialization. This method leaves chicken manure, which contains high levels of ammonia, on the ground, requiring manual cleaning and making it unsuitable for residential or large-scale commercial purposes. In Sri Lanka, the poultry sub-sector has seen significant growth, enhancing family food security and rural living standards (Abidin et al., 2021). A commercial breeder farm employs smart coops with automatic temperature control using a DHT22 sensor and PID controller, achieving precise temperature regulation. The system stabilizes at the set temperature within 121 seconds, with a 1.03% inaccuracy rate (Ahmad et al., 2014). Smart coops also use various sensors for temperature, humidity, ammonia detection, and automatic feeding, connected to a NodeMCU ESP8266. Data is displayed on a 20x4 LCD and accessible via the Blynk app. The system uses DHT22 for temperature and humidity, MQ-135 for ammonia, and a servo motor for feeding and cleaning. These sensors enable remote monitoring and control via WiFi (Alam et al., 2015). An IoT-based system using Telegram is designed to monitor and control coop temperature, employing modules like DHT11 for temperature and humidity, RTC for time tracking, an SD-card module for data storage, and a Wi-Fi ESP8266 NodeMCU module. This system improves productivity with fast response times, accurate timekeeping, and temperature control using a fan and bulb (Amir et al., 2014). An Arduino Uno system monitors and controls coop conditions with a DHT11 sensor for temperature and humidity, a weighing sensor for chicken weight, a bulb, and a cooling fan. The system maintains optimal conditions and tracks broiler weight, with parameters displayed on an LCD (Chuan et al., 2021).

2. Methodology

The project describes how to set up its components, including the DHT 22 sensor, vibration sensor, and RTC module act as the input of this system where it will control other output components such as the Peltier Thermocooling module,12V DC fan, buzzer, 12V DC water pump, Servo motor, and LCD. The following chapter will go over the comprehensive results andperformance assessments of each component.
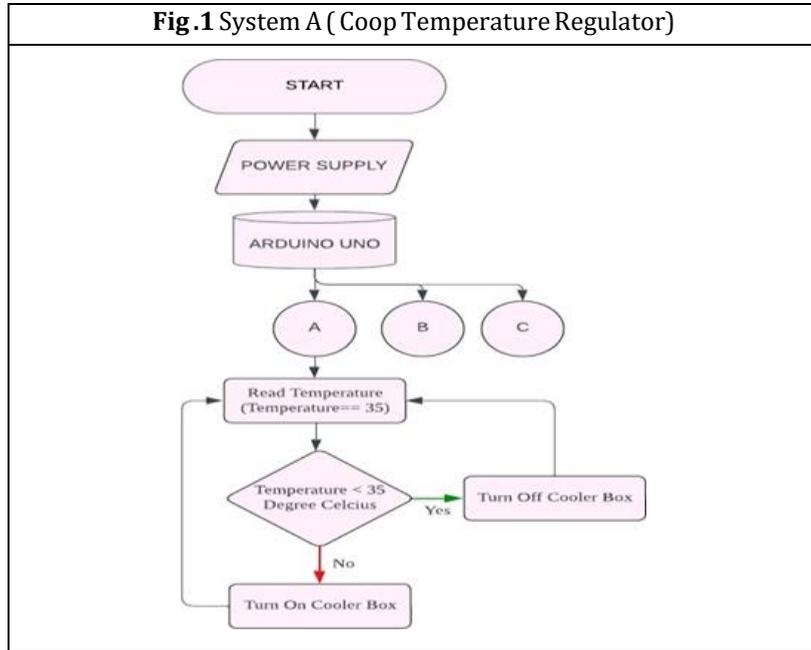
2.1 Flowchart of the System

This system consists of three separate subsystems, as shown in Figure 1, Figure 2, and Figure 3 which are labeled as System A, System B, and System C. These three subsystems work according to the input components where System A has the input component DHT 22, System B has Vibration sensor and System C has RTC module.

### 2.1.1 System A (Coop Temperature Regulator)

Figure 1 shows how the flowchart of this system works according to the input data from the DHT 22 sensor. When the sensor reads temperature and the temperature is less than 35 Degrees Celsius then the Cooler box will be turned off. Onthe other hand, if the temperature is above 35 Degrees Celcius, then the Cooler box will be turned on.

This system will be repeated automatically to ensure the air condition inside the coop is controlled.

**Fig.1** System A (Coop Temperature Regulator)

2.1.2   System B (Coop Safety System)

Figure 2 shows the flow chart of the coop safety system where here the vibration sensor plays a crucial role. When there is a vibration which is made by a predator is detected by the vibration sensor, the buzzer will be turned on for 30 seconds. If there is no vibration detected then the buzzer will remain off. This will indicate the presence of predators to the humans surrounding the coop.

**Fig.2** System B (Coop Safety System)
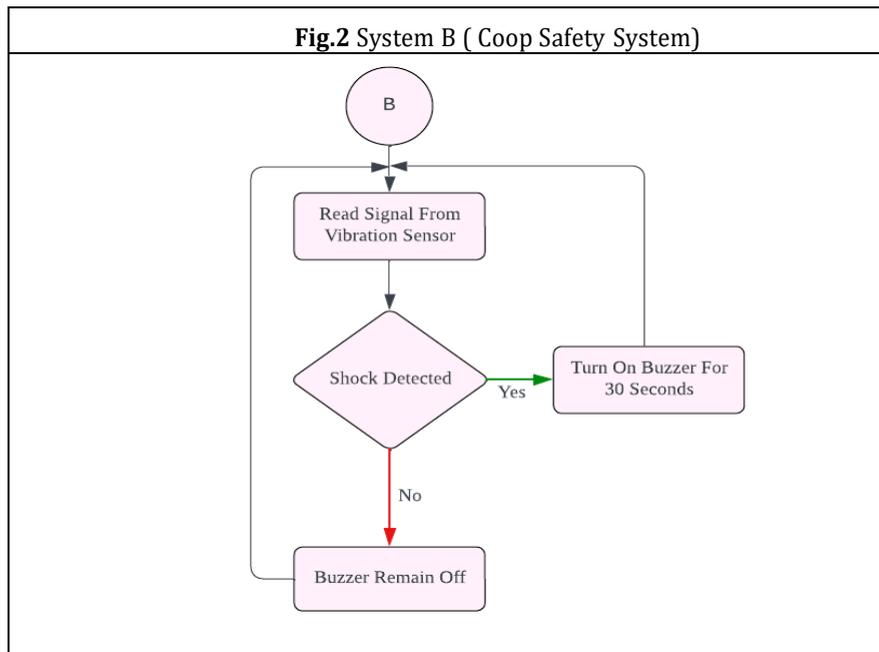
2.1.3   System C (Feeding, Drinking Water, and Coop Cleaning System)

Figure 3 shows the flowchart of System C which has the RTC module as the input sensor. This sensor will control three subsystems which are labeled as feeding, drinking water, and coop cleaning system. There will be three sets in 24 hours. When the time set has been reached, the RTC will send a signal to the output components such as the servo motor and 12V DC water pump to conduct the task given. The servo motor will be turned on for 3 seconds where it will drop the food for the chicken. The 12V DC water pump will be turned On for 5 seconds to supply drinking water and another 12V DC water pump will pump out water for 30 minutes to clean the manure of the chicken. Once done, the systems will wait for the next time to reach. This system will work repeatedly for the whole day.

Fig 3 System C (Feeding, Drinking Water, and Coop Cleaning System)
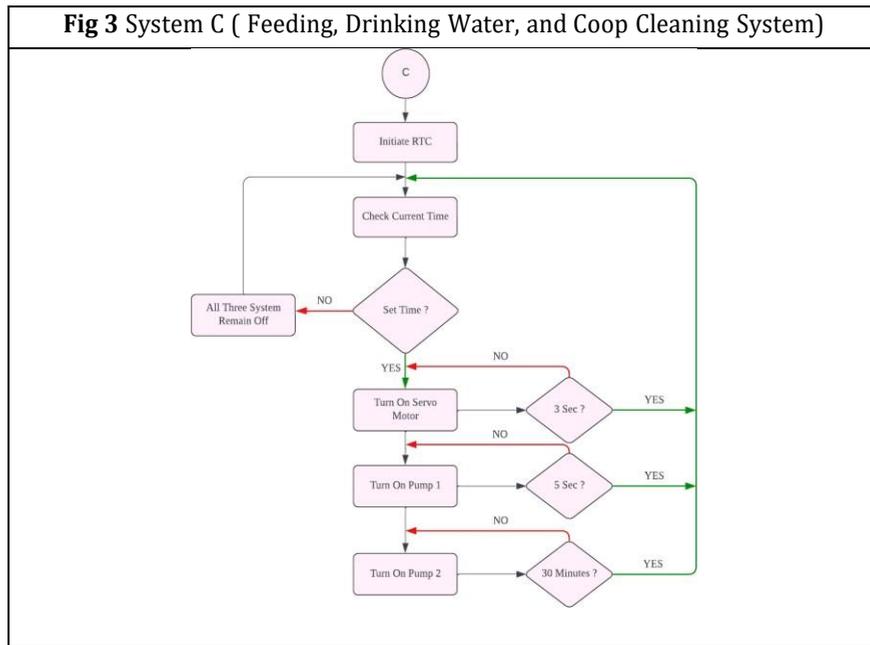
2.2   Block Diagram

Figure 4 shows the block diagram of the project which has the input components, microcontroller, and output components. The input components are DHT 22, Vibration sensor, RTC Timer switch, push button1, and push button2. The microcontroller used is Arduino Uno. The output components are a 12V DC water pump, Peltier Thermocooling module,servo motor, LCD, 12V DC fan, and buzzer. These input components will send signals according to the characteristics which will be controlled by the Arduino Uno which will send signals to the output components to conduct the task programmed.

Fig.4 Block diagram of the project
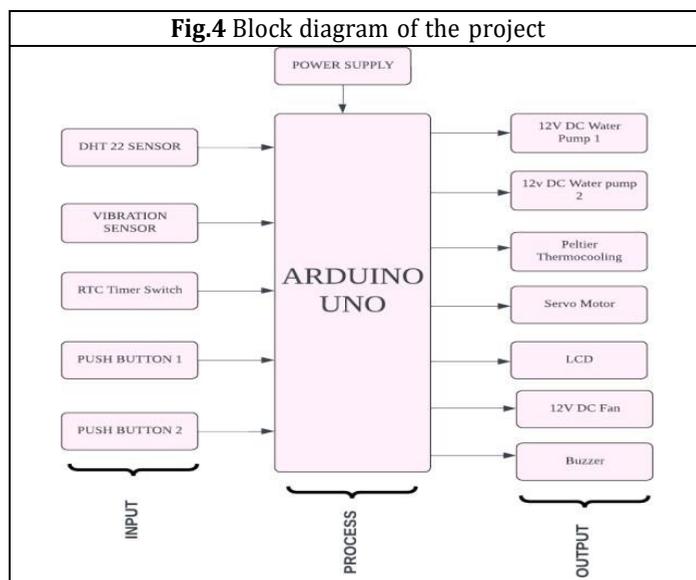
2.3 Overall Hardware Design and Circuit Diagram

2.3.1 Overall Experiment Setup

Figure 5 displays the system consisting of input and output components which are connected to the microcontroller unit Arduino Uno. container. This configuration controller all three subsystems with the labels of System A, B, and C.

2.3.2 Overall Final Design

Fig.5 Overall Experiment Setup
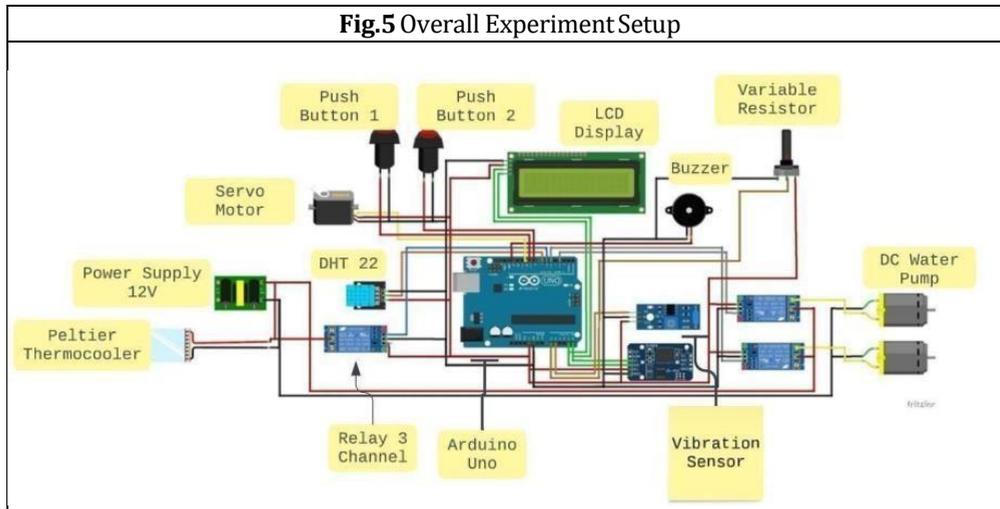
The project's finished hardware design is shown in Figure 6, which includes the main control unit which consists of input and output components. The DHT 22 sensor and Vibration sensor are placed inside the coop while the other output components and the main system are placed down of the project.

Fig.6 Overall Final Design

3. Result

In this study, an observation is made to test the systems in this project which are divided into three. Firstly, testing the temperature reading mechanism which has the DHT22 sensor as the input and the Peltier Thermo cooling device as the output. Secondly, the Safety measures of the coop were equipped with a vibration sensor and buzzer. Lastly, the RTC timer switch system where will turn on three sub-systems consisting of the servo motor, water pump 1, and water pump 2

a. DHT 22 Temperature Reading Testing

The temperature within the chicken coop was tracked using the DHT22 sensor. When the temperature hits 35°C, the cooling mechanism will be turned on. Once the temperature inside the coop is regulated to normal or set value, then the cooling system will be turned on. The cooling system consists of two Peltier thermocouples, two 12V large computer fans, and two 12V mini computer fans. There will be two times readings where one is on the day and another one is on the night. Temperature measurements were taken manually during the daily observation period. Figures 7 and 8 will show the temperature readings that have been recorded during daytime and nighttime.

Table 1 Temperature Reading On Day

Time (Minutes)	Set Tempetature (°C)	Current Temperature (°C)	Cooling System Status
0	35	33.5	Off
5	35	34.6	Off
10	35	35	On
15	35	36.6	On
30	35	35.8	On

Table 2 Temperature Reading at Night

Time (Minutes)	Set Tempetature (°C)	Current Temperature (°C)	Cooling System Status
0	35	29.30	Off
5	35	29	Off
10	35	28.2	Off
15	35	27.7	Off
30	35	28.5	Off

b. Safety Measure Sensor Testing

Figure 9 shows the signal reading of the vibration sensor with some scenarios starting from light tapping on the window of the smart coop until strong tapping. This scenario testing shows the sensitivity of the vibration sensor which will turn on the buzzer which will prevent the predators from breaking through the coop. Figure 9 shows the location of the sensor is placed and the indication of the trigger which is made before and after vibration or shock is made. Figure 9 shows that the sensor doesn't trigger the buzzer when there is light tapping, but it will be triggered when there is moderate or strong tapping made by the predator. This sensitivity is ideal for a safety measure sensor because small or light tapping can also be made by the chickens inside the coop since the window is visible inside. Moreover, to prevent the buzzer from being triggered by the chicken inside, this sensitivity suits well. Figure 10 shows the location of the vibration in the coop. When the sensor senses a vibration, the LED light will turn off and will light back if there is no vibration made.

Table 3 Vibration detection sensor testing

Test Scenario	Vibration Detected	Buzzer Activation	Response Time
Light Tapping	Not Detected	Off	Off
Moderate Tapping	Detected	On	Immediate
Strong Tapping	Detected	On	Immediate

Fig.7 Location of the vibration sensor
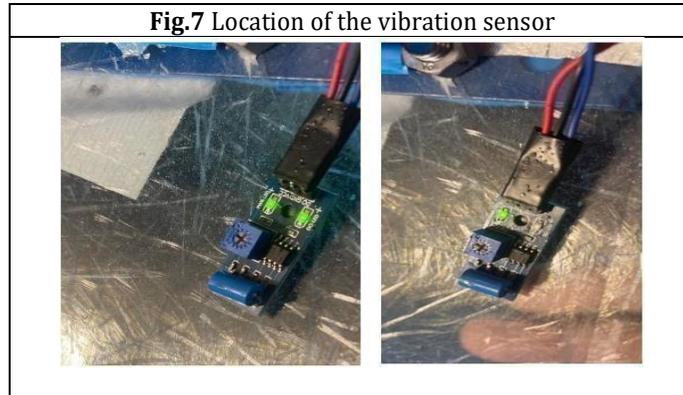
c. RTC Controlled Three Sub-System Testing

The smart coop has three subbed systems which are controlled by the RTC real-time clock. Figure 11 shows the reading of the recorded time of performance for the automatic feeding which consists of supplying water and feed to the chickens. Figure 12 shows the recorded data for the coop cleaning mechanism.

Table 4 Recorded data for the coop feeding system

Time (Hour)	Components	Task	Duration	Result
10:30 Morning	Servo Motor	Open (turn Left) to supply food	3	Expected
	Water pump system 1 (2 water pumps)	Pump out drinking water	5	Expected
12:30 Afternoon	Servo Motor	Open (turn Left) to supply food	3	Expected
	Water pump system 1 (2 water pumps)	Pump out drinking water	5	Moderate
8:30 Night	Servo Motor	Open (turn Left) to supply food	3	Moderate
	Water pump system 1 (2 water pumps)	Pump out drinking water	5	Expected

Table 5 Recorded data for coop cleaning mechanism

Time (Hour)	Components	Task	Duration	Duration (Minutes)	Result
10:30 AM	Water Pump 2	Cleaning the coop	1	5	Bad
			2	15	Moderate
			3	30	Good
12:30 PM	Water Pump 2	Cleaning the coop	1	5	Moderate
			2	15	Moderate
			3	30	Good
8:30 PM	Water Pump 2	Cleaning the coop	1	5	Bad
			2	15	Moderate
			3	30	Moderate

d. Chicken Growth

In this section, Figure 14 shows the chicken growth rate data which has been extracted on a daily observation basis. The table compares four types of chicken with the labels Ayam Kacuk 1, Ayam Kacuk 2, Ayam Daging 1, and Ayam Daging 2. All four chickens are identical, so an indication is needed. Ayam Kacuk is dark in colour compared to AyamDaging which is bright in colour. As an additional indication, a tag has been placed on the leg of Ayam Kacuk2 and Ayam Daging 2. There are two male chickens and two female chickens. As an observation from Figure 14, compared to the other birds, Ayam Kacuk 1 had the greatest average growth rate, at 8.3 grams each day. With 3.53 grams per day of growth, Ayam Daging 2 had the slowest rate. This implies that compared to Ayam Daging chickens, Ayam Kacuk chicks, especially Ayam Kacuk 1, may have more development potential under the same settings. Every chicken had asteady weight gain over the course of the 13 days, suggesting that they were growing healthily. Ayam Kacuk 1 showed the highest weight rise between Days 6 and 13, indicating a potential peak growth period duringthis time. There is an observable variance in growth rates within the same type. As an example, Ayam Daging 1 outgrew Ayam Daging 2, and Ayam Kacuk 1 outgrew Ayam Kacuk 2. This may be the result of individual changes in their environment, metabolism, or even health. Figures 15,16,17, show the growth rate evidence which was taken when extracting the data of the growth.

Table 6 Chicken Growth Rate Data

Chicken Type	Day	Weight (Grams)	Average Growth Rate (Grams Per Day)
Ayam Kacuk 1	1	64	
	6	76	8.3
	13	172	
Ayam Kacuk 2	1	60	
	6	73	6.8
	13	149	
Ayam Daging 1	1	54	
	6	70	6.9
	13	144	
Ayam Daging 2	1	61	
	6	66	3.53
	13	107	

Fig. 8 Growth Rate of Ayam Kacuk 1

Fig.9 Growth Rate of Ayam Kacuk 2

Fig.10 Growth Rate of Ayam Daging

Fig.11 Growth Rate of Ayam Daging 2

4. Conclusion

The development of a system that continuously monitors and regulates the temperature, light, humidity, and food supply for hens, as well as the integration of environmentally friendly features like rainwater collection and air filters, have all been accomplished by the smart chicken coop project. By precisely activating the cooler box, the DHT 22 temperature sensor preserves the ideal environment for the health of the chickens. The buzzer system and vibration sensor work well together to keep predators away from the hens. While the cleaning system is now only moderately efficient because of low water pressure, it will benefit from a high-pressure water pump in future modifications. The automatic feeding and drinking water supply systems operate as intended. Although cleaning requires some physical labor, the general functionality of the coop promotes healthy chicken growth. The coop is appropriateforresidentiallocations because of its carbon air filter-equippedaircirculationsystem, whichefficiently eliminates odors. All things considered, the project's primary objectives have been met, while additional improvements are recommended for better results. The hens' healthy development rates demonstrate the effectiveness of the coop and its possible advantages for poultry production. The DHT 22 is a good sensor for temperature reading but replacing it with a temperature sensor DS18B20 will enhance the project. Not only that, adding in an extra cooling mechanism which is the Peltier will increase the cooling effect which helps to regulate the coop temperature rapidly. Moreover, the Safety measures of this system consist of only one vibration sensor as input and one buzzer as output. In the future with the help of the Blynk app, safety measures can be indicated via mobile which increases the ease of using this coop although the user is far away from the coop. Lastly, The main problem and future recommendations needed from this system is the coop cleaning system. The existing two DC water pumps can be replaced by one high-pressure water pump. In addition, the coop cleaning system can also be added a wiper or brush cleaning mechanism which will increase the cleaning efficiency by 100 percent. Adding tubing to flush out thedirty water to the river will also be an enhanced way.

5.   Acknowledgement

References

[1] Suprianto, D., Pristiyaningrum, E., & Prasetyo, A. (2022). Smart Chicken Coop Ecosystem for Optimal Growth of Broiler Chickens Using Fuzzy on IoT. *Inform: Jurnal Ilmiah Bidang Teknologi Informasi dan Komunikasi*, *7*(1), 16-23.

[2] Murekatete, L., & Hakizimana, J. de D. K. (2023). Contribution of Poultry Farming Products on Farmer's Socio-Economic Well-Being in Rwanda: A Case of Cooperative of Murambi Poultry Farming "COMUPOFA". *Journal of Entrepreneurship & Project Management*, *7*(3), 106–118. https://doi.org/10.53819/81018102t2143

[3] Ute, Skiba., J., Dick., R., Storeton-West., S., Lopez-Fernandez., C., Woods., Sim, Tang., N., vanDijk. (2006). The relationship between NH 3 emissions from a poultry farm and soil NO and N 2 O fluxes from a downwind forest. Biogeosciences, doi: 10.5194/BG-3-375-2006

[4] Franzo, G., Legnardi, M., Faustini, G., Tucciarone, C. M., & Cecchinato, M. (2023). When everything becomes bigger: big data for big poultry production. *Animals*, *13*(11), 1804.

[5] Purnomo, P., Saam, Z., & Nazriati, E. (2016). Analisis Bau Limbah Perternakan Ayam di Pemukiman Terhadap Gangguan Psikosomatik Masyarakat Sekitar Kandang di Desa Sei Lembu Makmur. *Dinamika Lingkungan Indonesia*, *3*(1), 57-63.

[6] "Sri Lanka - One Health Poultry Hub. (2023). One Health Poultry Hub. Retrieved on August 24, 2023, from https://www.onehealthpoultry.org/where-we- work/sri-lanka/

[7] Enriko, I. K. A., Putra, R. A., & Estananto. (2021). Automatic Temperature Control System on Smart Poultry Farm Using PID Method. *Green Intelligent Systems and Applications*, *1*(1), 37–43. https://doi.org/10.53623/gisa.v1i1.40

[8] Syahrorini, S., Rifai, A., Saputra, D. H. R., & Ahfas, A. (2020, June). Design a smart chicken cage based on the Internet of Things. In *IOP Conference Series: Earth and Environmental Science* (Vol. 519, No. 1, p. 012014). IOP Publishing.

[9] Adinegoro, P., Habbani, M. H., Karimah, R. A., & Laksono, Y. A. (2020). The design of a telegram IoT-based chicken coop monitoring and controlling system. *JPSE (Journal of Physical Science and Engineering)*, *5*(2), 56-65.

[10] Ali, M. L., Rahman, M. A., & Taujuddin, N. S. A. M. (2020). Smart Chicken Farm Monitoring System. *Evolution in Electrical and Electronic Engineering*, *1*(1), 317-325.