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Mobile Application for Data Acquisition in Livestock Farming Systems: Case Study of Goat Farming in East Java Indonesia

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Abstract

The lack of real data availability in the agricultural sector, especially in the livestock sub-sector, has the potential and opportunities for optimal data processing. Stakeholders in agriculture require accurate field data to minimize costs and save time for profit maximization. This study aims to enrich and record livestock goat data with the help of an application that will assist in the managerial process so that the data collected can be analyzed and used by stakeholders for fast and precise decision-making. The application was created using the prototyping method for both mobile and web platforms. The application prototype was evaluated on functionality testing using a black box method, which resulted in a success in application tests. The application successfully performed real-data recording on the Android platform, offered a user-friendly display of goat information, and enabled documentation of goat livestock data on the website. This study contributes to current research by making data recordings of goats using an Android application for farmers and stakeholders. This tool provides significant benefits by delivering real-time data, enhancing decision-making processes, and offering insights that could lead to increased profitability and strategic planning for future business endeavors.

I. INTRODUCTION

The advent of Industry 4.0 has revolutionized industrial production, including agriculture, by integrating advanced frameworks, technologies, and applications. This transformation has given rise to the concept of smart farming, which is recognized for its data management, analytical prowess, and decision support systems. These capabilities facilitate precise predictions and comprehensive reporting, thereby enhancing certainty in agricultural practices [1]. Effective analysis and management lead to expedited and more precise decision-making in agriculture. The availability of well-managed agricultural data will be the foundation for building precision agricultural management. The development and accessibility of structured, real-time data are crucial for sustaining agricultural data systems [2]. This necessitates reliable and accurate data from not only internal sources, but also external sources to support agricultural activities.

While agricultural data is regularly collected in Indonesia, the challenge often lies in the accuracy of such data, which comes from a variety of sources and may not represent actual field data. Variability in collection methods further necessitates expert interpretation. Real, field-based data is particularly challenging to obtain, as many farmers carry out their agricultural management based on experience rather than systematic data management. This gap in reliable data, especially within the livestock sub-sector, presents an opportunity for optimization. The quality and reliability of the data collected by farmers, and the analysis derived from it depends on the quality of the data being collected, stored, and processed [3].

The livestock industry, including the demand for products such as meat, is a potential business with significant potential for increasing income [4]. In Indonesia, the goat population, while not large, has a crucial role as a meat provider and contributes to the national supply. Goat farming is a vital component of the rural agriculture economy, offering economic support through meat and milk production, which in turn satisfies nutritional requirements by providing animal protein.

The goat farming industry involves various stakeholders ranging from producers, such as farmers, to consumers. This includes intermediaries like collectors, butchers, and livestock brokers. For these stakeholders, access to accurate, field-based data is critical for reducing costs and time needed to maximize profits. Therefore, a continuous exchange of information will be very beneficial to produce high-quality information that support the production of superior quality livestock products.

This study aims to enrich and record goat farming data with the help of an application that will assist in the managerial process so that the data collected can be analyzed and used by stakeholders for precise decision-making. Specifically, this study seeks to answer two research questions: (1) How can information systems assist in recording the data characteristics of goat livestock needed in farm management? and (2) How to design a smart farming application as a solution for providing reliable data to the stakeholders?

The application prototype was validated by using the black box on functionality testing, which has been proven effective in most application tests. The advantages include the fact that testers do not need programming expertise, testing is done from the user's perspective, it helps identify inconsistencies in the requirements specification, and it facilitates collaboration between developer and testers. This study contributes to current research by providing a practical tool: an Android application for farmers and stakeholders to record goat farming data. This tool provides a significant benefit to users by offering immediate access to actual data, thus greatly reduces the time for decision-making process and enabling stakeholders to optimize profits and strategize for the future business. The anticipated outcome of this study is to assist farmers in recording daily data accurately and quickly, thereby improving their analytical skills and decision-making capabilities.

II. LITERATURE REVIEW

This section discusses basic terminology and processes regarding Smart Farming, such as information systems and technologies used in goat farming.

A. Information System

As advanced information systems and Internet technologies are adopted in Agriculture 4.0, a vast amount of farming data, such as meteorological information, soil conditions, marketing demands, and land uses, can be collected, analyzed, and processed to assist farmers in making appropriate decisions and increasing profitability. Therefore, agricultural decision support systems for Agriculture 4.0 have become a very attractive topic for the research community [5]. In other words, these systems are designed to collect and analyze data, and then provide recommendations and actionable insights. They deliver accurate and timely information on agricultural production and market trends while also offering features for feedback and online discussion [6]. Users can upload data for storage, analysis, processing, and receive feedback based on pre-set decision-making rules [7]. In addition, these systems can perform advanced data analysis and mining by integrating big data technologies. In the research of Rupnik, decision support systems are designed to integrate with existing farm management information system, enabling farmers to upload their own data, utilize several data analysis methods, and retrieve output [8]. Many platforms offer a suite of functions such as equipment management, data query, visualization, warning, push information, and other functions, which are accessible via web interfaces or mobile applications [9].

B. Smart Farming Technologies

The Smart Farming system is designed to manage farming process through the adoption and application of precision farming technologies. It uses knowledge bases and multiagent technologies to develop coordinated decisions on the real-time distribution, planning, optimization, and control of agricultural resources [10].

Smart farming technologies incorporate advanced technologies such as cloud computing, sensors, data warehouse, and big data to capture and store the received information from the user. Several studies have linked these technologies to agriculture, highlighting their contributions to providing up-to-date data, enhancing performance, ensuring data availability, and delivering predictive insights that support tactical decision-making [11]. Astill's research explained the necessity of using smart poultry management systems to increase production while reducing costs resource utilization. The technologies used such as smart sensors, farm process automation, and data driven decision platforms [12]. Jinbo discussed how cloud platform provides a convenient interface for the sensing device, allowing users to send the collected data to the cloud platform [13]. The data can be used for further analysis and visualization using smartphone websites or smartphone applications [14]. MySQL databases can be used to access the data stored in the database. Besides that, the data stored in the database were fetched and presented as a website that can be viewed using a personal computer, laptop, or mobile phone. On this website, the status of the movement of the goat population can be monitored [15]. A new concept of smart farming based on the use of the mobile application is based on integrating individual animal data to optimize decision-making processed directly from a smartphone.

In the research of Belanche he highlighted how farm management can be improved through the use of tools with smart phone terminals [16]. Android applications designed for farm management can focus on a comprehensive system technology solution. The key objective of the Android applications in this category is to enable farmers as users, to manage their farm resources and activities more efficiently and meritoriously to attain their objectives. For example, with such applications, farmers can track their livestock population size, identify the number of productive animals, and monitor daily production – all of which are the key to maximizing profit.

C. Research Stages

This study proposes an application that farmers and other stakeholders can use to collect real data on goat farming. Prototyping is identified as the best software development method for developing mobile applications when the information has a general purpose without identifying the detailed functions and features required [17]. The development of prototypes and proposed models is also done in parallel and in accordance with the needs of the farmers. The research stages can be seen in Figure 1.

The first step is to identify the requirements and analysis according to the information given by farmers and stakeholders, and then the prototype application is designed and modeled to record goat data. Next, the prototype is built using the Flutter code. From the results, the prototype is tested and evaluated using the black box method, and if successful, the mobile application is deployed.

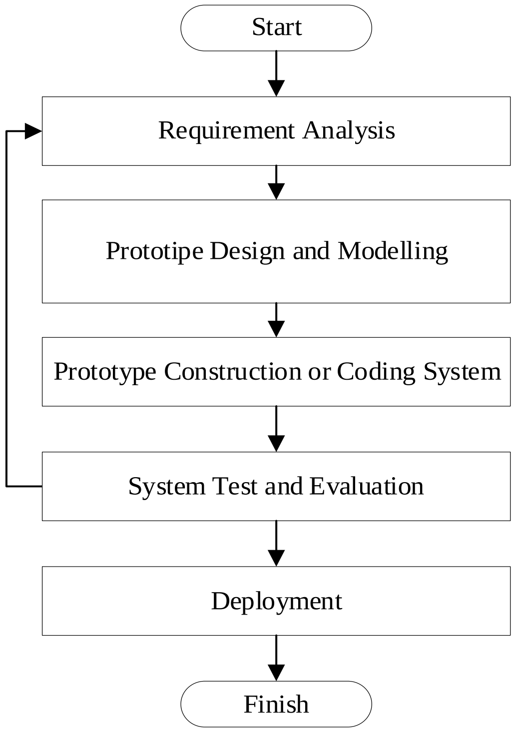


Figure 1. Research stages.

III. TESTING AND ANALYSIS

Finding bugs or errors in the operating procedures of an application is interpreted as the aim of software testing. Software testing involves using computer programs to execute procedures and compare actual behavior, which is expected to make a high-quality application [18]. Software testing is essential to repeatedly check for errors in the application to reduce the existing number of errors. Therefore, the ability of a program runs well and the application is in accordance with the expected results.

A. Test Case Scenario

Test cases were created for testing the mobile application using the black box method. Table 1 shows the test cases and the expected results or results that should appear in the mobile application. The test case contains a design for checking whether the mobile application is following the desired needs or needs to be revised.

Table 1
Test Case Scenario

Test	Test Scenario	Expected Results
Sign in	Entering a username and password	An error message showing the inability to login
	Entering the username and password in the database	A user enters the main page
Home	Displaying home with brief information	Displaying information on goat total population data, partners involved, and data on distribution and production
Unit	Displaying menu and adding data on milk production, milk distribution, goat livestock production, and goat livestock distribution	Adding data on milk production, milk distribution, livestock production, and livestock distribution and displaying recorded data.
Partner	Displaying the menu of partners and adding data on farmer partners, business partners, and collector partners and displaying recording data.	Adding data on farmers' partners, business partners, and collectors' partners and displaying recorded data
Farmers	Displaying menu and add data on population, feed, incoming livestock, outgoing livestock, and birth and death data on livestock from farmers.	Adding data on population, feeding history, incoming livestock, outgoing livestock, and birth and death data on livestock, and displaying recorded data.

B. Blackbox Testing

Black box testing is a software testing technique that focuses on specifying external functions of the software being developed. Black box testing tends to find several things, such as incorrect or non-existent functionality, database errors, data structure errors, data access errors, interface errors, user errors, performance errors, and initialization and termination errors [19]. The black box testing method does not have to pay attention to the details of the software. Testing the amount of test data can be calculated from the number of input data fields, the input rules that must be met, and the input limits that meet specifications. Using the black box method, the experiment was carried out several times until the appropriate results were obtained. This research uses black box using equivalence partition method. It can be used to partition the input domain into data classes so that the result of the case test can be obtained.

IV. RESULT AND DISCUSSION

The development of the mobile application started in September 2022 using the Prototyping method, which was modified according to system requirements. The development activities were divided into six stages, which include the analysis of users' needs, rapid design and modeling, construction with Flutter code, delivery for evaluating the mobile application prototypes, feedback from farmers on the modifications to improve the required specifications, and the usage of the prototypes for further development.

A. User Needs Analysis

The needs assessment was conducted throughout the system through the review of previous research and focus group discussions with stakeholders, focusing on the parameters needed to collect data on population size, distribution, and production of goats. Stakeholders include farmers, units, and livestock agencies in East Java Province. Their responses indicated the need for a goat data collection or recording system through websites and mobile devices that can record real data.

Therefore, this research focuses on developing mobile applications and websites to collect or record real data about the population, production, and distribution of livestock goats and partners involved in the business process. It was found that there were similar applications but did not record real data according to field observations. Based on the result of the core questions in FGDs listed in

Table 2, Stakeholders want a process for data acquisition that produces a consistent format and parameters that are based on field conditions. Therefore, the development of mobile applications and websites has an urgency to support livestock management.

Table 2
FGD Questionnaire with stakeholders

Questions	Answers
What goat livestock data is required to be managed?	Data on population, production especially milk and meat, and its distribution.
In goat population, what data is needed?	Sex, breed, age, commodity and number of goat livestock
Why do you need those goat population data?	To determine direction of livestock development, current conditions, future harvest goals, and necessary cost.
In goat production, for example goat milk, what data is required?	Milk quantity, price, demand, and origin
Why do you need those goat milk production data?	To determine the quality of milk when received from farmers, avoid cheating and maintain the quality of the milk (in stock).

B. Prototype design and Modelling

This stage uses design and modeling tools such as Unified Modelling Language (UML) to describe the business processes using a use case diagram. The use case diagrams will connect the user involved and the system. In contrast, the system function process flow was described using activity diagrams to determine the functions of the proposed application based on the user needs, as shown in Figure 2 and Figure 3.

Figure 2 highlights the roles of various users within the application. The 'Unit' is the primary user who will enter data into the application, including livestock, population and partner recording. The 'Admin' acts as a regulator, overseeing the registration of units, control and manages data entry process and checks to validate the data submitted by the Unit. 'Stakeholders' are actors who can use goat livestock data for decision support, such as Breeders' Association (HPDKI), veterinarians, and other government or non-government agencies. The 'Super admin' is an actor who plays a role in managing and controlling the whole process starting from data input, checking, granting user access rights, and managing system activities.

In Figure 3, the activity diagram for the 'Home' section shows that users must log in with their specific access rights. Upon successful log in, the application's main page displays a snapshot of the number of goat livestock, farmers, and partners. A filter option allows user to select a month and year to view detailed information on the number of goat livestock, production, and distribution.

C. Coding System or Functionality

This stage of development involved coding the PUSKA application, an Android-based mobile app, guided by the information obtained from stakeholder consultations, which informed the user requirements, prototype design and modeling. Created using Flutter for the mobile interface and PHP-Postgres for backend services, the application is divided into two parts, namely a web-based management panel for administrative tasks and Android-based applications for on-the-go use by farmers. It is based on a client-server with farmers as Android application users. At the same time, the server receives data and imports displays to the web directly connected to the database from mobile devices. Display of mobile applications is presented in Figure 4 and Figure 5.

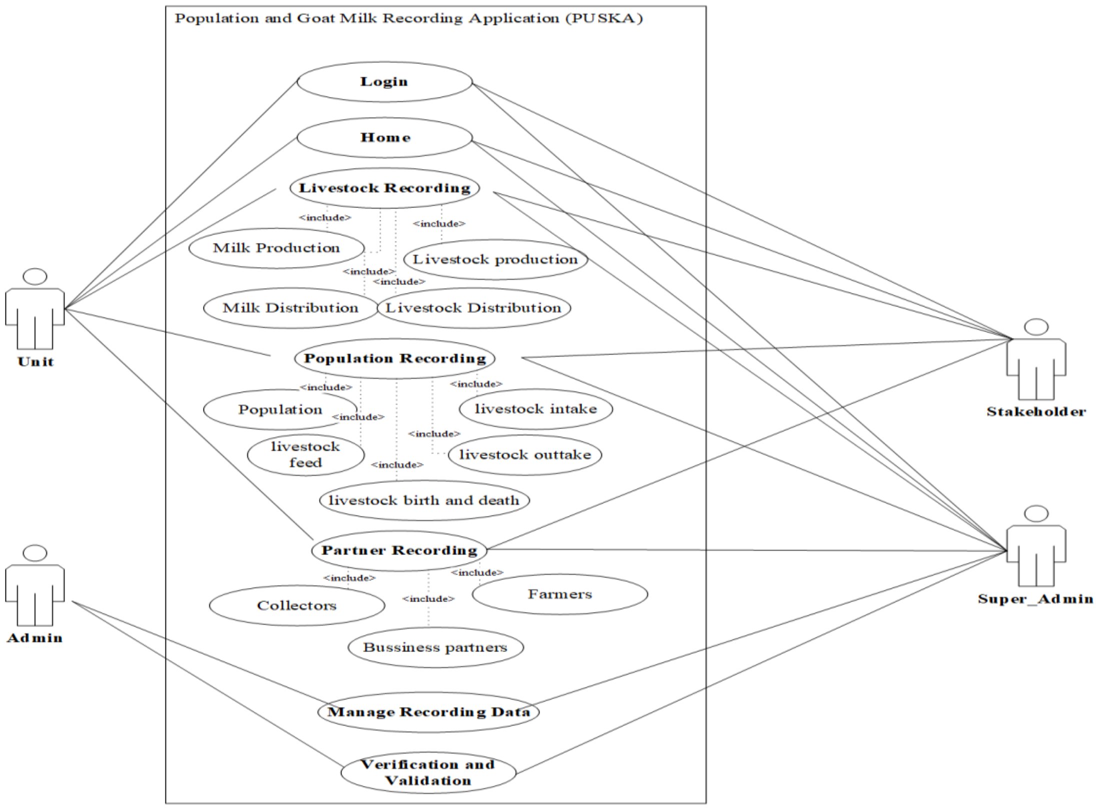


Figure 2 Use case diagram for PUSKA application

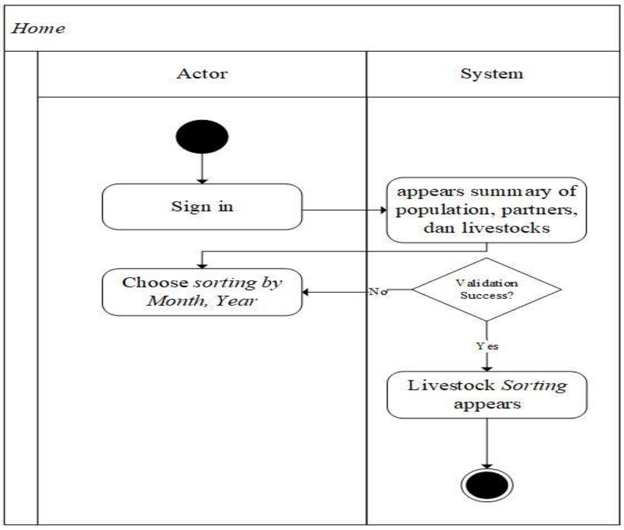
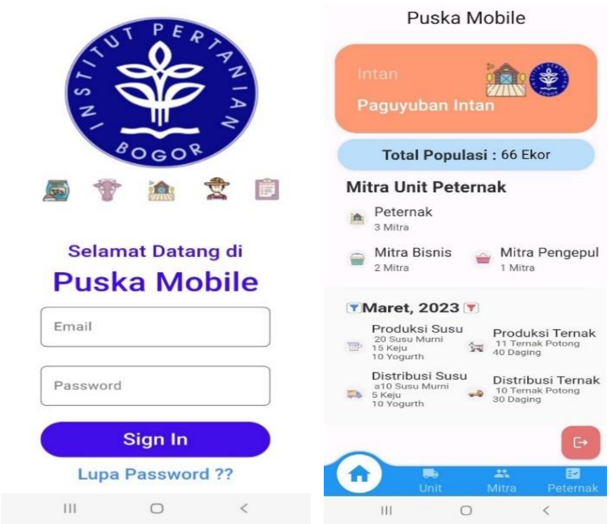
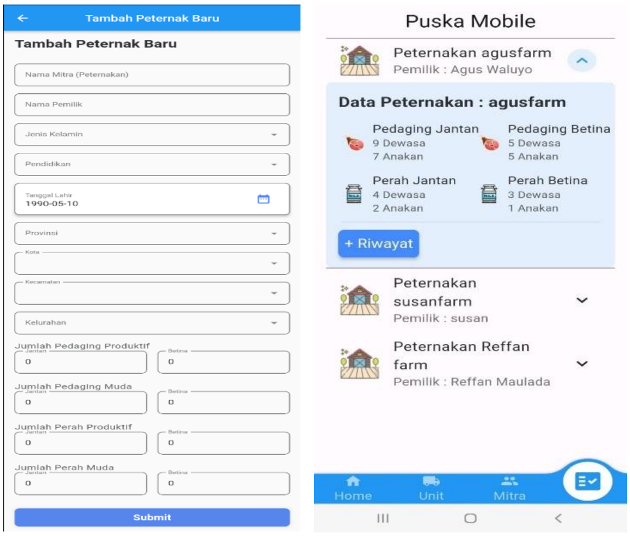


Figure 3 Activity diagram of Home in PUSKA application



(a) (b)

Figure 4 Application display: (a) login page, (b) main page



(a) (b)

Figure 5 Application display; (a) add/edit farmers data page, (b) farmers data with goat summary and history

D. System Testing, Evaluation, and Usage or Release

The system underwent testing and evaluation through Black Box testing using equivalence partition method, focusing on the functionality of the mobile application as the test scenario, this testing aimed to assess whether the system's functions operate according to the requirements. The test scenarios and test results are presented in Table 3 and Table 4.

For usability test, 40 respondents from the East Java farming community, including farmers, unit operators and other stakeholders were asked to complete a user experience survey. From this group, 12 respondents who were accustomed to using Android apps were chosen to engage directly with the PUSKA application. This user involvement was critical to gather genuine feedback on their experiences with the apps. Responses were measured using a Likert Scale, offering five graded response option for each statement or question, enabling the respondents to indicate the degree of their opinions, attitudes, or behavior. Respondents will choose the option that best matches their feelings about the statement or question. The questionnaire was also used to gain insight and measure aspects of user experiences as perceived by the farmers and stakeholders.

Table 3
Functional Test

Code	Test	Scenario	Expected Results
T01	Sign in	Entering a username and password	An error message showing the inability to login
		Entering the username and password in the database	A user enters the main page.
T02	Home	Displaying home with brief information	Displaying information on goat total population data, partners involved, and data on distribution and production
T03	Unit	Displaying menu and adding data on milk production, milk distribution, goat livestock production, and goat livestock distribution	Adding data on milk production, milk distribution, livestock production, and livestock distribution and displaying recorded data.
T04	Partner	Displaying the menu of partners and adding data on farmer partners, business partners, and collector partners and displaying recording data.	Adding data on farmers' partners, business partners, and collectors' partners and displaying recorded data
T05	Farmers	Displaying menu and add data on population, feed, incoming livestock, outgoing livestock, and birth and death data on livestock from farmers.	Adding data on population, feeding history, incoming livestock, outgoing livestock, and birth and death data on livestock, as well as displaying recorded data.

Testing is performed on several main views of PUSKA application based on the design of the test case instrument. Testing is performed up to 5 test data with codes T01-T05.

The obtained results are coded P01-P05. These results indicate that the PUSKA application worked as expected.

Table 4
Black box Testing Result

Code	Test	Expected Result	Results
P01	User types email and password	An error message showing the inability to login if wrong password is entered	
P02	Home will display brief information and filter data by month and year	Displaying home with brief information	
P03	Unit will display four sub menus on milk production, milk distribution , livestock production, and livestock distribution	Adding data on milk production, milk distribution, livestock production, and livestock distribution and displaying recorded data.	
P04	Partner will display three sub menus on farmers, business partners, and collectors	Adding data on farmers' partners, business partners, and collectors' partners and displaying recorded data	
P05	Farmers will display farmers that has been recorded and its history	Adding data on population, feeding history, incoming livestock, outgoing livestock, and birth and death data on livestock, as well as displaying recorded data.	

For user experience [20], some questions are based on the overall attractiveness and impression of the application and whether the farmer can complete the data recording task without unnecessary effort—the results are presented in Figure 6, Figure 7, and Figure 8. The questionnaire was given to 12 farmers respondents who used the PUSKA application and have experienced in using Android apps.

According to Figure 6, when asked about their engagement and interest while using the PUSKA application, 25% of the farmers strongly agreed that the application was attractive, while the remaining 75% agreed to the statement.

Figure 7 shows the farmers' opinions on the usefulness and enjoyment of features in the PUSKA application, with 27.3% of the farmers strongly agreed on the usefulness, 63.6% agreed, and the remaining 9.1% were neutral about it.

Finally, Figure 8 indicates 36.4% of farmers strongly agreed that the PUSKA application facilitated their data recording tasks, and 63.6% agreed that the application was helpful in this regard.

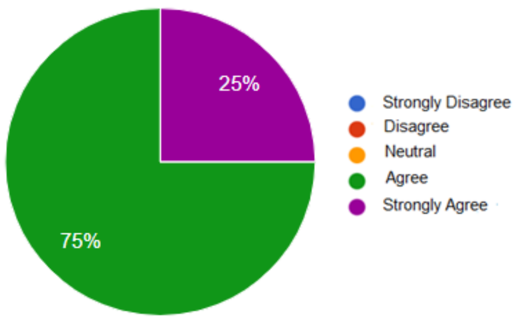


Figure 6 Farmers' engagement and attractiveness on the PUSKA application

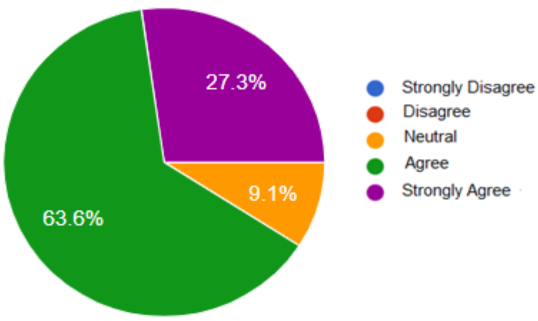


Figure 7 Farmers find features or functions in the PUSKA application useful.

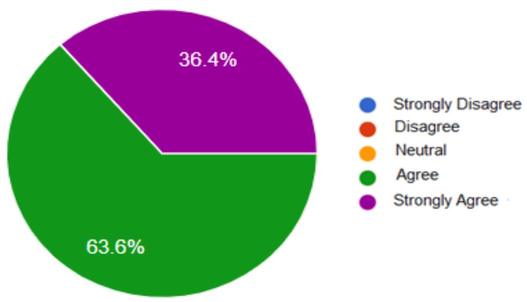


Figure 8 Farmers find the PUSKA application helpful and easy for recording livestock data.

V. CONCLUSION AND FUTURE WORKS

This research has successfully developed PUSKA, a mobile application designed to facilitate the process of recording goat livestock data into a system. Using the Android platform, PUSKA enables the real-time recording of data that reflects actual farm conditions and provides functionalities for displaying goat information and recording goat livestock data. Testing of the mobile application confirms that its features function effectively and align with user requirements. However, more studies are needed to fully evaluate the impact of this innovation and to address any potential confounding factors inherent in the farm management process.

Therefore, in the following PUSKA design, it is necessary to improve several features. These include the creation of a website administrative panel, integration of farm location mapping, and generation of reports from the recorded data to be displayed on the farmer's mobile application. Developing these features will ensure that the goat livestock data in the PUSKA system is reliable and serves as a valuable decision support tool for farmers and stakeholders. For future recommendations, more advanced features or improved technologies could be incorporated to record goat population, production, and distribution. The introduction of a dashboard website could present this information in an attractive and informative manner. Additionally, mapping the location of farms and generating comprehensive reports on livestock could form the basis of a business intelligence technology tailored for the goat farming industry that can be developed for future enhancements.

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