Mobile Application Development for Robusta Coffee Planting Cycle Mapping and Recording as Part of an Initiative to Revitalize Smart-Agriculture Technology

[1]Anak Agung Surya Pradhana, [2*]I Nyoman Darma Kotama
[1,2*]Fakultas Teknologi dan Informatika , Program Studi Sistem Komputer, Institut Bisnis dan Teknologi Indonesia
Email: surya.pradhana@instiki.ac.id[1*], darma.kotama@instiki.ac.id[2]

Keywords	
Information Technology, Smart-Agriculture, Mapping and Recording the Coffee Planting Cycle, System Design	Robusta coffee cultivation in Bali's Pupuan District is vital to the Indonesian economy. This study aims to contribute to the improvement of agricultural productivity through the development of a mobile application utilizing geographic information system (GIS) and the collection of robusta coffee cropping cycle data. The purpose of the application is to amass historical data pertaining to various stages of coffee plant development, including fertilization, insect management, and harvesting. By utilizing this application, agricultural practitioners are empowered to enhance the quality of their decision-making regarding the administration of their plantations. The study adhered to a methodical framework, which comprised gathering data, analyzing user requirements, designing the application, and developing it. An application is developed to provide assistance to administrators and producers in various tasks such as crop cycle recording, location setting, and farm management. With any luck, this application will aid in the development of a smart agriculture system in the Pupuan District of Bali and contribute to the enhancement of coffee farming's productivity and efficiency.

1. INTRODUCTION

Agriculture is one of the main sectors in the economy of many countries, including Indonesia. Robusta coffee is an important agricultural commodity[1], [2] and has a significant role in the Indonesian agricultural industry. One area that produces high quality robusta coffee is Pupuan District in Bali, Indonesia. Based on robusta coffee production data in Pupuan District, it can be seen that the ratio of coffee production to land area has fluctuated over time. Even though there has been an increase in production ratios in certain years, in 2017 and 2022 there has also been a decline in productivity[3]. Challenges such as climate change, price fluctuations and changes in planting patterns have put significant pressure on coffee farmers. This shows that there are problems in coffee plantation management that affect production results, which is one of the contributors to Indonesia's lack of coffee production compared to Vietnam, which tends to have a similar tropical climate.

In an effort to face these challenges and advance the agricultural sector, the concept of Smart Agriculture has become increasingly important. Smart Agriculture involves the use of information and communication technology to increase efficiency, productivity and sustainability in agriculture. Smart agriculture, or smart farming, is an approach to agricultural management that uses information and communication technology (ICT)[4]–[6] to increase agricultural efficiency and productivity. Various technologies such as sensors, GPS, and geographic information systems (GIS) are used in various phases of the crop cycle, such as land preparation, planting, maintenance, fertilization, pest control, and harvesting [7]–[9]. Several studies are related to the revitalization of smart-agriculture technology, namely smart irrigation [10] and the application of IoT technology directly to the planting process [11]–[13] to the post-harvest process[14], [15]. The application of this smart agricultural technology helps increase the efficiency and productivity of coffee plantations.

Based on related research and the problems faced by robusta coffee farmers in Pupuan subdistrict, this research is aimed at increasing efficiency in the smart agriculture system, so this research focuses on creating an application to record the planting cycle of robusta coffee in Pupuan subdistrict in Bali, by utilizing Geography Information System (GIS) and recording planting cycle data. Designing a mobile application for Mapping and Recording the Planting Cycle of Robusta Coffee, this research aims to initiate better historical data collection, which includes standard phases of coffee plant growth[16] including fertilization time, pest control, and harvest. With detailed data

recorded in this application, farmers can make the right decisions in managing their plantations, so that it is hoped that they can increase the efficiency and productivity of coffee plantations in Pupuan District and encourage the success of the smart agriculture system.

2. METHODS
Research Stages

In order to develop an effective and efficient mobile application to support the mapping and recording of the Robusta coffee planting cycle in Pupuan District, this research uses a systematic method in carrying out research[17]. The research stage is aimed at ensuring that the resulting application meets the needs of farmers and the coffee cultivation process, and can be a good starting point for a Smart Agriculture system in the future.
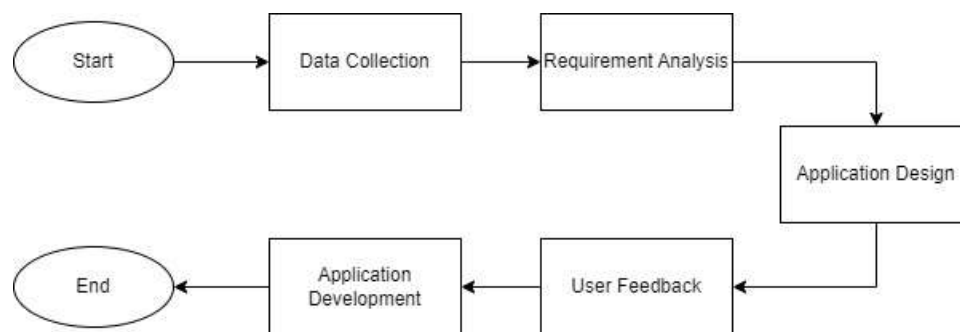

Figure 1. Research Stages

Based on Figure 1, the initial stages of research can be explained, namely collecting data by conducting observations and interviews with farmers in Pupuan sub-district, as well as searching for literature studies.to understand the latest concepts, technology and practices in the fields of Smart Agriculture, mobile applications in agriculture, geographic information systems (GIS), and Robusta coffee planting cycle management. Based on the results of data collection, we then carry out data collection related to analyzing user needs regarding system features that can be used as a reference in designing applications. At the application design stage using the Unified Modeling Language (UML) approach and display mockup design using Figma, the system feature design adapts to the analysis of user needs. After designing the application, it is necessary to provide feedback information from the user, so that the design results can be in accordance with the user's needs. Feedback from users is intended to finalize the application design, which can then be continued into the application development stage.

3. RESULTS AND DISCUSSION
System Design

This research uses Unified Modeling Language (UML) design, especially use case diagrams to describe the processes that can be carried out by system user actors. Use case diagrams make it easier to find out every detail of the system process that can be carried out by actors.
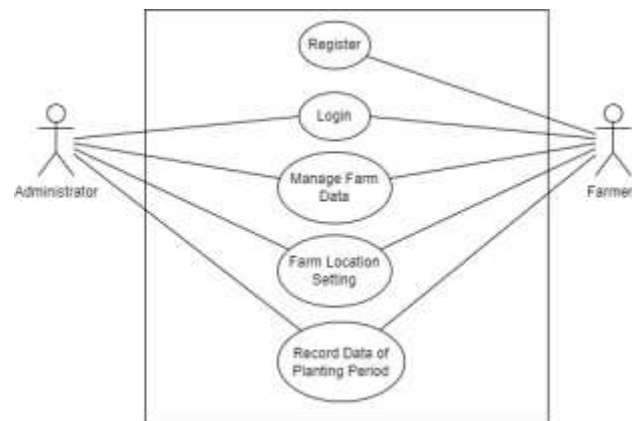
Figure 2. Usecase Diagram

Based on Figure 2, it can be explained that in this research there are 2 system user actors, namely administrators and farmers. Each actor can carry out processes on the system, namely the administrator actor can carry out the login process, manage farm data, farm location settings and record data of planting period. Likewise, farmer actors must carry out the registration process, then can carry out the login process, manage farm data, farm location settings and record data of planting period.

Application Development

Application design and development is an important step in this research to create effective and efficient technological solutions to support coffee farming management. The application design process will involve planning a user interface (UI) layout that is intuitive and easy for farmers to use, as well as integrating features that are relevant to their needs in managing agricultural cycles. Apart from that, the application architecture will also consider aspects of data precision, so that the information collected through the application can be guaranteed to be accurate and only used for research purposes and system improvements.

Figure 3. Register Page Application Mockup Design

Based on Figure 3, each of them explains in general how the main functions of the application will be used, namely to register yourself and input your plantation data via the registration page. When registration is complete, the registered gardens will appear on the GIS page and can be managed to record the planting cycle on the garden list page, which can be seen in Figure 4 below.
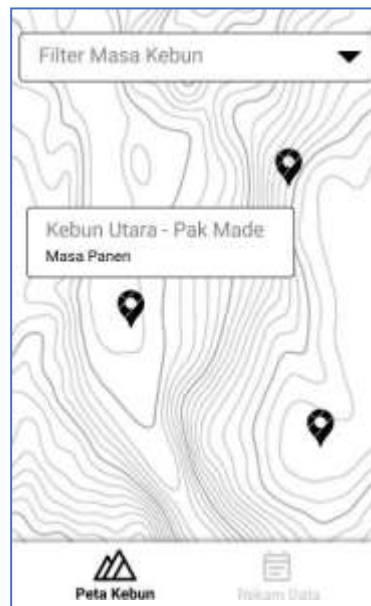
Figure 4. GIS Page Application Mockup Design

Based on Figure 4, the application mockup design for the GIS page can be shown. On this page, the location of the farmer's plantation data that has registered can be shown.

Figure 5. Garden List Page Application Mockup Design

Based on Figure 5, the application mockup design regarding the farmers' plantation list page can be explained. On this page, farmers can add the location of their coffee plantations. So that later you can know the location or coordinates of each garden.

Figure 6. Note-taking Application Mockup Design

Based on Figure 6, the application mockup design can be explained regarding the page for recording the harvest period, replanting period and adding data. On this page farmers can check the status of each plantation. This application page also functions to monitor and add data on the status of the planting and harvest periods for each farmer's garden.

Acknowledgement

4. CONCLUSION

The study's findings reveal the development of a mobile application that incorporates mapping technology (GIS) and data collection for monitoring the robusta coffee cropping cycle. The primary objective of the application is to gather more accurate historical data pertaining to many aspects of coffee plant growth cycles, encompassing fertilizer, pest management, and the process of harvesting. The utilization of the comprehensive data provided by this application is anticipated to enhance farmers' decision-making processes in the administration of their plantations, hence augmenting the efficiency and production of coffee plants in Pupuan Sub-district.The present study employs a rigorous methodology encompassing many stages, including data collection, analysis of user requirements, application design utilizing the Unified Modeling Language (UML), and subsequent application development. The research makes a significant contribution by offering an application that has the potential to enhance coffee production in the region, bolster the efficacy of the smart agriculture system, and provide coffee producers in Pupuan District, Bali with efficient technological solutions.

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