Development of FarmDirect: E-Stall for Smallholder Farmers

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**Abstract.** Smallholder farmers face numerous challenges in selling their products, including limitations in adopting modern technologies to market their products within small communities. To address this challenge, *FarmDirect*, an e-stall for small-scale farmers, was developed as a community-based digital platform. It connects farmers directly with consumers, especially those who live within the neighborhood. *FarmDirect* is making it simpler for farmers to showcase and sell their products, while giving buyers easy access to fresh, locally grown food. The platform helps strengthen local economies and encourages sustainable farming practices. The implemented features include tools like AI-powered product recognition, real-time messaging for direct communication, a community forum for sharing knowledge and a map-based interface to help consumers find products from nearby farm e-stalls.

# INTRODUCTION

Farmers in Malaysia commonly come from various backgrounds and their farming activities contribute to the growth of the local economy. For smallholders, they manage farms that belong to their family and often keep part of their produce for personal needs rather than selling everything. Some of them do farming as a side activity or a personal interest rather than a full-time farming job. They usually grow vegetables, flowers, fruits, and herbs. They also raise chickens or other small animals, producing eggs, meat, and fertilizer for their use, and only part of the produce is for sale. They usually sell their extra produce at local farmers’ markets or car boot sales.

The limited and inconsistent farming production contributes to inefficient marketing strategies and exposes smallholders to various challenges. Smallholders have limited access to buyers, and they are dependent on middlemen, which always reduces their profit margins. Additionally, factors such as unstable prices, poor financial stability, and low adoption of modern technologies hinder their ability to implement good practices and scale their operations [1]. A lack of digital literacy and limited availability of technology-driven solutions further restricts their market reach, leaving them reliant on traditional inefficient methods [2], [3]. Despite their limited resources and access to modern agricultural technologies, smallholder farmers play a vital role in ensuring local food security, preserving agrobiodiversity, and sustaining rural economies [4], [5].

Many works highlighted the success of e-commerce-based approaches in improving agricultural market access and reducing the middlemen issue. For example, the authors in [6], [7] emphasized the necessity of an application like *FarmDirect* to address these challenges. Many studies also show that tools that support real-time communication with user-friendly interfaces are also important for farmers with limited digital experience to connect with markets and adopt sustainable practices [8], [9]. The studies highlighted the importance of developing a platform that promotes fair market access and empowers farmers to manage their farms more effectively. Recent research also emphasizes the need for AI-integrated and blockchain-enabled agri-marketplaces that improve trust, traceability, and usability among rural farmers [14], along with mobile-first designs that cater to users with low digital literacy [15], [16].

This paper presents *FarmDirect*, a mobile application that serves as an e-stall for small-scale farmers and local community users. The objectives of the study include the following:

* To identify opportunities for developing a mobile application tailored to the specific needs and challenges faced by the smallholder farmers.
* To propose a solution, a mobile-based application which designed to allow sellers (farmers) to sell their products on e-stall, allow buyers (consumers) to browse farming products, facilitate online buying and selling, utilize AI camera detection, engage in a user forum, and explore a community interface that displays all farmer e-stalls on a map.

# Related Work

Many studies have highlighted the shortcomings of traditional marketing practises, which often fail to benefit farmers and nearby consumers. There is a lack of effective mechanisms for farmers to understand consumer preferences, while consumers have limited insight into the nearby seller and the quality of their produce [10]. Farmers face significant barriers in adopting digital tools, such as e-commerce platforms and sustainable farming technologies, due to limited digital literacy and the availability of digital solutions. These constraints hinder their ability to explore technologies that could enhance market access, improve operational efficiency, and support environmentally sustainable practices [11]. These problems have encouraged the development of online applications, mobile-based as well as web-based, aiming at empowering small-scale farmers.

For example, in [12] Manikandan et al. introduced a mobile application aimed at directly connecting farmers with consumers and retailers. Their study explores the benefits of digital platforms in providing direct market access, effectively removing intermediaries and enabling farmers to establish direct links with end buyers. Vivekanandan et al. [10] presented *Farm Connect Application*, which connects farmers and consumers. The system is designed not only to facilitate the buying and selling of agricultural products but also includes an IoT-based sensor network to support agricultural practices. Bhende et al. [13] proposed both android and website applications that enable farmers to sell their agricultural products across various levels of the marketing chain. It assists farmers in quickly and efficiently locating nearby markets, accessing real-time stock information, and identifying product demand. However, the application's features are primarily geared toward government-level operations.

More recent studies further support the shift toward intelligent and inclusive agricultural platforms. In [14], Patel et al. highlighted the value of AI and blockchain in enhancing transparency and efficiency in digital marketplaces. Musa et al. [15] demonstrated how AI-driven interfaces significantly improve adoption among rural users. Similarly, in [16], Tan and Singh emphasized the importance of designing e-commerce platforms specifically for smallholder farmers in Southeast Asia, aligning closely with the objectives of our *FarmDirect*.

Despite many related online applications, there are several challenges remain unaddressed in the domain. One of the application limitations is poor user experience due to the interface not being intuitive for users with limited digital literacy [17]. Furthermore, farmers are also often struggling in using the application features such as product navigation, searching items or managing listings without technical assistance. These usability issues are well-documented in recent studies that stress the importance of designing tools that accommodate the lack of knowledge in technology users [2], [3], [8].

Other than that, more existing solutions lack advanced tools like real-time product recognition or visual search features, which may help both sellers and buyers to simplify product management and discovery. Without these capabilities, users must rely on manual text insert or category browsing which usually time-consuming for those who are unfamiliar with the digital system. In contrast, *FarmDirect* introduced AI camera detection and category-based filter, which can help both users reduce cognitive load and streamline the product listing and search process.

# METHODOLOGY

## Requirement Analysis

Requirement analysis for the development of *FarmDirect* was conducted to gather and analyze the needs of users, including both farmers and customers. This research employed a questionnaire as the primary survey instrument, designed to align with the study’s objectives. The key dimensions of the questionnaire included demographics, access to technology, market access, digital literacy, and feature preferences. Below is the analysis of the questionnaire results:

* The majority of the participants are consumers, comprising 26 out of 42 respondents (63.9%), while the minority are both consumers and farmers (9.5%). The largest age group represented in the survey is 20–29 years old (26.2%). Regarding the frequency of buying or selling agricultural products, 33.3% reported doing so daily, followed by 26.2% weekly, 21.4% monthly, 14.3% rarely, and 4.8% who never buy or sell agricultural products.
* Only 14.3% of the participants do not rely on the internet for selling or purchasing agricultural products, and only 26.2% claim they do not need training to use the online platform.
* Home delivery is the most preferred option (73.8%), while fewer participants prefer pick-up points (11.9%) or on-farm pick-up (14.3%).
* The main issues raised by consumers include high prices (59.5%), lack of product variety (59.5%), quality concerns (52.4%), limited access to markets (45.2%), and lack of digital access or tools (33.3%).
* The most valued features include delivery services (73.8%), community forums (59.5%), real-time communication (57.1%), online payment (57.1%), and order tracking (2.4%).
* The barriers that discourage participants from using digital platforms include lack of digital skills (42.9%), trust issues (38.1%), and lack of trust in online payments (31%). The features that would encourage the use of e-stall services include convenience of the application (81%), price (69%), product quality (59.5%), and variety of products (54.8%). Out of 42 respondents, 54.8% are interested in buying or selling products through a digital platform.

An interview was also conducted via Microsoft Teams to gather additional insights and opinions from farmers. Below are the key observations from the interview:

* The farmer mainly sells products at local markets or through middlemen who visit the farm. While direct sales to consumers do occur, they are rare.
* The farmer expressed a preference for selling directly to consumers, as it allows for better prices. However, the farmer continues to depend on middlemen for convenience, particularly for transportation and finding buyers.
* The farmer struggles to find reliable buyers and feels that middlemen take a substantial share of the profits, resulting in unfair pricing.
* The farmer has not used digital platforms before, although there is awareness of their existence.
* The farmer indicated a strong preference for a platform that enables listing of products, direct communication with buyers, sales tracking, and order notifications.
* There was also interest from the farmer in interacting with other users on the platform, valuing the opportunity to share experiences, receive advice, and better understand customer preferences.

## *FarmDirect* SystemDesign

Figure 1 shows the rich picture diagram that illustrates the interactions and processes within *FarmDirect* system between each role of users. The purpose of this diagram is to visualize the overall relationship between the stakeholders *FarmDirect* system.

A diagram of a customer service

Description automatically generated

**FIGURE 1.** Rich picture diagram of *FarmDirect*

## *Farmdirect* Prototype

The *FarmDirect* was developed using *Flutter* as the front-end framework, with *Firebase* handling authentication and database management, and *Supabase* serving as the cloud media storage solution. The mobile application consists of several modules designed to address specific user needs.

### Product Listing & Selling Interface

As shown in Figure 2, the farmer interface allows users to upload product details, including images, price, category, and stock. The real-time *Firestore* backend enables seamless data management and retrieval, as shown in Figure 3.

### AI Camera Detection

An AI-driven camera interface, shown in Figure 4, enables users to capture product images, which are then analyzed by the *Gemini Vision API* to detect and automatically label the objects.

### Real-Time Chat

As shown in Figure 5, the chat system allows users to communicate directly with sellers or other users. Messages are stored in *Firestore* to ensure data persistence.

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| **FIGURE** **2.** Add Product | **FIGURE** **3.** Product Listing | A screenshot of a phone  Description automatically generated  **FIGURE** **4.** AI camera detection |
| A screenshot of a phone  Description automatically generated  **FIGURE** **5.** Real-Time Chat | A map with different locations  Description automatically generated  **FIGURE** **6.** Community Map View | A screenshot of a computer  AI-generated content may be incorrect.  **FIGURE** **7.** Search by item name |

### Community Map View

As shown in Figure 6, users can view the geographical locations of farmer stalls using Google Maps. Each stall is marked with a pin based on its address, which is geocoded into coordinates.

### Search and Camera-Based Detection

As shown in Figures 7 and 8, the system allows users to search for products either by entering a search term or by using the built-in camera to detect an object and find relevant listings.

### Forum Page

As shown in Figure 9 and 10, the forum page serves as a discussion board where users can interact, post questions, and share information.

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| A screenshot of a phone  AI-generated content may be incorrect. **FIGURE** **8.** Search by Camera Detection | **FIGURE** **9.** Forum Page | **FIGURE** **10.** Forum in Details |

The development of the *FarmDirect* prototype addresses key challenges identified through surveys and interviews, particularly limited market access, poor digital literacy, and reliance on intermediaries. While existing platforms such as *Farm Connect* [10] and Manikandan’s mobile application [12] laid the foundation for farmer-to-consumer digital platforms, they often fall short in terms of community interactivity, AI integration, and user-centric features tailored to rural environments. Using *FarmDirect*, farmers benefit from product listing, reduced reliance on intermediaries, and enhanced communication channels with buyers. Consumers gain access to a diverse range of fresh, locally sourced products with features like AI-powered detection, real-time stock updates, and community engagement tools. The map interface increases transparency and trust, allowing buyers to visualize where their food is coming from. This supports the assertion from literature that low-tech, community-based solutions can significantly enhance adoption rates among under-digitalized communities.

# conclusion

This paper presents *FarmDirect*, a mobile app focused on supporting smallholder farmers by improving their access to digital marketplaces as well as allowing consumers to get farming products around their neighbourhood. The app includes several practical features, such as object detection powered by AI, category filtering, direct messaging between farmers and consumers, and location mapping. These tools are carefully tailored to address the feedbacks from potential users, which are gathered through surveys and interviews. Our observation suggest that simple and well-designed digital tools can go a long way in making agricultural markets fairer and more sustainable. It can also serve as a baseline reference for developers to design and develop a community-based digital solutions for farmers. In the future, the application can be enhanced by adding features like machine for predicting prices and recommending crops, multi-language support for broader accessibility, a trust-building rating system, and offline access for farmers in areas with limited internet. With continued development, *FarmDirect* could serve as a scalable model for strengthening smallholder farming Malaysia.

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