

Design and Development of a Mobile-Based E-Commerce Application Using Flutter Framework for QOF Drink MSME with the Waterfall Method

Hadistilla Rayzan Fasya¹, Muhammad Iqbal², Fauzi³, Mutia Fadhila Hanim⁴, Assaida Ibka Putri⁵, Angga Pratama^{6*}

^{1,2,3,4,5} Faculty of Engineering, Information Systems Study Program, Malikussaleh University

hadistilla.230180143@mhs.unimal.ac.id^{1*}, muhammad.230180172@mhs.unimal.ac.id²,
fauzi.230180138@mhs.unimal.ac.id³, mutia.230180029@mhs.unimal.ac.id⁴, assaida.230180136@mhs.unimal.ac.id⁵,
anggapratama@unimal.ac.id^{6*}

Abstract

The increasing adoption of digital technology has encouraged micro, small, and medium enterprises (MSMEs) to utilize mobile-based information systems to improve operational performance, broaden market opportunities, and enhance customer service quality. Despite these developments, QOF Drink continues to manage product promotion, order processing, transaction recording, and delivery coordination through conventional methods, leading to operational inefficiencies and limited service accessibility. Therefore, this study aims to design and develop a mobile-based e-commerce application for QOF Drink by utilizing the Flutter framework and the Waterfall software development methodology. The development process includes requirements analysis, system design, implementation, system testing, and maintenance planning. Flutter was employed to build a responsive mobile application, while Firebase was integrated as the backend platform to handle user authentication, real-time database services, and transaction synchronization. The developed application combines customer, administrator, and driver functionalities into a single platform, providing features such as product catalog management, shopping carts, checkout, order history, delivery assignment, and real-time order tracking. The implementation results indicate that the proposed application streamlines business operations, improves transaction management, enhances customer convenience, and supports the digital transformation of QOF Drink through an integrated mobile-based e-commerce platform.

Keywords: E-Commerce; Mobile Application; Flutter; Waterfall; MSMEs.

1. Introduction

The rapid advancement of digital technology has significantly transformed the way businesses operate, particularly for micro, small, and medium enterprises (MSMEs). Digital transformation enables MSMEs to improve operational efficiency, strengthen customer relationships, and expand market reach by utilizing digital platforms to support business activities [1]. Along with the increasing use of smartphones, mobile commerce has become an important medium for providing products and services more efficiently. Mobile applications allow customers to access information, place orders, and complete transactions regardless of time and location, while enabling businesses to improve service quality and operational performance [2]. Flutter has emerged as one of the leading frameworks for developing cross-platform mobile applications because it enables developers to create applications for multiple operating systems using a single codebase. Combined with Firebase as a cloud-based backend platform, Flutter supports secure user authentication, real-time data synchronization, and efficient transaction management, making it suitable for modern mobile commerce applications [3].

Several previous studies have successfully implemented Flutter and the Waterfall software development model in developing mobile applications for marketplace platforms, inventory management, and online business services. Nevertheless, research focusing on beverage MSMEs that integrates customer transactions, administrative management, and delivery services into a single mobile application remains relatively limited [4][5]. QOF Drink is a beverage MSME that still performs several operational activities manually, including product promotion, order processing, transaction recording, and delivery coordination. These conditions often reduce operational efficiency, complicate transaction management, and limit customer access to products and services. As business activities continue to increase, the need for an integrated mobile-based information system becomes increasingly important to support more effective business operations. Therefore, this study proposes the design and development of a mobile-based e-commerce application for QOF Drink using the Flutter framework and the Waterfall software development method. The proposed application integrates customer, administrator, and driver functionalities into a single platform to simplify business processes, improve transaction management, facilitate delivery coordination, and support the digital transformation of QOF Drink through mobile technology.

1.1. E-Commerce System

E-commerce is a business model that utilizes internet-based technologies to facilitate the exchange of products, services, and information between sellers and customers through digital platforms. The implementation of e-commerce enables micro, small, and medium enterprises (MSMEs) to improve operational efficiency, expand market reach, and optimize transaction management while providing customers with easier access to products and services [1]. In this study, the e-commerce system was developed to digitalize the business operations of QOF Drink through a mobile-based platform. The application enables customers to browse beverage products, access detailed product information, place orders, and complete transactions electronically. In addition, administrators are able to manage product information, monitor customer orders, and organize transaction data through an integrated management system, thereby improving the efficiency of daily business activities.

1.2. Mobile-Based Application

A mobile-based application is software specifically designed to operate on smartphones and tablet devices, allowing users to access digital services through internet connectivity regardless of time and location. The increasing adoption of mobile technology has encouraged businesses to provide more flexible and accessible services, improving customer experience while supporting operational efficiency [2]. In this research, the proposed mobile application supports three categories of users, namely customers, administrators, and drivers. Customers can browse available products, place orders, complete checkout, and monitor order status, whereas drivers receive delivery assignments and update delivery progress directly through the application. This integrated approach improves communication among users and contributes to more efficient business operations.

1.3. Flutter Framework

Flutter is an open-source software development framework introduced by Google for developing cross-platform mobile applications using a single codebase. The framework provides high-performance rendering, customizable widgets, and rapid development capabilities, enabling developers to build responsive applications with a consistent user interface across Android devices [3]. Flutter was selected for this study because it simplifies the mobile application development process while maintaining application performance and interface consistency. Through Flutter, the QOF Drink application implements essential features such as product catalogs, shopping carts, checkout services, transaction history, and order tracking to provide users with a convenient and interactive shopping experience.

1.4. Waterfall Method

The Waterfall model is a Software Development Life Cycle (SDLC) methodology that organizes software development into sequential phases, including requirements analysis, system design, implementation, testing, and maintenance. Each phase is completed before proceeding to the next stage, allowing software development to be carried out systematically and in a well-controlled manner [5]. The Waterfall method was adopted in this research because the functional requirements of the QOF Drink application had been clearly identified at the beginning of the development process. The structured development stages facilitated systematic implementation, reduced unnecessary modifications during development, and ensured that the resulting application fulfilled the identified business requirements.

1.5. Firebase Backend

Firebase is a cloud-based Backend-as-a-Service (BaaS) platform that provides authentication, cloud database, cloud storage, and real-time synchronization services for mobile application development. By utilizing Firebase, developers can build application backends more efficiently without developing server infrastructure from the beginning. Firebase is a cloud-based Backend-as-a-Service (BaaS) platform that provides integrated services for mobile application development, including user authentication, cloud databases, cloud storage, and real-time data synchronization. These services simplify backend development by allowing developers to implement server-side functionalities without building dedicated server infrastructure [6]. In this research, Firebase was utilized to manage user authentication, store product and transaction information, and synchronize order status in real time. The integration of Flutter and Firebase enables customers, administrators, and drivers to access consistent and up-to-date information, thereby improving system responsiveness and supporting more efficient business operations.

2. Research Methods

This study employed the Waterfall software development method to design and develop a mobile-based e-commerce application for QOF Drink MSME. The Waterfall model was selected because it provides a structured and systematic development process, making it suitable for projects with clearly defined system requirements. Through its sequential development stages, the method enables each phase of the project to be completed and evaluated before proceeding to the next stage, thereby reducing development risks and ensuring that the resulting application meets user needs. The research consisted of data collection, system requirements analysis, system design, implementation, and system testing to ensure that the developed application fulfilled the identified functional and operational requirements [5].

2.1. Data Collection Methods

Data collection was conducted to obtain comprehensive information regarding the operational activities and business requirements of QOF Drink. This stage was essential for identifying existing problems, understanding user needs, and determining the functional requirements of the proposed mobile-based e-commerce application. Three data collection techniques were employed in this study, namely observation, interviews, and literature review. Observation was conducted by directly examining daily business activities, including product promotion, customer ordering, transaction recording, and delivery management. Interviews with the business owner were carried out to obtain detailed information regarding operational workflows, business challenges, and system expectations.

Meanwhile, the literature review was performed by examining books, scientific articles, and previous studies related to e-commerce systems, Flutter, Firebase, and the Waterfall software development methodology [3].

2.2. System Requirements Analysis

System requirements analysis was conducted to identify both functional and non-functional requirements before the application development process began. This stage ensured that the proposed system addressed the operational needs of QOF Drink while providing services that met user expectations. The proposed application involves three categories of users: customers, administrators, and drivers. Customers are able to register, log into the application, browse products, manage shopping carts, complete checkout, monitor order status, and review transaction history. Administrators are responsible for managing products, verifying customer orders, assigning drivers, monitoring transactions, and generating sales reports. Drivers receive delivery assignments and update delivery status after completing deliveries. In addition, the system considers several non-functional requirements, including usability, reliability, security, system performance, and compatibility with Android devices to ensure stable application performance.

2.3. System Design

The system design stage transformed the identified requirements into a structured software design. This process included the design of system architecture, database structure, user interface, and Unified Modeling Language (UML) diagrams to illustrate system functionality and interactions among users. The proposed system consists of three primary actors: customers, administrators, and drivers. Customers interact with the application to browse products, place orders, and monitor deliveries. Administrators manage products, customer transactions, and delivery assignments, while drivers receive assigned orders and confirm completed deliveries. The relationships among these actors are illustrated through the Use Case Diagram and Activity Diagrams presented in this study.

2.4. System Implementation

The system implementation stage transformed the approved system design into a fully functional mobile-based e-commerce application for QOF Drink. The application was developed using the Flutter framework with the Dart programming language to provide a responsive and user-friendly interface across Android devices. Flutter was selected because it supports efficient cross-platform development while maintaining consistent application performance and interface quality [3].

Firebase was implemented as the backend platform to support user authentication, product management, transaction processing, and real-time data synchronization. Through the integration of Flutter and Firebase, the application enables customers, administrators, and drivers to access consistent and updated information during business operations. The implementation process successfully integrated major application features, including product catalogs, shopping carts, checkout services, order history, driver assignment, and order tracking, resulting in a mobile-based e-commerce platform that supports the operational activities of QOF Drink [6].

2.5. System Testing

System testing was conducted to verify that the developed application fulfilled the specified functional requirements and operated as expected. This study employed the Black Box Testing method because it evaluates system functionality based on user interactions without examining the internal program structure [7].

The testing process covered the primary features of the application, including user registration, login, product browsing, shopping cart management, checkout, transaction processing, order tracking, product management, and delivery confirmation. The testing results indicated that all implemented features functioned successfully according to the expected outcomes without significant functional errors. These findings demonstrate that the proposed application is functionally reliable and capable of supporting the daily operational activities of QOF Drink through an integrated mobile-based e-commerce system.

3. Design of Proposed System Procedures

The proposed system procedures describe the overall design and operational workflow of the mobile-based e-commerce application developed for QOF Drink. The system was designed to integrate three primary user roles, namely customers, administrators, and drivers, into a unified platform that supports product ordering, transaction management, and delivery services in a more organized and efficient manner. The proposed workflow was developed based on the results of the requirement analysis conducted during the earlier stages of this research, ensuring that the system functionalities correspond to the operational needs of the business.

Before the implementation stage, the proposed system was modeled using Unified Modeling Language (UML) to provide a clear representation of the interactions between users and the system, as well as the sequence of activities performed during business operations. UML diagrams were utilized to simplify the visualization of system processes, identify user responsibilities, and describe how information flows throughout the application. The system design includes a Use Case Diagram, which illustrates the functional interactions between each user and the application, and Activity Diagrams, which describe the workflow of customers, administrators, and drivers during the execution of their respective tasks.

Through these system models, the proposed application structure can be evaluated before implementation, reducing the possibility of design inconsistencies and facilitating the software development process. The UML diagrams also serve as a reference for translating the system design into the implementation stage while ensuring that all functional requirements are properly represented within the developed mobile-based e-commerce application.

3.1. Use Case Diagram

The Use Case Diagram was developed to describe the functional interactions between users and the proposed mobile-based e-commerce application for QOF Drink. The system involves three primary actors, namely customers, administrators, and drivers, each having different responsibilities according to their respective roles. Customers perform activities such as user registration, login, product browsing, shopping cart management, checkout, and order tracking. Meanwhile, administrators manage product information, process customer transactions, assign delivery tasks, and monitor business operations, whereas drivers receive delivery assignments and update delivery status after completing customer orders.

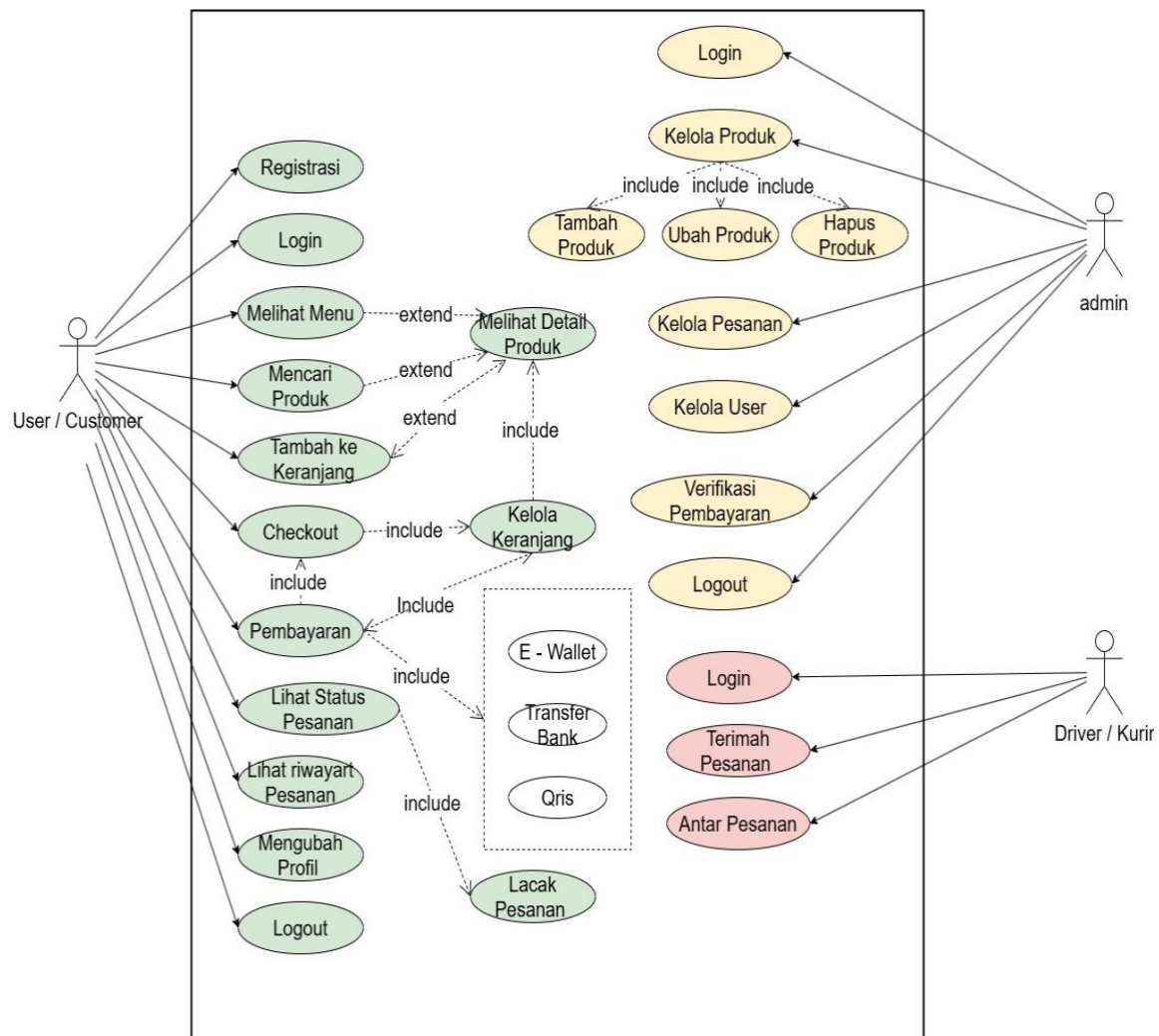
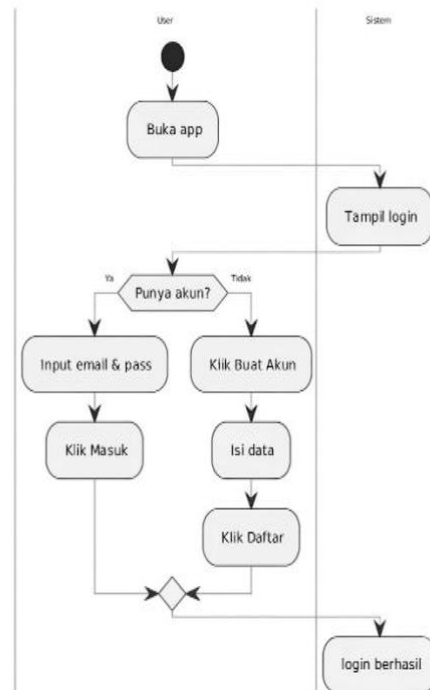
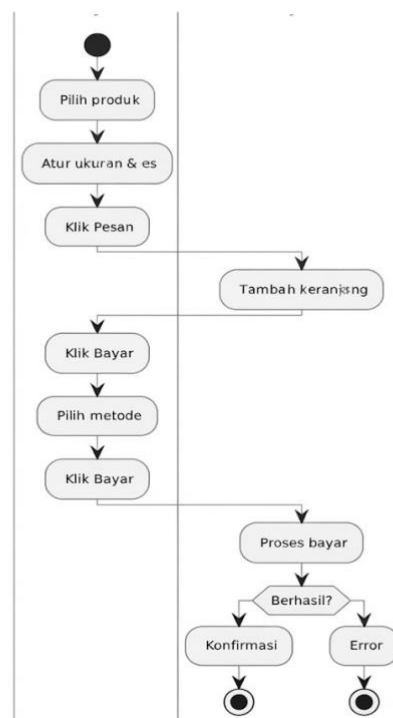


Fig. 1: Use Case Diagram

The Use Case Diagram provides a comprehensive overview of the interactions between users and the proposed system. It illustrates the main functionalities available to each actor and serves as a reference for identifying the functional requirements implemented during the application development process.

3.2. Customer Activity Diagram

The Customer Activity Diagram illustrates the sequence of activities performed by customers when interacting with the proposed mobile-based e-commerce application. The workflow begins when customers access the application and log into their accounts before browsing available beverage products. Customers can then view product details, select desired items, add products to the shopping cart, proceed to the checkout process, and complete the transaction. After the order has been successfully processed, customers are able to monitor the delivery status until the ordered products are received. This activity diagram provides a clear representation of the customer purchasing process and ensures that each transaction is carried out in a structured and systematic manner.

Activity Diagram Qof Drink (Bagian 1: Login & Registrasi)**Activity Diagram Qof Drink (Bagian 2: Pemesanan & Pembayaran)****Fig. 2:** Customer Activity Diagram**3.3. Administrator Activity Diagram**

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Activity Diagram Admin Qof Drink

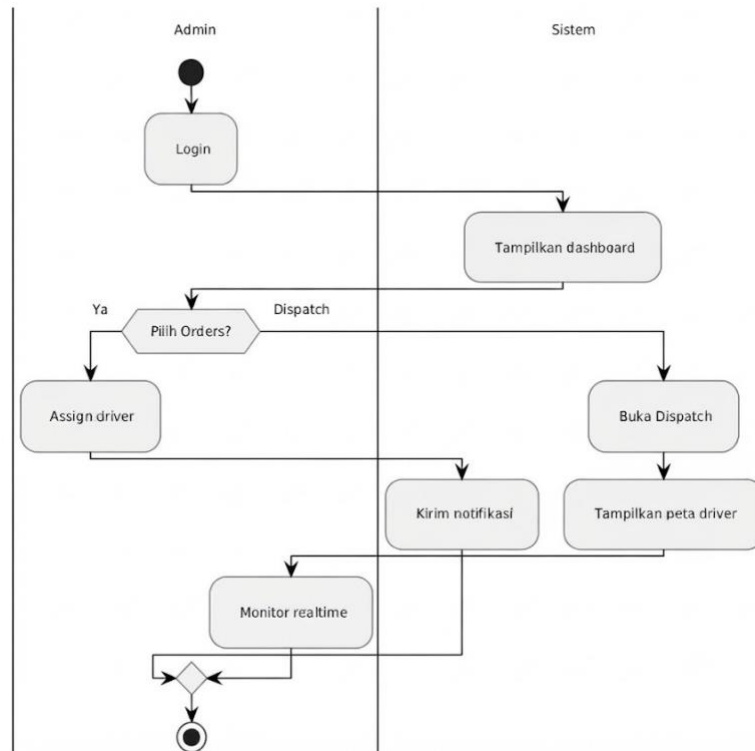
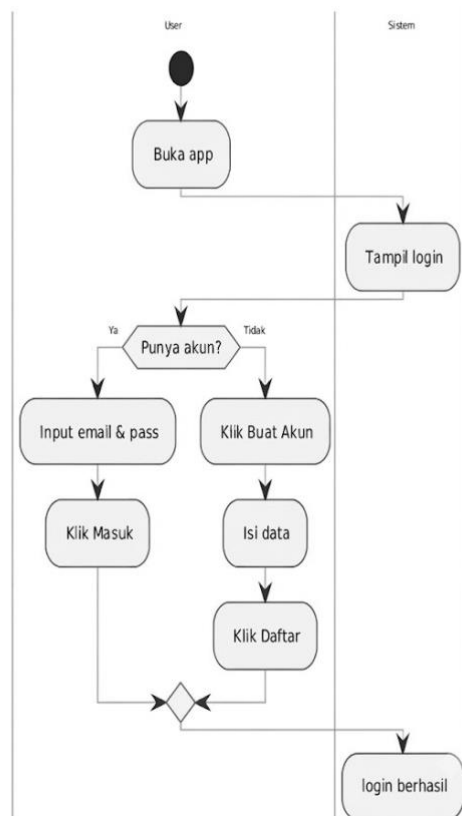
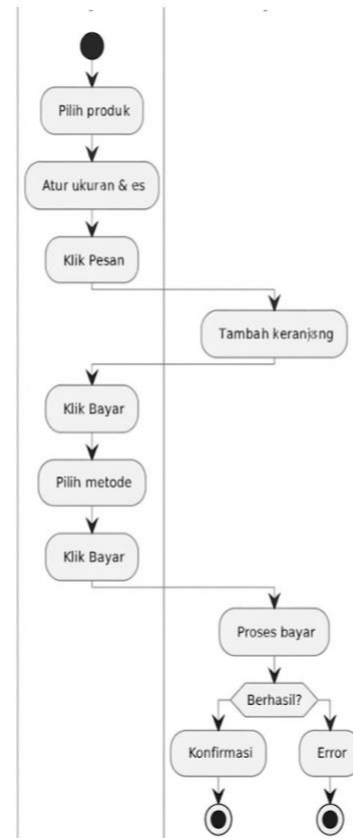


Fig. 3: Administrator Activity Diagram

3.4. Driver Activity Diagram

The Driver Activity Diagram describes the workflow performed by drivers during the product delivery process. After logging into the application, drivers receive delivery assignments from the administrator and access customer delivery information. Drivers then deliver the ordered products to the specified destination and update the delivery status after successfully completing the delivery. This activity diagram illustrates how the delivery process is integrated into the application, enabling real-time status updates and improving coordination between administrators, drivers, and customers.

Activity Diagram Qof Drink (Bagian 1: Login & Registrasi)**Activity Diagram Qof Drink (Bagian 2: Pemesanan & Pembayaran)****Fig. 4:** Driverr Activity Diagram

4. Implementation

The implementation stage presents the mobile-based e-commerce application developed for QOF Drink based on the proposed system design. The application was developed using the Flutter framework with Firebase as the backend platform to support user authentication, product management, transaction processing, and real-time data synchronization. The implemented system consists of several interfaces designed for customers, administrators, and drivers, where each interface supports specific business functions to improve operational efficiency and user experience.

4.1. Customer Dashboard Interface

The Customer Dashboard Interface serves as the main page displayed after users successfully log into the QOF Drink mobile-based e-commerce application. This interface was designed as the primary access point where customers can explore the application's main features before making purchasing decisions. The dashboard provides various components, including promotional banners, beverage categories, featured products, and a search function that enables customers to locate products quickly and efficiently. In addition, the interface presents product information in a structured and visually organized layout, allowing users to navigate the application with minimal effort.

The implementation of the customer dashboard improves the accessibility of shopping features by integrating essential functions into a single interface. Customers can easily browse available products, search for specific beverages, and access promotional information without navigating through multiple pages. The simple navigation structure and responsive user interface contribute to a more convenient shopping experience while reducing the time required to complete product exploration. As the primary interface of the application, the customer dashboard plays an important role in improving user interaction, supporting efficient product discovery, and encouraging customers to continue the purchasing process through the mobile-based e-commerce platform.

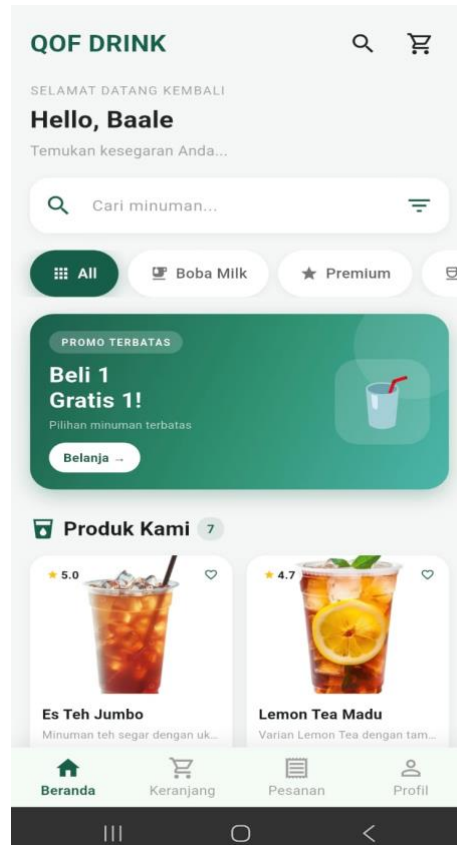


Fig. 5: Customer Dashboard Interface

4.2. Product Detail Interface

The Product Detail Interface provides comprehensive information about the selected beverage, including product images, descriptions, prices, available sizes, stock availability, and customer ratings. Customers can review this information before adding products to the shopping cart and continuing with the purchasing process.

Providing complete product information enables customers to make more informed purchasing decisions while minimizing ordering errors. The integration of the Add to Cart feature also simplifies product selection and improves transaction efficiency throughout the shopping process.

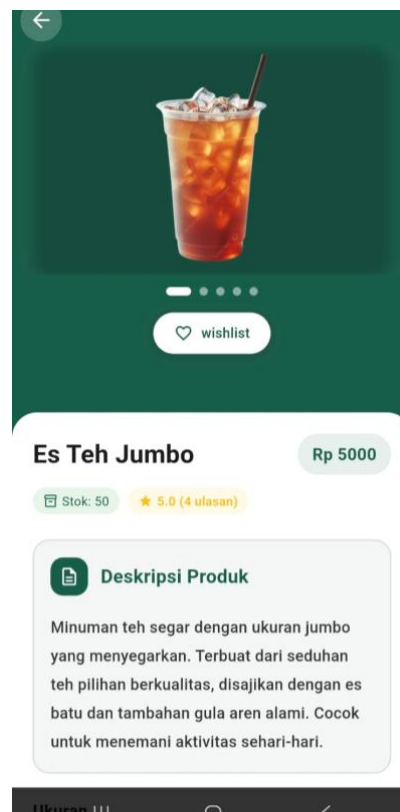


Fig. 6: Product Detail Interface

4.3.Shopping Cart Interface

The Shopping Cart Interface allows customers to review products selected for purchase before proceeding to the checkout process. Customers can modify product quantities, remove unnecessary items, and verify the total transaction value before confirming their orders.

This feature provides greater flexibility by allowing customers to adjust their purchases before payment is completed. As a result, transaction accuracy is improved, purchasing mistakes are minimized, and customers are provided with a more convenient and controlled shopping experience.

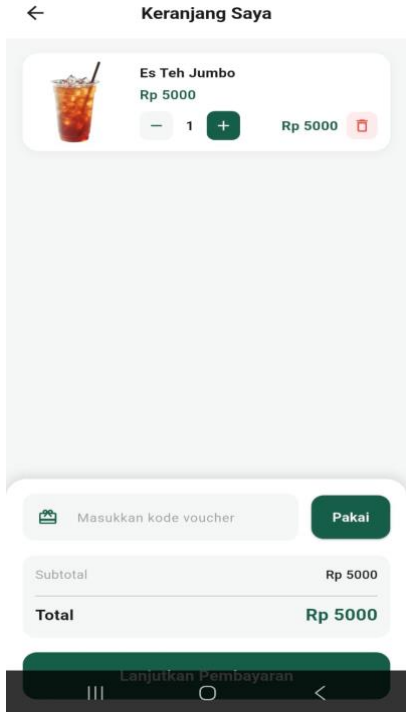


Fig. 7: Shopping Chart Interface

4.4. Order Tracking Interface

The Order Tracking Interface enables customers to monitor the progress of their orders after the checkout process has been completed. The application continuously updates delivery information, allowing customers to view the current order status from confirmation until successful delivery.

The implementation of this feature improves service transparency by providing real-time delivery updates throughout the delivery process. Customers can obtain accurate delivery information without contacting the administrator or driver, resulting in more efficient communication and improved service quality.

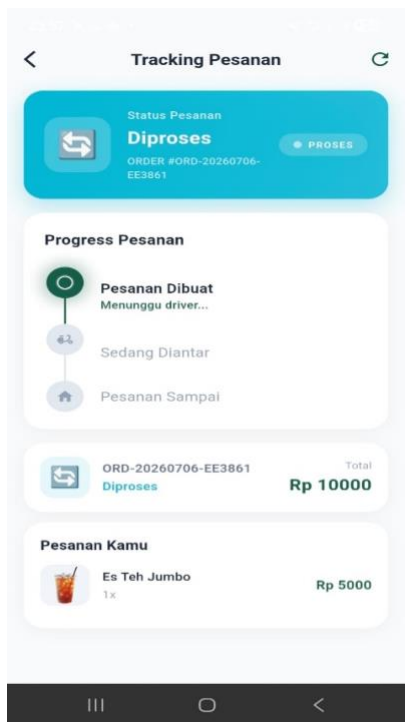


Fig. 8: Order Tracking Interface

4.5. Administrator Dashboard Interface

The Administrator Dashboard Interface functions as the central management page for the QOF Drink e-commerce system. Through this interface, administrators can manage product information, verify customer orders, monitor transaction records, assign delivery tasks, and supervise overall business operations.

The integration of these management functions into a single interface simplifies administrative activities and improves operational efficiency. Business owners are able to manage daily operational processes more effectively while maintaining accurate transaction records and monitoring customer activities.

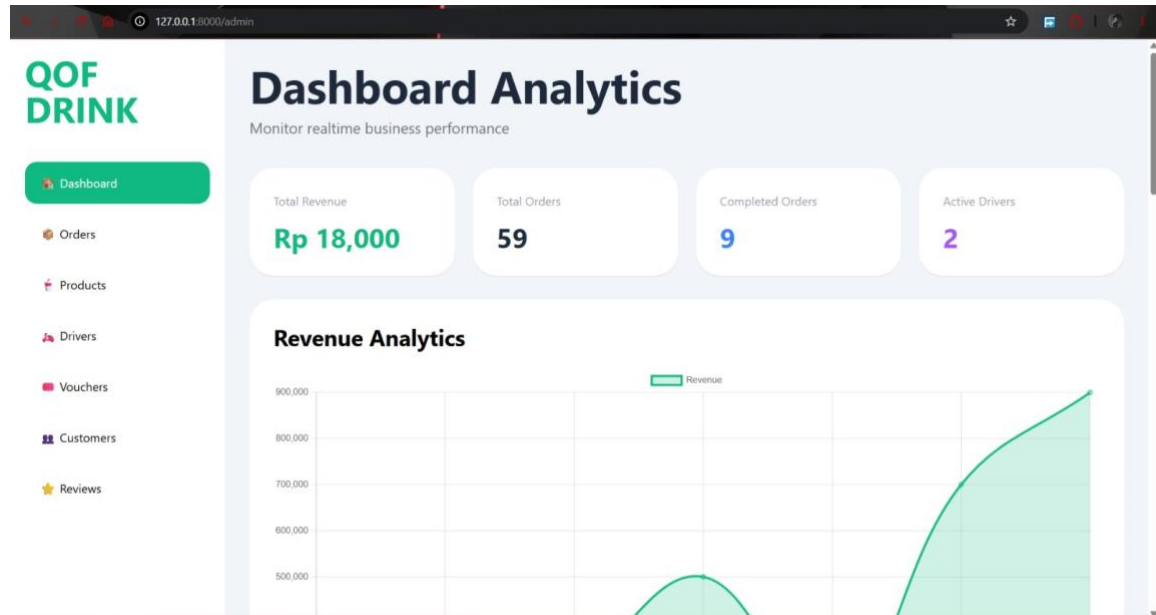


Fig. 9: Administrator Dashboard Interface

4.6. Driver Dashboard Interface

The Driver Dashboard Interface was developed to support delivery operations after customer orders have been verified by the administrator. Drivers can access assigned delivery tasks, view customer delivery information, update delivery status, and confirm completed deliveries directly through the mobile application.

This interface improves coordination between administrators and drivers by providing real-time delivery information and recording delivery progress within the system. Consequently, customers receive updated order information promptly, while delivery activities become more organized and transparent.

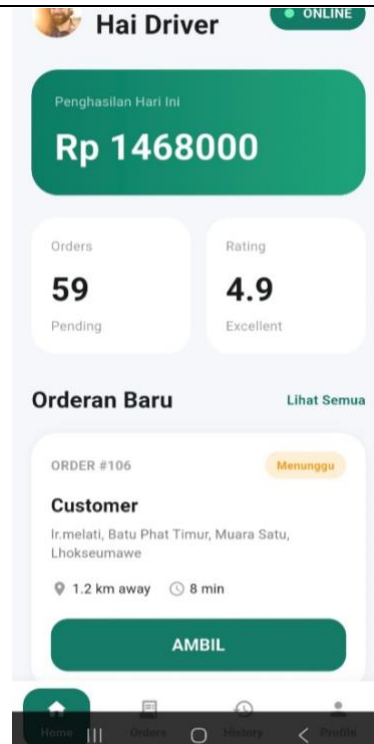


Fig. 10: Driver Dashboard Interface

4.7. Black Box Testing

To evaluate the functionality of the developed application, Black Box Testing was performed on the primary features available in the QOF Drink mobile application. This testing method focuses on verifying whether each function produces the expected output based on user interactions without examining the internal source code. The evaluation covered essential features for customers, administrators, and drivers to ensure that the application operated according to the specified functional requirements.

Table 1: Black Box Testing Results

Test Scenario	Expected Result	Test Result
User Registration	User account is successfully created	Valid
User Login	User successfully accesses the application	Valid
Product Browsing	Product information is displayed correctly	Valid
Shopping Cart	Selected products are stored successfully	Valid
Order Tracking	Order status is updated correctly	Valid
Product Management	Administrator manages product data successfully	Valid
Delivery Confirmation	Driver updates delivery status successfully	Valid

Based on the testing results, all major functionalities operated according to the expected outcomes without significant functional errors. The successful execution of each test scenario indicates that the developed application satisfies the identified functional requirements and is capable of supporting the operational activities of QOF Drink through an integrated mobile-based e-commerce system.

5. Conclusion

This study successfully designed and developed a mobile-based e-commerce application for QOF Drink using the Flutter framework and the Waterfall software development method. The developed application integrates customer, administrator, and driver functionalities into a single platform to support product management, online ordering, transaction processing, delivery coordination, and real-time order tracking. The implementation results demonstrate that the proposed system operates according to the identified functional requirements and provides a more efficient solution than the previous manual business process.

The implementation of the application improves business operations by simplifying transaction management, enhancing customer accessibility, and supporting more organized delivery services. Customers can conveniently browse products, place orders, complete transactions, and monitor delivery status through the mobile application, while administrators and drivers are able to manage operational activities more efficiently. Overall, the proposed system contributes to the digital transformation of QOF Drink by providing an integrated e-commerce platform that improves service quality and operational efficiency for all users.

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