# Design of a Location-Based Monitoring System for Agricultural Extension Officers at the Department of Food Security and Agriculture of Bojonegoro District Using the Waterfall Development Method and Hybrid Application

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***Abstract***

The Department of Food Security and Agriculture (DKPP) of Bojonegoro District is a government agency at the district level that focuses on food security and agriculture. The main objective of this department is to enhance the production of food crops, horticulture, and plantations through the improvement of human resources and agricultural infrastructure. DKPP Bojonegoro has undertaken various initiatives to improve the quality and quantity of agricultural products. One of these initiatives involves deploying extension officers to provide guidance and support to farmers in the field, both those formally affiliated with Farmer Groups (POKTAN) and individual farmers. In practice, each extension officer is assigned to a district or the area of a farmer group that requires assistance, with assignments subject to change and flexibility based on the needs of DKPP Bojonegoro. However, the challenge is difficulty in ensuring that the extension officers are effectively carrying out their duties in the field. The monitoring function performed so far relies solely on reports submitted by the extension officers, a method that may lack validity in verifying whether the officers are performing their tasks well in the field. In response to this issue, the proposed solution in this research is a Location-Based Monitoring System for agricultural extension officers. The goal is to facilitate DKPP in monitoring the presence of extension officers in designated areas and to automatically manage attendance when assigning officers to a farmer group or district. This research only focuses on system design.

***Keywords:*** *system design, attendance system, monitoring, location-based, hybrid application*

## 1. Introduction

The Department of Food Security and Agriculture (DKPP) of Bojonegoro District is a local government agency that focuses on food security and agriculture at the district level [1]. The primary goal of this department is to enhance the production of food crops, horticulture, and plantations through the improvement of human resources and agricultural infrastructure. DKPP Bojonegoro has undertaken numerous initiatives to improve the quality and quantity of agricultural products. One of the key strategies involves conducting outreach and assistance activities for farmer groups and individual farmers, carried out by extension officers assigned by DKPP to specific regions. DKPP Bojonegoro dispatches extension officers to provide guidance and support to farmers in the field, both those formally affiliated with Farmer Groups (POKTAN) and those who are not. These outreach and assistance activities are aimed at equipping farmers with better knowledge and understanding to enhance their agricultural productivity. The topics covered include the selection of quality seeds, disease management, plant care, new agricultural technologies, fertilizer distribution, marketing of agricultural products, and awareness of government assistance programs available to farmers. Through these outreach and assistance programs, DKPP Bojonegoro strives to empower farmers with the

necessary knowledge and skills, ultimately supporting their agricultural productivity and contributing to the overall development of the agricultural sector in the Bojonegoro District.

Agricultural extension officers play a crucial role in bridging the interests of the Department of Food Security and Agriculture (DKPP) and farmers. From DKPP's perspective, the focus is on how government programs aimed at increasing agricultural productivity and empowering farmers can be effectively implemented to achieve food and agriculture resilience, aligning with the department's goals. From the farmers' standpoint, the goal is to acquire better knowledge and skills in managing land and agricultural crops, ultimately improving their quality of life. Agricultural extension officers operate in the midst of farmers to convey DKPP's agricultural programs and provide guidance, ensuring that farmers can derive maximum benefits from these initiatives.

In practice, each extension officer is assigned to a district or the area of a farmer group that requires assistance. The assignment location can be flexible and adjusted according to the needs of DKPP Bojonegoro. However, a challenge arises as DKPP finds it difficult to ensure that extension officers are effectively carrying out their duties in the field. The monitoring function, until now, has relied solely on reports submitted by the extension officers, a method that may lack validity in verifying whether the officers are performing their tasks well in the field. To address this challenge, the proposed solution in this research is a Location-Based Monitoring System for agricultural extension officers. The goal of the system is to facilitate DKPP Bojonegoro in monitoring the presence of extension officers in designated areas and to automate the attendance management process when assigning officers to a farmer group or district. From the extension officers' perspective, this integrated system makes attendance tracking easier, eliminating the need for manual confirmation. To realize the proposed solution, several stages need to be undertaken. This research adopts the Waterfall software development methodology, which involves phases such as requirements analysis, design, implementation, testing, and maintenance [2]. The requirements phase is dedicated to analyzing the monitoring system's needs, actively involving DKPP Bojonegoro. The design phase focuses on designing the system based on the analyzed requirements. The implementation phase involves system development or coding according to the established design. Subsequently, the system undergoes testing, and the final stage is the implementation of the developed system at DKPP Bojonegoro.

The implementation of a monitoring system within an organization is crucial for various aspects such as monitoring work processes, administrative procedures, and attendance in specific areas. Regarding the issues raised in DKPP Bojonegoro, specifically monitoring the attendance of extension officers in their assigned locations, several research studies have explored the development of attendance monitoring systems using various technologies [3]. Some focus on hardware technologies like RFID [4] or NFC [5]. Other research using artificial intelligence to identify person in attendance system process [6][7]. Some researchers using media more commonly used like fingerprint scanning systems [8], web/mobile-based attendance systems [9][10], and QR code [11].

For attendance processes outside the office or in the field, several studies have developed a GPS-based attendance system [12] [13] [14]. The advantage of this technology is obtaining information about where employees are making their attendance. Typically, this is in the form of a mobile or web-based application. The advantage of web-based systems is that users don't need to install an application on their devices but can always access it through a web browser. The drawback of web-based attendance systems is the lack of exclusivity and security, as anyone can access the system if they know the website address. The advantage of native mobile applications is accessibility to smartphone hardware. However, the disadvantage is the compatibility with various hardware. Therefore, in this study, an attempt is made to develop an attendance system with a hybrid mobile approach.

Considering the challenges in DKPP Bojonegoro related to monitoring field officers, the most suitable solution appears to be a location-based monitoring system. This is because the locations of extension officers vary and are flexible, changing according to the needs of DKPP Bojonegoro.

## 2. Methods

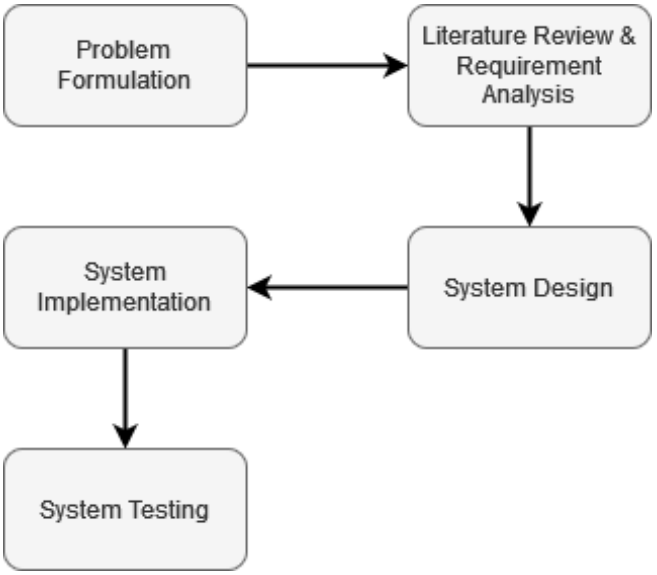


Fig1. Research Methods

**Problem Formulation:**
In this step, the researcher first identifies the problem to be investigated. The proposed issue is the implementation of a location-based monitoring system for DKPP Bojonegoro's agricultural extension officers. This system aims to automatically detect the varying and flexible locations of extension officers, meaning it can adapt to the specific needs of DKPP Bojonegoro.

**Literature Review and Requirement Analysis**
Literature review is conducted to search for information related to theories, methods, and concepts relevant to the issues addressed in this research. The gathered information will serve as a reference for problem-solving. Literature review activities include searching for information and references in the form of textbooks, literature, internet sources, and other materials related to the research topic, specifically location-based monitoring for agricultural extension officers in the environment of DKPP Bojonegoro.
Requirement analysis is performed to identify the requirements necessary for developing the location-based monitoring system. These requirements encompass both the system's needs and the data needs that will be processed within the system.

**System Design:**
Once the system requirements are identified, the next step is to design the location-based monitoring system for agricultural extension officers in the DKPP Bojonegoro environment. The system design includes the design of the user flow, system interface, system architecture, and the Entity-Relational Diagram (ERD) for the database.

**System Implementation:**
Once the system design is completed, the next step is to implement the system or create program code according to the previously made system design. This implementation covers the implementation of the system's database, the frontend or system interface implementation, and the backend system implementation.

**System Testing :**
The next step is for the researcher to conduct system testing to verify if the created system is functioning well and is user-friendly for those who will be using it, namely DKPP Bojonegoro and

agricultural extension officers. If there are still issues, we as researchers will revisit the system design and implementation steps previously undertaken to ensure that problems are effectively resolved.

## 3. Result

Here are the results of the design of the location-based monitoring system. This includes the system architecture design, use case diagram, class diagram, database design, interface design, and the implementation results of the system's UI.

**System Architecture:**

The system architecture is designed based on the requirements and tools needed. In this research, based on Figure 2, the system architecture adapts to the needs of the platform used, which is a web-based system and a mobile application. The mobile application is intended for agricultural extension officers tasked with providing guidance to farmers. Since extension officers can be assigned to various districts in the Bojonegoro Regency, a mobile application is well-suited for monitoring the activities of extension officers in their assigned locations.

Meanwhile, the web application is designed for the DKPP Bojonegoro admin. The admin is responsible for scheduling assignments for agricultural extension officers. A web application is chosen for its flexibility and accessibility from various locations and devices. Both systems, the mobile and web apps, directly connect to a RESTful API where the system logic is embedded. The RESTful API is also connected to the database for data storage and retrieval. With this architecture, there is seamless integration between the various components of the system to efficiently manage the tasks of agricultural extension officers.

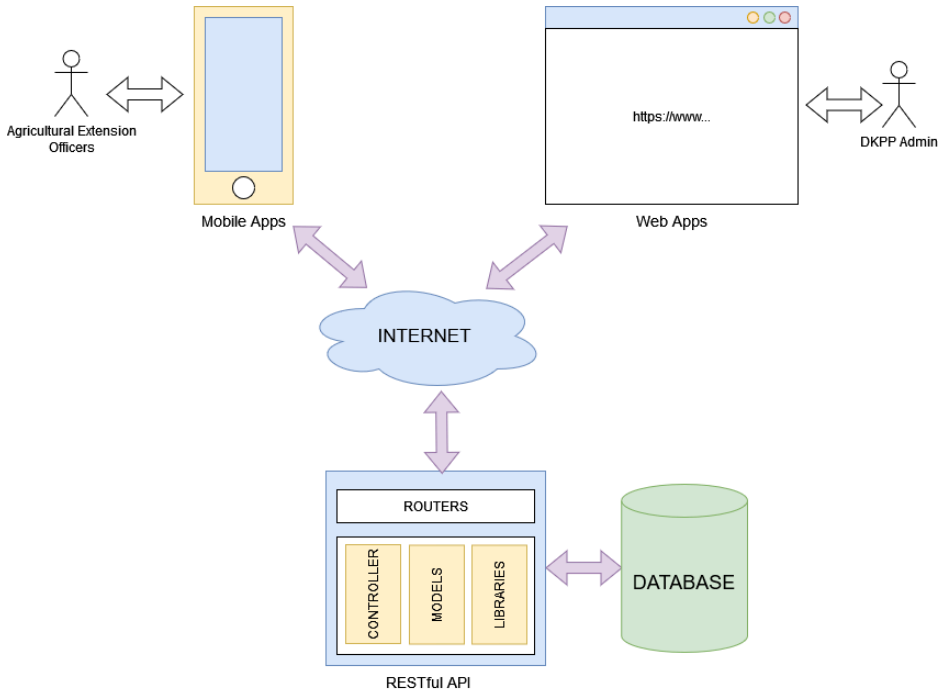


Fig 2. System Architecture

**Use Case Diagram:**

A use case diagram is created based on the needs of DKPP Bojonegoro to monitor field facilitators. It consists of two use case diagrams, namely the use case diagram for the website application and the use case diagram for the mobile application.

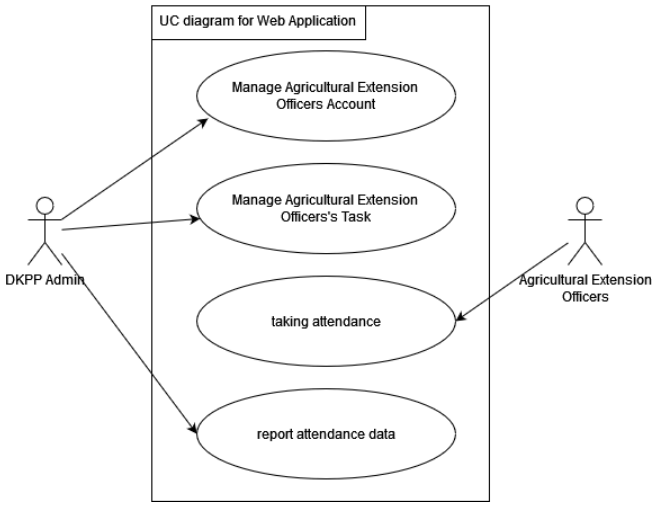


Fig 3. Use Case diagram for the web application

To produce a usable system, the first step is to understand the purpose of the system. The involved users include the Admin, who plays several crucial roles, such as viewing information about the attendance recorded by facilitators. The Admin can also add, modify, or delete counseling tasks as needed. Additionally, the Admin can manage facilitator account data, including adding, modifying, or removing registered facilitator data in the system. Figure 3 is the Use Case Diagram of the facilitator attendance management system.

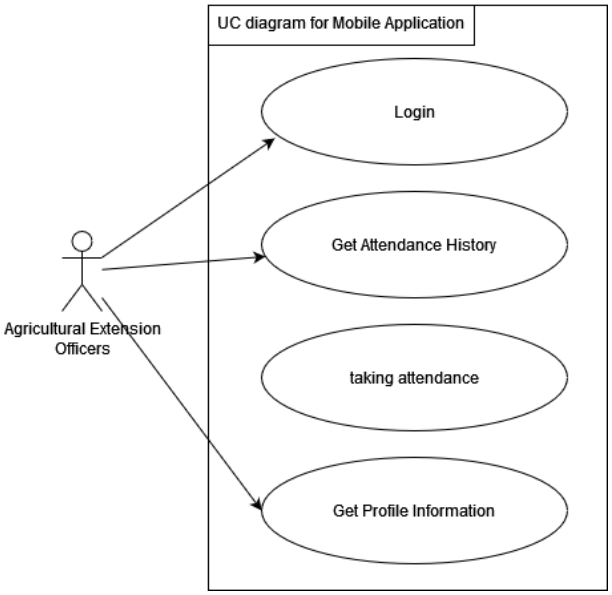


Fig4. Use Case Diagram for the mobile hybrid application

Figure 4 represents this use case, explaining how an employee logs into the application to access their attendance history and profile. To access the attendance history, the employee must log in first. In this case, attendance also includes information about the attendance area, user location, and maps.

**Class Diagram:**

The Class Diagram is used to define the static structure of a system. This diagram illustrates the classes in the system along with their attributes and methods. Moreover, the Class Diagram also depicts the relationships and associations between the classes in the system, aiding in modeling the relationships between components and interactions between objects in the software. The Class Diagram can be seen in Figure 5.

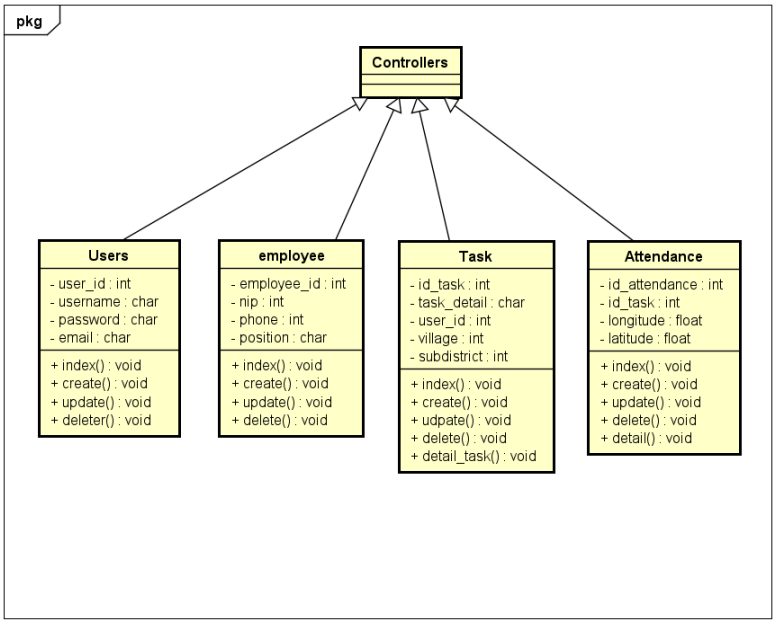


Fig 5. Class Diagram for web application

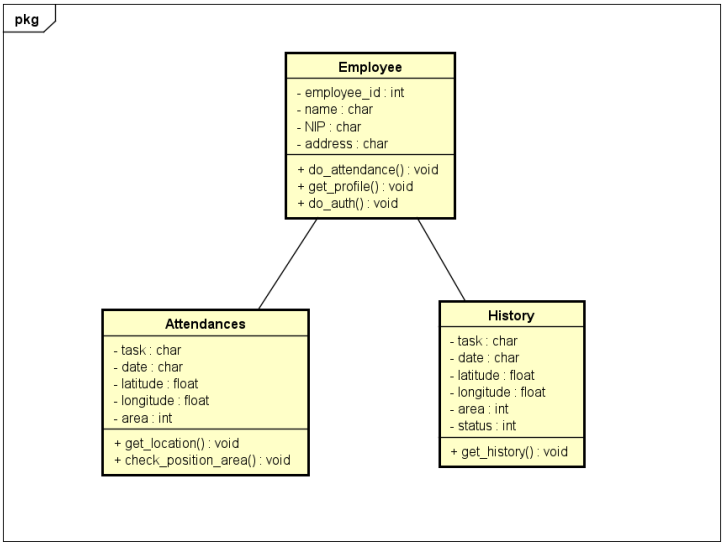


Fig 6. class diagram for mobile application

Figure 6 depicts the class diagram of the hybrid mobile, where “Employee" class have attributes such as employee_id, name, address. The "Attendances" class includes attributes such as task, date, user location (latitude, longitude), and attendance area. On the other hand, the "History" class comprises attributes like task, date, location, and status.

## Database Design:

Figure 7. illustrates the results of the database design for the agricultural assistance monitoring system. The database design is based on the data obtained in the initial process, namely the system requirements analysis.

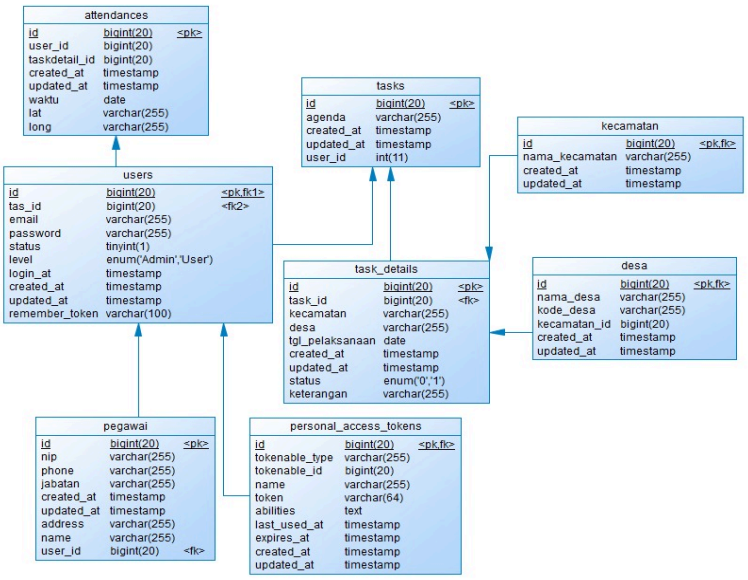


Fig 7. Database Design

Figure 7. represents the Physical Data Model (PDM) database diagram for attendance, storing the necessary data for attendance, including schedule information, employees, attendance history, and employee accounts.

## User Interface Design:

The outcome of the final process in this research design is the system interface. The system interface is crucial as it facilitates interaction between DKPP Kabupaten Bojonegoro and the system.

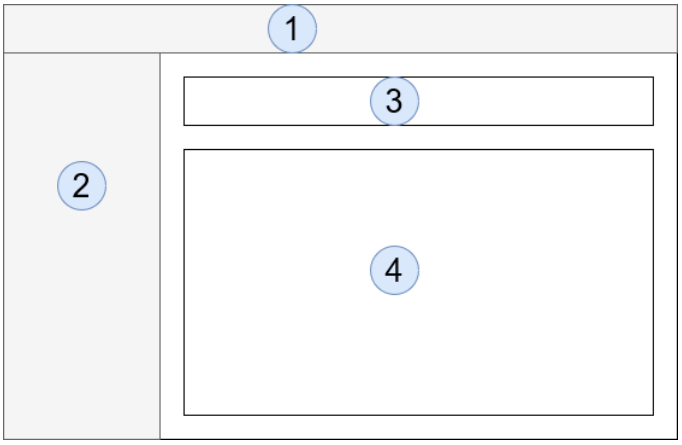


Fig 8. Web User Interface

In Figure 8, it shows the result of the interface design for the default web application page. There are four main sections on this page: (1) the header, (2) the sidebar or side menu, (3) the page title, and (4)

the content. This interface is used for pages other than login, the main page, and proposal forms. The layout is designed to be uniform and consistent to make users more familiar with the system interface, thus enhancing the ease of learning how to use the system.

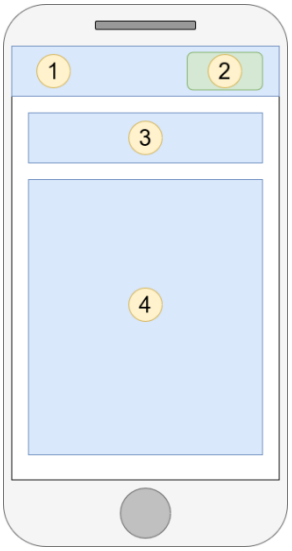


Fig 9. Mobile Hybird User Interface

In Figure 9, it displays the result of the interface design for the default hybrid mobile application page. There are four main sections on this screen: (1) the header apps, (2) the button menu, (3) the screen title, and (4) the apps content.

## User Interface Implementation Result

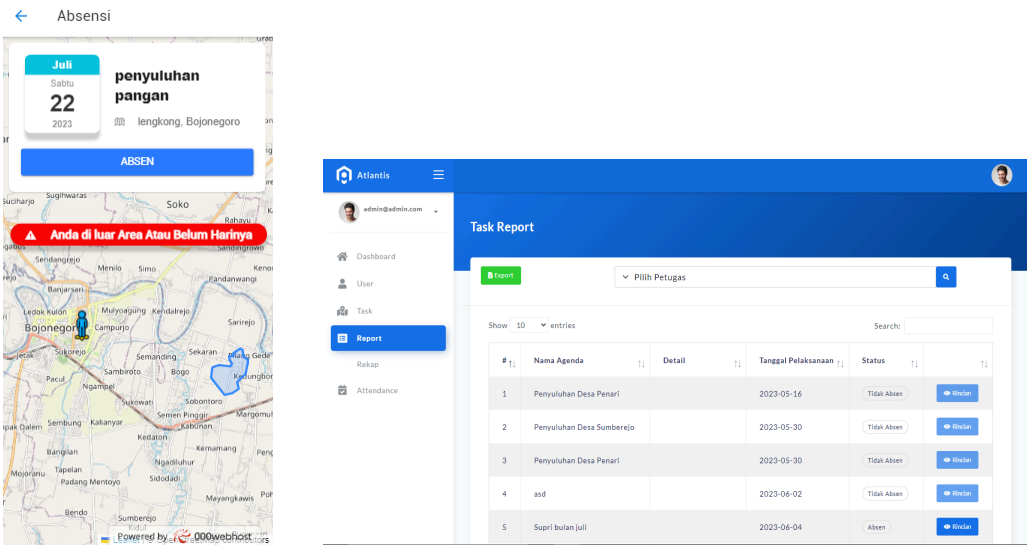


**Fig 10.** Implementation User Interface Web and Mobile Hybrid

The results of the user interface implementation from the designed system are shown in Figure 10. There are two outcomes of the user interface implementation: one for the hybrid mobile application and the other for the web application.

## 4. Conclusion

This research aims to address the issues at DKPP Bojonegoro, specifically the monitoring process of agricultural extension officers. The manual monitoring process currently in place is inefficient. Therefore, in this study, a system was designed to monitor the activities of agricultural extension officers in the form of a location-based monitoring system. The research results in the design of a system that includes system architecture, use case diagram, class diagram, database diagram, and the implementation of the user interface system. Two systems were developed: a web-based system for DKPP Bojonegoro administrators and a hybrid mobile system for field agricultural extension officers.

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