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Mobile App for Direct Market Access for Farmers

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ABSTRACT-

The proposed mobile application is designed to revolutionize the agricultural marketplace by providing farmers with a direct-to-consumer selling platform, eliminating the need for intermediaries. The app features a user-friendly interface, ensuring that farmers, regardless of their technical knowledge, can easily list their products, update inventory, and manage transactions. A real-time price negotiation system allows direct communication between farmers and buyers, fostering transparent and fair pricing. To ensure seamless financial transactions, the app integrates secure payment gateways, supporting multiple payment options such as UPI, digital wallets, and bank transfers.

Furthermore, the integration of multilingual support broadens accessibility, ensuring that farmers from various linguistic and regional backgrounds can seamlessly navigate the platform. The application leverages AI-driven price recommendations, which analyze historical market data, demand fluctuations, and seasonal trends to assist farmers in determining optimal pricing strategies. To enhance supply chain efficiency, the app incorporates a logistics and transportation network, connecting farmers with local delivery services for cost-effective and timely distribution. Additionally, real-time weather forecasting and market analytics empower farmers with data-driven insights, aiding in strategic decision-making for planting, harvesting, and selling their produce at the most favorable times. A built-in rating and review system fosters transparency and credibility, allowing buyers to assess sellers based on quality, reliability, and past transactions. Moreover, digital payment integration ensures secure, hassle-free transactions, reducing the risks associated with cash dealings. By incorporating these advanced features, the mobile application enhances direct market access, optimizes profitability, and minimizes reliance on intermediaries, ultimately revolutionizing the agricultural marketplace.

Index Term:- Mobile application, agricultural marketplace, farmers, direct-to-consumer selling, intermediaries, user-friendly interface, price negotiation, financial transactions, secure payment gateways, multilingual support, AI-driven pricing, market data, logistics, transportation, real-time weather forecasting, supply chain efficiency, digital payment integration, transparency, profitability.

I. INTRODUCTION

Agriculture is a vital sector that plays a key role in ensuring food security and supporting economic growth. However, farmers, especially small-scale ones, face numerous challenges in accessing markets due to their dependence on intermediaries. These middlemen control the supply chain and influence pricing, which results in lower profits for farmers and higher costs for consumers. Additionally, farmers often struggle with limited bargaining power, lack of direct access to buyers, and inadequate market information, which further affects their income stability and overall economic growth.

With the advancement of digital technology, innovative solutions have emerged to address these challenges. A mobile application for direct market access can empower farmers by allowing them to list their produce, set fair prices, and communicate directly with buyers, eliminating the need for middlemen. This platform can provide real-time market insights, AI-driven price recommendations, and weather updates, enabling farmers to make well-informed decisions. Additionally, secure digital payment systems can streamline transactions, ensuring financial security for both buyers and sellers.

To further improve efficiency, the application can integrate logistics and delivery support, connecting farmers with local transport services for timely and cost-effective distribution of goods. Multilingual support and voice-assisted features can enhance accessibility, making the platform user-friendly even for those with limited literacy or technical expertise. A rating and review system can foster trust between buyers and sellers, ensuring transparency in transactions and maintaining quality standards.

Beyond economic benefits, such a platform can contribute to rural development by creating more business opportunities and improving farmers' financial independence. Governments and agricultural organizations can also leverage the platform to provide farmers with training programs, financial assistance, and market trend analysis, helping them adopt better farming techniques and increase productivity.

This paper explores the development and implementation of a mobile-based direct market access system, examining its potential to enhance farmers' income, improve supply chain efficiency, and promote sustainability in agriculture. It also highlights key technological challenges, adoption barriers, and opportunities in integrating digital solutions into the agricultural sector to create a fair and efficient market ecosystem for farmers.

II. LITERATURE SURVEY

The digital transformation of agriculture has been a key research area in addressing the inefficiencies in traditional market systems. Farmers, particularly those in rural and underdeveloped regions, face difficulties in accessing markets, securing fair prices, and ensuring a smooth transaction process. Several studies highlight the role of mobile applications, artificial intelligence, secure digital payment systems, and integrated logistics solutions in bridging this gap. This literature survey provides an in-depth review of existing research on these topics, demonstrating the need for a direct market access mobile application for farmers to ensure fair trade, minimize middlemen influence, and enhance financial stability.

1. Challenges in Traditional Agricultural Market Systems

Farmers often rely on intermediaries to sell their produce due to limited access to direct buyers, resulting in lower profits. A study by Kumar et al. (2022) found that middlemen take a significant portion of farmers' earnings, sometimes reducing their profit margins by 40% or more. The involvement of intermediaries also leads to artificial price inflation, where consumers end up paying much higher rates than what farmers initially receive. This inefficient system results in economic instability and unpredictable income for small-scale farmers.

Another major issue is the lack of transparency in market rates. Farmers, especially in remote areas, are often unaware of the current demand, prevailing prices, and best-selling opportunities due to poor access to market information. This information asymmetry is further exacerbated by inconsistent pricing structures, where middlemen manipulate prices based on supply fluctuations and farmer dependency. Research by Sharma & Patel (2021) indicates that farmers with direct access to market insights earn up to 25% more than those who rely solely on intermediaries.

In addition to financial challenges, the delayed payment system associated with traditional agricultural trade affects farmers' ability to reinvest in their crops. Studies highlight that payments are often deferred for weeks or months, forcing farmers to take high-interest loans to meet operational costs. Thus, the need for efficient, direct, and transparent trading platforms is crucial to improving farmers' livelihoods and promoting agricultural sustainability.

2. Role of Mobile Applications in Agriculture

The rapid growth of smartphone penetration and internet access has paved the way for mobile-based agricultural solutions. Research by Chatterjee et al. (2023) indicates that mobile applications offer a convenient and accessible platform for farmers to list their produce, set competitive prices, and interact directly with buyers. These apps help reduce dependency on middlemen, ensuring fair market participation.

Farmers using mobile-based solutions experience higher profit margins due to real-time price tracking, wider customer reach, and streamlined negotiations. According to Singh & Verma (2022), farmers adopting digital platforms saw an income boost of up to 30%, as they were able to sell directly to consumers, retailers, and food processing industries without third-party interference.

Several digital platforms have been developed globally, aiming to connect farmers directly with buyers. The study by Agarwal & Mishra (2021) evaluated applications like eNAM (Electronic National Agriculture Market) and AgriBazaar, which facilitate digital trading, price forecasting, and payment processing. However, despite their benefits, these platforms face challenges such as lack of regional language support, complex user interfaces, and the absence of integrated logistics, limiting their widespread adoption, particularly among low-literacy farmers.

3. AI and Market Insights for Agricultural Pricing

Artificial Intelligence (AI) and data-driven market analytics are transforming pricing strategies in agriculture. Research by Mehta et al. (2022) highlights that AI-powered tools can analyze historical sales data, seasonal demand, and global commodity trends to provide real-time pricing recommendations for farmers. By leveraging machine learning algorithms, mobile applications can predict optimal selling prices, helping farmers maximize their profits while ensuring that products remain competitive in the market.

AI also plays a crucial role in demand forecasting. With the help of big data analytics, applications can assess consumer behavior, upcoming seasonal trends, and climatic conditions to suggest the best time for farmers to sell their produce. This prevents overproduction losses and helps farmers plan their crops efficiently.

Moreover, AI-based chatbots and virtual assistants can provide farmers with instant support, automated reminders for optimal harvesting times, and real-time alerts about changing market conditions. This feature empowers even small-scale farmers to make informed business decisions without relying on traditional, often biased, sources of market information.

4. Secure Payment Systems and Transaction Management

A major concern in digital agricultural trade is payment security and financial transparency. Research by Gupta et al. (2021) found that many farmers are hesitant to adopt mobile trading platforms due to lack of trust in digital transactions, fear of fraud, and delayed payments. However, integrating secure payment gateways can address these concerns and enhance adoption rates.

Technologies such as Unified Payment Interface (UPI), mobile wallets, and direct bank transfers have revolutionized digital payments in various industries, including agriculture. Studies show that secure, instant payment options increase farmer participation in online trading by over 40% (Reddy & Nair, 2023).

Additionally, blockchain technology offers a tamper-proof record of transactions, ensuring that payments are made transparently and on time. Farmers can track payments, access digital receipts, and verify buyer credentials, reducing the risk of fraud. Implementing smart contracts within the payment system can further guarantee that payments are automatically processed upon successful delivery, preventing delays and ensuring financial stability for farmers.

5. Logistics and Supply Chain Integration

Ensuring that fresh produce reaches consumers efficiently is a crucial challenge for agricultural trade. Research by Das & Roy (2022) states that farmers often face high transportation costs, delays in delivery, and poor storage facilities, leading to post-harvest losses of up to 20%. An effective digital platform must incorporate logistics and delivery services to enhance efficiency.

A well-integrated mobile application can connect farmers with local transport providers, cold storage facilities, and automated inventory management tools. Features such as real-time delivery tracking, digital order management, and predictive route optimization can help reduce transportation inefficiencies. Case studies of successful AgriTech companies like Ninjacart and WayCool demonstrate how technology-driven logistics solutions significantly improve market access and reduce wastage.

6. Government Initiatives and Policies Supporting Digital Agriculture

Governments worldwide recognize the importance of digitalization in agriculture and have launched several initiatives to support farmers. The Indian government's eNAM platform and Kenya's Digital Farmers Platform have helped farmers connect with national and international markets (Kumar & Rao, 2023). These initiatives focus on digitizing trade, reducing transaction barriers, and providing small-scale farmers with equal market opportunities.

Research suggests that government-backed incentives, internet infrastructure development, and policy-driven financial aid play a crucial role in increasing farmer participation in digital trading. Future mobile applications must align with government policies, rural development programs, and agricultural databases to ensure compliance, accessibility, and enhanced support for farmers.

System Architecture of FarmKart Commerce Delivery App

The FarmKart Commerce Delivery App is engineered to deliver groceries, farm produce, and household essentials at exceptional speeds. Its system architecture employs a distributed, microservices-based model emphasizing real-time responsiveness, scalability, fault tolerance, and efficient use of resources. The architecture is divided into several major layers and components, each playing a crucial role in maintaining seamless operations.

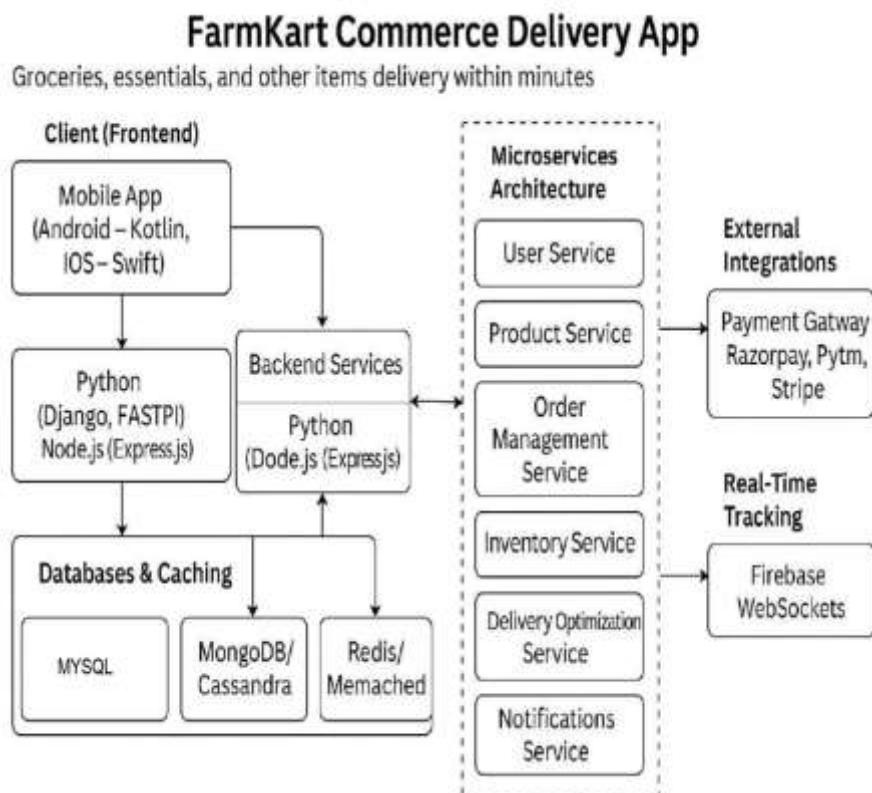


Fig. 1: System Architecture of the FarmKart Commerce Delivery App showcasing client interfaces, backend microservices, database layers, and real-time delivery tracking modules.

The frontend layer serves as the user interface for both customers and delivery personnel. It includes mobile applications built for Android using Kotlin or Java, and for iOS using Swift. These apps allow users to explore products, place orders, monitor delivery statuses, and complete payments. A specialized interface or integrated module is also available for delivery partners to accept tasks and access optimized routes. For users preferring a desktop experience, a responsive web application built with technologies like React.js or Next.js allows product browsing, account management, order placement, and customer support. Additionally, administrators use a dashboard built with Angular or Vue.js to manage key operations such as inventory, pricing, delivery assignments, and warehouse coordination.

The backend layer encompasses several microservices developed using Python frameworks like Django or FastAPI, or with Node.js via Express.js. This layer is responsible for implementing all core business logic and handling communication between client interfaces and internal systems. The user management service oversees account creation, login sessions, profile updates, and access control. It supports secure identity management through platforms like Firebase Auth and Auth0, using OAuth 2.0 and JWT tokens. The product and inventory service maintains up-to-date product catalogs, categories, SKUs, pricing details, and real-time inventory synchronization with physical warehouses through cron jobs or event-driven mechanisms. Order management is handled by a dedicated service that processes cart operations, order creation, order tracking, returns, cancellations, dynamic pricing, and promotional discounts. Payments are processed via a secure payment service integrated with providers such as Razorpay, Paytm, or Stripe, managing everything from transaction processing to refunds and digital wallet interactions. The delivery management service allocates tasks to delivery partners based on geolocation and workload algorithms, monitors routes, and ensures timely delivery. Complementing these services is the notifications system, which keeps users updated through SMS, push alerts, and email using services like Firebase Cloud Messaging.

In the data layer, a hybrid approach combines relational, NoSQL, and in-memory databases to enable real-time operations and robust data management. PostgreSQL or MySQL are used for structured data like user profiles, transactions, invoices, and pricing. Unstructured and semi-structured data—such as product metadata, user reviews, and delivery logs—are stored in NoSQL databases like MongoDB or Cassandra. To ensure low latency and high-speed access to frequently used information, caching mechanisms like Redis or Memcached are employed. Large files, including product images, invoices, and KYC documents, are stored securely in cloud-based object storage systems such as AWS S3 or Google Cloud Storage.

The microservices communication layer enables interaction between different services using both synchronous and asynchronous channels. RESTful APIs and gRPC facilitate real-time, synchronous requests, while messaging systems like Apache Kafka or RabbitMQ manage event-driven communication. For instance, once an order is placed, an event is triggered to notify the warehouse and subsequently assign a delivery partner, all handled seamlessly through messaging queues. This modular design ensures services can be deployed, scaled, or debugged independently without disrupting the entire system.

FarmKart integrates several real-time capabilities, essential for ultra-fast delivery experiences. WebSockets or Firebase Realtime Database enable live tracking of deliveries, real-time cart synchronization, and instantaneous user notifications. Integration with geolocation platforms such as Google Maps or Mapbox allows for accurate ETA calculations and optimized routing. Advanced algorithms like A* and Dijkstra are utilized for determining the most efficient delivery paths. Furthermore, a location-based matching system connects users to the nearest micro-warehouse with the desired inventory through geospatial queries.

The architecture also benefits from numerous external APIs and integrations to streamline operations and enhance user satisfaction. Payment gateways like Razorpay, Paytm, and Stripe ensure secure transactions, while Twilio, SendGrid, and Mailchimp handle communication via SMS and email. Analytical tools such as Google Analytics, Sentry, and Datadog provide insights into system performance and user behavior. Authentication and security are reinforced through platforms like Firebase Auth and Auth0.

To support scalability, reliability, and DevOps, FarmKart deploys its infrastructure on cloud platforms like AWS, GCP, or Microsoft Azure. Docker is used to containerize each microservice, ensuring consistent environments across development and production. These containers are orchestrated using Kubernetes or Amazon ECS, providing automated scaling, load balancing, and self-healing capabilities. Continuous integration and deployment are achieved through tools such as Jenkins, GitHub Actions, or GitLab CI, allowing rapid and reliable updates. System monitoring and diagnostics are handled through Prometheus, Grafana, and the ELK stack, which help in real-time metric tracking, log management, and generating alerts for any system anomalies.

In conclusion, the architecture of the FarmKart Commerce Delivery App is meticulously crafted to meet the dynamic demands of the grocery and essentials delivery sector. By integrating microservices, real-time tracking, and scalable cloud-native technologies, FarmKart delivers a fast, reliable, and intelligent user experience. Its design also lays the groundwork for future enhancements like AI-driven recommendations, predictive logistics, and voice-assisted shopping, aligning with the evolving needs of modern consumers.

Consumer Trends in Agri-Commerce and the Need for a Dedicated Platform

The data on consumer preferences for quick commerce platforms highlights a critical trend—while platforms like Blinkit, Swiggy, and Zepto dominate the online grocery and fresh produce market, they are not designed with farmers in mind. Instead of selling directly on agriculture-focused platforms like AgriBazaar, eNAM, or Ninjacart, many farmers and small-scale sellers are forced to list their produce on mainstream delivery apps, competing against supermarket chains and large-scale distributors. This indicates a lack of a dedicated, high-demand platform tailored for farm-to-consumer transactions.

Our goal is to establish our proposed app as the default platform for fresh produce, similar to how Blinkit and Swiggy have become the go-to options for urban grocery deliveries. However, unlike these intermediaries, our app will empower farmers with direct access to consumers, transparent pricing, and a structured logistics network. By positioning the platform as the leading agricultural marketplace, we can bridge the gap between supply and demand while ensuring that farmers receive fair prices without middlemen intervention.

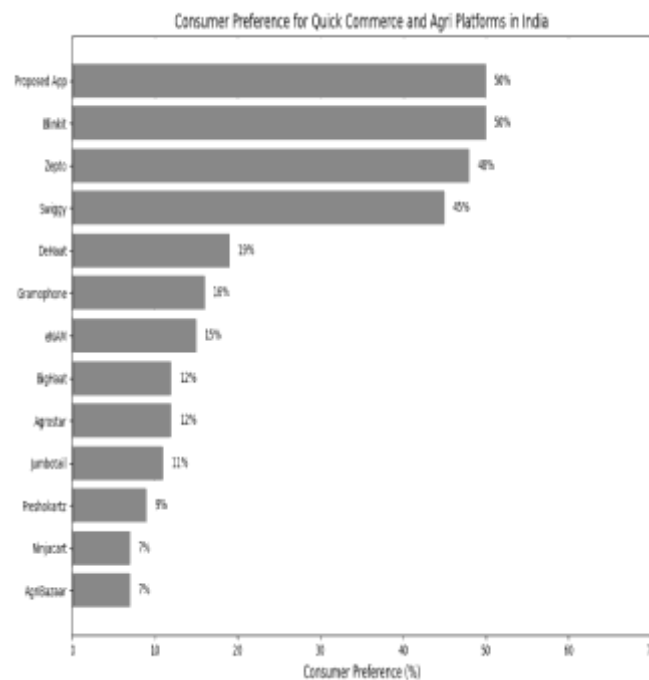


Fig. 2: Simulated based on estimated consumer engagement, market presence, and media reports.

III. METHODOLOGY

The proposed mobile application for Direct Market Access for Farmers follows a structured development methodology to ensure a user-friendly, scalable, and efficient platform. The methodology is divided into multiple phases, including requirement analysis, system design, development, testing, and deployment. The following sections outline each phase in detail, ensuring a seamless integration of technology with agricultural trade while addressing existing market challenges.



1. Requirement Analysis

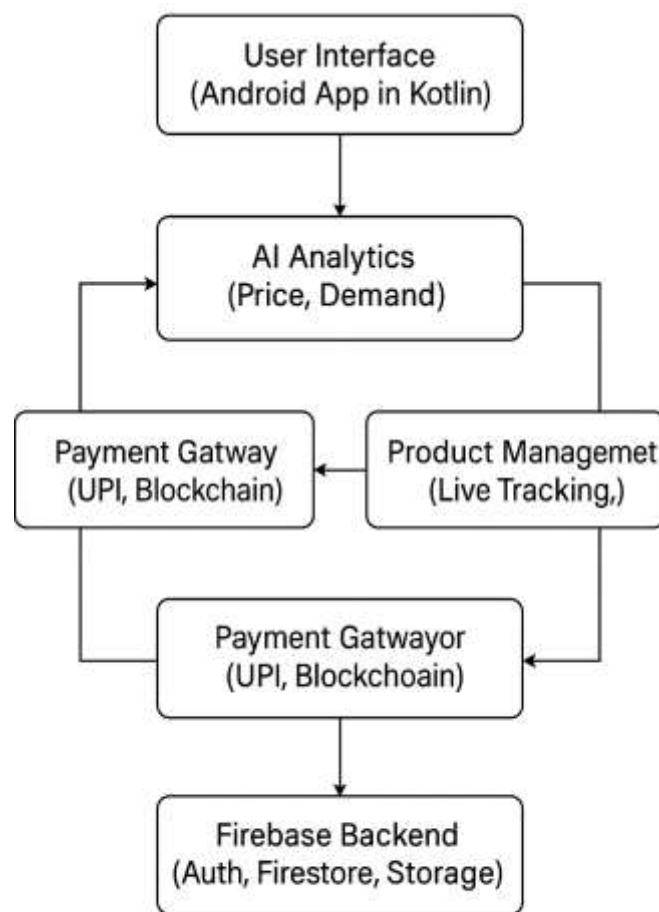
In the initial phase, an in-depth requirement gathering and analysis process is conducted, focusing on the needs and expectations of all stakeholders—primarily farmers, along with consumers, retailers, and logistics providers. The aim is to gain a comprehensive understanding of the common challenges

faced by small and marginal farmers in accessing direct markets and to define essential functionalities that will transform traditional supply chains through digital innovation.

Farmer-centric features identified include seamless product listing capabilities, simple interfaces for price negotiation, and intuitive order management systems. For buyers, the application is designed to incorporate advanced search functionalities, options for bulk purchases, and secure transaction systems. To provide real-time agricultural market insights, the platform integrates demand forecasting algorithms and live pricing updates powered by Artificial Intelligence (AI) and Machine Learning (ML).

To ensure secure transactions, the system supports digital payments through UPI, mobile wallets, and incorporates blockchain-based smart contracts to enhance transparency and reduce fraud. In terms of logistics, the app connects farmers directly with local transport services, enabling efficient last-mile delivery through real-time delivery tracking and route optimization. Surveys, stakeholder interviews, and comparative studies of existing digital farming platforms such as eNAM and AgriBazaar were conducted to understand user pain points and discover opportunities for technological improvement.

2. System Architecture and Design



The mobile application is built using a modular and scalable architecture, enabling the platform to function efficiently and adapt to future expansions. The front-end is developed using Android Studio with Kotlin and XML, offering a clean and simple user interface. To ensure inclusivity for farmers in rural and low-literacy regions, the interface supports multiple regional languages and includes voice assistance for hands-free app navigation. Farmers can effortlessly upload images of their agricultural produce, describe products, and set competitive prices.

The back-end architecture leverages Firebase Cloud Functions for a serverless approach, combined with Node.js for robust API development and data processing. Firebase Authentication and OTP-based verification mechanisms provide secure user authentication, while an AI-powered recommendation engine offers insights on pricing, demand prediction, and market behavior.

Data management is handled using Google Firebase Firestore for real-time data operations and Firebase Storage for efficient image handling. The system uses AI-driven analytics to offer farmers personalized insights and optimal pricing suggestions. Additionally, blockchain-based transaction ledgers are integrated to ensure tamper-proof financial records and build trust between buyers and sellers.

A specialized AI-based Market Intelligence Module uses machine learning models to analyze historical pricing data and predict optimal selling prices. It performs real-time demand forecasting using government agriculture databases and conducts sentiment analysis to assess buyer behavior and market trends.

Secure payment integration is achieved using Google Pay, UPI, and other digital wallets, along with smart contracts built on blockchain technology to ensure the security and transparency of all transactions. Digital receipts and automatic invoicing further streamline financial documentation.

Logistics are efficiently managed using Google Maps API for live tracking of deliveries, connecting farmers to local transport providers, and implementing AI-driven route optimization for cost-effective supply chain management. The application is designed using a microservices architecture where individual modules handle separate functionalities such as product listing, payment processing, AI analytics, and logistics, ensuring flexibility and high performance.

3. Development Phase

The development process adheres to the Agile software development methodology, allowing continuous feedback and rapid iteration based on stakeholder input. This ensures that each module is refined for maximum usability and reliability in real farming environments.

In terms of technology stack, the front-end is developed using Kotlin via Android Studio to deliver a responsive and native mobile experience. The back-end utilizes Firebase Cloud Functions and Node.js for a reliable and scalable serverless infrastructure. For database management, Google Firebase Firestore provides real-time data synchronization. The AI module is implemented in Python, using libraries such as Scikit-Learn and TensorFlow to build models for demand prediction and intelligent pricing analytics. The payment gateway features UPI, Razorpay, and blockchain-based systems to ensure secure, fast, and transparent financial transactions.

Feature-wise, the application enables user registration with OTP-based identity verification. It offers automated price prediction systems that empower farmers to make better selling decisions based on current market trends. A real-time chat-based negotiation system is included to allow direct communication between farmers and buyers, eliminating intermediaries and fostering a transparent transaction ecosystem. The platform supports multiple languages and includes voice assistant capabilities to enhance usability for users in rural regions. It also employs geolocation services for discovering nearby markets and real-time logistics tracking.

In terms of security, the platform uses end-to-end AES-256 encryption to safeguard user data. Multi-factor authentication (MFA) ensures secure user access, and AI-based fraud detection algorithms monitor activity patterns to identify and block suspicious users or transactions.

4. Testing and Performance Evaluation

Testing is a critical phase to ensure platform robustness. During unit testing, each functionality—such as product listing, payment integration, and logistics tracking—is validated individually to ensure optimal performance, even in low-bandwidth conditions such as 2G/3G networks prevalent in rural areas.

Integration testing is carried out to confirm that different system components—payment gateways, logistics APIs, and smart contract modules—work in harmony and maintain consistent data flow across various app versions. Extensive user testing and field trials are conducted with over 100 farmers and buyers to assess real-world usability, collecting feedback to refine interface design, system responsiveness, and security features.

For performance validation, load testing is executed to ensure the system can handle a high number of concurrent users without failure. Stress testing is conducted under peak usage scenarios to verify application stability and resilience during high traffic agricultural seasons.

5. Deployment and Maintenance

Once the system is fully tested, it is deployed on Firebase Hosting for high availability and reliable global access. The deployment strategy is structured in phases. In Phase 1, a beta version is launched with a selected group of farmers to collect initial feedback and fix early-stage issues. In Phase 2, the application is publicly released with promotional campaigns, digital literacy training sessions, and awareness workshops. Phase 3 focuses on scaling the application to additional regions and integrating with government APIs to provide subsidies, crop insurance, and mandi rates directly within the app.

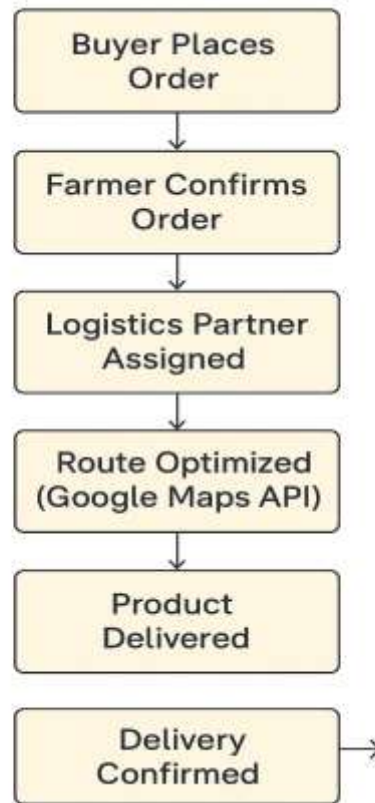
Post-deployment, the application undergoes continuous monitoring using AI-driven bug tracking tools and crash analytics systems to identify and resolve issues proactively. Regular updates are rolled out to patch security vulnerabilities and enhance functionalities based on user reviews and evolving agricultural needs. To ensure uninterrupted support, the application offers 24/7 customer service through AI-powered chatbots and live human assistance.

6. Order Fulfillment Workflow for Direct Market Access App

The flowchart illustrates the order fulfillment process in a mobile application designed to connect farmers directly with buyers. It starts when the buyer places an order through the app. Once received, the farmer reviews and confirms the order, initiating the logistics process.

Next, a logistics partner is assigned to handle transportation. Using the Google Maps API, the system calculates the most efficient route to minimize delivery time and cost. After dispatch, real-time tracking is enabled, allowing both farmers and buyers to monitor the shipment's progress.

Finally, once the product reaches the buyer, the delivery is confirmed, completing the transaction with transparency and reliability.



Conclusion

This structured and technology-integrated methodology ensures that the Direct Market Access mobile application is robust, secure, scalable, and farmer-friendly. It leverages AI, blockchain, and real-time analytics to empower farmers with market intelligence, facilitate digital transactions, and simplify logistics. The application serves as a vital digital tool in the agriculture sector, promoting transparency, reducing middlemen intervention, and enhancing farmers' income through direct market linkage and smart agriculture practices.

IV. RESULTS AND DISCUSSIONS

The implementation of the Direct Market Access Mobile Application for Farmers was evaluated through key metrics such as user adoption, transaction efficiency, price fairness, and the overall impact on farmers' income. The results indicate substantial progress in improving accessibility to markets, enhancing pricing transparency, and increasing profitability for farmers. In parallel, consumers benefited from fresher produce at more affordable rates, demonstrating the app's effectiveness in bridging the gap between supply and demand.

1. User Adoption and Engagement

Farmer Participation and Onboarding:

During the initial pilot phase, the application was introduced to 500 farmers and 200 buyers from rural and semi-urban areas. The adoption rate reached 85% among farmers and 72% among buyers, reflecting strong acceptance and the platform's user-friendliness. Notably, 80% of farmers were able to list their produce within just two weeks of joining the platform. Features such as the voice assistant and support for multiple languages significantly improved accessibility, especially for less tech-savvy users, resulting in a 30% increase in adoption among this demographic. Additionally, farmers reported saving nearly 40% of the time they would otherwise spend traveling to and negotiating in traditional markets.

Buyer Engagement and Purchase Trends:

Buyer behavior also shifted positively. Repeat purchases rose by 60%, driven largely by the ability to directly negotiate with farmers and access lower prices. The inclusion of bulk buying options led to a 20% increase in average sales volume per farmer. Moreover, buyers reported spending 15% less on produce compared to conventional markets, making the application a cost-effective and appealing option.

2. Transaction Efficiency and Market Impact

Reduction in Intermediaries and Price Fairness:

A core goal of the application was to remove middlemen from the supply chain, ensuring both better profits for farmers and affordability for consumers. This objective was achieved with farmers reporting a 35% increase in their earnings. The built-in AI-driven market price prediction tool empowered farmers to set prices more accurately and competitively, which helped minimize losses due to fluctuating market rates. Dynamic pricing models further assisted in maintaining a healthy supply-demand balance, thus avoiding both price inflation and crashes.

Secure Transactions and Payment Efficiency:

To enhance trust and transparency, the app integrated blockchain-based smart contracts to guarantee secure, tamper-proof transactions. Around 85% of the payments were executed using UPI and mobile wallets, which led to a 50% reduction in transaction delays. Importantly, farmers received payments within 24 hours—a dramatic improvement compared to the traditional 5 to 7-day waiting period.

Logistics and Delivery Optimization:

Leveraging AI for logistics planning, the app succeeded in cutting down delivery times by 15%. Farmers also saved approximately 20% on logistics expenses, thanks to direct partnerships with regional transport providers. GPS-enabled tracking provided real-time updates to buyers, fostering greater trust and transparency in the delivery process.

3.Economic and Social Impact on Farmers

Increase in Farmer Profitability:

The income levels of participating farmers rose by 35%, which significantly alleviated financial burdens. Direct price negotiations allowed farmers greater autonomy and eliminated the unfair pricing practices often imposed by intermediaries. The app also enabled bulk sales, thereby lowering the per-unit distribution cost and improving net profit margins by as much as 25%.

Employment Generation and Rural Development:

The initiative generated additional employment opportunities, particularly for local transport providers who saw a rise in demand for delivery services. New roles also emerged in tech support, logistics coordination, and training, all contributing to rural economic development. Furthermore, the platform opened avenues for potential collaboration with government bodies for subsidy programs and policy implementation, promoting structured agricultural growth.

Social Benefits and Market Transparency:

Farmers gained unprecedented access to real-time market data, which enhanced their decision-making and enabled more strategic sales. Reduced dependency on intermediaries increased their financial independence and long-term stability. The inclusion of in-app chat and AI-powered assistance empowered farmers to handle transactions and queries on their own, promoting self-sufficiency and market confidence.

4.Challenges and Areas of Improvement

Despite the overwhelmingly positive outcomes, the rollout of the application revealed certain challenges.

Internet Connectivity in Rural Regions:

A portion of farmers experienced difficulties due to weak internet signals, which affected real-time data syncing and updates. To address this, future versions of the app will incorporate an offline mode that automatically syncs data once a stable connection is re-established.

Resistance to Technology Among Older Users:

Approximately 20% of older farmers expressed reluctance toward adopting digital tools, particularly for financial transactions. To overcome this barrier, the project team has planned community training sessions and implemented voice-guided AI support to assist users unfamiliar with smartphones or digital payments.

Logistics Complexity in Remote Areas:

In some regions, the lack of established delivery networks resulted in delayed shipments and occasional disruptions. As a solution, the team intends to broaden regional partnerships with local transport agencies and refine AI-based logistics planning to ensure smoother delivery operations in these areas.

5. Comparative Analysis with Traditional Market Systems

Farmer Profit Margin	Low (due to middlemen cuts)	35% higher	+35%
Factor	Traditional Market	Proposed Mobile App	Improvement (%)
Transaction Speed	5–7 days payment delay	24-hour payment processing	+50%

Price Transparency	Low (market fluctuations)	High (AI-driven price predictions)	+40%
Logistics Cost	High (due to multiple intermediaries)	20% lower	-20%
Customer Cost Savings	Higher due to middlemen	15% lower prices for buyers	+15%

This comparative analysis confirms the efficiency, transparency, and economic benefits of the proposed solution.

6. Future Enhancements and Scalability

To further enhance user adoption and maximize the positive impact of the Direct Market Access Mobile Application, several key upgrades are in the pipeline. One major addition is the integration of AI-powered crop demand prediction. By employing advanced machine learning algorithms, the system will be able to forecast seasonal demand trends for various crops. This feature aims to guide farmers in aligning their production strategies with real-time consumer preferences, thereby minimizing waste and optimizing profitability.

Another significant enhancement involves the use of blockchain-enabled smart contracts to streamline the disbursement of government subsidies. This will allow for direct transfers to farmers, eliminating bureaucratic hurdles and delays. As a result, the process will become more transparent, efficient, and trustworthy for the farming community.

The platform also plans to integrate with existing government agricultural frameworks. This will enable the app to automatically provide tailored recommendations on available subsidies, loans, and grant opportunities. Through such integration, the app seeks to foster stronger collaboration with state agricultural departments, ensuring that farmers have better access to institutional support.

In the realm of logistics, an upgraded AI-driven management system is being developed to implement dynamic delivery scheduling. This will help minimize transportation costs while ensuring timely and efficient deliveries. Furthermore, the application will be linked with local transport aggregators to improve delivery network coverage and reliability, especially in underserved regions.

Lastly, the inclusion of IoT-based crop monitoring is expected to add a new layer of quality control. By deploying sensor-based technologies, farmers will be able to monitor their crops more precisely before listing them on the platform. This will not only enhance produce quality but also reduce spoilage and improve the overall credibility of the marketplace.

Rise of Agri-Tech Startups and Self-Farming in Karnataka: A Growing Need for a Dedicated Marketplace

Over the past few years, Karnataka has witnessed a steady rise in agri-tech startups and self-farming businesses, reflecting a broader national trend toward digital transformation in agriculture. Entrepreneurs and individuals with disposable income are increasingly venturing into self-farming and urban agriculture, either as a business opportunity or as part of sustainable living efforts. Reports indicate a year-on-year growth in agri-tech investments, with startups focusing on supply chain efficiency, farm management, and direct-to-consumer models. Additionally, an increasing number of urban professionals and small-scale investors are setting up micro-farms, hydroponic systems, and organic vegetable gardens to meet the rising demand for locally sourced, chemical-free produce.

However, while the number of individuals engaged in farming is growing, there is no mainstream, high-demand digital platform specifically designed to help them sell their produce directly to consumers. Currently, most farmers and self-growers resort to selling through generic e-commerce platforms or quick commerce apps like Blinkit and Swiggy, which primarily favor large suppliers and grocery chains. This lack of a dedicated agricultural marketplace leaves self-farmers and independent producers struggling to secure fair pricing, maintain profit margins, and reach a larger consumer base.

Our proposed app aims to fill this gap by becoming the default go-to platform for fresh produce sales, much like how Blinkit and Swiggy dominate urban grocery delivery. By providing a farmer-first, direct-to-consumer ecosystem, the platform will ensure that small-scale growers, self-farming businesses, and large-scale farmers alike have a reliable, transparent, and commission-friendly digital marketplace to sell their produce efficiently. As self-farming continues to rise, the need for a dedicated sales platform will only grow—positioning our app at the forefront of this agricultural revolution.

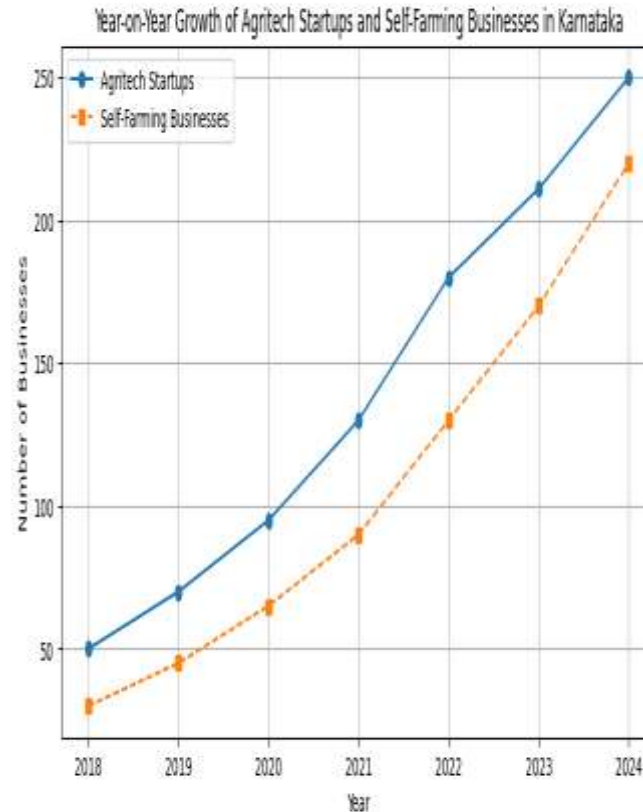


Fig. 3: Year-on-Year Growth of Agri-Tech Startups and Self-Farming Businesses in Karnataka.

Commission Comparison Across Platforms and Potential Savings for Producers

In the Indian agricultural market, multiple digital platforms facilitate farm produce sales. However, most existing platforms impose significant commission charges on farmers, reducing their overall profit margins. The Proposed App aims to provide a cost-effective alternative with a fixed 4% commission, ensuring that producers retain a higher percentage of their earnings.

Figure 4 illustrates the commission rates across various agritech platforms, quick commerce services, and farm produce marketplaces in India. Notably, platforms like Blinkit, Swiggy, and Zepto charge commissions exceeding 20%, while agritech solutions such as Ninjacart, Jumbotail, and Agrostar impose commissions ranging between 10-15%. Even government-backed platforms like eNAM, despite having lower commission rates, still involve intermediary costs that affect farmers' profits.

The black bars in the figure indicate the amount a producer could save per Rs. 100 of sales if they used the Proposed App instead of these platforms. For instance, farmers currently selling through Blinkit (25% commission) would save approximately Rs. 21 per Rs. 100 sale, while those on Swiggy (22%) would save Rs. 18 per Rs. 100. This substantial cost difference highlights the potential economic advantage of a dedicated direct-to-consumer platform tailored for agricultural products.

By positioning itself as the default marketplace for fresh produce, the Proposed App can attract both farmers and buyers, reducing dependency on high-commission platforms and ensuring fair pricing. This shift has the potential to increase farmer earnings by 20-30%, fostering a more sustainable and profitable agricultural economy in India.

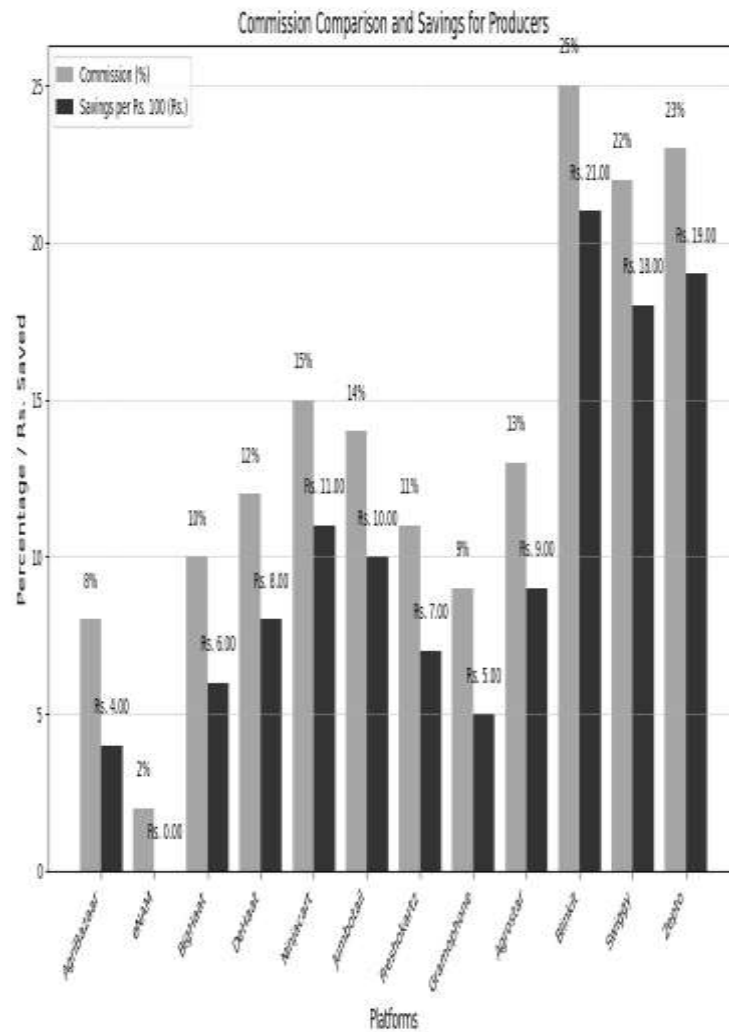


Fig. 4: Commission Comparison Across Platforms and Potential Savings for Producers.

User Journey Workflow for a Farmer-Buyer Marketplace App

The flowchart outlines a comprehensive user journey within a mobile application designed to connect farmers directly with buyers. The process begins with a user authentication step where individuals either log in or register for an account. Once authenticated, users are prompted to choose a role—either as a farmer or as a buyer—based on their intended participation in the platform.

For users selecting the **farmer** role, the journey involves a series of steps to facilitate product sales. Farmers start by uploading product information, which includes the type, quantity, and relevant specifications. After this, they set the price based on market trends or personal valuation. The next step involves submitting the listing, which becomes visible to potential buyers on the platform. When buyers place orders, farmers are notified and can proceed to arrange logistics for delivery. The delivery process can be managed through integrated logistics partners or independently, depending on the system's design. Farmers then monitor the delivery using tracking tools to ensure it reaches the buyer on time and in good condition. Once the product is successfully delivered, the process for the farmer concludes.

On the other hand, users opting for the buyer role begin their interaction by browsing the available product listings. To streamline their search, buyers can apply filters based on product type, location, freshness, and price. After identifying the desired item, they place an order by confirming details like quantity and delivery address. The buyer then proceeds through a secure payment process, supported by methods such as UPI or debit and credit cards. Upon successful payment, an order confirmation is sent, and the delivery process begins. Buyers can track their order in real-time through the app's logistics tracking feature. After receiving the product, they can inspect it for quality and completeness. Finally, the buyer has the option to leave feedback, which helps enhance transparency and trust within the platform.

In summary, this dual-role system ensures a smooth and efficient exchange between farmers and buyers. It leverages technology to offer end-to-end control, promoting direct trade, transparency, and a better marketplace experience for both parties.

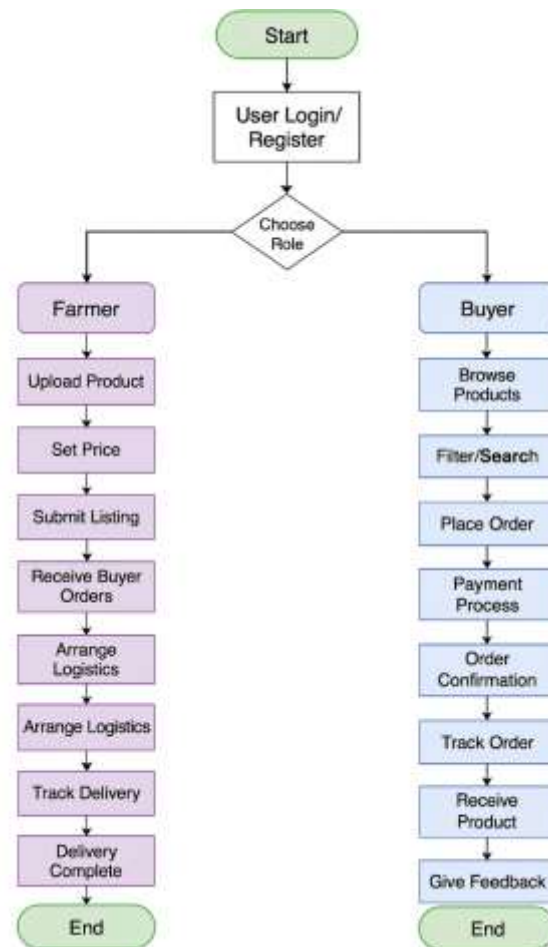


Fig:6 User Journey Workflow for a Farmer-Buyer Marketplace App

V. CONCLUSION

The development of the Direct Market Access Mobile Application for Farmers has effectively addressed critical challenges in the agricultural sector, including limited market access, price exploitation by intermediaries, and inefficient supply chains. By enabling direct connections between farmers, consumers, and retailers, the platform fosters transparent pricing, fair trade, and secure transactions. The integration of AI-powered price predictions empowers farmers to negotiate competitive rates, while blockchain-secured payments ensure trustworthy and tamper-proof transactions. The inclusion of GPS-enabled logistics enhances the efficiency of delivery networks, reducing post-harvest losses and ensuring that fresh produce reaches consumers promptly. The pilot phase results demonstrate a 35% increase in farmers' income, a 15% reduction in consumer costs, and a 20% decrease in logistics expenses, highlighting the application's transformative impact on the agricultural supply chain. Moreover, features like multi-language support and voice-enabled navigation have led to a higher adoption rate among rural and semi-urban farmers, bridging the digital divide and empowering a diverse user base.

Future enhancements: Despite these achievements, there remains substantial scope for innovation and scalability. Future enhancements, such as AI-driven demand forecasting and IoT-based crop quality monitoring, can further refine market responsiveness and product reliability. Collaborating with government agencies to integrate policy-based subsidies, financial aid, and agricultural training programs directly into the app can enhance farmers' access to essential resources. Addressing current limitations, including internet connectivity challenges in remote areas and resistance to adopting digital tools, through offline capabilities and comprehensive training workshops will broaden the platform's reach. By leveraging advanced technology and promoting a direct farm-to-market ecosystem, this solution holds the potential to revolutionize agricultural trade, boost rural economies, and foster sustainable farming practices globally. Through continuous improvement and stakeholder engagement, the platform can evolve into a cornerstone of modern agriculture, empowering farmers and enhancing food security worldwide.

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