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Food Ordering Simulation on Drivethru

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ABSTRACT

Food ordering services through drive-thru systems still face several challenges, such as long waiting times, order inaccuracies, and inefficient service processes, especially in high-demand conditions. Therefore, an effective solution is needed to simulate and optimize the ordering workflow before real implementation. This study aims to design and implement a drive-thru food ordering simulation application that can improve service speed and accuracy. The system was developed using the Forward Engineering method with the Waterfall process model, which includes requirements analysis, system design, implementation, and testing. The simulation integrates queue management, user interface design, and order processing into a unified system that represents real-world drive-thru operations. The results show that the developed application is able to simulate the food ordering process effectively, helping users understand the service flow and reducing potential inefficiencies in waiting time and order handling. Thus, this simulation can be used as a supporting tool for improving service quality in the culinary industry.

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1. INTRODUCTION

In the digital era, service efficiency has become a primary focus for various sectors, including the fast food industry. Drive-thru service is an innovation aimed at speeding up the transaction process without the need to leave the vehicle. Drive-thru food ordering systems are an efficiency solution in the digital era, especially post-pandemic, where the demand for fast and contactless transactions is increasing. Restaurants like XYZ Balikpapan have adopted Arena software-based queue simulations to reduce wait times by integrating information technology such as touchscreen interfaces and real-time data processing systems, which require further development. (Septiana, 2024; Azadi, et al, 2024; Nur & Hastuti, 2020)

Simulation is a representation of real operations or processes executed in a virtual environment with the aim of understanding or improving the system. In this context, simulations are used to digitally depict the drive-thru service flow. Queue system simulations using software have proven effective in analyzing restaurant service performance, as seen in the case study of XYZ Restaurant, which successfully reduced customer wait times by 40%, and the computer network simulation for food delivery, which was tested using a client-server model. (Septiana, 2024; Mariniello & Friano, 2021)

Food ordering is the process of customer interaction with a service system to select and purchase food. This process typically includes menu browsing, item selection, and payment processing. Several studies implementing food ordering involve stochastic simulation algorithms to predict order preparation times, such as the Pizza Delivery Chain model using the SimPy and Random modules in Python. A LabVIEW-based

system is also used to simulate the hotel reservation process by integrating countdowns and discount calculations. (Guwanchgeldiyeva & Yazgulyyeva, 2025; LabVIEW, 2022; Saksham, 2021)

Drive-thru, as part of a fast-service system, allows customers to make transactions without having to get out of their vehicles. This concept demands speed of service, order accuracy, and an efficient backend system. Drive-thru technology has evolved from the use of microphones to an Arduino microcontroller-based touchscreen LCD interface capable of automatically displaying menus and total payments. Studies at McDonald's demonstrate the importance of ergonomic drive-thru lane design for various vehicle types. (Lanawaang, 2024; Kumparan, 2023; Nur & Hastuti, 2020)

Problems such as long queues and ordering errors still frequently occur. Therefore, simulating a drive-thru ordering system is crucial for testing process flows and optimizing service. This research focuses on the design and development of a food ordering simulation system that represents the actual drive-thru service process by combining queue analysis, user interface, and workflow optimization. This research aims to design a drive-thru food ordering simulation system that accurately represents the service process. (Zulkarnain & Sudin, 2024; Whitenack & Mahabir, 2022)

The novelty of this research lies in the comprehensive integration of queue system simulation, ordering interface, and data processing into a single simulation model that closely mimics real-life restaurant operations, focusing on local drive-thru service and a digital technology-based approach. The software-based simulation model can be modified and customized to meet needs, making it flexible for implementation in various operational scenarios.

2. METHOD

This research employed the Forward Engineering method to develop a drive-thru food ordering simulation system from an abstract concept to a concrete implementation. This approach involved converting requirements specifications and design models into functional code through structured steps, ensuring alignment with the initial research objectives. (DevX, 2024;Devita, et al, 2023)

Furthermore, the Waterfall Process Model consists of the stages of requirements analysis, design, implementation, testing, and maintenance. Waterfall was chosen because of its ability to provide comprehensive documentation and tight stage control. Waterfall supports a gradual transformation from conceptual design to implementation, aligning with the principles of forward engineering. This model is sequential, where each stage must be completed before moving on to the next. The model, as shown in Figure 1, consists of five phases: (Gurnov, 2025; Sallu, et al, 2023)

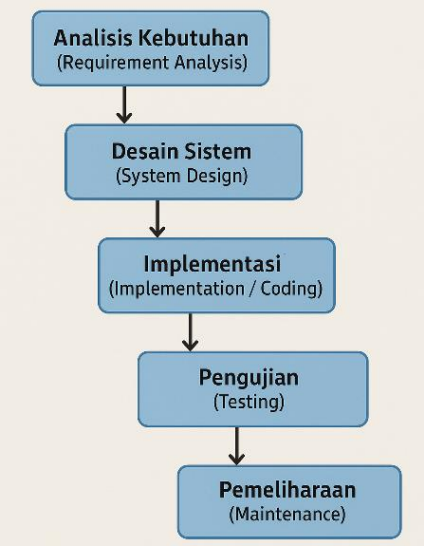

Figure 1. Waterfall Process Model

This research employed the Forward Engineering method to develop a drive-thru food ordering simulation system, transforming conceptual models into a functional application. The implementation of this method was carried out through the Waterfall process model, which consists of several structured stages.

1. Requirements Analysis: At this stage, requirements are gathered from users or clients. The goal is to understand what is required of the system to be developed. (Popoola, et al, 2024). In the requirements analysis stage, data were collected by identifying user needs for both customers and restaurant staff, including features such as product selection, order processing, and transaction management.
2. System Design: This stage aims to translate requirements into system architecture and technical design. (Buede & Miller, 2024). In the system design stage, the system architecture was modeled using UML diagrams, including use case diagrams, class diagrams, flowcharts, and sitemap structures to represent the system workflow and interactions.
3. Implementation (Coding): At this stage, the system design is converted into program code according to the selected programming language and technology. (Joel, et al, 2024). During the implementation stage, the designed system was translated into program code by developing the user interface, database structure, and core functionalities such as order processing and menu management.
4. Testing: This stage aims to ensure that the system runs as required and is bug-free. (Aniche, 2022). In the testing stage, the system was evaluated to ensure that all features functioned properly according to the specified requirements, including order input, data processing, and output display.
5. Maintenance: After the system is deployed, changes or improvements may be needed. (Narne, et al, 2024). This stage focuses on bug fixes, feature enhancements, and system adaptation to new environments. The maintenance stage involves improving and updating the system based on potential future needs, such as adding new features or optimizing system performance.

3. RESULT AND DISCUSSION

This section presents the findings of the study along with measurable evaluation results obtained from system testing. The discussion highlights not only the system design but also the performance of the application based on functional testing and simulation outcomes. Quantitative results are included to provide a clearer assessment of system effectiveness in improving service efficiency and order processing accuracy.

3.1. User Needs Analysis

The users of this system consist of customers and restaurant staff (admins). Customers need an easy-to-use interface to select food and make payments. Restaurant staff (admins) need a system to receive and process orders efficiently. The following are some of the modules/menus required by the Drive-Thru Food Ordering Simulation application for each user:

1. Customers
   a. View Product List <<include>> View Product Details
   b. Place an Order
2. Admin (Restaurant Staff)
   a. Login
   b. Main Menu (Dashboard)
   c. Manage Product List <<include>> Manage Product Details
   d. Check Order Status
   e. Print Transaction History

3.2. Functional Requirements Analysis

The functional requirements analysis for the Drive-Thru Food Ordering Simulation application includes:

1. Consumers
   a. Consumers can view product names, prices, and images. When consumers select a product, product details such as description, size, additional options, and complete pricing information, including packaging and tax, will appear.
   b. Consumers can select the desired product and quantity, including any special notes (e.g., "without ice"). After selecting the desired product, the consumer confirms the order, which will then be forwarded to the admin for processing.

2. Admin (Restaurant Staff)
   a. Admins enter their username and password. The system will then verify their identity before accessing the dashboard.
   b. Admins can display a summary of incoming orders, order status, product quantity, and transaction history, as well as notifications of new orders or product stock.
   c. Admins can manage (add, edit, view, and delete) the food/drink list. Admins can manage product names, categories, prices, and availability status, including product detail management, which allows them to manage product details such as descriptions, sizes, variants, and images.
   d. Admins view and monitor customer orders, display a list of orders by status (pending, processing, completed), and update order statuses (e.g., from "processing" to "ready for pickup").
   e. Admins print transaction reports within a specified timeframe.

3.3. Flowchart Analysis

The following figure 2 is a flowchart of the food ordering process at the drive-thru.

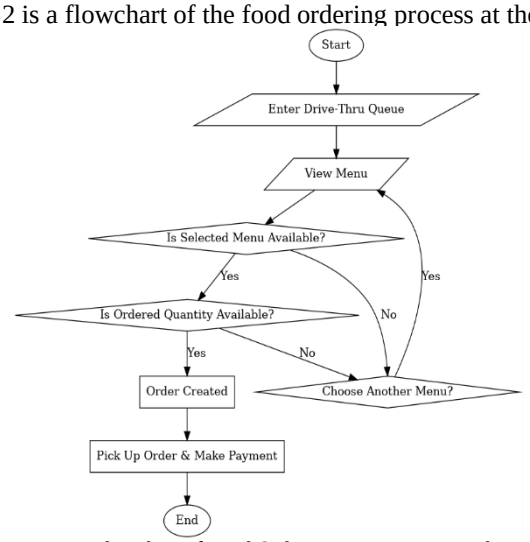

Figure 2. Flowchart of Food Ordering Process at Drivethru

This flowchart describes the process of ordering food through a drive-thru system. The process starts when a customer enters the drive-thru queue and views the available menu. The system then checks whether the selected menu item is available. If the item is not available, the customer is asked to choose another menu item. If the selected item is available, the system checks whether the requested quantity is sufficient. If the quantity is not available, the customer can select another menu item. Once both the menu item and quantity are available, the order is created. Finally, the customer proceeds to pick up the order and make the payment, and the process ends.

3.4. Sitemap Analysis

Based on the flowchart above, the sitemap requirements for the Food Ordering Simulation application on Drivethru can be seen in Figure 3 below.

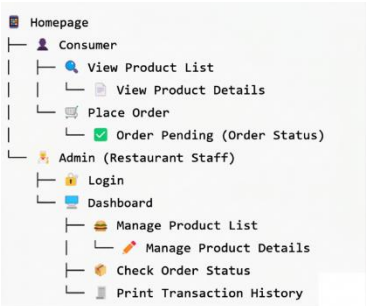

Figure 3. Sitemap Simulation of Food Ordering on Drivethru

This sitemap shows the structure of a restaurant application with two main user paths:

1. Customer Path

   This path is designed for customers. They can:

   a. View the list of available food items (View Product List)
   b. Check detailed information about each item (View Product Details)
   c. Place an order (Place Order)
   d. Track their order status (Awaiting Order / Order Status)

2. Admin Path (Restaurant Staff)

   This path is for restaurant staff to manage operations. They can:

   a. Log in to the system (Login)
   b. Access the main control panel (Dashboard)
   c. Manage menu items (Manage Product List & Details)
   d. Monitor and update order status (Check Order Status)
   e. Generate transaction reports (Print Transaction History)

This structure helps separate customer activities from staff management functions, making the system more organized and efficient.

3.5. Use Case Diagram

The following figure 4 is a use case diagram to display the relationship between actors (Consumers and Restaurant Staff) with the modules/menus in the Food Ordering Simulation application on Drivethru.

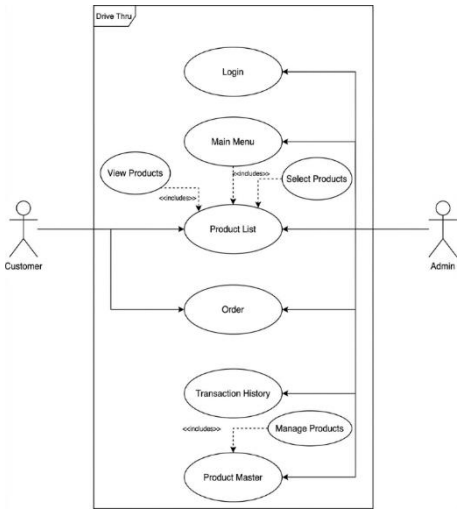

Figure 4. Use Case Diagram of Food Ordering Simulation on Drivethru

This Use Case Diagram for the Drive Thru system illustrates the interactions between two main actors: the Customer and the Admin.

1. Customer Flow

   a. The Customer interacts with the front-end of the system to perform two main tasks:
   b. View Products: Customers can browse the Product List to see available items.
   c. Place Order: Once they have decided, customers proceed to the Order use case to finalize their purchase.

2. Admin (Restaurant Staff) Flow

   a. The Admin manages the back-end operations and has more comprehensive access:
   b. Authentication: The Admin must Login to access the system's Main Menu.
   c. Menu & Inventory Management: Through the Main Menu, the Admin can view the Product List. They are also responsible for Manage Products, which directly affects the Product Master (the core database of items).

d. Operational Oversight: The Admin monitors the Order process and can access the Transaction History for reporting and record-keeping purposes.

3.6. Class Diagram

A Class Diagram is a diagram in UML (Unified Modeling Language) that describes the structure of a software system by showing the classes to be created based on MVC (Model, View, Controller) and the relationships between classes such as associations, inheritance, and dependencies. Furthermore, from the use case diagram, the following is a Class Diagram for the Food Ordering Simulation at Drivethru as shown in Figure 5.

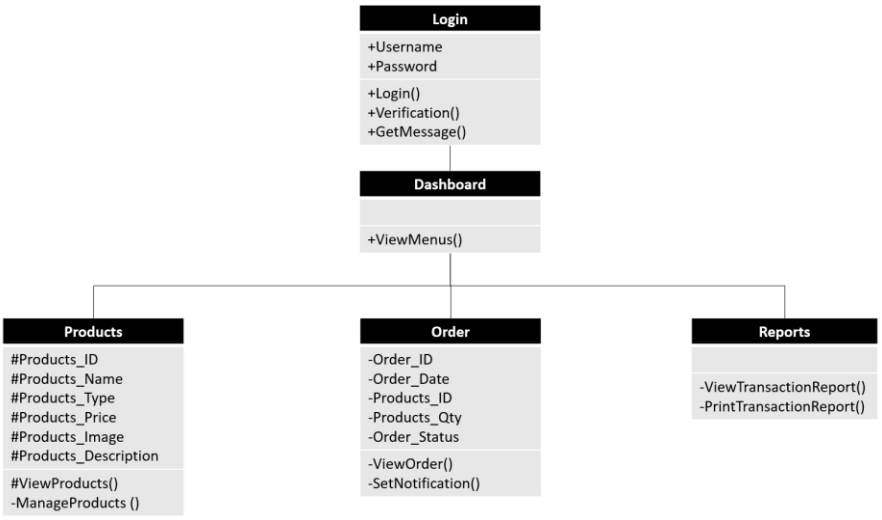

Figure 5. Class Diagram of Food Ordering Simulation at Drivethru

3.7. Database Design

Database design is the process of designing a database structure to efficiently store and manage data. The database design that will form the basis for implementing the Food Ordering Simulation interface on Drive-Thru can be seen in Figure 6 below.

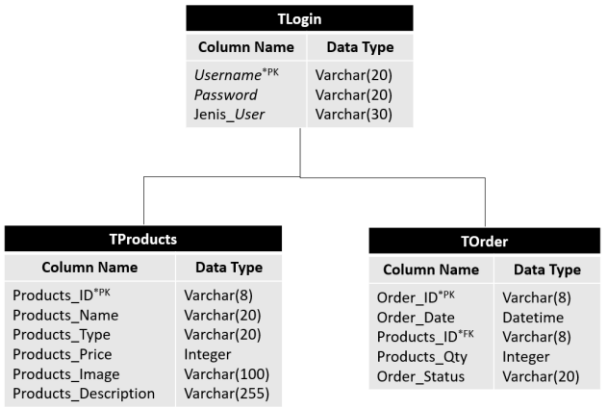

Figure 6. Database Design Simulation of Food Ordering on Drivethru

3.8. Interface Implementation

Interface implementation is the stage of developing the application's appearance (user interface) that will be used by users. The primary focus is on comfort and ease of interaction, such as creating input forms,

buttons, navigation menus, and visual layouts to suit the design and user needs. Figures 7 to 12 illustrate the implementation of the Food Ordering Simulation interface on Drive-Thru:

1. Login Form: This is the system's initial page, where users log in by entering their username and password. This form aims to secure access and differentiate user access rights between admin and customer.

Figure 7. Login Form

2. Dashboard Form: This is the main page after logging in. It serves as the main gateway and displays a quick summary of important information, such as the number of orders on the drive-thru, kitchen processes (cooking/packing), and other important notifications.

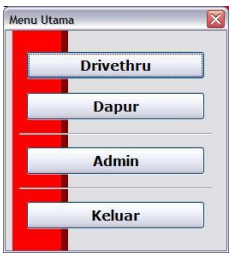

Figure 8. Dashboard Form

3. The Product/Menu List Form displays the entire list of food and beverages available at DriveThru, complete with images, names, and prices. Users can view the product options before placing an order.

Figure 9. Product/Menu List Form

4. The Order Form displays the page where customers place food orders. Customers can select the desired product, specify the quantity, and the system will calculate the total price. The order is then saved and processed by the admin or kitchen.

Figure 10. Order Form

5. The Product/Menu Management Form displays the page used by the admin to add, change, or delete available product data. This form helps the admin manage the menu provided by DriveThru to ensure it remains up-to-date.

Figure 11. Product/Menu Management Form

6. The Order List Form displays all orders that have been placed, both those currently being processed and those that have been completed.

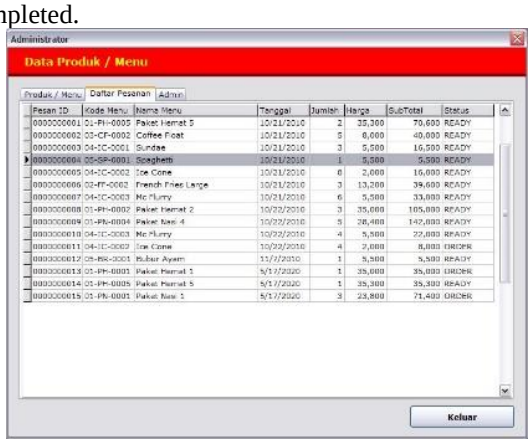

Figure 12. Order List Form

3.9. System Testing & Evaluation

The evaluation approach combines functional testing and performance simulation to ensure both correctness and efficiency of the system. To ensure that the developed system meets the defined requirements, system testing and evaluation were conducted using functional testing and simulation scenarios. Functional testing was performed to verify that all system features operate correctly. The testing results are summarized as Table 1 follows:

Table 1. Functional Testing Result

No	Feature Tested	Test Scenario	Expected Result	Result
1	Login	Input valid/invalid credentials	Access granted/rejected accordingly	Success
2	Product Display	View product list and details	Data displayed correctly	Success
3	Order Processing	Place order with selected items	Order stored and sent to admin	Success
4	Order Status Update	Admin updates order status	Status updated in real-time	Success
5	Report Generation	Generate transaction report	Report generated correctly	Success

Based on Table 1, all tested features functioned as expected, resulting in a 100% success rate in functional testing.

Simulation testing was conducted to evaluate system performance under operational conditions. The results are summarized in Table 2.

Table 2. Simulation Testing Result

No	Parameter	Result
1	Average Processing Time	1–2 minutes per order
2	System Response Time	< 2 seconds
3	Order Accuracy	98%
4	Maximum Concurrent Orders	10–15 orders

The results show that the system is capable of handling multiple orders efficiently with fast response time and high accuracy. Based on both functional and simulation testing, the system demonstrates good performance in supporting drive-thru food ordering processes. The structured workflow and automation features contribute to:

1. Faster order processing time
2. Reduced human error in order input and calculation
3. Improved service efficiency through queue management

Therefore, the system can be considered effective as a simulation tool for analyzing and optimizing drive-thru service operations.

4. CONCLUSION

This study successfully developed a drive-thru food ordering simulation application using the Forward Engineering approach with the Waterfall model. Based on the system design and implementation results, the application is able to represent the real-world drive-thru service process, including menu selection, order processing, and transaction management. The simulation results indicate that the system can support a more structured ordering flow, minimize potential ordering errors, and improve service efficiency in terms of process clarity and waiting time management. In addition, the integration of user interface design, queue simulation, and database management demonstrates that the system functions according to the defined requirements. Therefore, this application can be utilized as a simulation tool to analyze and optimize drive-thru service processes in the culinary industry. The testing results show that the system achieved a 100% success rate in functional testing and demonstrated efficient performance with an average processing time of 1–2 minutes per order. Future development may include the integration of automated queue systems, vehicle detection sensors, and artificial intelligence to further enhance system performance and adaptability as well as using Artificial Intelligence to predict serving times and adapt menu dynamics.

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