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Design and Development Optimized FIFO Queue System for Food Outlets

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ABSTRACT

In today's fast-paced food service industry, the efficiency of queue management is vital to operational success, profitability, and customer satisfaction. This study evaluates an integrated queue management system's impact on these critical areas. The results show an average satisfaction score of 80.11% from customers and 90.37% from food outlet owners, demonstrating the system's strong effectiveness. The research focused on the importance of reducing perceived waiting times through real-time updates, which enhance customer tolerance and satisfaction. By combining online and onsite ordering, the system provides real-time updates, order tracking, and notifications to boost efficiency and minimize cancellations. Despite some identified weaknesses, such as the absence of direct customer reviews and existing bugs, the system holds significant potential for improving user experience. These findings highlight the necessity for continuous development and maintenance to optimize the system further. Overall, this approach promises to advance the operational capabilities and customer satisfaction levels of food outlets.

1. INTRODUCTION

Sales operations in food outlets play a crucial role in improving efficiency, operational profits, and customer satisfaction. With technological advancements in the digital era, many restaurants are transitioning to online sales systems and platforms to enhance customer convenience. However, developing effective sales system applications presents significant challenges, particularly in integrating conventional ordering systems with online platforms. Research has shown that food outlet service optimization can significantly impact organizational performance and customer satisfaction [1]. Based on field observations and interviews, constraints

such as limited seating capacity during peak hours have led to extended wait times, significantly impacting customer satisfaction levels. These operational challenges highlight the need for an optimized system that can effectively manage both online and offline orders while maintaining service quality.

The efficiency of queue management in food outlets plays a crucial role in enhancing operational efficiency, profitability, and customer satisfaction. A study on the influence of automated queue management system optimization and self-ordering highlights the significant positive impact of such systems on organizational performance [2], [3]. This underscores the necessity for effective queue management and self-ordering app solutions in the food service industry to handle high customer volumes efficiently.

Human behavior in queues is strongly influenced by perceived waiting times and the level of information provided during the waiting process. According to a study, when consumers experience "empty time" waiting without an update or waiting for as long as 5 minutes without information they tend to become frustrated and impatient, leading to negative emotions and a higher likelihood of abandoning the queue or canceling orders [4], [5]. The cognitive timer theory suggests that customers perceive time to pass more slowly when they are uninformed, particularly during unpredictable waiting periods such as service production.

However, when transparent, real-time updates are provided, such as order tracking or position in the queue, customers feel more in control, and their tolerance for waiting increases. This demonstrates that effective queue management, whether in physical or virtual environments, depends on reducing perceived waiting times through continuous communication and information sharing, which can ultimately improve customer satisfaction and reduce cancellations.

Various studies have explored different queue management systems within the food service sector. One study developed a management information system for food courts that emphasized seat-based ordering [6]. However, this study did not consider integrating online and onsite ordering systems. Other studies have concentrated on online ordering systems but lacked an effective queue management component [7]. These findings underscore the necessity for a more holistic approach that integrates both online and onsite ordering with optimized queue management.

To address these challenges, a practical solution involves creating an integrated queue management system combining online and onsite ordering. This system should provide real-time updates to customers about their order status, reducing perceived waiting times and improving satisfaction. Food outlets can enhance operational efficiency and minimize order cancellations by using an optimized FIFO (First In, First Out) approach and incorporating features such as order tracking and notifications. This approach not only addresses the limitations of existing systems but also improves overall customer experience.

1.1 Literature Review

1. Queue
   Queue represents a critical aspect where individuals form sequential lines for service access. This prevalent scenario emerges when service demand surpasses available capacity at a given time point, creating a temporary backlog of customers. Such situations necessitate a structured waiting period for service fulfillment [8].
2. Optimized FIFO
   FIFO (First In, First Out) is a queuing method that ensures the first item in the line is the first to be processed. It is commonly utilized in inventory management and data processing. By incorporating specific algorithms or rules, an optimized FIFO system enhances efficiency, manages queues, and reduces wait times [9].

3. Technology Acceptance Model
   The Technology Acceptance Model (TAM) studies the adoption of information technology using well-tested indicators to measure and explain technology acceptance. It helps understand how external factors influence users' beliefs, attitudes, and intentions. TAM addresses the reasons behind the failure of many systems due to users' lack of intention to use them, thereby facilitating the prediction and explanation of technology adoption. Moreover, its robust framework assists organizations in identifying and overcoming barriers, ensuring smoother implementation and greater user satisfaction [10].
4. Flutter
   Flutter is a cross-platform development framework derived from Dart that enables the creation and deployment of high-performance mobile applications. Its flexibility and efficiency allow developers to create applications running seamlessly across multiple operating systems while maintaining consistent performance and a single source code base [11].
5. MySQL
   MySQL is a program used to access online databases, allowing applications to add, retrieve, and process data stored within a database server. This functionality makes it possible for applications to interact with and manage data efficiently, ensuring that operations like data entry, updates, and queries are performed seamlessly in an online environment [12].
6. Unified Modeling Language
   Unified Modeling Language (UML) is a visual language that uses symbols and diagrams to help people understand and design complex systems. By providing a standardized way to visualize system components and their relationships, UML is ensuring that everyone has a clear understanding of the system's structure and functionality [13].
7. Activity Diagram
   An Activity Diagram is derived from a Use Case Diagram and includes a sequence of activities. This type of diagram models the processes within a system, illustrating the control flow from one activity to another. Activity Diagrams can depict various branches, concurrent activities, and parallel processes, offering a comprehensive view of the workflow. By describing these interactions and processes, Activity Diagrams can aid in comprehending complex systems and identifying potential enhancements [14].
8. Use Case Diagram
   Use Case Diagram visually depicts the interactions within a system, by showcasing different processes and how various actors (such as users or other systems) interact with these processes. This intuitive visualization of system behavior helps bridge communication between technical and non-technical stakeholders, supporting a clear understanding of current operations and assisting in planning future system improvements [15].

2. RESEARCH METHODS

2.1 Technology Acceptance Model (TAM)

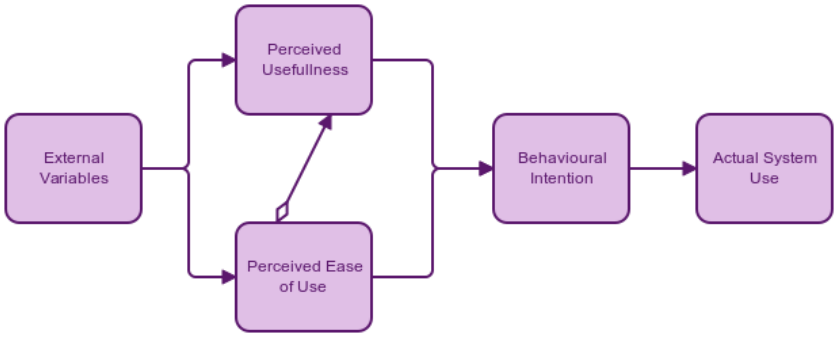

Figure 1. Method Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a framework that is used to understand and predict user acceptance and usage of technology. It follows a structured approach, similar to a project development lifecycle, to evaluate the factors influencing technology adoption.

1. External Variables:
   Factors such as the user's prior experience with technology and age can influence their perception and acceptance of the queue management system. Understanding these variables helps tailor the system to meet diverse user needs.
2. Perceived Usefulness:
   Researchers made the system useful and easy to use so it can improve operational efficiency to increase user acceptance.
3. Perceived Ease of Use:
   Researchers aim to make the system intuitive and user-friendly, catering to all ages and technological backgrounds. This includes creating accessible interfaces and offering real-time updates on queues to improve the overall queueing experience.
4. Behavioral Intention:
   The willingness of users to adopt the system is influenced by its perceived usefulness and ease of use. Using effective queue management can help the adoption of the system.
5. Actual System Use:
   Researchers monitor the application of the system by gathering feedback. This phase involves assessing how well the system reduces waiting times and improves customer satisfaction.

2.2 Optimized First In First Out (FIFO)

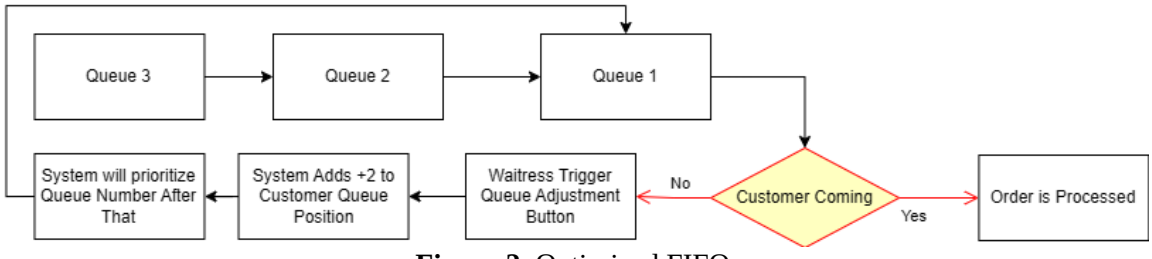

Figure 2. Optimized FIFO

The Optimized FIFO Queue System introduces a dynamic priority adjustment mechanism while maintaining original queue numbers. In this system, as shown in Figure 1, when a customer in Queue Position 1 is absent, their processing priority shifts behind Position 3, effectively making them Position 4 in the processing sequence. Simultaneously, the customer in Position 2 receives immediate processing priority, followed by Position 3, without any changes to their assigned queue numbers.

This priority adjustment is initiated through a waitress adjustment queue button on the queue interface upon identifying an absent customer. When identifying an absent customer, the waitress will press the button to adjust the queue and the system will automatically add two positions to their queue number and will prioritize the queue number after that. This adjustment mechanism ensures continuous flow within the queue while maintaining fair order processing for all customers.

Key to this optimization is the system's ability to handle customer absence without disrupting the overall queue efficiency. Rather than allowing absent customers to create bottlenecks, the +2 position adjustment provides a balanced solution that accommodates brief customer delays while preventing excessive wait times for other customers. The automatic resequencing feature ensures that all queue positions remain properly organized after each adjustment, maintaining the fundamental FIFO principles while adding necessary flexibility.

3. RESULTS

3.1 System Architecture Diagram

1. Activity Diagram

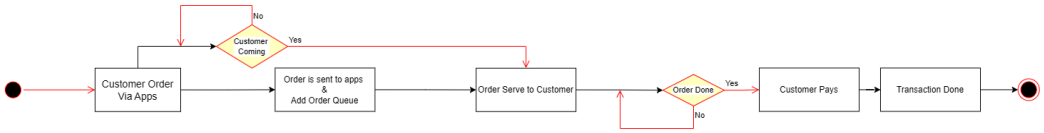

Figure 3. Activity Diagram for Ordering Online

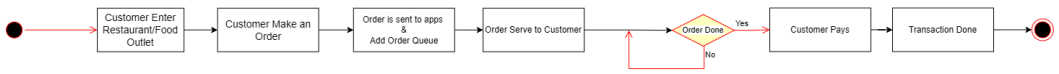

Figure 4. Activity Diagram for Ordering Offline

The online ordering process in a food service context is shown in Figure 3. It begins with the customer placing an order via the app. After placing the order, it is sent to the apps and added to the order queue. Simultaneously, the system checks if the customer is coming to the food outlet. If the customer is not coming, the process loops back to the beginning. If the customer is coming, the order remains in the queue. Once the order is ready, it is served to the customer. The next step involves checking if the order is complete. If the order is not completed, the process loops back to serving the order. If the order is complete, the customer proceeds to pay, and the transaction is concluded.

Figure 4 shows the process of offline ordering within a food outlet. It starts with the customer entering the restaurant and making an order. The order is then sent to the app and added to the order queue. Following this, the order is served to the customer. The process checks if the order is complete. If the order is not completed, the process loops back to serving the order. If the order is complete, the customer proceeds to pay, thus completing the transaction.

This FIFO (First In, First Out) optimization clearly represents the steps involved in both online and offline ordering processes, highlighting key checks and actions that facilitate efficient service delivery and enhance customer experience. The system ensures that orders

are managed efficiently, reducing wait times and improving overall satisfaction for both customers and staff.

2. Use Case Diagram

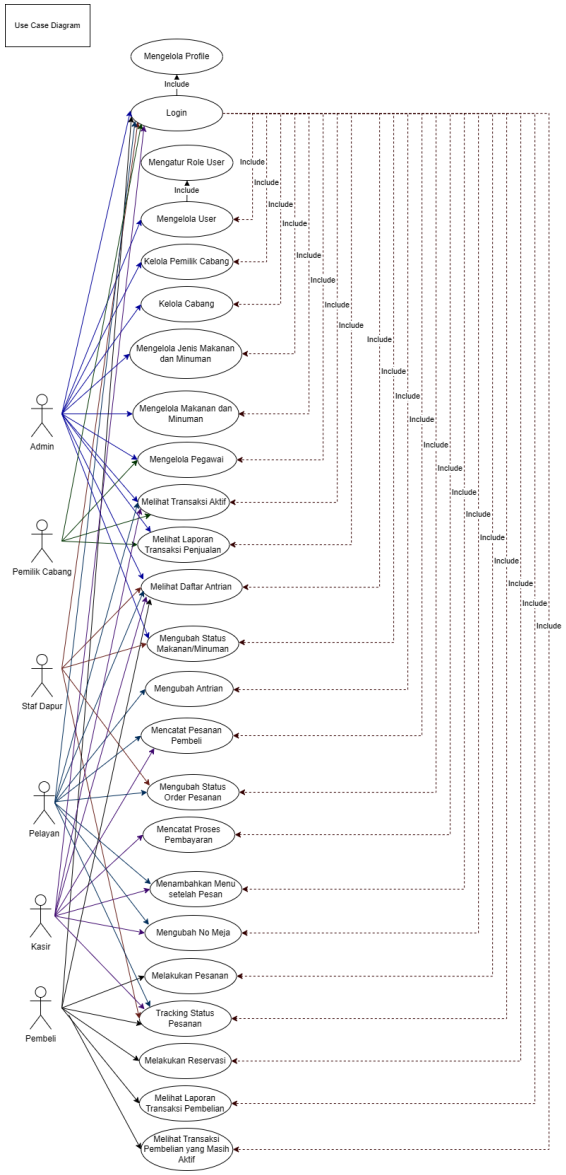

Figure 5. Use Case Diagram Queue System

The use case diagram shown in Figure 5 details the interactions between various roles and the system within a food service environment. These roles include Admin, Pemilik Cabang (Branch Owner), Staf Dapur (Kitchen Staff), Pelayan (Waiter), Kasir (Cashier), and Pembeli (Buyer/Customer). The system functionalities cover profile management, user roles, branch administration, and transaction oversight.

Admins are tasked with managing user profiles, roles, branches, food and drink items, product categories, and monitoring sales transactions. Pemilik Cabang supervises branch employees and oversees branch sales transactions. Staf Dapur tracks orders, updates order statuses and can change menu statuses within their branch. Pelayan records orders, manage

seating arrangements, updates order statuses, and can adjust the queue for reservations for customers that are late, allowing kitchen staff to process other orders in the meantime. Kasir handles payment processing. Pembeli can place and track orders, make reservations, and access transaction reports. This system is designed for efficient queue management and real-time updates to enhance customer satisfaction and operational efficiency, aligning with the goals of the food service industry.

3.2 Implementation

1. Home and Ordering Page

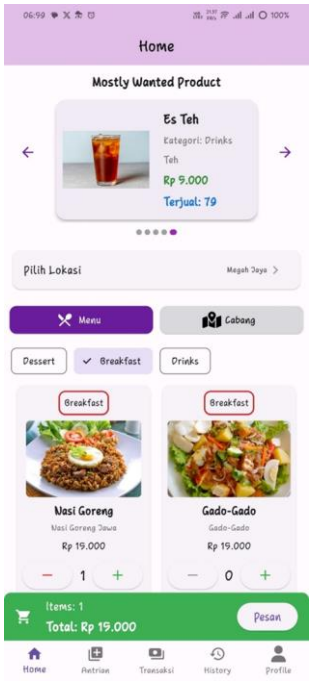

Figure 6. Home and Ordering Page

Figure 6 shows the homepage, which includes features to view the entire menus or select a menu based on categories. Customers can see all available menu items at their location. To order, customers select the desired menu items and press the add button. Once done, they can press the 'Pesan' button to finalize and process their order.

2. Queue List Page

Figure 7. Queue List Page

Figure 7 displays the queue list page, which allows users to view the entire queue and see their processed menu items, indicated as completed. Customers can see their order's queue number. For waitresses, a button is available to adjust the queue if a customer does not show up. When pressed, the queue number will increase by 2 from the current position.

3. Detail Transaction Page

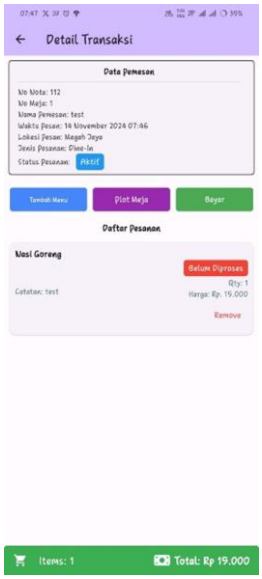

Figure 8. Detail Transaction Page

Figure 8 displays the detailed transaction page, which allows users to view transaction details. Customers can see the details of their orders. For waitresses and cashiers, a button is available to add menu items or change the customer's desk number. Cashiers can also press the 'Bayar' button to proceed with payment. After the customer pays, the status will automatically change to ‘Selesai’ indicating that the order has been completed.

4. DISCUSSION

1. Survey Results for Customers in Food Outlets

To understand customer satisfaction and preferences in our food outlets, we surveyed customers. The survey aimed to gather insights on various aspects of their dining experience, including order processing, waiting times, and overall satisfaction.

Below are the results from our survey, where a rating of 1 indicates a bad experience and 5 indicates a satisfying experience:

Table 1. Survey Results for Customers

Questions	Respondents	Average Results
This app makes it easier to find the food I want	12	4.05
This app helps me get complete information about the menu	12	4.17
This app helps me to know my order queue status	12	4.33
….	….	….

The app's interface is simple and not confusing	12	4.25
The ordering process in this app is clear and easy to understand	12	4.58
….	….	….
I enjoy the experience of using this app	12	3.58
How do you rate the layout and appearance of the entire system?	12	4.33
	Average Score	**80.11%**

Below is the graph from our survey, where a rating of 1 indicates a bad experience and 5 indicates a satisfying experience:

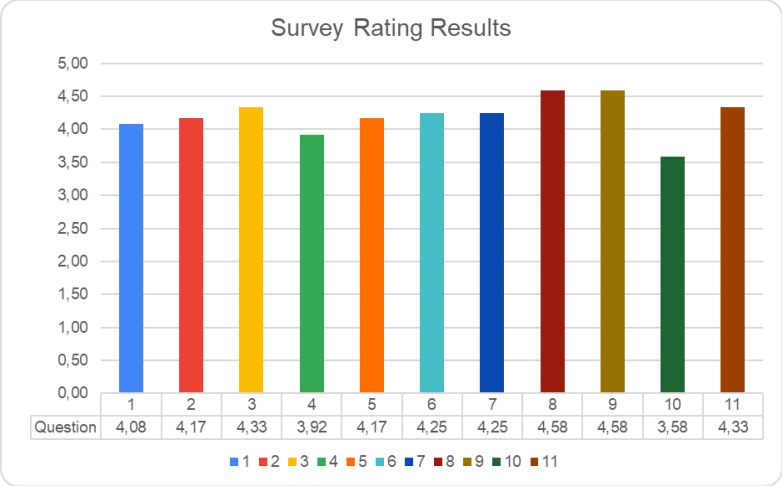

Figure 9. Survey Rating Results for Customers

The graph in Figure 9 shows the average scores of each question from our survey, with the responses ranging from 1 (bad experience) to 5 (satisfying experience). The overall average score from the survey questions 1 to 11 is 80.11%. This indicates that, on average, customers are satisfied with their experience, as a score above 80% reflects satisfaction with the system.

2. Survey Results for Owners in Food Outlets

We also surveyed the owners of our food outlets to gain insights into their perspectives on operational efficiency and queue management. The survey focused on their views on current systems.

Below are the results from our survey, where a rating of 1 indicates a bad experience and 5 indicates a satisfying experience:

Table 2. Survey Results for Owner Food Outlets

Questions	**Respondents**	**Average Results**
The process of updating the menu and prices is simple	5	4.8
This system helps me track queues better	5	4.4
This app is easy to use	5	4.6
Waitress/Kitchen Staff/Cashier can easily track orders	5	4.6
Kitchen Staff can easily manage customer order	5	4.8

The waitress can help customers to order	5	4.6
….	….	….
Sales reports are easily accessible and understandable	5	4.4
….	….	….
The app's interface is simple and not confusing	5	4.8
….	….	….
I would recommend this app to other store owners	5	4.6
….	….	...
How do you rate the layout and appearance of the entire system?	5	4.8
	Average Score	**90.37%**

Below is the graph from our survey, where a rating of 1 indicates a negative experience and 5 indicates a positive experience:

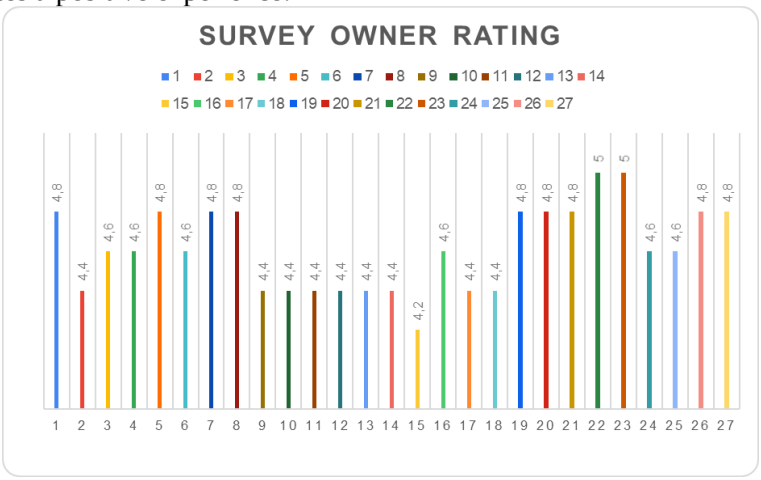

Figure 10. Survey Rating Results for Owner Food Outlets

The graph in Figure 10 represents the average scores for each question from our survey, with an overall average rating from questions 1 to 27 is 90.37%. This high average score reflects a positive experience and satisfaction among the owners regarding operational efficiency and queue management in their food outlets.

5. CONCLUSION

Based on the survey results assessing the website designed by the researchers, an overall average score of 80.11% was obtained from customers, indicating that the system effectively meets their needs and is highly satisfactory. Likewise, an average score of 90.37% was achieved from the owner food outlets survey, highlighting strong approval of the system's operational efficiency and queue management. These high satisfaction scores suggest that the system is perceived as both useful and easy to use, which are critical for user adoption. The system's ability to enhance operational efficiency and customer experience, as evidenced by the survey results, demonstrates its practical value and user-friendliness. However, the researchers identified some areas for improvement, such as the inclusion of features like customer reviews and the need to address system bugs. These insights point to the necessity for ongoing maintenance and further development to enhance the overall user experience. In conclusion, the system shows significant potential in fulfilling customer orders and ensuring the efficient operation of food outlets. The

positive feedback indicates a strong likelihood of continued use and satisfaction, while the researchers will identify areas for improvement and highlight the importance of iterative development to meet user needs.

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