

MOBILE-BASED APP FOR MONITORING AND CONTROLLING LAYING HENS' PRODUCTIVITY

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Abstract

Eggs are one of the primary animal protein sources widely consumed in Indonesia. According to data from the Ministry of Agriculture of the Republic of Indonesia, the number of eggs consumed in Indonesia reaches 21.10 kg per capita/year. That high number is attributed to the affordability and accessibility of egg. Therefore, laying hen farmers as the primary supplier of eggs, have a crucial role in maintaining the productivity of their hens. This is because productivity significantly impacts the quantity of eggs produced. There are various factors that can influence the productivity of laying hens including their feed and water consumption as well as the environmental conditions of the coop. This research focuses on developing a system for monitoring and controlling those productivity factors using an Android-based application. The mobile app was developed using Flutter framework and being integrated with installed sensor system in the coop. The system has many features including to monitor the water quality through pH levels and turbidity measurement, an automated feeding control, and environmental monitoring by tracking ammonia level, temperature and air humidity. The result of the functionality has been tested using Black-box method and the result achieved 100% operational capability. The result shows that this mobile app can support farmer to ensure the productivity of their hens.

Keywords: Controlling, Laying Hens, Mobile Apps, Monitoring, Productivity

INTRODUCTION

Eggs are one of the sources of protein that is widely consumed by Indonesians. According to data from the Ministry of Agriculture, the average consumption of laying hens' eggs in Indonesia reached 21.10 kg/capita/year as of November 2023 (Ministry of Agriculture of the Republic of Indonesia, 2023). This high level of consumption is driven by the fact that eggs are a nutritious, affordable, and easily accessible food. Because of those primacies, eggs have always been on high demand in the Indonesians markets. The growing demand for eggs requires the laying hen's farmer to focus on maintaining the productivity of their laying hens.

Productivity refers to a condition where laying hens can produce eggs at a high rate (Satriawan, 2022). There are various factors that influence the productivity levels of laying hens. The factors include nutrition, through food and drinking water, and the environmental condition of the coops. Laying hens need to be fed at least twice daily, in the morning and evening. However, overfeeding can also cause fat accumulation, which can reduce egg production (Taufiq Hidayat, 2024). Aside from proper feeding, the quality of drinking water also significantly impacts productivity levels, because water plays a crucial role in maintaining laying hen's biological functions, such as digestion and growth (Yulianti *et al.*, 2024). One of the parameters of qualified drinking water is it should have a pH level in the range of 6.5-8 (Hasanah, 2024). Moreover, the environmental conditions of the coops, such as air temperature, humidity, and the ammonia level, also play a crucial role in ensuring the laying hen's productivity. The ideal air temperature should remain between 18-28°C (Arif Maulana *et al.*, 2021), because high temperatures can cause heat stress impairing the hens' capacity

to sustain egg production. Additionally, air humidity levels should be maintained between 67-88% (Luthfi *et al.*, 2020) since the higher humidity levels can exacerbate the effects of heat and further impact the hens' comfort in their productivity. The cumulated laying hens' excreta in the coop can lead to elevated ammonia levels, creating a significant risk to both hens and farmers. Ammonia concentration exceeding 20ppm (Susilo & David, 2023) can potentially lead to severe health complications and, in extreme cases, mortality.

To maintain those factors within ideal limits, the implementation of application become as the primary result for farmers to have easier managerialism. The extensive research has been conducted in digital technologies to simplify the process in the application. The application also developed using the Flutter framework. The application uses an integrated IoT-based system and Android-based applications that connected to the internet. The system can help farmers as the users to monitor and control various factors that influence the productivity of laying hens, and with this system, it can provide monitoring of drinking water quality, controlling feeder, and supervision of environmental conditions within the coop, in the real-time.

LITERATURE REVIEW

Laying Hens

Laying hens are a type of chicken that is specifically raised to produce eggs. These hens generally classified into 2 types with their own characteristic. First is the light type which is known for its white and slender feathers. This type of hens is specialized for produce eggs only. Meanwhile, the second type is medium type or called dual-purpose hens, with brown feathers and medium body size. This medium type can be sold as broiler chicken after reaching their culling phase (Basri *et al.*, 2022).

The laying hens' life cycle is divided into 3 phases, namely the starter or brooder phase which starts at the age of 1-8 weeks, the grower phase which starts at the age of 9-13 weeks, and the layer or finishing phase when the hens reach peak its productivity and begin to lay eggs. Following the layer phase, the productivity of laying hens will slowly decrease until the chicken is culled (Tarman *et al.*, 2021).

Prototyping Method

Prototyping is one of the software development methods that consist of 5 phases, there are communication, quick plan, modelling quick design, construction of prototype, development, delivery and feedback.

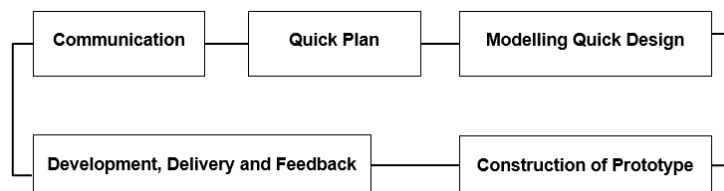


Figure 1. Prototyping method

The implementation of this method begins with the communication phase, where the information is gathered through interviews or observations. Then, the quick plan phase, which is the phase of designing the solution for the users' problems. The next phase is modelling quick design,

this phase created a high-fidelity design as a foundation for the software development. Then, move to construction of prototype phase, when the development of the application begins. The final phase is development, delivery, and feedback phase that involve a test for the entire developed systems to the end users and ensure that is suits the user needs.

This method has advantages because it suitable for research that has a relatively short period of time in order to facilitate the further development process. In addition, this method is also suitable for partner-based research because it is designed to always adjust the results according to the needs of the end users (Wahyudin & Rahayu, 2020).

RESEARCH METHOD

Communication

In the first phase, interviews with farmers, as an end-users, and observations at the coop were conducted to identify their main problems. The result of this phase concluded that the maintenance management process was still carried out manually by the farmers. This kind of management required more time and energy due to their large coops.

Quick Plan

After identifying the main problem, the next phase is focused on planning an effective solution to address the issue. The solution idea is to use the implementation of a mobile-based application as a tool for monitoring and controlling the coop's management process.

Modelling Quick Design

Based on the proposed solution, the next phase is designing the mobile application. This phase began with creating a wireframe design, followed by designing the high-fidelity design using Figma as the design tools.

Construction of Prototype

During this phase, the mobile-based application is developed using Framework Flutter, and created based on the approved design. The outcome of this phase is a functional mobile-based application that integrated with IoT devices.

Development, Delivery and Feedback

In this final phase, testing is conducted on the developed app with the end users. During this process, their feedback is gathered and serves as the basis for improvement, ensuring the final product align with users' requirements.

RESULTS AND DISCUSSION

Application Development Result

The development of the application, as a tool for monitoring and controlling the productivity factor of laying hens, includes five main features,

a. Home Page



Figure 9. Home page

This is the initial page when users open the application. It provides real-time information about the current quality of drinking water and the condition of the poultry coops.

b. Feeding and Setting Schedule Page

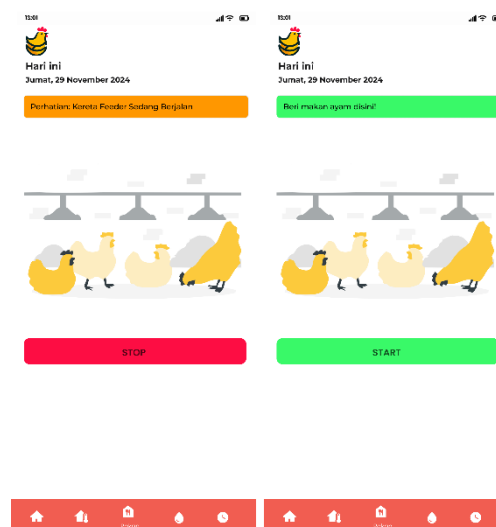


Figure 10. Feeding page

Feeding page allow users to control the feeding process for the laying hens by only pressing the “Start” button. This action will activate the feeder in the coops to dispensed foods into the containers. To stop this feeding process, users only need to press the “Stop” button. This page is used when users want to feed their hens outside the scheduled times that have been set in the app.

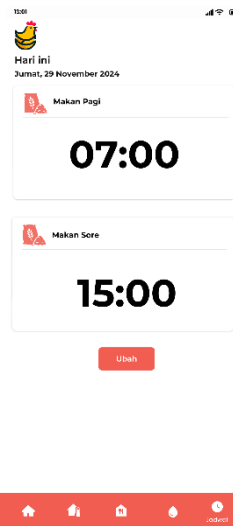


Figure 11. Setting schedule page

This schedule page allows users to set the feeding schedule by selecting a specific time. Once the users have set feeding time here, the feeder in the coops will automatically dispense the foods into the container based on the set schedule. This feature helps users to simplify feed management process to be more efficient.

c. Drinking Water Monitoring Page



Figure 12. Drinking water monitoring page

This page provides real-time information about the quality of drinking water, including the pH levels and turbidity. These details help users to determine when the water need to be replaced. Apart

from that, this page also informed the amount of water left in the container and notify the users when it is time to refill the water container.

d. Coops Monitoring Page



Figure 13. Coops monitoring page

The last page is for monitoring the coop's poultry condition. This page provides information about ammonia levels, humidity, and air temperature in real-time. The color indicator on this page will turn red if the indicators exceed their ideal range.

Application Test

The developed mobile application needs to be tested to verify all the features operated by the users needs. Table 1 provides the result of the functionality testing of the application.

Table 1. Functionality testing

No	Features	Test Case	Expected Result
1.	Home Page	Information Box	Showing real-time data of all indicators and date, time
2.	Feeding Page	Start Button	Activate feeder
		Stop Button	Stopping feeder
3.	Schedule Page	Time Setting	Adjust automation feeding schedule in morning and evening
4.	Monitoring Coops Page	Ammonia Levels	Displaying real-time information of ammonia level in the coop
		Air Temperature	Displaying real-time information of air temperature in the coop
		Air Humidity	Displaying real-time information of air humidity in the coop
	Monitoring	pH Levels	Displaying pH levels of drinking water
5.	Drinking Water Page	Turbidity Levels	Displaying turbidity levels of drinking water
		Water Amount	Displaying remaining water volume in the container

Based on the testing result, all the features within the application functioned as intended. This outcome indicates that the application successfully met the user requirements and ready for practical use.

CONCLUSION

The development of monitoring and controlling the productivity of laying hens is successfully built throughout the prototyping method. The development goes through 5 phases including communication, quick plan, modeling quick design, construction of prototype and final development, delivery, and feedback. After going through these five stages, the result was a mobile-based application that was built with the Flutter framework and had 4 main functions. These four functions include monitoring drinking water quality with pH level parameters and water turbidity, automatic feeding control, and monitoring environmental conditions in the cage with parameters of ammonia level, temperature, and air humidity. The developed apps are then tested for functionality to ensure the product meets the user's requirements. The testing result is all the features 100% function as expected.

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