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NukkadDrop: Design and development of multi-role B2B E-Commerce

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Abstract - *This paper presents the design and development of a multi-role Business-toBusiness (B2B) e-commerce platform that aims to empower small-scale entrepreneurs, artisans, and local business owners by providing a unified digital marketplace. The proposed system integrates four core modules Business Owner, Shopkeeper/Customer, Delivery Partner, and Administrator to streamline product management, order tracking, and delivery operations. Developed using JavaFX for the frontend and Firebase for the backend, the system ensures real-time synchronization, scalability, and data security. The platform eliminates the dependency on physical markets and intermediaries, thus enabling fair trade, faster transactions, and broader reach. The architecture and methodology proposed in this work promote digital inclusion, transparency, and operational efficiency among small-scale business communities.*

Key Words: B2B E-Commerce, JavaFX, Firebase, Supply Chain Management, Digital Marketplace, Business Automation.

1. INTRODUCTION

The evolution of digital commerce has significantly reshaped business ecosystems by enabling efficient connectivity between producers, wholesalers, and consumers. However, small-scale and rural entrepreneurs continue to face challenges in accessing digital platforms due to infrastructure limitations, lack of awareness, and high dependency on traditional selling methods. These constraints restrict market visibility, limit scalability, and create inefficiencies in supply chain operations.

A multi-role Business-to-Business (B2B) ecommerce platform addresses these issues by integrating all essential stakeholders within a single digital environment. The system connects business owners, shopkeepers, delivery partners, and administrators, thereby ensuring transparent operations and seamless communication. Through this structure, business owners can list and manage products, shopkeepers can directly purchase items from verified sellers, and delivery partners can coordinate logistics with real-time tracking capabilities under administrative supervision.

The platform is implemented using JavaFX for the graphical user interface and Google Firebase for backend operations, including authentication, database management, and cloud storage. Data communication is achieved through Firestore's REST API, ensuring secure and efficient synchronization across all modules. This modular architecture enhances scalability, performance, and maintainability, making the system adaptable to future expansions and technological upgrades.

By enabling direct interaction between producers and buyers, minimizing manual dependencies, and introducing automated delivery coordination, the proposed system contributes to improving market accessibility and operational efficiency among small-scale business sectors.

2. LITERATURE REVIEW

Recent advancements in e-commerce systems have introduced several platforms and frameworks focusing on digital trade, supply chain automation, and delivery optimization. However, most existing systems address specific aspects of ecommerce rather than providing a unified, multi-role solution that caters to both smallscale producers and business stakeholders.

Prachi Dixit (2024) conducted a comparative analysis of B2B and B2C platforms, emphasizing the structural and functional differences between business transaction models. Although this research provided valuable insights into the B2B domain, it did not explore integrated systems that support multiple user roles simultaneously.

Megawati C. Alam et al. (2025) presented a bibliometric study on supply chain management practices among small and medium enterprises (SMEs), identifying the need for accessible, technology-driven tools to optimize production and delivery. The study highlighted the technological gap between large enterprises and rural SMEs, reinforcing the necessity for modular, realtime systems.

Sophea Horng and Pisal Yernade (2023) developed a delivery management system utilizing Google Maps integration to improve delivery efficiency for small enterprises. While this system enhanced logistical accuracy, it lacked product-level management and administrative supervision capabilities.

Karaoulanis Andreas (2024) explored sustainable delivery models and smart logistics for urban networks, addressing environmental efficiency in last-mile delivery. Despite focusing on sustainability, the work did not include commerce integration for small-scale vendors.

Sena Efsun Cebeci et al. (2022) proposed a secure e-commerce framework emphasizing transaction security and data integrity. However, the absence of multirole

coordination and real-time logistics limited its practical adoption for rural enterprises.

Existing literature collectively indicates a strong need for a modular e-commerce framework capable of bridging business management, logistics, and administration within a single platform. The proposed system addresses these gaps by integrating all core stakeholders business owners, shopkeepers, delivery partners, and administrators through a unified, cloudbased architecture.

3. METHODOLOGY/SYSTEM DESIGN

The proposed system follows a modular and service-oriented architecture, designed to integrate multiple stakeholders Business Owners, Shopkeepers, Delivery Partners, and Administrators within a unified platform. Each module performs distinct operations while maintaining realtime synchronization through a cloud-based backend. The system emphasizes scalability, security, and maintainability using modern development tools and APIs.

A. System Architecture

The platform utilizes a three-tier architecture consisting of:

1. **Presentation Layer (Frontend):** Developed using JavaFX, this layer provides an interactive user interface designed in Scene Builder. It enables users to perform rolespecific operations such as product listing, order management, and delivery tracking.
2. **Application Logic Layer:** Implements business rules, input validation, and data handling through RESTful communication between JavaFX and the backend services.
3. **Data Layer (Backend):** Powered by Google Firebase Firestore, this layer manages all user data, product records, orders, and delivery statuses. Authentication and secure access control are handled through Firebase Authentication, ensuring verified and role-based entry.

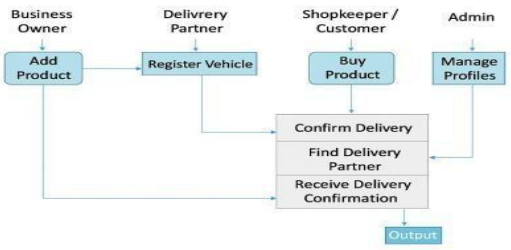

Fig. 1. System Architecture of the proposed multi-role B2B e-commerce platform.

All layers communicate through Firestore's REST API, using JSON-formatted data packets to maintain consistency and reduce latency.

B. Functional Modules

1. **Business Owner Module:** Enables product registration, stock management, order approval, and feedback monitoring. Business owners can directly interact with customers and confirm delivery requests through the system.
2. **Shopkeeper / Customer Module:** Facilitates browsing, purchasing, and tracking of products from multiple business owners. This module provides real-time order updates and payment confirmation functionalities.
3. **Delivery Partner Module:** Manages delivery operations including registration, task acceptance, delivery tracking, and payment receipt after successful completion.
4. **Admin Module:** Provides system-wide management functions such as user verification, profile management, and analytics reporting to maintain operational transparency.

C. Data Flow and Communication

Each transaction, such as placing an order or confirming delivery, triggers a series of REST API requests that update Firestore collections in real time. Firebase's eventdriven structure ensures that changes made by one module are reflected across all relevant components instantly. This eliminates manual synchronization and improves operational reliability.

D. Development Environment

The application is developed using:

- **Programming Language:** Java
- **Frontend Framework:** JavaFX with Scene Builder
- **Backend Service:** Firebase Firestore (NoSQL) and Firebase Authentication
- **Tools and Dependencies:** Maven for dependency management, IntelliJ IDEA for development, and GitHub for version control
- **Operating Environment:** Windows / Linux with stable internet connectivity

E. System Workflow

The workflow begins with user registration, followed by authentication and role-based access allocation. Business owners upload products, which are visible to shopkeepers for purchase. Upon order placement, the system assigns a delivery partner, who updates delivery status until confirmation is received. The admin monitors all operations through an integrated dashboard.

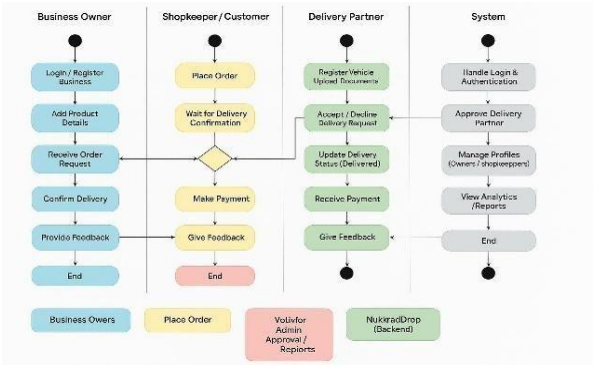

Fig. 2. Workflow illustrating the operational sequence between Business Owner, Shopkeeper, Delivery Partner, and Admin modules.

including Business Owners, Shopkeepers or Customers, Delivery Partners, and the Admin. Business Owners can register and manage their products, Shopkeepers can browse and purchase products, Delivery Partners handle order fulfillment, and the Admin oversees verification and system management.

F. Use Case Representation

The use case representation illustrates how different users interact with the NukkadDrop system to perform their respective roles. It captures the major actions of each actor within the system, including Business Owners, Shopkeepers or Customers, Delivery Partners, and the Admin. Business Owners can register and manage their products, Shopkeepers can browse and purchase products, Delivery Partners handle order fulfillment, and the Admin oversees verification and system management.

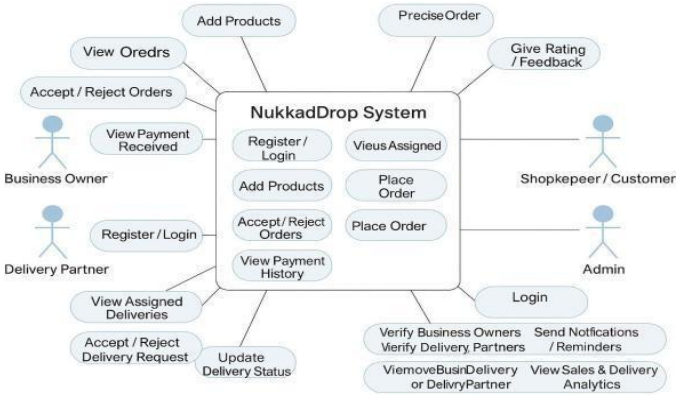

Fig. 3. Use case diagram showing interactions between system users and core functionalities.

4. IMPLEMENTATION AND RESULTS

The system is implemented as a desktop based JavaFX application connected to a cloud backend powered by Google Firebase. The implementation phase focuses on integrating all four modules Business Owner, Shopkeeper/Customer, Delivery Partner, and Admin into a cohesive workflow, ensuring data consistency, real-time synchronization, and secure communication.

A. Development Environment

The system is developed using JavaFX for the graphical user interface and Google Firebase Firestore as the backend database. The development environment is configured as follows:

- Frontend Framework: JavaFX
- Backend: Firebase Firestore, Firebase Authentication, and Cloud Storage
- Programming Language: Java (JDK 17)
- Development Tools: IntelliJ IDEA and Maven for dependency management
- Version Control: Git and GitHub for source code management
- Operating Environment: Windows 10 or later

This configuration provides real-time synchronization, secure authentication, and automatic scalability via Firebase infrastructure.

B. Functional Workflow Execution

The system's primary workflow involves product listing, order placement, delivery assignment, and feedback recording. Business Owners upload product details that are displayed in the Shopkeeper/Customer interface. When an order is placed, the system assigns a Delivery Partner based on availability. Once the delivery is confirmed, the Admin updates transaction status and records payment data.

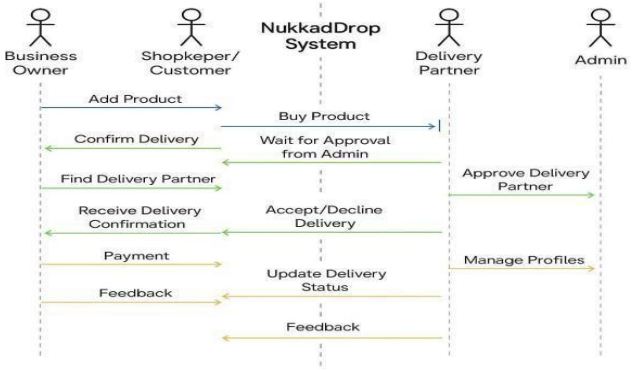

Fig. 4. Sequence diagram showing event flow and message passing between system entities during order processing.

C. DATA MODEL AND ENTITY DESIGN

The system adopts an object-oriented approach to maintain clear relationships between core entities. Each class represents a functional component of the system such as BusinessOwner, Shopkeeper, DeliveryPartner, Admin, Product, Order, and Payment. Firestore collections mirror these relationships, providing a documentbased schema that simplifies scalability and reduces redundancy..

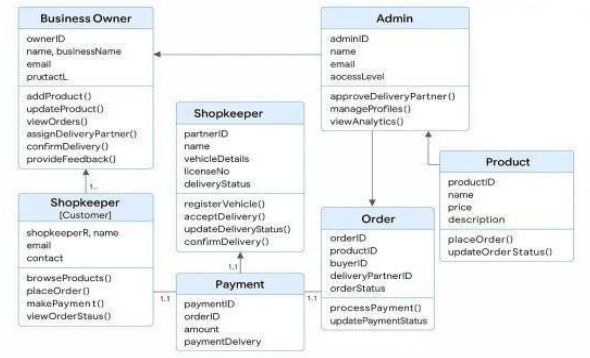

Fig. 5. Class diagram depicting system entities and their relationships in the data model.

D. RESULTS AND PERFORMANCE ANALYSIS

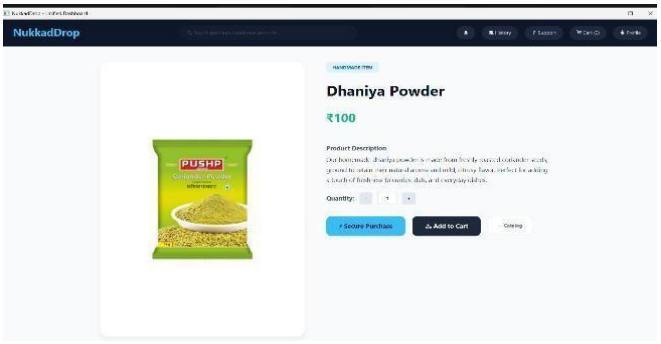

Fig.6 . Multi Role Login Page

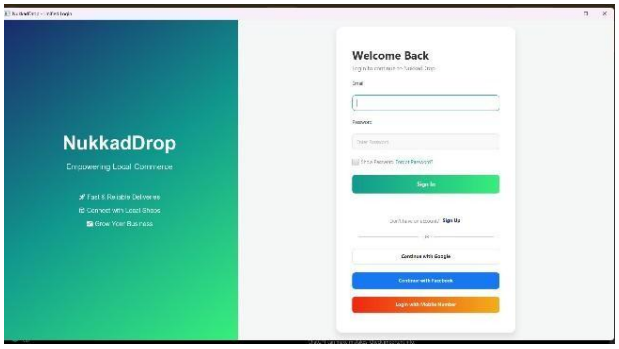

Fig.7 . Product Card with Description

Testing and evaluation confirm stable performance and minimal latency during real-time data transactions. The system efficiently handles multiple simultaneous operations such as product uploads, order confirmations, and delivery updates. Firebase's optimized NoSQL structure ensures consistent read/write performance under moderate load conditions.

Table : Comparison With Existing Systems

Feature	Existing Systems	Proposed System
Product Management	Yes	Yes
Delivery Tracking	Partial	Yes
Multi-role Access	No	Yes
Real-time Sync	Limited	Yes

The following outcomes were observed:

- Reduced delay in order confirmation and delivery tracking due to real-time synchronization.
- Smooth role-based navigation between modules without crossaccess conflicts.
- Secure authentication and data handling through Firebase's built-in security model.

5. APPLICATIONS

The proposed NukkadDrop platform can be applied in various business environments, particularly for small-scale enterprises, rural entrepreneurs, wholesalers, and local retailers. It facilitates digital product management, supply chain automation, real-time delivery tracking, and business analytics. The system can support multi-vendor marketplaces, improve logistics coordination, and enhance market accessibility for SMEs. Furthermore, it provides a scalable foundation for future integration of artificial intelligence, digital payment systems, and advanced business intelligence features, making it suitable for modern e-commerce ecosystems. The platform also promotes transparency and trust among stakeholders by providing real-time updates and secure role-based access control. Additionally, it reduces operational overhead and manual intervention, resulting in improved efficiency, faster order processing, and enhanced customer satisfaction.

6. CONCLUSION AND FUTURE SCOPE

The developed system successfully integrates multiple user roles Business Owner, Shopkeeper/Customer, Delivery Partner, and Admin into a unified ecommerce environment designed to support small-scale enterprises. The modular architecture, implemented using JavaFX and Firebase Firestore, ensures scalability, security, and real-time communication across all operational levels. The system demonstrates efficiency in managing product listings, orders, and deliveries, offering an end-to-end solution for small businesses seeking digital transformation.

The integration of Firebase's cloud infrastructure eliminates the need for local servers, reducing deployment complexity while maintaining high availability and performance. Role-based authentication enhances system reliability by ensuring secure and independent access control for each user type. The results indicate that the platform effectively streamlines supply chain processes for rural and small-scale businesses by bridging the gap between production and retail.

Future enhancements will focus on extending the platform's capabilities through mobile integration, AI-based product recommendations, and analytics driven business insights. Features such as delivery route optimization, sales forecasting, and multilingual support will further improve user accessibility and business scalability. Additionally, incorporating secure digital payment gateways and automated invoice generation will enhance transparency and usability.

The system establishes a scalable foundation for inclusive e-commerce ecosystems, providing small enterprises with the technological infrastructure to compete in a digitally connected marketplace.

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