Smart Chicken Farming: Monitoring System for Temperature, Ammonia Levels, Feed in Chicken Farms

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Abstract. In this study, embedded system technology was implemented in the supervision system of chicken farms. This system works by utilizing sensors that are used to collect data on temperatures, ammonia levels, chicken food in the chicken coop. The method used in this study consisted of three stages. The first stage is a literature study on problems that often occur in chicken farms. The second step is to make observations directly to the farm to get more information. Then proceed with the implementation and testing. The research data were collected through observations and interviews with breeders on chicken farms, Bogor district. The results of the study show that the system can monitor ammonia levels, chicken food weight, and room temperature. The farmer can easily monitor the condition of chicken farms and get SMS notifications on situations that need to be dealt with immediately. The research data were collected through observations and interviews with breeders on chicken farms, Bogor district. The results of the study show that the system can monitor ammonia levels, chicken food weight, and room temperature.

1. Introduction

Businesses in the sector of chicken farming can produce large profits. However, the chicken farming business also has a reasonably high risk, which is evidenced by the number of chicken farming businesses that have been bankrupt due to various constraints [1]. This phenomenon can occur due to many factors, such as financial problems, diseases, errors in managing livestock, and others. The problem factor in chicken farming is often caused by mistakes and negligence in managing and caring for chickens.

The problem is often found comes from all routines in monitoring and controlling poultry farms that are still manually utilizing human labor, where the resources and energy are minimal [2]. On the other hand, demand from consumers for livestock products is increasing day by day and requires more advanced technology to reach optimal efficiency. Factors that are often overlooked are temperature, ammonia, and food in chicken farms. Inappropriate temperature does not support chickens to breed [3]. Similarly, ammonia levels are too high, and the amount of food is inadequate. These factors are the key to running a chicken farm. If a chicken farmer can overcome the problem, the quality and quantity of chickens produced will increase.

One solution is to replace conventional methods by using the latest technology supported by a variety of the latest sensors. This sensor is expected to be able to regulate the temperature of the room inside the farm automatically, monitor ammonia levels in the chicken farm, and notify the farm owner that the animal feed has run out. Thus, the solution to these problems can increase the income of farmers and maintain and improve the quality and quantity of chickens.
and farming. The benefits of this research are expected to produce smart farming prototypes that will facilitate chicken farmers in managing their farms.

2. Method
There are several previous studies related to this project. The first study was conducted by Sneha. M., by integrating wireless sensors and mobile networks to control and monitor the livestock environment. The DHT22 sensor module is used to detect temperature and humidity levels of the air. The result is that all temperature and humidity levels detected by the sensor are displayed on the monitor serial. The next study was carried out by Rupali B. Mahale & S. Sonavane [4], which is implementing a system that can monitor the level of food availability on chicken farms. The results in this study are that the user will receive the user through the GPRS network about the level of food and drinks on the farm [5]. In a different study with Rupali B. et al. integrating the WSN (Wireless Sensor Network) and GPRS (General Packet Radio Service) network to automatically monitor ammonia levels. This research uses the MQ135 sensor. The ammonia threshold is 40% and when the sensor detects this value, the fan will run automatically [6].

The method used in this study consisted of three stages. The first stage is the literature study and analysis of the problems that often occur in the management of chicken farms. The next step is direct observation of the farm to explore further data in order to design a monitoring system. After the analysis and design of the system are done, the steps taken are implementation and testing. The monitoring system that was previously designed will be implemented and tested directly on the farm. After the prototype is complete, a field survey is carried out along with carrying a blueprint of the system that has been designed to discuss directly with the owner of the chicken farm whose chicken farm we will implement.

According to the survey, and interviews conducted in the chicken farm Citadang, Bogor, in May 2019. We do consummation system design using Raspberry PI3 as a server, Load Cell as a measure of the weight of food, DHT22 sensor as temperature and humidity, sensor MQ137 as a detector of ammonia levels, and using Wemos as a sensor regulator microcontroller. The figure below shows the block diagram of this system, which we call Smart Chicken Farming (SCF).

![Smart Chicken Farming Architecture](image.png)

**Figure 1.** Smart chicken farming architecture
The temperature and humidity of livestock rooms are essential factors for chicken survival. Chicken is a homeothermic animal; in other words, the chicken's body temperature is relatively stable, not too influenced by the surrounding environment. This fact is in a certain age of the chicken [7]. However, at the age of 0-5 days, chickens still cannot regulate their body temperature. They can regulate their body temperature optimally since the age of 2 weeks. Therefore, the role of the heater temperature is crucial to maintain the temperature optimal for chickens to grow. The stability of the room temperature will be maintained and monitored through one of the features in SCF, which is an automatic temperature regulator using LPG (Liquefied Petroleum Gas).

| Age (Days) | Temperature (°C) | Humidity (%) |
|------------|------------------|--------------|
| 1          | 32-29            | 60-70        |
| 3          | 30-27            | 60-70        |
| 6          | 28-25            | 60-70        |
| 9          | 27-25            | 60-70        |
| 12         | 26-25            | 60-70        |
| >15        | 24-25            | 60-70        |

The table shows that each age has a different optimal temperature. Therefore, the role of the heater temperature is crucial to maintain the temperature optimal for chickens to grow. Automatic Cage Heater serves to regulate the temperature on the farm so that it is always optimal and stable. If the temperature on the farm is getting cold, the temperature regulator will regulate the heater to issue a higher temperature by turning the valve so that more gas comes out so that the fire generated by the heater will be more significant. If the temperature at the farm is too hot, then the temperature regulator will regulate the heater to not be too hot by turning off the valve lever instead so that the fire generated by the heater will be minimized. Furthermore, the temperature controller will send information about the room temperature and heating status to the farm owner with a Bluetooth connection, which can be accessed by the farm owner using the web application provided.

The ammonia odor is one of the pungent odors found in farms that are sourced from chicken manure and dead chickens that can cause harmful effects for chickens [8]. In the SCF system, one of the features is detecting ammonia levels found in the farm environment. Ammonia detection feature is created by using a sensor MQ-137, which can detect specific levels of ammonia in the air [9].

With this feature, the ammonia level will be monitored by the user. When the ammonia level is at a high level that has a bad influence on chickens and the surrounding environment, then the user will get a notification immediately clean the livestock, to remove chicken manure and dead chicken carcasses also spray cleaning fluid. Ammonia levels can endanger chicken production at certain levels. In table 2 shows the levels of ammonia, which can affect the health of chickens [10].
Table 2. Ammonia levels and its effects on chicken

| Ammonia (ppm) | Smelled         | Egg production effect | Weight loss effect |
|---------------|-----------------|-----------------------|--------------------|
| 20-25         | Began to smell  | No                    | No                 |
| 25-30         | Smells          | Slight                | Slight             |
| 50-60         | Strong smell    | Yes (+)               | Yes (+)            |
| 100           | Nasal irritation| Yes (+++)             | Yes (++)           |
| 200           | Eye irritation  | Yes (+++)             | Yes (+++)          |

In the table above, yes (+) means it has a mild effect, and more signs (+) indicate that it has a more severe effect on chickens. Based on the information from the table, we can see that ammonia levels have a quite severe influence on chicken farming, which can affect the health, quality, and yield of chicken production.

Ammonia detector works by taking all the data detected by the MQ137 sensor and then displays the amount of ammonia detected on the web. When the sensor detects ammonia levels greater than or equal to 25 ppm, the photometer display on web monitoring is green. At levels greater than 25 ppm and smaller than 50 ppm, the photometer display on web monitoring is yellow. Moreover, at levels higher than 50 ppm, the display of the photometer on the web is red, and the notification of the cage writing must be cleaned. The system will also send an SMS to the user via the SMS gateway as a warning that the enclosure must be cleaned.

To get healthy and fat chickens, the chicken needs to eat regularly and not lack food sources. For this reason, food supply in chicken farms is one of the critical factors that influence the growth and development of broilers, because if the food supply is not maintained its presence, then chicken growth will automatically be disrupted.

The Food Indicator functions to monitor the chicken food stock in the chicken food container. If the food stock at the food container is almost depleted, the device will issue a sound and warning light indicator, so that the farm owner can refill the chicken food container as soon as possible.

The chicken food monitoring system works in a way, each chicken food container is given a weighing sensor, so if the weight of the chicken food container is below the standard limit for the food weight needed, the chicken food monitoring system know that the food in the livestock is almost depleted and needs to be refilled. Besides, farm owners can also find out or access information about the weight and leftovers in each chicken-eating place through the application provided.

Food indicators work by utilizing a loadcell sensor to find out the rest of the chicken food supply. The food indicator system will work by weighing the weight of the food supply using loadcell, then the scales from the loadcell received by the microcontroller, then the microcontroller sends the scales to the server.

After the data is obtained and sent to the server, the server will process the data. If the food supply per dose is above 7 kg, the web will display the results of the scales in red graphs because, according to interviews and field surveys, this value is considered too excessive so that the potential for food scattered or decaying. If the food supply is available between 3 to 7 kg, the web will display the results of the scales with a green graph showing an adequate amount of food. If the food is less than 3 kg, then the web will display the results of the scales with a red graph, and the system will send an SMS warning to farmers that the food supply is about to run out.
3. Results and discussion

When we are implementing the SCF system, the first thing to do is connecting the food indicator system with the food supply tank, after that the weight calibration is done before the system is connected to the server, so that the scales data obtained are precise and accurate. After the calibration process is complete, the food indicator is linked to web monitoring. Furthermore, checking on web monitoring is done to check whether the data from the scales send to the server and has been displayed correctly.

Based on the results of testing the data, the results of the scales entered correctly. Besides that the weight color indicator displayed on the web can appear and change entirely according to the weight of the remaining feed at that time. After that, it is done adding weight and reducing the weight of the food tank. The changes are recorded in real-time and displayed on the monitoring web. An SMS gateway test is also performed whether it can send SMS messages if the food size is less than 3 kg. The result, SMS notifications can be sent in real-time properly.

At the time of conducting experiments at the chicken farm location. The first day is done by recording the temperature conditions at the farm for one full day (24 hours) nonstop. The sensor then sends data once every 60 seconds to the database to be stored and processed. From so much data, the average temperature is made every hour. This condition is hazardous for the condition of the chicks, which if it is too cold, will cause the chicks to shiver and die slowly. Therefore, SMF designs a feature that is used to control temperature conditions to make it more stable and not change drastically. After the system is implemented, the same method is used again by measuring for one full day the condition of the cage temperature. The table below shows a comparison of the temperature in the livestock before and after SMF was implemented.

| Time       | Temperature Without SCF (°C) | Temperature With SCF (°C) | Ammonia levels (ppm) |
|------------|-----------------------------|---------------------------|----------------------|
| 00:00 - 04:00 | 19,94                       | 30,34                     | 9,40                 |
| 04:00 - 08:00 | 20,81                       | 30,91                     | 17,79                |
| 08:00 - 12:00 | 26,59                       | 29,80                     | 25,26                |
| 12:00 - 16:00 | 27,71                       | 29,83                     | 24,21                |
| 16:00 - 20:00 | 25,01                       | 30,77                     | 26,33                |
| 20:00 - 24:00 | 20,72                       | 29,97                     | 39,43                |

Table 3 shows that the temperature can be controlled after SCF implemented. This because we are using the Fuzzy logic algorithm in SCF. Fuzzy logic will control the rotation of the heater fuel valve based on the temperature. If the temperature is cold, it will open, while when the temperature is hot, it will shrink or do nothing. Thus, the Automatic Cage Heater feature in SCF successfully control the temperature according to the conditions desired by farmers.

In the implementation that we do directly on farms, this tool works well and detects ammonia levels found in farms. In this implementation, we set the sensor to send data on ammonia levels every 1 hour. From the data in table 3, changes in ammonia gas levels continue to increase in the night. This phenomenon is caused because while sleeping, and more chicken poops, and it is increasingly piling up. To prevent ammonia levels in the livestock, we previously proposed a solution that is to turn on the fan when the ammonia level is at a dangerous level. However, from the testing results of removing ammonia levels, using a fan is not significant. Therefore,
we propose a solution that is when ammonia levels are at a dangerous level, the system will send an SMS to the user. This SMS contains information about ammonia levels have reached dangerous levels and must immediately clean the chicken coop.

4. Conclusion
The conclusion from the tests carried out that the system made has run well. Farmers will find it easier to monitor and maintain chickens. From the results of the implementation that has been carried out, it can be seen with the Automatic Cage Heater; the temperature conditions can be adequately maintained and close to the ideal temperature. This circumstance is beneficial for farmers, especially farmers, who have a huge cage to monitor the temperature conditions. With the food indicator system in chicken farms, farmers can monitor and know the state of the food supply just by accessing the web, and if the food supply is almost gone, the farmer will be reminded via SMS sent directly to them. Finally, in the implementation of Ammonia Detector in chicken farms, farmers can see how much ammonia gas levels in the farm. Besides, with the detection of ammonia levels, farmers can reduce the danger of diseases originating from ammonia gas so that the chickens produced have good quality and healthy.

From our research, there are several suggestions for further research, like adding sensors like CCTV and motion detection sensors. To prevent chickens from being stolen or eaten by wild animals and to develop an IoT-based Smart Chicken system so users can control their farms from anywhere and anytime.

5. References

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