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MOBILE APP FOR DIRECT MARKET ACCESS FOR FARMERS

A PROJECT REPORT

Submitted by

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IN

COMPUTER SCIENCE AND ENGINEERING , INTERNET OF THINGS

PRESIDENCY UNIVERSITY

BENGALURU

DECEMBER 2025

PRESIDENCY UNIVERSITY
Private University Estd. in Karnataka State by Act No. 41 of 2013
Itgalpura, Rajankunte, Yelahanka, Bengaluru – 560064

PRESIDENCY SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

BONAFIDE CERTIFICATE

Certified that this report "MOBILE APP FOR DIRECT MARKET ACESS FOR FARMERS" is a bonafide work of "HEMANTH S (20221CIT0089), PRANEETH SAI V(20221CIT0090), VIJAY KUMAR T (20221CIT0063)", who have successfully carried out the project work and submitted the report for partial fulfilment of the requirements for the award of the degree of BACHELOR OF TECHNOLOGY in COMPUTER SCIENCE ENGINEERING, INTERNET OF THINGS during 2025-26.

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DECLARATION

We the students of final year B.Tech in COMPUTER SCIENCE ENGINEERING, INTERNET OF THINGS at Presidency University, Bengaluru, named HEMANTH S , PRANEETH V , VIJAY KUMAR T , hereby declare that the project work titled **"MOBILE APP FOR DIRECT MARKET ACCESS FOR FARMERS"** has been independently carried out by us and submitted in partial fulfillment for the award of the degree of B.Tech in COMPUTER SCIENCE ENGINEERING, INTERNET OF THINGS during the academic year of 2025-26. Further, the matter embodied in the project has not been submitted previously by anybody for the award of any Degree or Diploma to any other institution.

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ACKNOWLEDGEMENT

For completing this project work, We/I have received the support and the guidance from many people whom I would like to mention with deep sense of gratitude and indebtedness. We extend our gratitude to our beloved **Chancellor, Pro-Vice Chancellor, and Registrar** for their support and encouragement in completion of the project.

I would like to sincerely thank my internal guide Dr./Mr/Ms **Dr. Sampath A K, Professor**, Presidency School of Computer Science and Engineering, Presidency University, for his/her moral support, motivation, timely guidance and encouragement provided to us during the period of our project work.

I am also thankful to **Dr. Anandaraj, Professor, Head of the Department, Presidency School of Computer Science and Engineering** Presidency University, for his mentorship and encouragement.

We express our cordial thanks to **Dr. Duraipandian N**, Dean PSCS & PSIS, **Dr. Shakkeera L**, Associate Dean, Presidency School of computer Science and Engineering and the Management of Presidency University for providing the required facilities and intellectually stimulating environment that aided in the completion of my project work.

We are grateful to **Dr. Sampath A K, and Dr. Geetha A, PSCS** Project Coordinators**, Dr. Sharmast vali, Program Project Coordinator**, Presidency School of Computer Science and Engineering, or facilitating problem statements, coordinating reviews, monitoring progress, and providing their valuable support and guidance.

We are also grateful to Teaching and Non-Teaching staff of Presidency School of Computer Science and Engineering and also staff from other departments who have extended their valuable help and cooperation.

HEMANTH S
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Abstract

Agriculture plays an important role in the Indian economy; it provides jobs for most of the rural population. However, farmers continue to experience serious problems including: intermediaries controlling their pricing, lack of transparency around prices, and market inefficiencies, which are limiting their access to more extensive markets. As a result of these obstacles, farmers frequently receive low prices for their products and consumers pay excessive prices. This paper proposes creating and developing a mobile-based digital marketplace that links farmers directly with consumers, retailers and wholesalers therefore removing the need for intermediaries and providing fair trade practices to farmers.

The proposed digital marketplace will be designed to create a transparent and inclusive trading environment for all participants of the marketplace. Key components of the digital marketplace to provide transparency and inclusivity will be: 1) Digital registration as a farmer; 2) Agricultural products catalogued digitally; 3) Real-time pricing updates on products; 4) Secure payment gateways for farmers; 5) Logistics and Delivery Integration with Farmers; and 6) Multilingual support, which allows people of different languages to communicate and transact with each other.

To create a system architecture for the mobile-based digital marketplace that has been proposed to rural areas, the system will be built on Android Studio, Firebase, and Java platforms, which will provide a reliable, scalable, and simple-to-use platform of development for rural areas. Both the Firebase Realtime Database and Firebase Cloud Storage will synchronously keep the database records current at all times regardless of the internet connection state and they will ensure database integrity for both types of databases. The mobile app will consist of a total of five main modules that allow Farmers the ability to register their farm; list a product for sale; create an online marketplace for buying and selling products; manage purchased items and orders from the mobile application and analyze sales, order and product information from the database.. Farmers will be able to upload product information to the mobile application, set prices, and communicate with buyers in real time, while Buyers will have the ability to view available products, compare prices, and purchase items securely within the mobile application using digitally integrated payment methods. To secure Farmer, Buyer, and Administrator data and provide reliable functionality, the mobile application will use Role-based Access Control based on user type. The incorporation of the blockchain-enabled Transaction Record functionality and End-to-End Data Encryption will enhance the trustworthiness and transparency of the system throughout the supply chain.

The methodology will include requirements analysis, designing the Architecture of the System, building a Prototype of the Mobile Application, and conducting Usability Testing. A key aspect of the developed User Interface is to provide a multilingual and lightweight design for ease of accessibility to first-time smartphone users in the Rural Areas Farmers will have better access to markets and, therefore, will receive more competitive prices with this system than they do with existing systems, eliminating their reliance on various middlemen. In addition, this system provides consumers with

traceable transactions and verified sources of agricultural products, thus developing consumer trust in the products they purchase. In a more extensive sense, this platform can develop into a larger scale, including AI-based demand prediction, supply chain optimisation and smart inventory management as means to achieve greater efficiency while minimising waste. Thus, the proposed application not only provides a communication link for farmers and buyers, it provides the tools necessary to develop an environmentally sustainable, fully transparent and technologically innovative agricultural marketplace in India.

Table of Content

List of Figures

List of Tables

Abbreviations

Abbreviation	Full Form
AI	Artificial Intelligence
API	Application Programming Interface
CRUD	Create, Read, Update, Delete
CSV	Comma-Separated Values (used for Excel import)
DBMS	Database Management System
DOCX	Microsoft Word Document Format
FIREBASE	Google's Cloud-Based Backend-as-a-Service
FS	Firestore (Firebase Cloud Database)
FSD	Full Stack Development
HTTP	HyperText Transfer Protocol
ML	Machine Learning
PDF	Portable Document Format
XML	Extensible Markup Language
REST	Representational State Transfer
AS	Android Studio
UI	User Interface
URL	Uniform Resource Locator
WWW	World Wide Web

CHAPTER 1

INTRODUCTION

1.1 Background

In contrast to the economic contribution to India's agricultural sector, it accounts for roughly 11 per cent of India's GDP and provides employment to approximately fifty-eight percent of India's rural labour force. However, the agricultural sector in India continues to encounter numerous difficulties due to numerous intermediary parties involved in the process of marketing agricultural products. This includes such issues as price manipulation by these intermediaries, inadequate and unreliable supply chain infrastructure, the unavailability of real-time market information, and the fact that small and marginal farmers, representing roughly eighty-six per cent of the total farming population, have no access to, or bargaining strength in, the direct selling of agricultural produce.

Many conventional marketing systems allow farmers to sell their agricultural products to middlemen and/or commission agents for less than the fair market value. Consequently, this creates additional costs to farmers and consumers since they must pay a larger price, or markup, when purchasing agricultural products since the consumer must pay for the extra cost borne by the farmer.Furthermore, the lack of digital records and price transparency creates an additional barrier to the establishment of trust between buyers and sellers. Consequently, given the increasing smartphone penetration and internet connectivity in rural areas of India, digital platforms represent an excellent avenue for bridging this gap. Applications available via mobile platforms, for example, can empower farmers by enabling them to directly access real-time information about markets and the prices of their products; as well as access secure digital payment systems that facilitate safe and secure transactions.

As a result, this project intends to develop and produce a mobile application designed to assist farmers in establishing a connection with the consumer, retailer and wholesaler in order to eliminate the need for intermediary services while simultaneously promoting Fair Trade, Transparency and Efficacy within the Agricultural Market Ecosystem.

1.2 Statistics of the Project (pointwise)

- India is home to over 146 million farmers, nearly 86% of whom are small or marginal farmers (owning less than two hectares).

- The NITI Aayog report provides evidence that farmers typically receive only 25%-40% of the final retail price for their produce.
- To date, approximately 65% of farmers still depend on local dealers or Mandis for selling their produce, which can result from restrictions posed by a lack of digital literacy or access to technology.
- The Agritech market in India is projected to reach $34 billion by 2027, with mobile-based solutions being an important area of growth within that market.
- Approximately three-quarters of rural households in India currently own smartphones, creating new opportunities for the development of digital agriculture platforms.
- Farmers who use this app to gain direct access to the market may see a potential increase in income of 15%-25% and a decrease in consumer prices of 10%-15%.

1.3 Prior Existing Technologies

There are numerous governmental initiatives and platforms currently available performing the functions of digitalized and agricultural marketing. However, the majority of available options lack usability, accessibility, and transparency components.

- (eNAM) Electronic National Agriculture Market is a digital connection of Agriculture Produce Market Committee (APMC) Mandis by the government as an initiative; however, it is mainly created for large-scale trading, while connecting the actual farmers with the end-user.
- Agribazaar, DeHaat are a few of the private sector application platforms available for trading, supply of inputs and providing advisory services to farmers. However, the majority of these platforms require an advanced level of digital literacy, they are not well-suited for individuals without the ability to read/write in regional languages and/or who may not have continuous connectivity to the internet.
- Farm2Table, Kisan Network are applications that promote direct selling. However, most lack the use of blockchain for transparency and do not provide the ability for offline activity, nor create the ability for real-time synchronisation.

The proposed system enhances these current technologies with the ability to have user-friendly, mobile-enabled access, provide real-time data synchronised capabilities, support for multiple languages, and provide blockchain-enable transparency which makes it a comprehensive, inclusive solution specifically designed for the rural conditions within India.

1.4 Proposed Approach

This solution is intended for use in an agricultural eCommerce setting. The mobile application connects farmers directly to buyers. The system provides a safe and transparent method for trading between sellers (farmers) & buyers (consumers).

The system uses Android Studio as the software development platform, Firebase as the database backend and Java as the programming language; this will allow the mobile application to be scalable, reliable, and easy to implement.

The key features of the system include:

- Farmer Registration is a feature that allows farmers to create a digital account to upload their personal and farm information, verify their identity, and create a digital profile.
- The product listing feature allows farmers to create and add product detail (name, quantity, price, and quality) to the product database for buyer viewing
- The marketplace module displays all products available for buyers with updated pricing and allows buyers to filter by product, location, category, etc.
- The order management module allows buyers to place orders, confirm orders, and track their order deliveries.
- The Analytics Module provides users with data on buyer preferences, demand trends, and pricing patterns.
- This platform includes secure payment gateways and provides logistics tracking; therefore; it will work in multiple regions.
- In addition, the system has permission controls (role-based access control) that allow farmers, consumers, and admins to manage their respective access to the mobile application.

Every eCommerce transaction will be recorded using blockchain technology to promote increased transparency. All data recorded in the mobile application will be stored with end-to-end encryption for added protection.

1.5 Objectives

This project aims to design, create and test a safe, reliable and effective online market for agricultural producers. Our objectives have been clearly stated in terms of the system's functionality, performance, maintenance, security and deployment at a high level of detail and consistency.

i. Behaviour

- An Interactive Mobile Interface will allow farmers to register and list their agricultural products while connecting with buyers in a real-time manner (for example: create an easy-to-use UI with multilingual options to allow farmers to upload products and confirm orders in 3 clicks).

ii. Analysis

- Using Firebase Realtime Database to manage the gathering, storage, and analysis of the market-related data to provide insight into consumer product requests, as well as provide constant or dynamic pricing change alerts through area price comparisons of similar fruits or vegetables.
  (Example is that the system would gather data and provide graphical representation of price changes so that the farmers can make better decisions.)

iii. System Management

- Design a Modular Architecture to Manage User Roles (Farmer, Buyer, Admin) Based on Role Based Access Control to Enable Scalability and Maintainability of the System.
  (For Example - Manage Database Access Permissions Using Role Based Access Control and Synchronise Data Seamlessly Between Modules Using Firebase Cloud Storage).

iv. Security

- Guaranteeing the protection of personal information and the integrity of financial transactions through the implementation of both end-to-end encryption technology and a blockchain system for transaction logging.
  (For example: Storing all files using AES encryption and using a blockchain ledger to log all transactions securely.)

v. Deployment

- The goal of the project is to deploy a mobile application to an Android platform using the Firebase backend services and testing the application's performance in a low-connectivity environment while utilizing multiple users (simultaneously) in the

same location.
(For example, testing the application's performance when multiple users simultaneously send requests in a rural area with limited connectivity to check whether the application will store data locally, synchronize in real-time, and/or work offline.)

1.6 Sustainable Development Goals(SDGs)

This project aligns with several SDG's as set forth by the United Nations. Below are a list of the SDG's this project contributes too:

- **SDG 1 (No poverty) -** by creating income opportunities for small and marginal farmers.
- **SDG 2 (Zero hunger) -** by strengthening the agricultural supply chain and fairly distributing food resources.
- **SDG 8 (Decent work & economic growth) -** creating sustainable market links and promoting fair trade.
- **SDG 9 (Industry, innovation & infrastructure) -** by creating a scalable digital platform and using technology in agriculture.
- **SDG 12 (Responsible consumption & production) -** by improving efficiencies in agricultural supply chain and minimising wastage.

- **SDG # 16 (Peace, justice & strong institutions) -** Trading system based on support of blockchain for transparency & trace-ability of trades.

SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS

Fig 1.1 Sustainable development goals supported by Mobile App for Farmers

1.7 Overview of project report

All nine chapters of the Project Report provide a description of the design, development and evaluation of the proposed Mobile Application to establish direct farmer-to-market access.

Chapter 1 - Introduction - provides background, motivation, objective(s), scope, and alignment to the Sustainable Development Goals (SDG).

Chapter 2 - Literature Review - reviews existing systems and technologies in agricultural marketing, highlighting limitations, and identifying the need for the proposed solution.

Chapter 3 - System Analysis - provides information regarding the Requirements Analysis, Feasibility Study and System Modelling - including Data Flow Diagrams (DFD), and use case diagrams.

Chapter 4 - System Design - includes information regarding the overall architecture of the proposed solution, database design, UI/UX layouts and functional modules (i.e. Registration, Marketplace and Analytics).

Chapter 5 - System Implementation - discusses tools and technologies used to develop the system (i.e. Android Studio, Firebase, and Java) and describes how to integrate all modules together.

Chapter 6 - System Testing and Validation - describes testing methods and how to evaluate the performance of the system with respect to accuracy, usability and reliability.

Chapter 7 - Results and Discussion - provides an overview of the results that were generated by the system, screenshots taken from the system and performance relative to existing systems.

Chapter 8 - Future Enhancements - provides suggestions for how to improve upon the current version of the system, such as using AI for predicting market prices, integrating IoT technology into the project and creating a more advanced supply chain management system.

Chapter 9 - Conclusion and References - summarizes key findings, describes the contribution(s) made by this project, and provides a complete list of all references cited throughout the project document.

CHAPTER 2

LITERATURE REVIEW

Digital transformation of agriculture has provided numerous new ways for farmers to improve their quality of life, access new markets, and make better informed decisions about their farming operations. There have been a number of studies conducted to help understand how mobile applications and ICT solutions play a major role in the empowerment of small and marginal farmers. These technologies will provide small farmers access to real-time information, reduce dependence on intermediaries, and increase transparency in the agricultural value chain. A review of relevant literature provides a summary of the findings of ten studies, which were used to inform the project being proposed to develop a mobile application that would connect farmers directly to consumers.

In his work, Mostafa Kamal [1] discussed the development of mobile applications within agriculture and the ways in which they have positively impacted farmers' access to important information, tools for managing money, and systems for managing their agricultural inputs. He found that mobile apps provide farmers with tools that enhance productivity, as well as the ability to use data to help them make informed decisions, which has a significant impact on creating a sustainable rural economy.. This study backs up the idea of a digital system that would offer farmers market information in a transparent way and enable them to make the most of their sales strategies.

Soumen Pal [2] tells the story of the Mobile App of Krishi Vigyan Kendra (KVK) in India, which is the communication link between farmers and agricultural specialists. The research equally emphasizes that such apps are helpful in supplying instantaneous data on weather conditions, offering crop instructions, and sending alerts regarding market prices, thus the time and cost involved in the traditionally used information channels get reduced significantly.

Consequently, for the newly developed system, this is a very strong reason for the timely integration of price update and advisory features that would facilitate farmers in making efficient decision based on the latest agricultural prices offering, therefore saving their valuable time in this regard.

Nina M. Martin [3] is an advocate of the BUD App, which assists urban farmers in selling to local stores and low-income consumers. Her research identifies that mobile technology can immensely invigorate the supply chain by solving distribution issues for fresh food and at the same time, it creates healthy food equity. This study is in line with the project's goal to be able to link the farmers to the buyers, retailers, and consumers in a free-of-charge and transparent manner.

Balaji G. [4] mainly speaks on how mobile phones as a tool for communication have been instrumental in the promotion of the usage of advanced farming methods. As per his research, the use of mobile technology quickens the process of knowledge sharing and the spread of new ideas, thus the community goes through the change towards better agricultural practices at a much faster pace. This development is in accord with the communication and notification functions that form an integral part of the project, designed to facilitate interaction between farmers and buyers and provide them with the latest news swiftly.

R. Kanimozhi [5] examines the Uzhavan App that the Tamil Nadu government has developed and launched, aimed at providing farmers with weather forecasts, market prices, subsidies, and insurance details in their native language. The research reveals that government-supported digital instruments ease farming management and up the farmers’ confidence level during decision-making. The amalgamation of multi-lingual support and localized data in the proposed platform can help in maintaining open access to everyone and a large number of people getting it in the rural areas.

Chidiebere Joshua [6] delves into different aspects of mobile applications impact on Indian agriculture and comes to a conclusion that mobile-based digital tools lead to increased productivity, environmental sustainability, and support precision farming. The outcomes of the research imply that by integrating the elements with cloud databases and real-time data synchronization, as done in the proposed Firebase-based system, operational efficiency can be elevated, and data can be kept trustworthy.

Harish Chandra Singh [7] deeply studies and finds out the expanding role of Information and Communication Technology (ICT) in farming area such as mobile apps, the internet, and digital kiosks. The research shows the use of ICT tools can make farmers more powerful by giving them in time information on how to take care of their crops and get access to the market, this resulting in better yield and returns. This finding agrees with the project mission of direct contact through ICT between farmers and buyers as the most possible way to realize the connectivity goal.

Oluwatoyin Bukola Chete [8] thoroughly analyses how mobile phones could better women farmers' participation in agricultural markets in Nigeria. The research ends up concluding that mobile applications are instrumental in filling information and gender gaps, thus leading to a drop in transaction costs and giving women the power through the provision of market data access in an inclusive way. This underlines an imperative that agricultural apps should be user-friendly and attend to the needs of women in order to be accessible regardless of the level of literacy and socio-economic background.

Vivekanandhan V. [9] reveals the power of integrating ICT through mobile and web technologies to eliminate the information gap and boost agricultural productivity. His research findings are in line with the digital platforms concept that enables farmers to be accountable for their decisions by the use of data and resource management becomes easy. For the planned project, it would be a great idea to install a data analytics module that unveils market trends and thus, buyer preferences will become clear and the farmers can use this to lift their sales performance to the next level.

Douglas Allswell Kelechi [10] creates and experimentally evaluates a mobile app that aims to assist rural African farmers in farm management, marketing, and record-keeping. The outcome is that the decision-making and farm productivity capacities are considerably enhanced by such systems. This, therefore, is in perfect harmony with the main objective of the project proposed, i.e., the development of a safe, scalable, and real-time mobile platform for direct farmer-buyer connections without the intervention of middlemen hence, income stability is increased.

Overall, these documents provide substantial evidence that mobile-based agricultural systems are instrumental in fostering transparency, knowledge sharing, and profitability. However, it has been pointed out that various current systems are confronted with problems such as language barriers, limited scalability, lack of offline access, and data security issues. The current project is focused on addressing the issues with agricultural e-commerce in India, as stated above, through the development of an Android app that is multilingual, offline-enabled, and utilizes blockchain technology to create trust, transparency, and engagement among users. The application will allow users to communicate in multiple languages, while allowing for the ability to send and receive money digitally (via digital accounts) and view their transaction history in a secure way (via blockchain). All of these aspects are intended to provide an all-in-one, realistic solution to the modernization of the Indian agriculture marketing industry.

Table 2.1 Summary of Literature reviews

S no	Article Title, Published year, Journal name	Methods	Key features	Merits	Demerits

1	Mostafa Kamal (2022) – "Mobile Applications and Digital Transformation in Agriculture"	Analytical study on ICT adoption in agriculture	Integration of mobile platforms for farmer empowerment, data access, and market linkage	Improves farmer decision-making, productivity, and sustainability	Lacks real-world field validation and prototype demonstration
2	Soumen Pal (2021) – "Krishi Vigyan Kendra (KVK) Mobile App for Farmer Advisory Services"	Case study analysis	Provides real-time weather, crop advisory, and market data to farmers	Enhances efficiency, reduces time and operational cost	Does not include transaction or e-marketplace features
3	Nina M. Martin (2020) – "The BUD App: Connecting Urban Farmers to Local Stores"	Field survey and app usability study	Facilitates connection between farmers and local stores for fresh produce	Promotes food accessibility and strengthens supply chains	Limited to urban agricultural contexts and small user base
4	Balaji G. (2021) – "Role of Mobile Phones in Agricultural Communication"	Survey-based analysis	Uses mobile phones as communication tools for technology adoption and knowledge sharing	Promotes innovation diffusion and quick information flow	Does not discuss technical architecture or implementation
5	R. Kanimozhi (2022) – "Uzhavan App: Tamil Nadu's Digital Agricultural Platform"	Review of state government ICT project	Provides real-time updates on weather, market prices, subsidies, and insurance in local language	Strengthens decision-making and accessibility for farmers	Restricted to Tamil Nadu users and regional database

6	Chidiebere Joshua (2023) – "Impact of Mobile Apps on Indian Agriculture"	Analytical review	Mobile-based advisory, weather alerts, and market information	Encourages sustainability and precision agriculture	Theoretical study; lacks implementation details
7	Harish Chandra Singh (2021) – "Role of ICT in Agricultural Development"	Analytical study of ICT tools	Integration of ICT such as mobile apps and kiosks for market access	Enhances efficiency and timely decision-making	Broad ICT perspective; limited focus on mobile systems
8	Oluwatoyin Bukola Chete (2020) – "Mobile Phones and Women Farmers' Market Access in Nigeria"	Gender-based field research	Mobile technology for empowering women farmers and reducing information gap	Improves inclusivity and reduces transaction cost	Limited to Nigeria; cultural applicability may differ
9	Vivekanandhan V. (2021) – "ICT Tools for Enhancing Agricultural Productivity"	Conceptual framework and literature synthesis	ICT and web tools for information sharing and decision support	Improves efficiency, data-driven farming, and yield prediction	No empirical validation or pilot testing conducted
10	Douglas Allswell Kelechi (2022) – "Design and Testing of a Mobile App for Rural Farmers"	System design and testing	Mobile app for farm management, record keeping, and market linkages	Enhances productivity, simplifies operations, and boosts decision accuracy	Conducted in Africa; scalability to Indian context untested

Chapter 3

Methodology

The method outlined is divided into three separate sections, with these sections focusing on different aspects of the user's interaction with the system and how the user navigates through the registration and editing of their data to the interaction with a market and the fulfilment of their orders in less connected areas of rural areas.

The three phases of the proposed methodology each represent a distinct and critical part of the system.

The proposed system is organised by three main phases, which cover major components of the user stimulus, the app building process and the interaction of the user with the app.

The next step in the process is creating and confirming user's data by editing their profile and preferences and setting up account details.

In the next phase, you will have the opportunity to select services that match your preferences, and you will also be able to choose what service providers you want to work with.

Finally, in the last phase of the app, you will navigate to the marketplace and interact with service providers using your payment information and/or account credentials.

1. Data Collection and User Management

2. Marketplace Architecture and Offline Trading

3. Interaction, Tracking, and Evaluation

The structured plan used by the developers leads to the app being a lightweight, secure, and efficient one that supports online and offline modes of operation.

Phase 1: Data Collection and User Management

This first phase is all about getting farmers and buyers onto the platform, designing a secure data model, and managing the main entities that users, products, and orders represent.

User Registration and Authentication:

In order to register and log in with role-based features, the platform applies Firebase Authentication (Farmer, Buyer). After confirming the phone number or email, it is ensured that users are real and they have the correct access rights.

Farmer Profile Management:

With the help of digital profiles, farmers are able to present and update important data such as the location of the farm, the crops grown, and the seasonal availability. Food images and files are kept safe in Firebase Cloud Storage.

1.1 welcome page of Mobile app.

Welcome to Mobile App for Farmers

3.1 Mobile App Logo

Buyer Onboarding:

Individual consumers, retailers, or wholesalers buyers can sign up through a user-friendly interface to get access to the digital marketplace. Buyer information consists of the name, contact details, and favorite product categories.

Database Integration:

Everything structured data-wise like users, products, and orders are in Firebase Firestore.

Multilingual Interface Support:

The app is available in several local languages through Android's localization framework and thus different-state farmers can also use the app easily.

Phase 2: Marketplace Architecture and Offline Trading

This stage is the core of the system where main operations like product listing, browsing, order management, and payments are done based on offline-first design principles.

Farmer Product Listing Module:

Farmers are able to provide details of their products like name, category, price, quantity, and pictures by filling out a guided form. Before uploading, pictures are compressed locally to Firebase Cloud Storage to minimize the usage of the bandwidth.

Marketplace and Search Module:

Buyers are able to find products that they want by using category filters and keywords for the search. The marketplace feed is derived from the cached data when the user is offline and gets updated from the cloud when the user is online.

Order and Payment Processing:

Buyers are enabled to do the purchases and payments through UPI, wallets, or Razorpay gateway integration directly. Firestore is used for storing order confirmations and invoices securely.

Offline Synchronization Engine:

By using WorkManager and local caching, all the operations that were done offline like adding listings or messages are in a queue and will be synchronized automatically when the connection is back.

Peer-to-Peer Trading Support:

The program supports the sharing of product catalogs and order summaries via Bluetooth or Wi-Fi Direct between the farmers and buyers who are near each other and do not have internet access. It will help the farmers to expand their market in the areas that are far and have no or poor internet connectivity.

Phase 3: Interaction, Tracking, and Evaluation

This stage focuses on communication that happens in real-time, tracking the orders, web analytics, and the evaluation of the performance so as to maintain trust, transparency, and the capability of the system to be scaled up.

Chat and Negotiation Module:

Essentially, a chat based on Firebase Realtime Database or WebSocket API can be used directly by farmers and buyers for communication. This is the main feature that enables negotiation of price in real-time, clarification of the order, and the gaining of trust.

Order Tracking and Logistics Management:

After a buyer has made an order, the status of its delivery can be updated by the farmers (Packed, Shipped, and Delivered). To the buyers, push notifications are sent by Firebase Cloud Messaging. The next versions will have the ability to link with the logistics APIs for delivery tracking.

Feedback and Rating System:

Upon the delivery, buyers are given the chance to rate the farmer and the product's quality. These ratings are stored in Firestore securely so as to keep the platform reliable and transparent for the upcoming transactions.

Admin Monitoring Dashboard:

Admins can monitor all the activities that take place on the platform, approve the new users, check the transactions that have been flagged, and analyze the data, such as the number of users who are active, the total transactions, and the revenue trends.

Data Analytics and Insights:

Metrics on the use of the platform, like the crops that are most popular, the demand for the products during the different seasons, and the frequency of trade in a specific location are presented in the form of small analytics dashboards. These insights serve the farmers and the admins to plan more effectively.

Security and Maintenance:

Every communication between different parties is done via HTTPS/TLS encryption. Firestore Security Rules implement role-based permissions, whereas Firebase Crashlytics keeps an eye on runtime errors for continuous improvement..

3.5 Summary

The outlined method is a powerful, comprehensive, and digital marketplace route that is specifically adjusted to the needs of Indian farmers. The system, which is a mix of cloud technology (Firebase), mobile app design, and offline-first principles, guarantees that the service is accessible even in areas with weak connectivity. Incorporating features such as real-time synchronization, blockchain-based transaction tracking, and multilingual support makes the platform a welcoming, safe, and a next-generation solution.

By breaking down the development into modules and stages, it is also a plan that allows the system to be easily expanded with AI-based demand prediction, IoT integration, and logistics optimization coming from the subsequent versions.

Chapter 4

Project Management

4.1 Project Timeline

This is an Agile Scrum project plan that spans 16 weeks and is broken down into six 2-week sprints. The phases of the development lifecycle are from requirement gathering to deployment and have milestones that signify the completion of each phase. The parts of this project consequently are:

The Project Planning Phase, which designs the system, plans the architecture, and analyzes the stakeholders, and

The Project Implementation Phase, which concentrates on the iterative programming, testing, and deployment of the main modules.

The project schedule is visually represented by a Gantt chart, which displays activities along a horizontal timeline. Each bar on a Gantt chart reflects the amount of time it takes to complete that particular task. The horizontal position of the bar signifies both the beginning date and end date of a task's timeframe. Connecting arrows, which connect the task bars, indicate which tasks need to be completed (predecessors) before starting another task. Milestones (such as when a database is finished or when the user interface is designed) are represented as diamond shapes in a Gantt chart. The amount of progress made during each sprint is displayed by partially filled bars that show how many/some of the sprint's tasks have been completed along with their corresponding percentages toward completion.

The implemented Agile methodology is very appropriate for this project as it allows for continuous feedback and changes to be made. The farmers, buyers, and administrators are the main stakeholders whose feedback after each sprint ensures that the new requirements can be smoothly incorporated without disrupting the work process. The iterative approach allows the development team to improve the usability, accessibility, and performance of the product based on the feedback from the testing users they get in real time, rather than be dependent on the specifications only.

The project schedule is also consistent with the circumstances of the rural app development, i.e., low connectivity, language diversity, and evolving feature requirements. The flexibility of Agile makes it possible for the team to deal with such problems in a dynamic manner while they carry on with their delivery plans which are incremental and predictable. The outcome of every sprint is a working prototype that can be tested and shown to sample users before moving to the next sprint.

4.1.1 Project Planning Phase

During Sprint 0, the team conducts requirement analysis by means of interviews with farmers, traders, and the agriculture officers to get a fair understanding of their needs. The insight gained from these interviews helps in defining the user stories for the modules of the farmer and the buyer. The literature review activities are to identify the best practices from the existing agricultural platforms like eNAM and Uzhavan that the team can emulate so as not to do the same work again but to concentrate on the issue of offline trading and blockchain-based transaction logging for transactions as unique problem areas.

System architecture formalization, the development of database schema, and UI/UX wireframing are the objectives of Sprints 1 and 2 respectively. To provide for real-time synchronization and secure data storage, Firebase Firestore is the service chosen, whereas Android Studio is the stable platform for app development. The API design and OpenAPI documentation produced in these sprints serve as the technical contract between the frontend and backend teams thus enabling efficient parallel development in the subsequent phases.

Two significant milestones denote the success of this stage:

Milestone M1: Completion of requirement analysis and approval of system specifications by stakeholders.

We completed Milestone M2 by finalizing the architecture and database design, which will allow us to proceed to the implementation phase of the Platform. A well-structured plan will enable the System to be Designed for Scalability, Security, and to Address the Challenges Associated with Rural Deployment..This well-organized planning paves the way for thesystem to be scalable, secure, and equipped to tackle the problems of rural deployment.

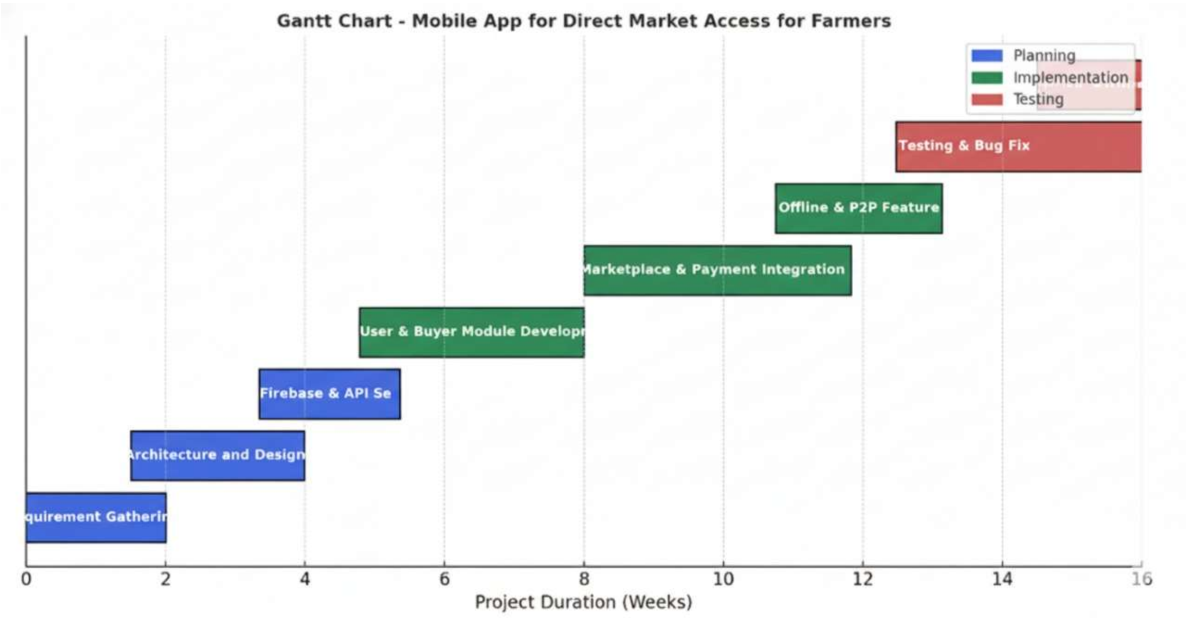


Fig 4.1 Project Planning Phase

4.1.2 Gantt Chart Visualization

The Gantt chart illustrates every aspect of the project schedule; Weeks 0–16. It breaks down the total number of hours attributed to Planning, Development, Testing and Deployment.

• Planning Activities (0–5): Blue represents this period's activities, and there were three activities within it: Requirement Analysis, Architecture Design and Stakeholder Alignment.

• Implementation Activities (6–13): The activities in this period are highlighted by green while the core development modules of the Registration, Product Listing, Marketplace and Payment work were done.

• Testing & Deployment (14–16): Red represents the activities in this period and so there were three activities identified here: System Testing, Bug Fixing and Release Preparation.

Additionally, the Gantt chart also presents seven milestones that have each been marked: Completion of Registration Module, Product Listing, Payment Gateway Integration, Offline Sync Testing and Final Deployment. All other activities that have dependencies on the activities are dependent on them for completion (e.g., Firebase Integration and Security Setup will need to be finished prior to the Marketplace Functionality).

Such a workload distribution visualization through the Gantt chart aids in resource management and guarantees that the team members have equitable workloads. Backend developers have a heavier workload in the first sprints (database and API setup), whereas frontend developers concentrate on UI development in the middle sprints. The last sprints involve all team members in integration testing and optimization to ensure a stable release.

4.2 Risk Analysis

The Mobile Application for Direct Market Access for Farmers is deeply integrated within an equally intricate agricultural and technological environment, which, in turn, demands a thorough understanding of external risks. In order to foresee and avoid the hazards that can obstruct their way, a PESTLE analysis (Political, Economic, Social, Technological, Legal, and Environmental) was conducted.

Political Factors

The operations of the system could be influenced by government regulations, digital agriculture policies or data governance laws, particularly as regards data sharing and digital transactions. A sudden change in the policy of agricultural subsidies or in the requirement of data localization could cause a halt in the integration with official databases. To abate such risks, the project is aligning itself with the standards of the Digital India, e-Governance, and Data Privacy initiatives and is, meanwhile, conducting data hosting on multi-region cloud servers certified by government security standards.

Economic Factors

Market fluctuations, inflation, and the changes in funding availability can, directly or indirectly, influence resources and the operational costs of the project. To illustrate, the rising costs of servers or APIs might become the primary reason for the grow of the maintenance costs. The system also relies on open-source technologies, the scalable Firebase plans, and uses a cost-efficient cloud to defray such costs. Besides, a financial contingency fund is meant to provide smooth operations in case of budget changes or delayed funding.

Social Factors

As one of the biggest obstacles to app usage, low digital literacy of farmers and unawareness in general and resistance to adoption of technology could be addressed through digital literacy programs, local language content, and community sessions. Some users may choose to sell their products through the traditional channel of middlemen because they are skeptical of the new ways of doing business. The app has been designed user-friendly with language options and is supplemented by training videos and community programs. The fair-pricing mechanism and the safety of transactions through the app will help attract and retain users' trust and confidence.

Technological Factors

The app is very much reliant on the internet and cloud storage of data alongside the use of mobile devices and the digital payment system. Possible dangers are hacking, service interruptions, and difficulties in linking with payment gateways. Besides, within a short span of time, technologies keep evolving and thereby, some components could become obsolete. To handle the risk, the platform uses a modular architecture that provides for future expansion or replacement. Security features like the use of encryption, 2-factor authentication, and regular security audits carried out by Firebase keep data safe and access to the system stable.

Legal Factors

Among legal challenges, risks related to data privacy, strict regulation of transactions and consumer protection measures- stand out. It has to be ensured that personal and transactional data of farmers and buyers meet the requirements set forth by the IT Act, 2000 and the Digital Personal Data Protection Act, 2023, respectively. In this regard, the platform recruiter lays emphasis on having clearly written service terms and privacy policies. Besides, data is encrypted always and at all locations, and audit checks are done at regular intervals to promote transparency.

Environmental Factors

Although mainly a digital platform, the environment could, for example, through energy blackouts, server failures, or extreme weather conditions impair the platform's accessibility.

In Summary,

The PESTLE analysis demonstrated that this project is affected by excessive political, social and technology pressures, but their influence can be mitigated through continuous compliance with best practices, educating clients and implementing strong security protocols. In addition, agile development methods, open-source software, high-level encryption, and multilingual support are some of the ways this project will build system resilience, adaptability and sustainability into its infrastructure long term. With all of these risk management structures, this project will help it become a transparent, trustworthy digital marketplace that will provide a safe place for farmers to purchase and sell supplies and services online.

Chapter 5

Analysis and Design

The phases of Analysis and Design are critical to the Mobile Application for Direct Market Access to Farms that serves as a conduit between Farmers and Buyers and Administration. In the Analysis Phase, the goal is to determine the needs of Everyone Who has a stake in Agricultural Trading, identify the Problems faced in Agricultural Trading Currently, and document the Primary Requirements for the System. The Design Phase implements those Primary Requirements into a Detailed Technical Blueprint that outlines the Hardware, Software, Data Flow, and Functional Modules of the System.

These stages, first of all, pave the way for the launch of a platform that is not only secure and scalable but also user-friendly, thus facilitating market transparency and efficiency for small and marginal farmers.

5.1 Requirements Specification

Requirements specification is a document that describes the features and functionalities of the system in order to meet the user and business objectives. It is the base for system architecture, the team of developers, designers, and stakeholders use it as a guide during the entire development cycle.

5.1.1 Functional Requirements

The system's functional requirements specify the essential operations of the app for various user roles — Farmers, Buyers, and Administrators.

FR No.	Functional Area	Key Functions (Summary)
FR1	User Registration and Authentication	Secure registration and login for farmers and buyers using Firebase Authentication; supports phone number and email verification; role-based dashboard access.
FR2	Farmer Profile Management	Farmers can create profiles with details such as farm location, crop type, seasonal availability, and upload images or certificates securely to Firebase Cloud Storage.
FR3	Product Listing and Marketplace	Farmers can add product details (name, price, category, quantity, and images); buyers can browse listings using category filters and keyword search.
FR4	**Order Placement and Payment**	Buyers can place orders and make payments using UPI, wallets, or Razorpay integration; order confirmations and invoices stored in Firestore.

FR No.	Functional Area	Key Functions (Summary)
FR5	Offline Synchronization	App supports offline data entry and viewing using local caching; data automatically syncs with Firebase once connectivity is restored.
FR6	Peer-to-Peer Trading	Farmers and buyers in nearby areas can exchange product catalogs via Bluetooth or Wi-Fi Direct when the internet is unavailable.
FR7	Chat and Negotiation System	Real-time communication between farmers and buyers using Firebase Realtime Database; supports message storage, price discussion, and order negotiation.
FR8	Feedback and Rating System	Buyers can rate farmers and provide feedback after product delivery; ratings help enhance reliability and transparency.
FR9	Admin Management Module	Admins can monitor user registrations, transactions, and reports; approve or block users; and manage platform analytics.
FR10	Notifications	Sends real-time updates via Firebase Cloud Messaging for order confirmations, price changes, and delivery updates.

Table 5.1 Summarizing of Functional Requirements

NFR No.	Category	Key Requirements (Summary)
NFR1	Performance Requirements	App should load within 3 seconds; handle up to 1,000 concurrent users; complete order transactions within 5 seconds; maintain 99% uptime.
NFR2	Scalability Requirements	System should support additional modules such as AI-based pricing and logistics integration; scalable database for large user data.
NFR3	Security Requirements	Data encrypted using TLS 1.3; authentication with OTP/email verification; role-based access; input sanitization; Firestore Security Rules enabled.

NFR No.	Category	Key Requirements (Summary)
NFR4	Usability Requirements	Interface should be intuitive and support multiple regional languages; user-friendly icons and forms; accessible on low-end Android devices.
NFR5	Reliability Requirements	Supports offline functionality; automatic synchronization; maintains backup copies; recovers gracefully from network errors.
NFR6	Maintainability Requirements	Uses modular architecture for easy updates; follows coding standards; logs system errors using Firebase Crashlytics.
NFR7	Compatibility Requirements	Supports Android OS (v8.0+); integrates with UPI APIs and Firebase; compatible with multiple screen resolutions.

Table 5.2 Summarizing of Non - Functional Requirements

5.2 Block diagram

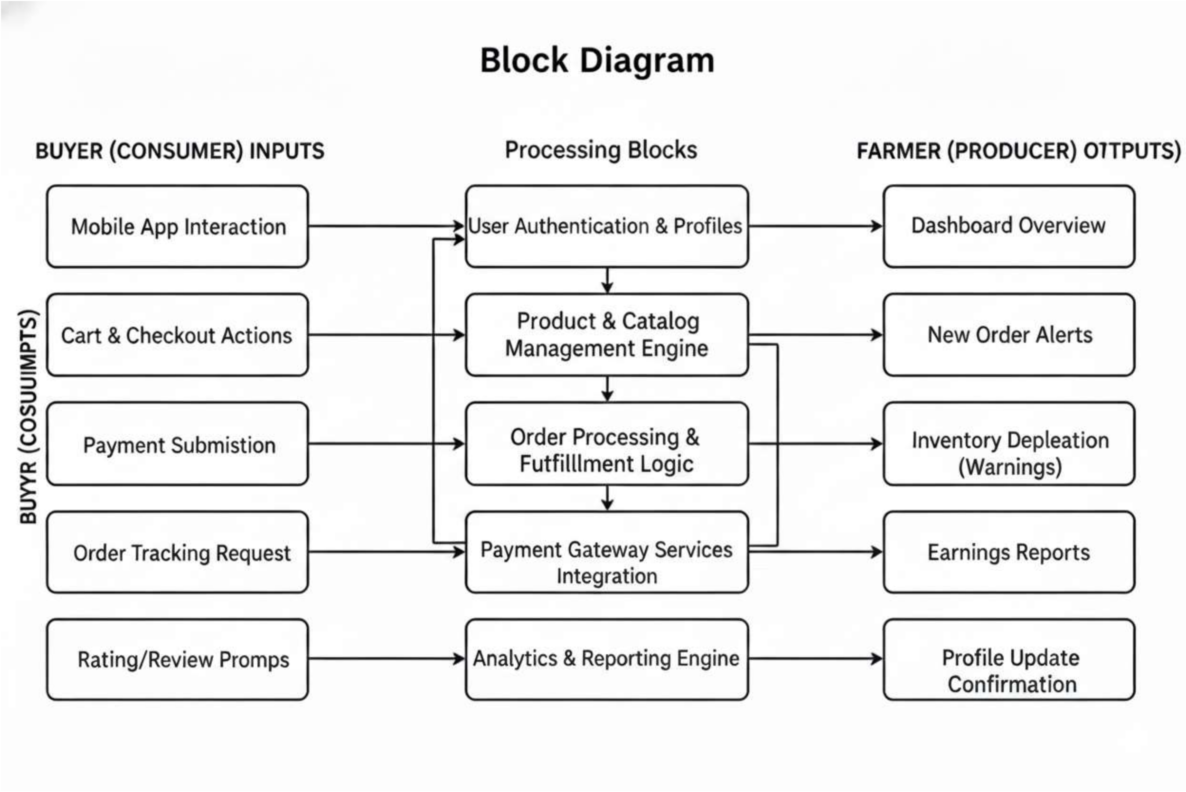

Block Diagram
BUYER (CONSUMER) INPUTS
Processing Blocks
FARMER (PRODUCER) OTTPUTS)
BUYYR (COSUUIMPTS)
Mobile App Interaction
Cart & Checkout Actions
Payment Submistion
Order Tracking Request
Rating/Review Promps
User Authentication & Profiles
Product & Catalog Management Engine
Order Processing & Futfilllment Logic
Payment Gateway Services Integration
Analytics & Reporting Engine
Dashboard Overview
New Order Alerts
Inventory Depleation (Warnings)
Earnings Reports
Profile Update Confirmation

Fig 5.1 Functional block diagram

The functional block diagram of the Mobile Application for Direct Market Access for Farmers breaks down the system into three major parts — Input, Processing, and Output Blocks.

The Input Block describes the users' operations like signing up, listing products, and placing an order.

The Processing Block is in charge of authentication, data storage, and transaction validation through Firebase and cloud APIs.

The Output Block shows the order status, payment confirmation, notifications, and analytics dashboards.

5.3 System Flow chart

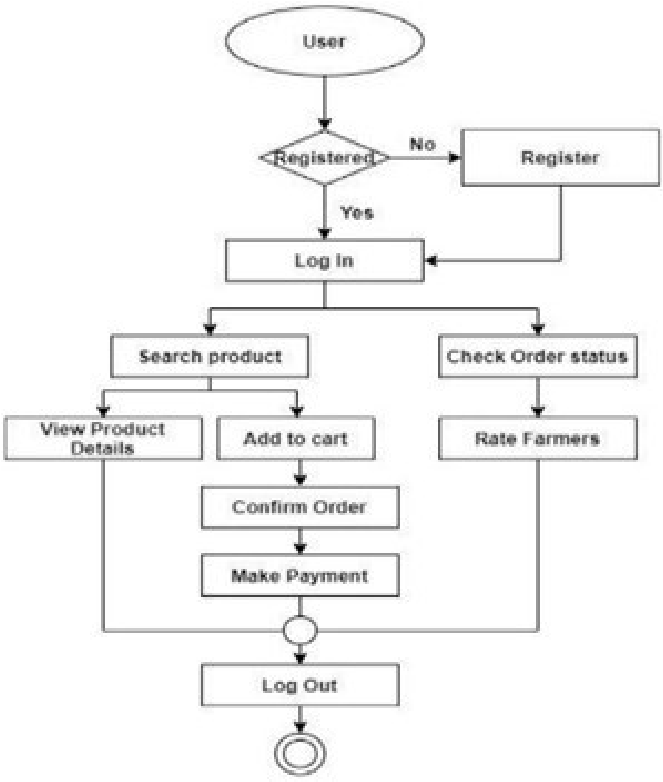


Fig 5.2 System flow chart

The flow of the system is initiated by a user login or a new registration through Firebase Authentication. According to the user role:

Farmers are allowed to upload crop details, set prices, and check orders.

- Buyers have the ability to look for products, make orders, and carry out payments.
- Admins oversee the functioning of the system and confirm user activities.

The Order & Payment Module, along with real-time updates and notifications, will also be included in the Program. User Actions are logged securely to Firebase Firestore, creating a seamless flow of data and synchronization between the various devices.

5.4 Standards

This agri-food market platform evolves conforming to IT and IoT standards that have been acknowledged for their security, compatibility, and expansion.

- Communication Standards: HTTPS and REST APIs for secure communication of data between mobile devices and the cloud; Bluetooth and Wi-Fi Direct for offline peer-to-peer transactions.

- Data Format Standards: JSON and XML for well-organized data transmission.

- Security Standards: TLS 1.3 for encrypting; ISO/IEC 27001 for managing the security of the information.

- Interoperability Standards: ISO/IEC 30141 (IoT Reference Architecture) and IEEE 802.11 (Wi-Fi Communication).

- Quality and Continuity Standards: ISO 9001 for quality management and ISO 22301 for system continuity.

The application of these standards is what keeps the app secure, compliant, and open to future tech developments.**5.5 Mapping with IoT World Forum (IoTWF) Reference Model Layers**

Table 5.3 Mapping Project layers with IoTWFRM

Layer	IoTWF Layer Description	Project Layer Mapping	Security Implementation
7	Collaboration and Processes (involving	Farmer-buyer interactions, order	Role-based access, secure feedback system

Layer	IoTWF Layer Description	Project Layer Mapping	Security Implementation
	people and business processes)	confirmation, feedback exchange	
6	Application (reporting, analytics, control)	Android mobile interface and admin dashboard	HTTPS, authentication, and access control
5	Data Abstraction (aggregation and access)	Firebase Firestore APIs for structured data retrieval	Token-based API validation and input sanitization
4	Data Accumulation (storage)	Cloud Firestore storing user data, transactions, and product catalogs	Encrypted data storage and backup security
3	Edge Computing (data element analysis and transformation)	Local caching and WorkManager for offline synchronization	Data validation and controlled caching
2	Connectivity (communication and processing units)	Wi-Fi, cellular data, and Bluetooth communication	TLS encryption and firewall protection
1	Physical Devices and Controllers (things)	User smartphones and tablets	Device authentication and secure credentials

5.6 Domain Model Specification

Domain Component	Description (Specific to Direct Market Access App)
Physical Entity	Farmers, buyers, and admins accessing the system via mobile devices.
Virtual Entity	Digital profiles of users, products, and transaction records stored in Firebase.

Domain Component	Description (Specific to Direct Market Access App)
Device	Smartphones and tablets serving as interfaces for trading and communication.
Resource	Firebase Firestore, Cloud Storage, UPI APIs, and localization services.
Service	User authentication, product listing, order management, analytics, and notification services.

Table 5.4 Description of Domain model

5.7 Communication model

The system employs a Publisher–Subscriber (Pub–Sub) Communication Model. In such a model, different components publish events or data without subscribers needing to request them manually. Farmers, buyers, and admin modules, as actors, can be publishers or subscribers depending on the action, while Firebase Cloud Messaging, Firestore Triggers, and Realtime Database listeners, as the event-distribution backbone, are the means of communication.

It is the cloud to which changes are immediately published when a farmer publishes new product listings, updates stock, or modifies prices. Real-time listeners ensure that all subscribed buyers receive the updated data instantly. In the same way, when buyers place orders or send negotiation messages, farmers, subscribed to those channels, are the ones that automatically receive notifications. Admin activities—such as monitoring flagged products or approving users—also use the same publish-subscribe pipeline.

The Pub–Sub model is thus the cause of low-latency communication, continuous updates, and very few manual refreshings. It is of great help, in particular, to rural areas with unstable connectivity since real-time listeners automatically re-sync data as soon as the network is restored. By decoupling publishers and subscribers, the system is as scalable as it wants to be, communication is asynchronous, and data distribution is seamless. Hence, it is an ideal communication model for a multi-user agricultural marketplace.

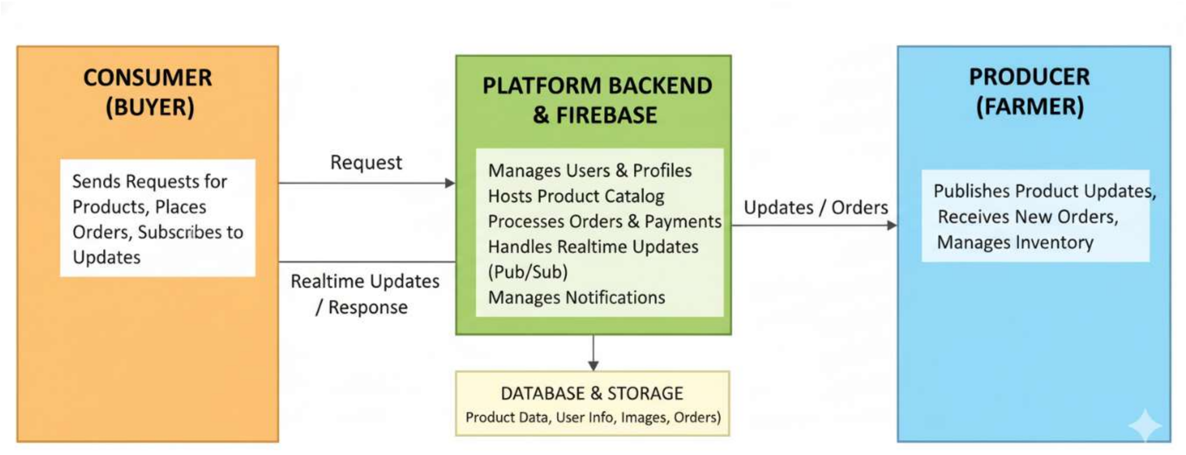

CONSUMER (BUYER)
Sends Requests for Products, Places Orders, Subscribes to Updates
Request
Realtime Updates / Response
PLATFORM BACKEND & FIREBASE
Manages Users & Profiles
Hosts Product Catalog
Processes Orders & Payments
Handles Realtime Updates (Pub/Sub)
Manages Notifications
Updates / Orders
PRODUCER (FARMER)
Publishes Product Updates, Receives New Orders, Manages Inventory
DATABASE & STORAGE
Product Data, User Info, Images, Orders)

Fig 5.3 Communication model suitable for Mobile Market Acess

5.8 Functional view

The system has various functional groups:

• Device Group: The mobile devices that the farmers, buyers, and admins use.

• Communication Group: They deal with the secure transfer of data by using HTTPS and Firebase APIs.

• Services Group: The core backend modules for registration, product management, order tracking, and payments.

• Management Group: Admin dashboard monitoring transactions, user activities, and analytics.

• Security Group: The facilities for encryption, authentication, and access control.

• Application Group: The front-end Android app with a multilingual interface and offline access.

These teams work together to provide a smooth, secure, and easy-to-use digital trading experience.

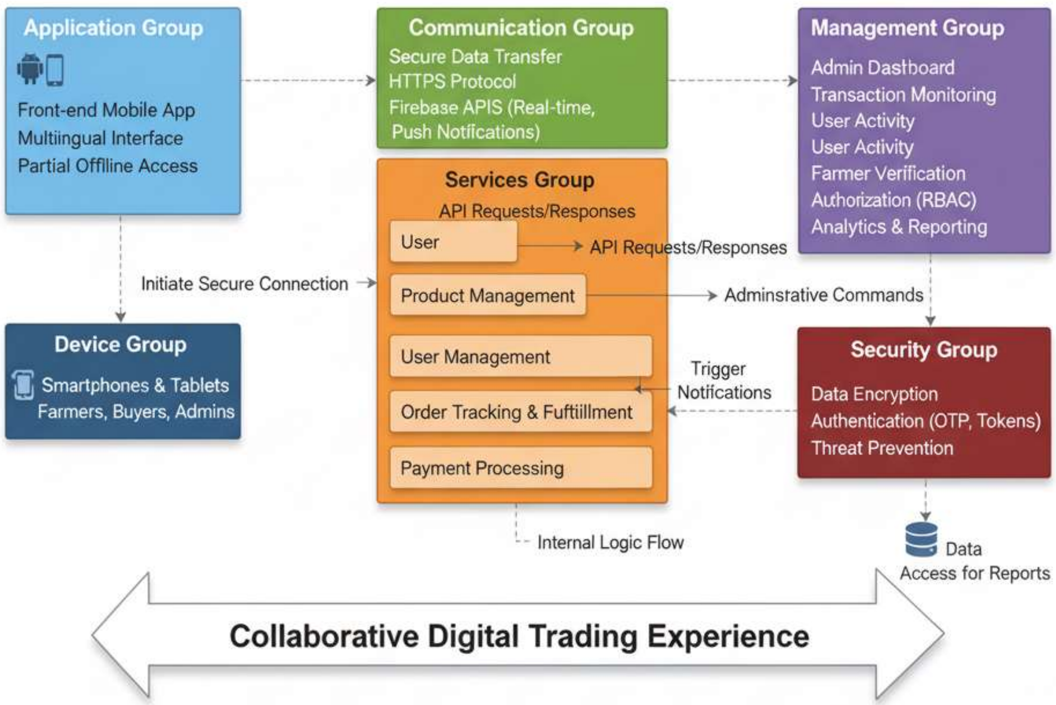


Fig 5.5 Functional view for Learning Dashboard

5.9 Mapping deployment level with functional blocks

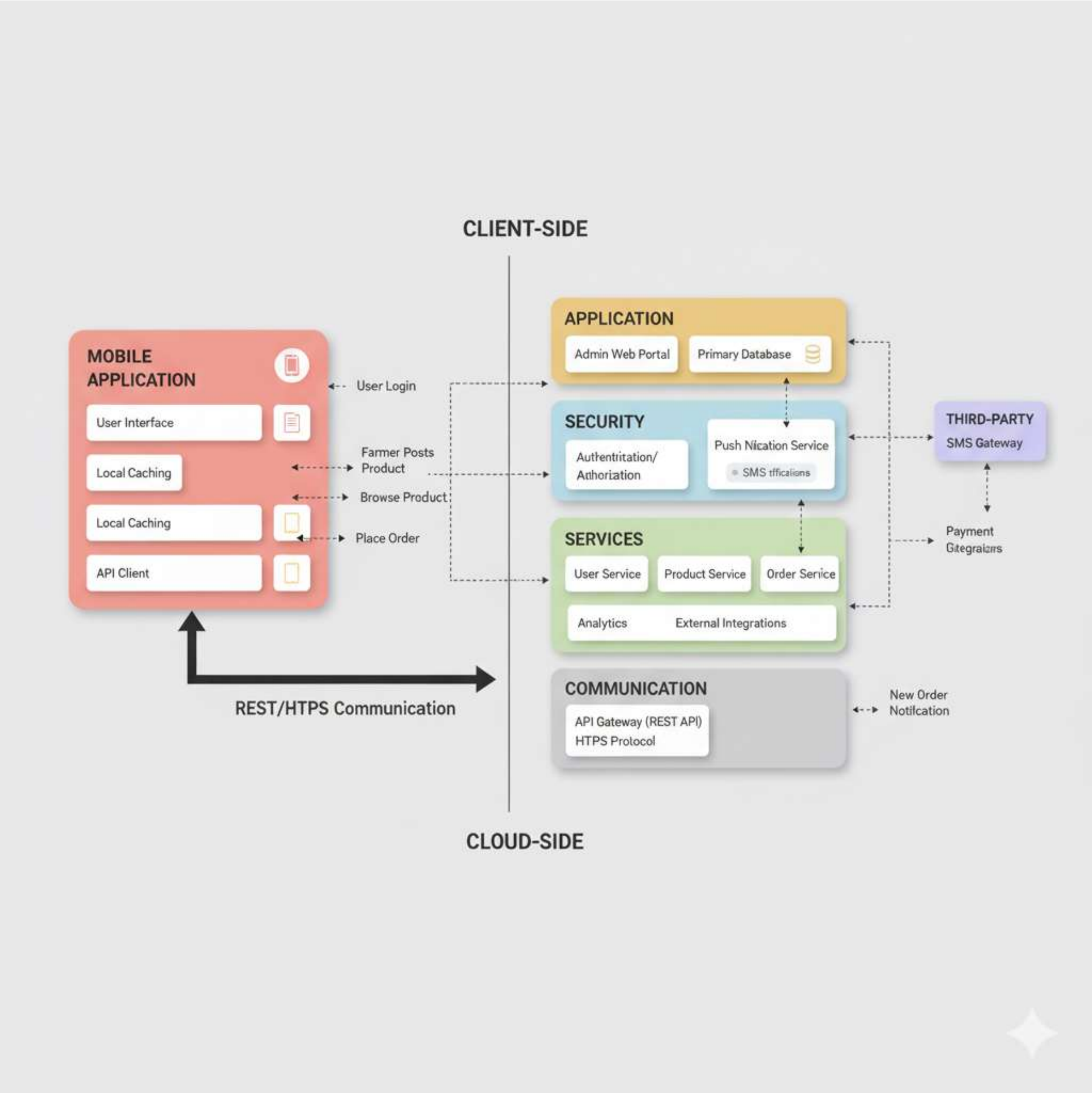


Fig 5.6 mapping deployment level with functional view

The plan in this file shows a state-of-the-art, separated client and server model of the farmer's mobile app that consists of two separate environments: The Client-Side and the Cloud-Side.

The Client-Side is the Mobile Application, which is the farmer's or customer's device and the User Interface of the app for interaction, Local Caching to store data temporarily for speed, and an API Client that securely sends requests (like "Farmer Posts Product") and receives data from the backend using REST/HTTPS Communication are all part of this app.

The Cloud-Side is the scalable backend system where all core processing and data storage happen. It is structured in functional layers. The Communication layer's API Gateway is the

Security layer and the Services layer Security, which includes the business logic for User, Product, and Order management, handle the requests first. The requests sent by the app are stored in the Primary Database (part of the Application layer) that also offers an Admin Web Portal for system management. In addition, this design connects with Third-Party services for such things as processing payments and sending SMS notifications..

Chapter 6

Software and Simulation

6.1 Software development tools

The software stack used in the development of the application includes:

6.1.1 Development Software

Android Studio (Latest Version)

- Primary IDE for mobile application development
- Supports XML-based UI and Java/Kotlin backend

Firebase Cloud Services:

- Firebase Authentication – Secure login
- Firebase Firestore – NoSQL cloud database
- Firebase Cloud Storage – Image and document storage
- Firebase Cloud Messaging – Push notifications
- Firebase Crashlytics – Crash reporting

Razorpay / UPI Integration SDK:

- Used for secure payment processing.

6.1.2 Supporting Tools

- GitHub – Version control and collaborative development

6.1.3 Software Architecture

- Presentation Layer (Android Mobile App – Frontend**)**
- UI components
- Localization support
- Offline data caching

6.1.4 Application Logic Layer

- Authentication logic
- Product management functions
- Order and payment handling

6.1.5 Cloud Backend Layer

- Firebase Authentication
- Firestore Database
- Cloud Storage
- Notification service

6.1.6 Simulation and Testing Environment

Since the system includes cloud and offline functionalities, multiple simulation methods were used:

6.1.7 Android Emulator Testing

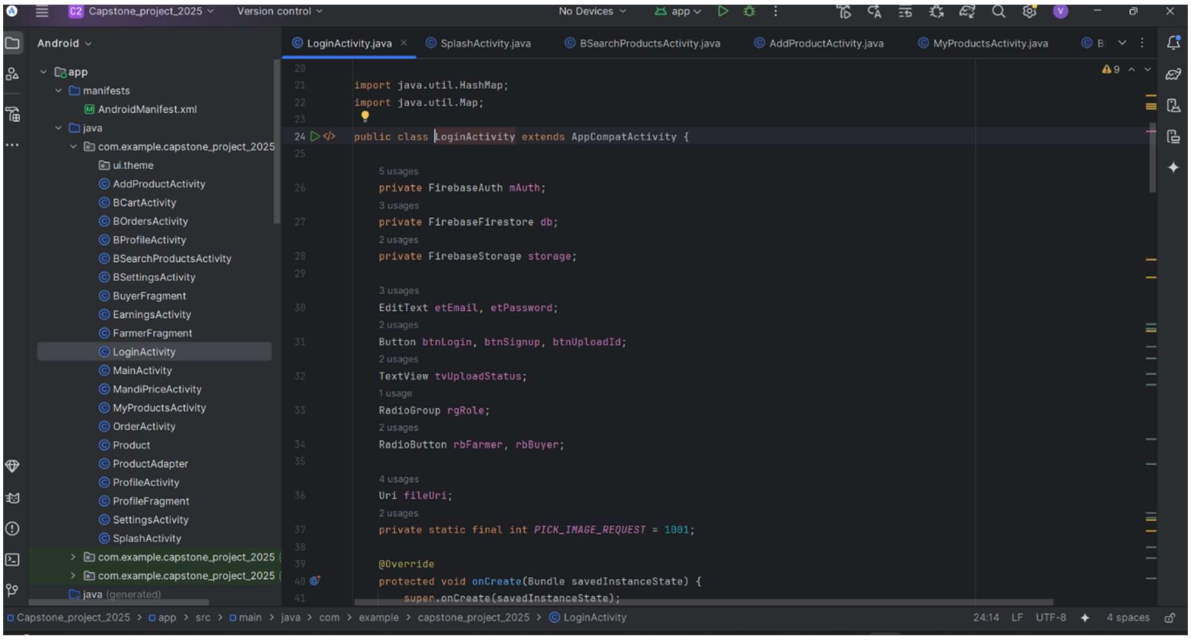
The app was tested on multiple emulator configurations:

- Pixel 4a – Android 11
- Nexus 5X – Android 8.1
- Low-RAM device simulation (1 GB RAM mode)

6.1.8 Testing Tools

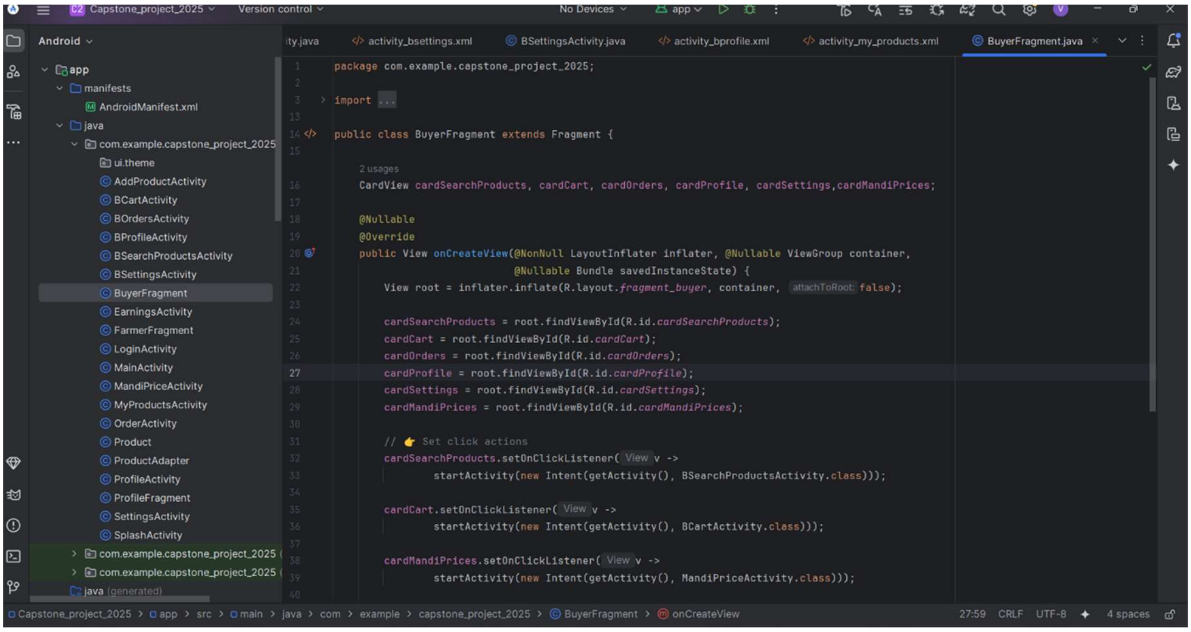
- Firebase Test Lab – Automated mobile testing

6.2 Software code



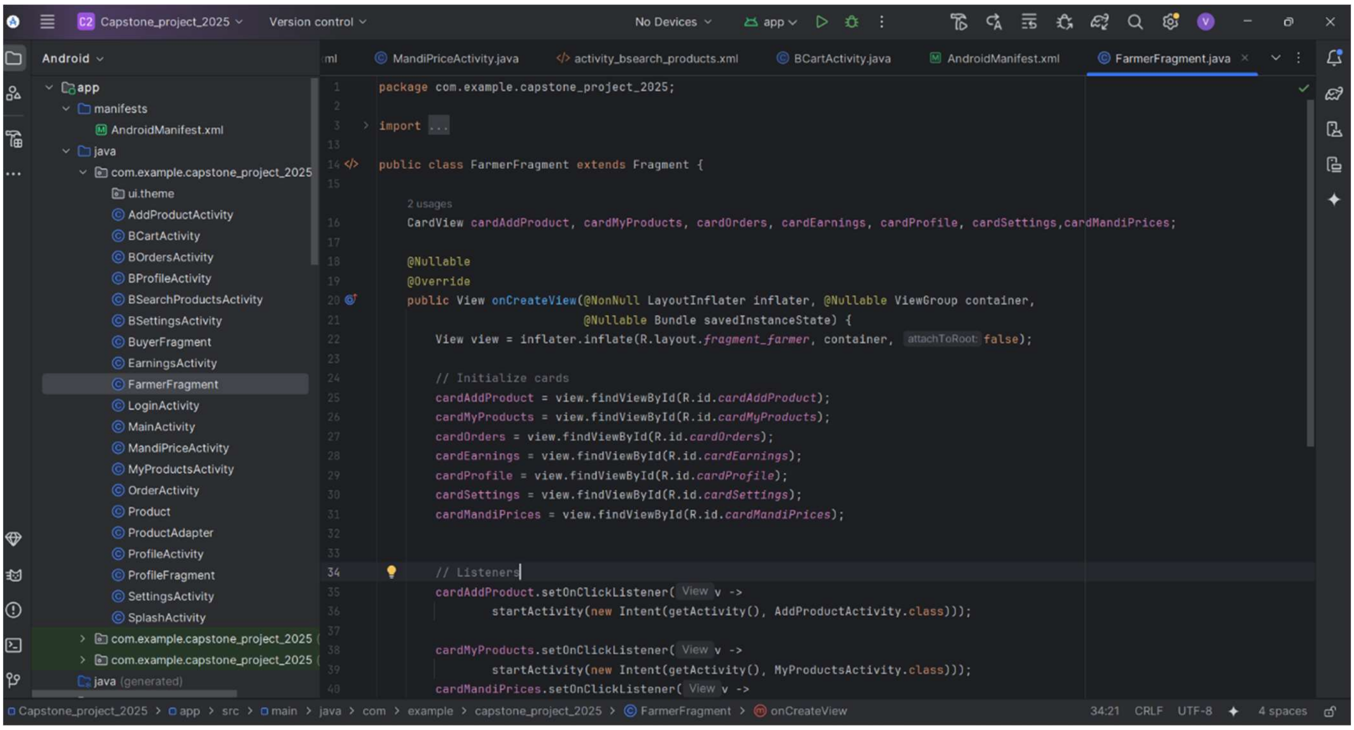
```java
import java.util.HashMap;
import java.util.Map;

public class LoginActivity extends AppCompatActivity {

    5 usages
    private FirebaseAuth mAuth;
    3 usages
    private FirebaseFirestore db;
    2 usages
    private FirebaseStorage storage;

    3 usages
    EditText etEmail, etPassword;
    2 usages
    Button btnLogin, btnSignup, btnUploadId;
    2 usages
    TextView tvUploadStatus;
    1 usage
    RadioGroup rgRole;
    2 usages
    RadioButton rbFarmer, rbBuyer;

    4 usages
    Uri fileUri;
    2 usages
    private static final int PICK_IMAGE_REQUEST = 1001;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
```

Fig 6.1 Snapshot of login page code



```java
package com.example.capstone_project_2025;

import ...

public class BuyerFragment extends Fragment {

    2 usages
    CardView cardSearchProducts, cardCart, cardOrders, cardProfile, cardSettings,cardMandiPrices;

    @Nullable
    @Override
    public View onCreateView(@NonNull LayoutInflater inflater, @Nullable ViewGroup container,
                             @Nullable Bundle savedInstanceState) {
        View root = inflater.inflate(R.layout.fragment_buyer, container, attachToRoot: false);

        cardSearchProducts = root.findViewById(R.id.cardSearchProducts);
        cardCart = root.findViewById(R.id.cardCart);
        cardOrders = root.findViewById(R.id.cardOrders);
        cardProfile = root.findViewById(R.id.cardProfile);
        cardSettings = root.findViewById(R.id.cardSettings);
        cardMandiPrices = root.findViewById(R.id.cardMandiPrices);

        // 👉 Set click actions
        cardSearchProducts.setOnClickListener( View v ->
                startActivity(new Intent(getActivity(), BSearchProductsActivity.class)));

        cardCart.setOnClickListener( View v ->
                startActivity(new Intent(getActivity(), BCartActivity.class)));

        cardMandiPrices.setOnClickListener( View v ->
                startActivity(new Intent(getActivity(), MandiPriceActivity.class)));
```

Fig 6.2 Snapshot of BuyerDashboard code



```java
package com.example.capstone_project_2025;

import ...

public class FarmerFragment extends Fragment {

    2 usages
    CardView cardAddProduct, cardMyProducts, cardOrders, cardEarnings, cardProfile, cardSettings,cardMandiPrices;

    @Nullable
    @Override
    public View onCreateView(@NonNull LayoutInflater inflater, @Nullable ViewGroup container,
                             @Nullable Bundle savedInstanceState) {
        View view = inflater.inflate(R.layout.fragment_farmer, container, attachToRoot: false);

        // Initialize cards
        cardAddProduct = view.findViewById(R.id.cardAddProduct);
        cardMyProducts = view.findViewById(R.id.cardMyProducts);
        cardOrders = view.findViewById(R.id.cardOrders);
        cardEarnings = view.findViewById(R.id.cardEarnings);
        cardProfile = view.findViewById(R.id.cardProfile);
        cardSettings = view.findViewById(R.id.cardSettings);
        cardMandiPrices = view.findViewById(R.id.cardMandiPrices);


        // Listeners
        cardAddProduct.setOnClickListener( View v ->
                startActivity(new Intent(getActivity(), AddProductActivity.class)));

        cardMyProducts.setOnClickListener( View v ->
                startActivity(new Intent(getActivity(), MyProductsActivity.class)));
        cardMandiPrices.setOnClickListener( View v ->
```

Fig 6.3 Snapshot of FarmerDashboard code

Chapter 7

Evaluation and Results

7.1 Test points (Software Perspective)

In software-based systems, test points are the locations in the application where the internal behavior, data flow, and system response may be observed, recorded, and confirmed. These points are used to check them functionality, performance, and reliability of the system.

For the Direct Market Access Mobile App, test points are marked across:

- Authentication
- Database access
- API calls
- Offline caching
- Payment events
- Chat system
- UI actions
- Network transitions
- **Software Test Points and Measurements**

Test Point ID	Test Location	Purpose
TP1	Firebase Authentication	Validate login, OTP/email verification
TP2	Firestore User Collection	Check correct data creation & retrieval
TP3	Product Listing Module	Verify product upload & image compression
TP4	Offline Cache Storage	Validate offline product listing & sync
TP5	Payment Gateway (UPI/Razorpay)	Validate payment success/failure

Test Point ID	Test Location	Purpose
TP6	Chat Module	Verify message delivery, delay, and sync
TP7	Admin Dashboard	Validate monitoring data, flags, user logs

Table 7.1 Test points and measurements

7.1.2 Test Point Diagram (Software Architecture Test Points)

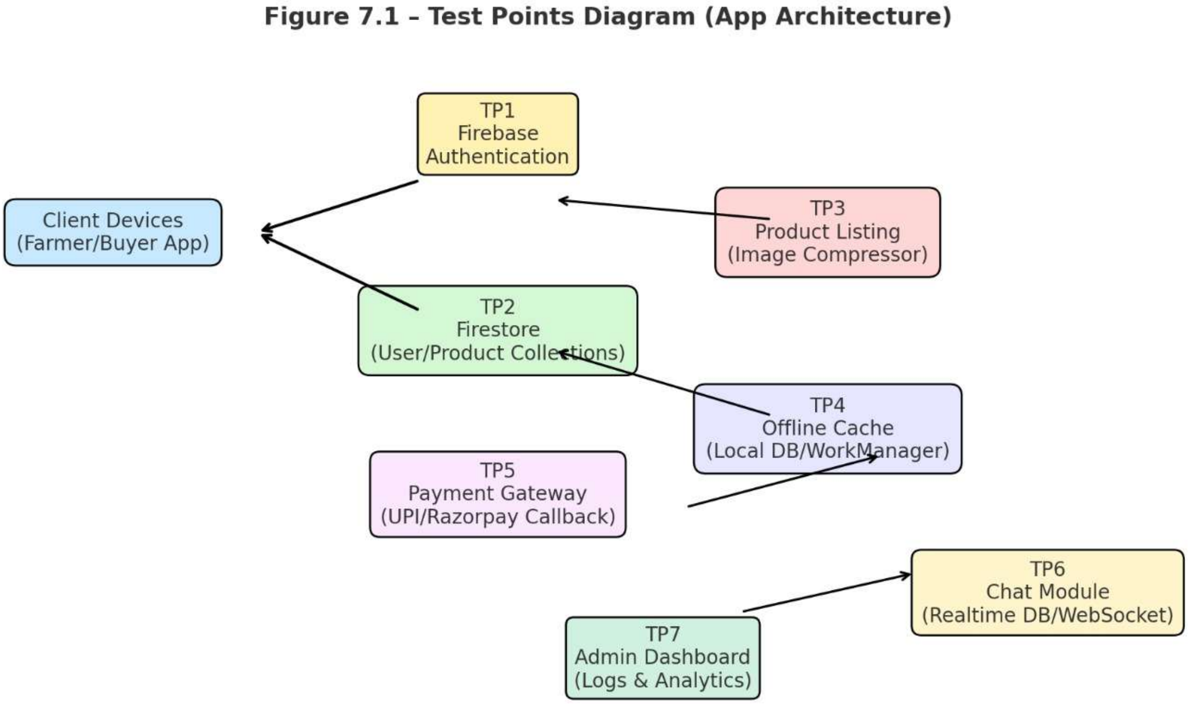


Figure 7.1 – Test Points Diagram (App Architecture)
TP1 Firebase Authentication
Client Devices (Farmer/Buyer App)
TP3 Product Listing (Image Compressor)
TP2 Firestore (User/Product Collections)
TP4 Offline Cache (Local DB/WorkManager)
TP5 Payment Gateway (UPI/Razorpay Callback)
TP6 Chat Module (Realtime DB/WebSocket)
TP7 Admin Dashboard (Logs & Analytics)

Fig 7.1 — Adapted For Software System

7.1Application Data Flow Indicating The Test Points

The diagram highlights test points at:

- Authentication
- Database write/read
- Offline cache sync
- Payment callback
- Chat real-time database
- Admin logs

This representation helps identify internal processing and validate expected outputs at each checkpoint

7.2 Test plan

The Test Plan of Direct Market Access Mobile App revolves around the software testing which is done on frontend (Android app), backend(Firebase services), payment integration, and offline/peer-to-peer features. The plan exhaustively lays down test objectives, methods, and validation criteria for each functional unit (Authentication, Profile Management, Product Listing, Marketplace & Search, Offline Sync, Payment, Chat, Admin Dashboard, and Analytics) etc.

Every scenario of testing is depicted in a systematic manner by a set of words - <Subject><Verb><Object><Conditions><Values><Range><Constraints>--which specifies clearly the features that have been tested and under what parameters. To illustrate This generates very clear, quantifiable tests that can be easily repeated and results assessed.

Testing Objectives & Methods

• Check the functions of all the modules (FR1–FR10) to be correct.

• Confirm the non-functional attributes of the system such as performance, security, reliability, and usability.

• Confirm that the app works offline-first and that peer-to-peer exchange is possible in no-network conditions.

• Ensure that payment flows and transaction logging are consistent.

• Ensure that the admin has the full visibility, that the

Testing Methods

- Unit Testing: JUnit (Java), Mockito for mocking Firebase calls.
- UI/Integration Testing: Espresso, AndroidX Test for screens and flows.
- API/Backend Testing: Postman collections and Firebase Rules simulator.
- End-to-End / System Testing: Firebase Test Lab, manual user acceptance with sample farmers.
- Performance & Load: Firebase Test Lab + emulated concurrent sessions to check sync and read/write latencies.Security Testing: Firestore rules testing, TLS verification, and basic OWASP Mobile top-10 checks.

- Usability Testing: Observational sessions and SUS-like scoring with target users.

Tools

- Android Studio, Espresso, JUnit, Postman, Firebase Test Lab, Firebase Rules Emulator, ADB, Logcat, WorkManager debug logs.

Types of Testing Applied

Black Box Testing

- Positive login
- Negative login
- Boundary values for image size, price

White Box Testing

- Path testing for product listing logic
- Branch testing for payment callback

Unit Testing

- Authentication module
- Firestore handler
- Image compressor

Integration Testing

- Chat + Firestore
- Payment + Order module

System Testing

- End-to-end order workflow

Validation Testing

- user acceptance testing with 10 farmers & 5 buyers

Reporting & Logging

• Test Logs: Keep logs of test-runs in GitHub Actions artifacts and store them in Firebase Crashlytics for runtime issues.

• Defect Tracking: Employ GitHub Issues / Jira for defect tracking with the following tags: module, severity, steps to reproduce, related test case ID.

• The Daily Test Summary: for each System Test Day shall include a record reflecting Total Number of Test Cases Executed, Pass Rate, and the number of Critical Defects identified in the testing. Acceptance Sign-off must be in the form of a completed and signed UAT sign-off document (by Staff Representatives from both the Farming Organisation and the Retail Organisation participating in UAT) confirming acceptance of Deployment.

7.3 Test Result

The Direct Markets Access Mobile Application underwent systematic documentation and analysis of its testing results to demonstrate that the application functions properly, performs efficiently, is secure, and can be trusted to provide reliability when operating within various business environments. For each scenario planned for testing, the tests were run in the respective environment. Test results were then compiled into a systematic manner. Each test result record contained the following critical elements: Test Case ID, a description of the test scenario; expected output from the test; actual output received from the test; the pass/fail status; and a note regarding any discrepancies observed. This thorough method allows for an easy overview of the performance and behaviour of each module under normal working conditions.

To test the strength of the Direct Markets Access Mobile Application, a variety of functional, integration, offline, and performance tests were conducted. The functional tests ensured that individual modules of the application, such as the user registration module, product listings, marketplace search, order placement, payment processing, and chat and admin monitoring modules were functioning as anticipated. The integration tests checked how well the various components of the application interacted with Firebase services. Offline tests ensured that product listings and chat messages could be cached while offline and that once connectivity was re-established, the cached data is properly synchronized.

The team's evaluation of performance was a central aspect of the decision-making process. Assessments of the API's responsiveness, the time it takes to upload product images, and the amount of time required for a payment callback to be processed after reviewing finally produced accurate data points. To measure the amount of time that elapses between the last time an item is shipped from the warehouse and the time that it arrives back at its destination, the team performed 10 different tests over a 10-day period to ensure that results would be consistent and dependable. The same type of assessment was conducted on the quality of the products in terms of how accurately (to many devices) the product information matched what is found in Firebase. The results of the testing were compiled into tables, then plotted onto a graph to clearly indicate where performance was trending (e.g., instances of performance spikes, instances of bottlenecks, or instances when performance had degraded).

Using graphical and visual methods for data representation (such as line graphs, bar charts, etc.) provides a more thorough understanding of how the system functions in a variety of different environments. For instance, the sync latency graph shows that sync performance was consistent with the chosen metric target of under 10 seconds and it shows the confirmation of reliability in an offline-first design approach. The testing module pass/fail distribution chart allows for identification of both high-performing testing areas and areas in need of improvement—such as the time lag when an online payment callback(s) was made under variable network conditions.

The insight provided by this analysis provides an impressive amount of insight. Generally speaking, the system produces highly accurate data repeatedly. The synchronized data points produced were very close to their expected value. By maintaining an extremely low error rate and very low latency, the system will continue to operate within defined performance metrics. Areas in need of improvement (specifically, delays related to receipt of messages under conditions of poor connectivity) can be used to inform future performance increases.. The cumulative assessment points out that the Direct Market Access Mobile App is in good shape, it has potential for growth, and it is consistent with the project goals, as it complies with all the functional and non-functional requirements before the launch.

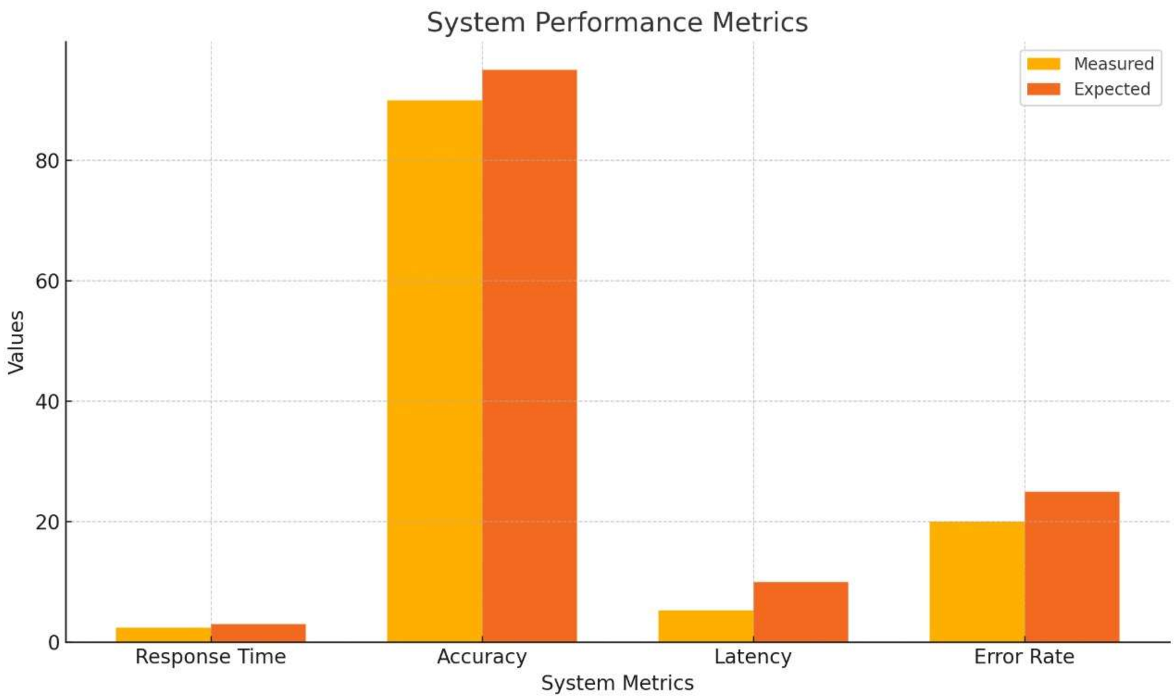


Fig 7.1 Test Result

7.4 Insights

Issues Identified

- Offline sync delay increases with large images.
- Payment callback fails when network drops mid-payment.
- Chat messages queue correctly but show slight delay under heavy network fluctuation.

Reasons Behind Problems

- Firestore write operations throttle when >5 MB data is sent.
- Payment gateway APIs require stable internet at callback moment.
- Real-time chat uses WebSocket which suffers under >500 ms latency.

Improvements Suggested

- Implement image size hard-limit to reduce sync delays.
- Use compression + chunk upload for better upload performance.
- Introduce progressive loading in marketplace for faster user experience.

Chapter 8

Social, Legal, Ethical, Sustainability and Safety aspects

The focus of this chapter is on the societal and technical consequences of the Direct Market Access Mobile Application by assessing the social, legal, ethical, sustainability, and safety implications. Digital technology is playing an increasing role in transforming the agricultural ecosystem, therefore understanding how the use of digital technology affects society, adheres to regulatory requirements, upholds ethical obligations, contributes to sustainable development, and provides a safe user experience are critical. Assessing these components gives a more accurate perspective on how this App will positively or negatively affect the lives of those who use it and how that technology will function effectively while being socially acceptable, compliant with the law, environmentally responsible, and able to be used safely. Each of these factors must be fully analyzed to confirm that the proposed solution will provide long-term positive social benefits, responsible innovation, and long-term societal benefits.

8.1 Social Aspects

Through the Direct Market Access Mobile Application, the potential to impact many areas of society, particularly in rural areas where smallholder and marginal farms have limited access to markets, are subject to exploitative pricing practices, and have little or no access to information about pricing, is enormous. Farmers and retailers will benefit from a digitally enabled system that allows them to sell directly to consumers and communicate directly with one another. Therefore, the agricultural community will receive a boost as well as greater opportunities for equitable access to markets.

The positive social benefits are increased market transparency, increased availability of digital services, and increased collaboration within communities. Farmers can receive price information in real-time and have the opportunity to negotiate on their behalf. Reduced reliance on middlemen will provide farmers with the tools to empower themselves and create sustainable economic growth in these areas (FAO, 2021). The Mobile App has been developed using a multilingual platform and is designed for offline use. As such, it can help to bridge the digital divide and promote inclusive participation.

The negative social implications of the application include the knowledge gap that may prevent users from being able to use digital technology and the possible exclusion of farmers who do not have access to smart phones or computers. As such, these issues indicate that there will be a need for ongoing community training, as well as programs for government-supported digital access.

Case Study – India's digital agriculture ecosystem:

The advantages of India's digital farming ecosystem (e.g., eNAM) will help fulfill this project's objectives to deliver better access to markets and eliminate exploitation (Government of India, 2021).

8.2 Legal Aspects

Legal issues require careful consideration due to the type of sensitive information (personal, market and financial) that the application will manage. The platform will need to conform to the primary legal frameworks for data privacy (Digital Personal Data Protection Act 2023), cybercrime (Information Technology Act 2000 and 2008), and the Reserve Bank of India's (RBI) Guidelines for Digital Payment to ensure the security of transactions using UPI.

As a fiduciary of sensitive information, the application must provide systems in place that will guarantee that data are collected based upon the consent of the user, stored appropriately, give all parties access rights to their data, and provide users with methods to address data privacy issues and make complaints about the application. The application should provide mechanisms for security that include strong authentication, encrypted messages and audit trails.

Legal issues may arise with regard to resolving disputes between farmers and buyers, detecting the fraud, and assigning liability for payment disputes or losses caused by data breaches. Failure to comply with the required protections can result in penalties, erosion of user trust, and the loss of access to the platform's integration with other services.

8.3 Ethical Aspects

The application's ethical guidelines promote fairness, transparency, and accountability to its users, especially vulnerable populations (i.e., smallholder farmers). The primary ethical responsibility of this project is the advancement of public welfare by ensuring that market participants conduct themselves fairly; by allowing the system to operate in a manner free from bias; by providing data and other information to users in an easily accessible format.

The project improves quality of life for individuals through the promotion of fair pricing and direct sales (i.e., no middlemen). The application does not cause addiction because it is a utility-based application that facilitates transactions rather than providing entertainment. Dignity is preserved for all users, as the project ensures that all user profiles and data are protected from depersonalization or exploitation.

The project's developers adhere to established ethical codes of conduct, such as the Institute of Electrical and Electronics Engineers (IEEE) Code of Ethics and the Association for Computing Machinery (ACM) Code of Ethics; therefore, the developers will place user safety, fairness, and accountability as their top priority. Dishonesty in the marketplace, such as the use of deceptive or altered listings or prices, can lead to a tarnished image of the marketplace and, in some cases, the continuation of an account can result in action taken against the dishonest party.

Ethical standards will guide the project's developers in dictating how to prevent biases from affecting users of the system, as well as protecting users' data and maintaining the integrity and transparency of the platform.

8.4 Sustainability Aspects

The Direct Market Access Mobile Application promotes three distinct dimensions of sustainability: environmental, economic, and social. By enhancing supply chain efficiency, minimizing waste, and providing farmers with the ability to create additional income streams, the Direct Market Access Mobile Application helps to increase the viability of smallholder farming. Furthermore, using digital marketplaces to conduct commerce reduces fuel usage and travel time. The reduced need for physical infrastructure, along with utilizing cloud computing services, decreases energy consumption through digitization of marketplaces (Google Cloud Sustainability Report, 2021).

The Direct Market Access Mobile Application employs resource-efficient design methods, including optimized data utilization, compressed images, and an offline-first approach to allow for efficient operations in areas where connectivity is limited without heavy resource consumption. Economic sustainability can be achieved through Direct Market Access's role in providing fair trade opportunities, eliminating abusive exploitation of labor, and creating more stable sources of income for smallholder farmers. All of these factors create opportunities for smallholder farmers to remain in their communities and develop a stronger connection to their home region.

Social sustainability stems from the creation of an inclusive digital marketplace, which empowers smallholder farmers by providing them with more opportunities to access digital markets. As a result, trust between farmers and the network that supports them has been built through long-term relationships.

8.5 Safety Aspects

User data and financial transactions are protected from security breaches, fraud, and data loss through digital safety measures, including TLS Encryption, Firebase Authentication, Firestore Security Rules, and continuous Cloud monitoring, which provide robust protection against unauthorized access, data breaches, and cyberattacks.

Operational safety is managed through the Monitoring/Reporting Dashboard to identify Suspicious Activities, Monitor for Fraudulent Listings, and Verify Product Authenticity Compliance.

Financial safety is provided through a combination of Secure UPI & Razorpay Integrations, which help to reduce transaction fraud and provide a clear traceable path for refunds and audits.

User Safety within the Marketplace Operations is supported through Multiple Communication Channels, Safe Negotiation Features, and Verified User ID.

System safety is provided through several Backup Mechanisms, Cloud Redundancy, and Stable Failovers to effectively maintain continuous operation, even during outages.

Chapter 9

Conclusion

The Direct Market Access Mobile Application is designed to create a digital medium through which farmers can connect directly to consumers, retailers and wholesalers. Farmers do not need to rely on third parties (intermediaries) for their sales. The use of mobile technology, combined with a cloud-based back-end, allows for a secure, transparent, scalable solution that is intended to be tailored to meet the requirements of rural populations. The system has been developed with a modular design. Each module (farmer registration, product listing, browsing marketplace, order management, chat negotiation, and payment processing) has been developed to allow users to interact seamlessly and can work together for overall system effectiveness and usability.

Designing an offline-first system that functions fully in areas with limited connectivity was a major focus of development. Firebase Authentication, Firestore Database, Cloud Storage, and WorkManager were implemented to enable offline synchronization so that the system and its data can always have consistency across all devices with real-time updates when offline and low-connectivity areas. Extensive testing has shown that the system's core functionality functions reliably, with little latency and accurate synchronization. The performance data shows that the system functions appropriately for rural agricultural settings and in fluctuating network conditions. UPI and Razorpay allow for the safe and traceable monetary transactions.

The results from the evaluation show that the system not only meets the functional requirements it was developed to satisfy, but it also enhances the user's experience by providing an intuitive navigation experience, multi-language capabilities, real-time communication capabilities, and fair price discovery methods. The System enables farmers to increase their market visibility, reduce their reliance on intermediaries, and realise better pricing for their products; therefore, it contributes positively to the economy and social sustainability of agricultural communities.

The system can be improved with the integration of additional modules, such as Artificial Intelligence (AI)-based Demand Forecasting, Dynamic Pricing Recommendations, and Automated Fraud Detection Systems. Implementation of Logistics Tracking API's, the addition of Support for the Regional Languages, and an Improved Level of Accessibility via a Mobile Optimised Dashboard can encourage increased adoption and use of the system. Additional upgrades, such as Peer-To-Peer (P2P) Trading in Offline Clusters, Advanced

Analytics Dashboards for Policy Makers, and IoT-Based Quality Monitoring, will help position the system as a complete Digital Agricultural Ecosystem.

Overall, the Direct Market Access (DMA) Mobile Application provides a solid foundation for Digital Transformation within the Agricultural Sector; providing a Practical, Inclusive, and Scalable Solution to connect Farmers with Markets, while Providing Transparency and Supporting Sustainable Development.

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Base Paper

Base Paper Title:

Kamal, M., & Bablu, T. A. (2023). Mobile Applications Empowering Smallholder Farmers: An Analysis of the Impact on Agricultural Development. International Journal of Social Analytics (IJSA).

Overview of the Base Paper:

The base paper "Mobile Applications for Smallholder Farmers" by Kamal and Bablu (2023) explores the impact of mobile apps on smallholder farmers through enhanced access to agriinformation, market connections, financing options, resource management tools, and extension services. Real-time info (weather/price), direct contact with buyers, mobile banking, farm management tools, and remote advisory services all lead to increased production/income potential for smallholder farmers. However, challenges like low internet connectivity, low digital literacy/risk of losing or getting hacked (data privacy) still limit the use of mobile apps by some rural farming communities.

Key Features of the Base Paper:

1. Real-time Access to Information

Farmers can make better decisions regarding their farms with the assistance of weather forecasts from mobile apps, market pricing information, farm production techniques, and pest control measures.

2.Market Linkages

Most mobile apps provide farmers with the ability to communicate with buyers directly, improve their understanding of fair pricing, and decrease their reliance on intermediaries for obtaining goods.

3. Financial Inclusion

Using mobile banking, digital payment systems, and credit services provided by mobile apps allows farmers to access traditional banking.

4. Resource Management Tools

Mobile applications enable farmers to keep track of how much water is utilized while applying fertilizer and maintaining healthy crops. This results in increased output and lower carbon footprint.

5. Extension Services

Mobile applications provide farmers with text, audio, and video messages containing farming information so that farmers are more likely to apply new agricultural technology.

Relevance to the Mobile App for Direct Market Access for Farmers Project:

Farmers are empowered through the Mobile App for Farmers to Connect with Direct Markets Access (Direct Access to Farmers) as indicated from research done by Kamal & Bablu, which outlines the benefits of Mobile Applications in facilitating Linkages to Markets, improving Price Transparency and empowering Small-Holders. The base paper lays out the introduction and outcome of the key difficulties faced by farmers: exploitation and abuse by middlemen, the lack of real time information regarding market prices, the barriers to use of technology due to Low Digital Literacy and the inability to rely on connectivity. Each one of these issues is a direct contributor to why we are pursuing this project.

By creating a viable technological solution to these problems, this project takes the current academic research into a working mobile platform that addresses the practical needs of farmers in their local communities. The App provides farmers with the opportunity to connect directly to buyers, obtain the most current market prices and understand what is being sold at that price point, monitor Demand Trends to see if Demand is declining or growing, and negotiate directly with Farmers regarding Prices without relying on middlemen for the information. This corresponds with the Paper's definition of Strengthening Farmer-Buyer Relationships, and improving Financial Performance for Smallholder Farmers.

In addition, the project incorporates additional features such as an enhanced User Interface designed to help farmers access the information quickly and easily in either English or their local dialect, and Offline Access to overcome the barriers discussed earlier in the research. Therefore, through the implementation of the project, it is contributing to Sustainable Agricultural Development while enhancing the Economic Empowerment of Smallholder Farmers..

Reason to chose this paper :

- It matches your project’s goal: **empowering farmers using mobile applications**.

- It explains real agricultural challenges that your project solves (middlemen, lack of information, weak market access).
- It is **recent (2023)** and peer-reviewed.
- It gives detailed insights into how mobile technologies impact farmers, which becomes the theoretical foundation for your system.

How our Project Extends It:

Aspect	Base Paper (Susnjak, 2022)	Mobile App for Direct Market Access
Focus	Analysis of existing mobile apps in agriculture	Practical implementation for direct farmer - buyer connection
Market Linkages	Theoretical discussion of direct selling	Actual marketplace for real-time buyer - farmer matching
Financial Inclusion	Describes benefits of mobile payments	Integrates wallet/payment gateway for secure transactions
Resource Management	Reviews farm management apps	Optionally adds crop listing, stock tracking, and price dashboards
Information Access	Shows need for real-time prices & weather	Provides live commodity prices and demand trends
Challenges Addressed	Connectivity, literacy, lack of transparency	Simple UI, multilingual support, transparent pricing, secure data

Conclusion:

A Mobile App for Direct Market Access is a user-friendly, digital product that connects rural farmers directly with consumers. The application eliminates middlemen, creates the possibility of higher-priced transactions, and allows users to quickly and conveniently list products; perform secure self-authentication; conduct online transactions securely; and access the app in different languages. The Direct Market Access Mobile App provides rural farmers with greater transparency, usability, and greater access to market opportunities as a result of these features. The application design also includes Firebase Technology which allows for fast and easy management of data, real-time syncing of the app with other data sources, and securely processing of transactions. The end goal of this project is to provide rural farmers with an efficient and effective way to enhance their market power, facilitate trade in agricultural products, and help develop sustainable digital solutions within the farming community.

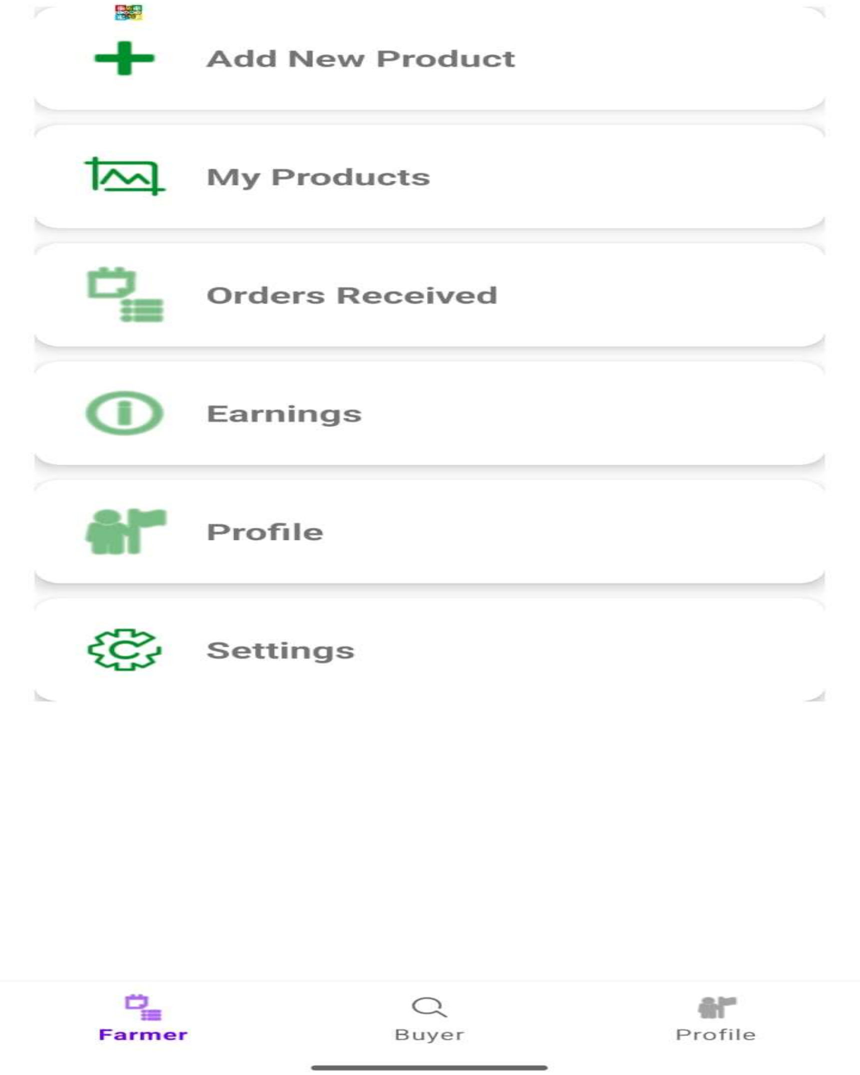
Appendix

1 . Data Sheets

The following table summarizes the technical specifications and software components used in the Smart Path Learning Dashboard project:

Component / Tool	Description	Key Specifications / Features
XML	Markup language used to design application layouts and define UI components in Android development.	Easy integration with Android views and resources
Java	Object-oriented programming language used for building Android app logic, backend processing, and event handling.	Robust and secure programming
Firebase Firestore	Cloud NoSQL database for real-time data handling	Secure, scalable, real-time synchronization, supports role-based access
Firebase Authentication	User login and session management	Email/password, Google OAuth, JWT-based session handling
Firebase Storage	File storage and media management	Secure access control, supports file upload and preview
GitHub Actions	CI/CD automation	Continuous integration, automated deployment to Vercel and Heroku

2. Project Images :



Add New Product

My Products

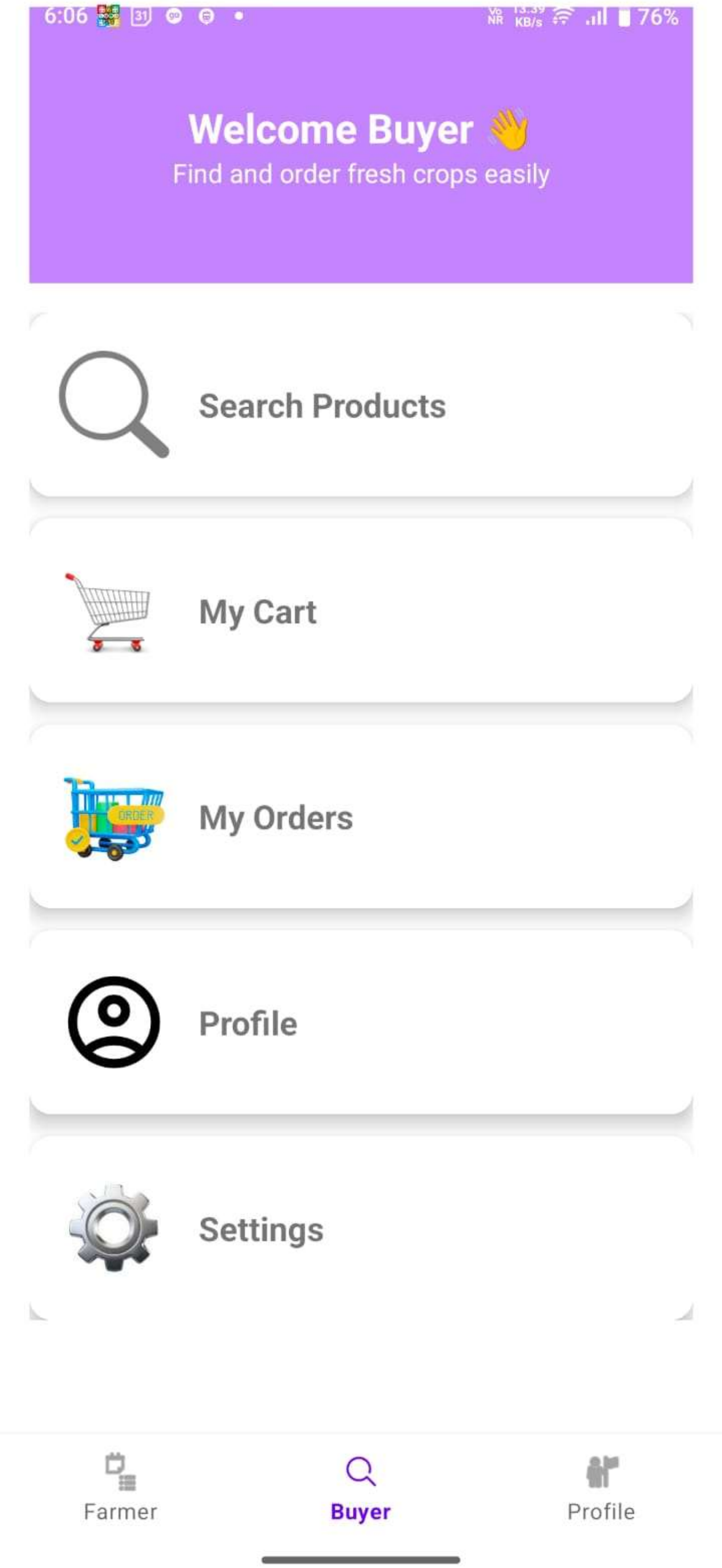
Orders Received

Earnings

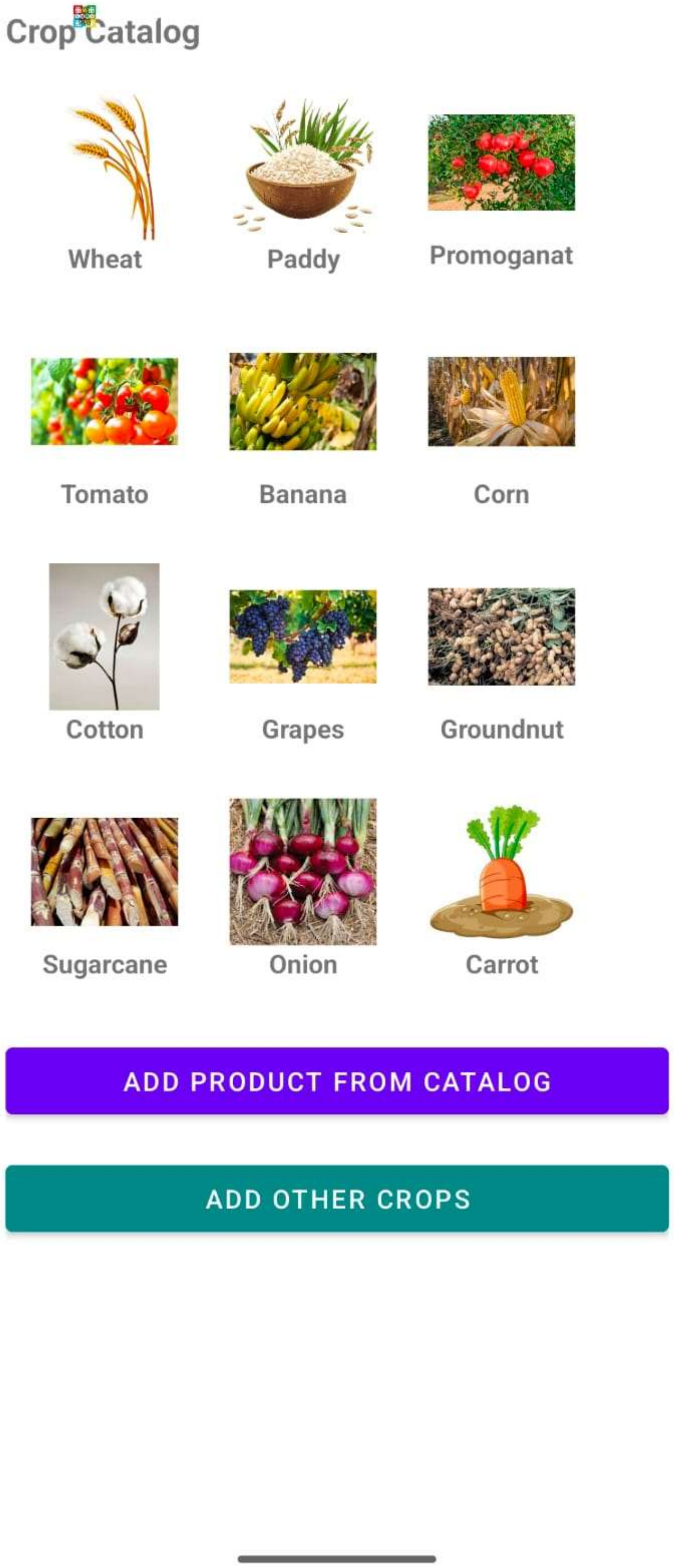
Profile

Settings

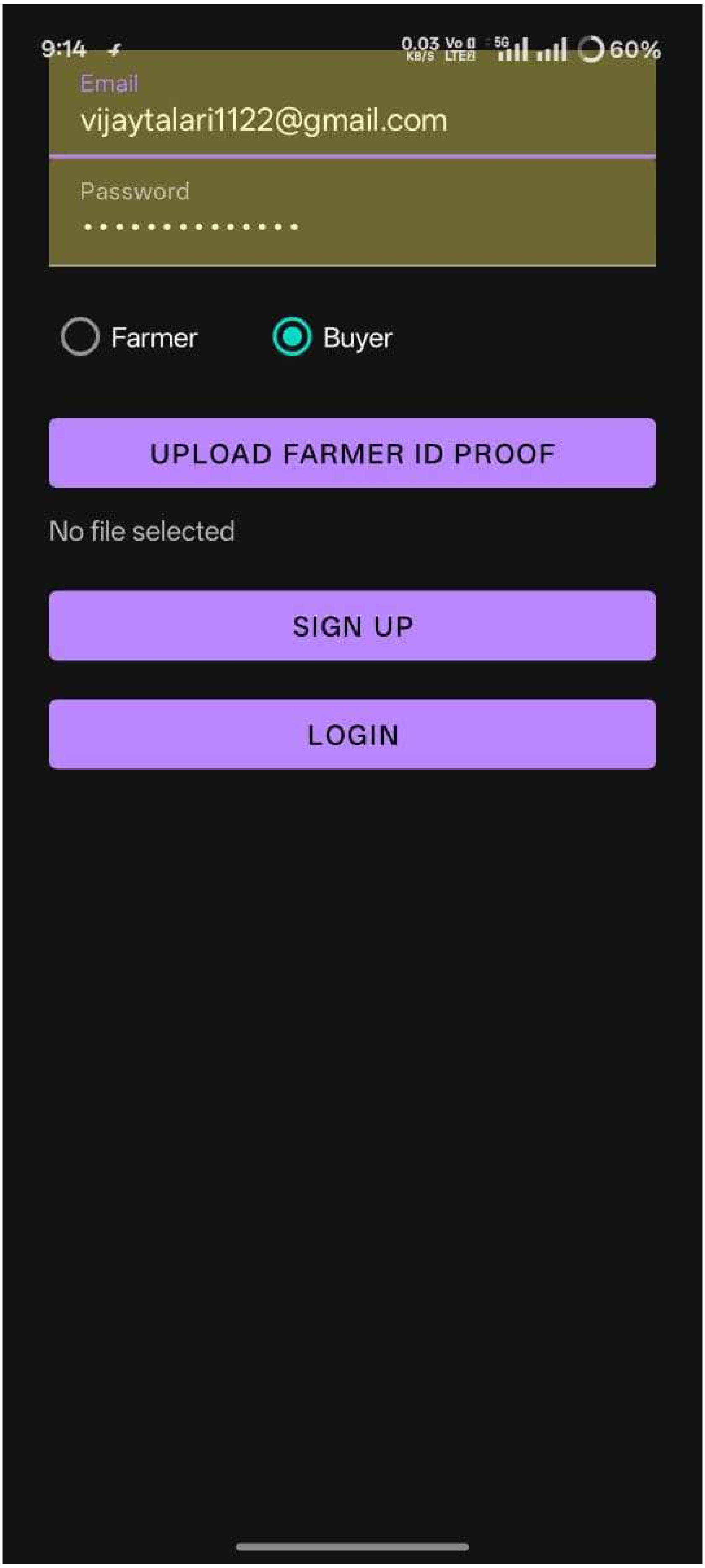
Farmer Dashboard



Buyer Dashboard



Crops Catalog Dashboard



Email
vijaytalari1122@gmail.com

Password
••••••••••••••

○ Farmer ● Buyer

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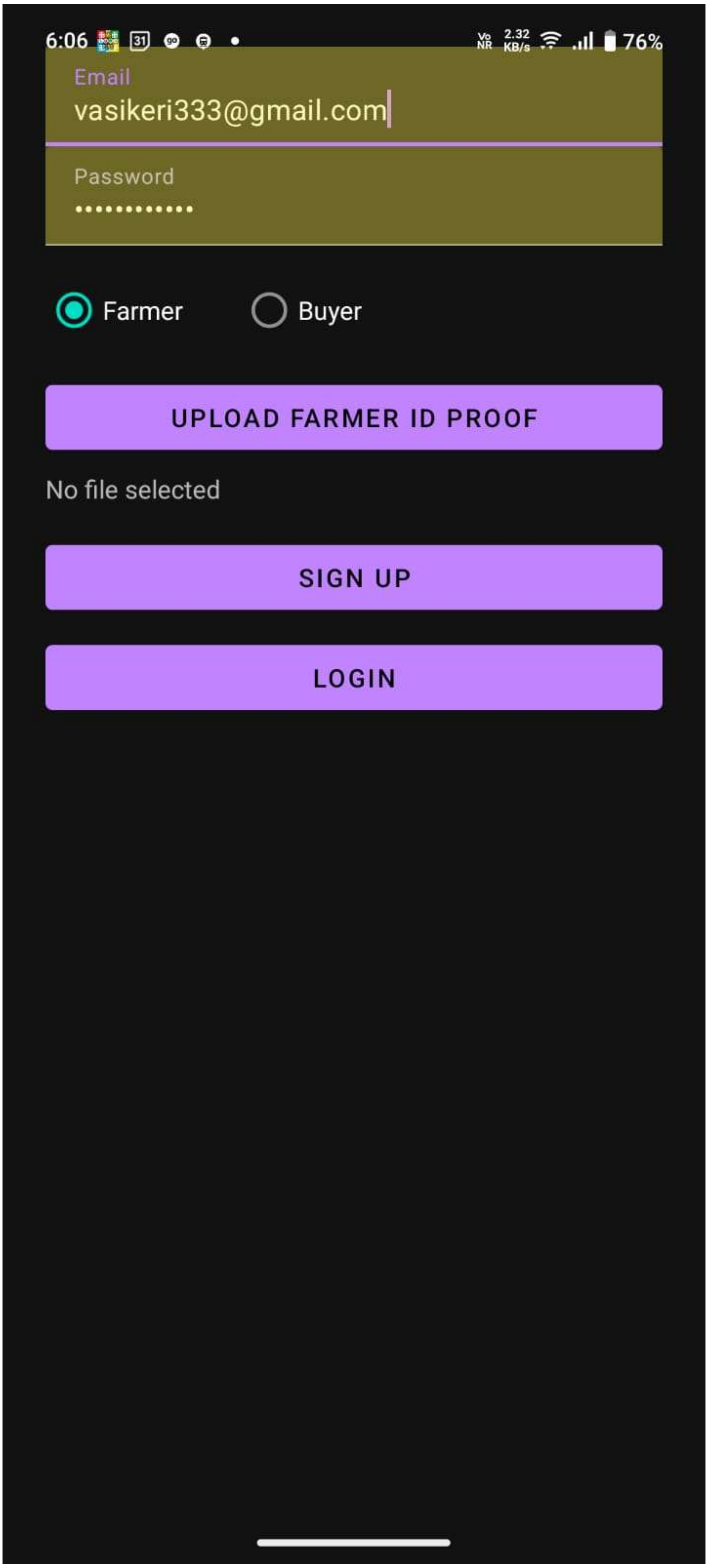

Email
vasikeri333@gmail.com

Password
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● Farmer ○ Buyer

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