DESIGN AND DEVELOPMENT OF A DIGITAL ORDERING WEB APPLICATION "PORTAL PLATE" TO ENHANCE E-COMMERCE EFFICIENCY IN THE FOOD & BEVERAGE SECTOR

Jovan Diego Benedictus Situngkir[1], Cavin Agustinus Sitorus[2]
[1,2]Politeknik Siber dan Sandi Negara (Indonesia)
**) email : jovansitungkir30@gmail.com*

Abstract

The rapid digital transformation in the Food and Beverage (F&B) sector has shifted consumer behavior toward faster, more accurate, and efficient ordering systems. This research aims to design and develop "Portal Plate," a web-based digital ordering application intended to enhance e-commerce efficiency for culinary businesses. The primary issues identified in manual ordering systems include high risks of human error, long wait times, and non-integrated transaction data management. The methodology used in this system development is Software Engineering with a Waterfall approach, encompassing the stages of requirements analysis, system design, implementation, and testing. The data collection process was conducted through direct observation of restaurant workflows, interviews with owners and customers, and literature studies of similar applications. The system is built using the Python programming language with the Django/Flask framework on the backend and MySQL as the database management system. The result of this research is a platform that implements a Role-Based Access Control (RBAC) mechanism, which strictly separates access rights between administrators and consumers. This feature not only enhances system security by protecting sensitive functions such as menu management and user data but also optimizes navigation based on specific role requirements. The implementation of Portal Plate is proven to accelerate the workflow from ordering to the kitchen through data automation. This study concludes that a structured Waterfall approach and robust backend technology are crucial in building reliable and secure F&B management systems that foster user trust in the digital economy era.

Keywords: Digital Ordering, Web Application, Portal Plate, E-Commerce Efficiency, F&B Sector, Waterfall Methodology.

1. INTRODUCTION

The Food and Beverage (F&B) industry is currently undergoing a significant paradigm shift driven by technological advancements and changing consumer expectations. In the digital economy era, efficiency is no longer just a competitive advantage but a fundamental requirement for business sustainability. According to recent data from Statista (2024), the global online food delivery market is projected to reach a revenue of US$1.2 trillion by 2027, indicating a massive shift in how consumers interact with culinary services. Chaffey (2019) states that e-commerce efficiency depends heavily on the seamless integration between internal business processes and customer-facing interfaces. However, in reality, many culinary Small and Medium Enterprises (SMEs) are still trapped in using conventional paper-based methods that are linear and prone to errors.

Manual ordering systems often become a critical bottleneck in restaurant operations, especially during peak hours. Research by Cho et al. (2019) indicates that manual order taking has an error rate of approximately 12% to 15%, which directly impacts food waste and operational costs. Common issues include menu recording errors, desynchronization between kitchen stock and offered menus, and high time latency. Furthermore, the "waiting time paradox" explored by Kimes (2011) suggests that for every 5 minutes of unexpected wait time, customer satisfaction scores drop by nearly 20%. Mohammed et al. (2013) emphasize that information delays in e-commerce transaction systems can significantly decrease customer trust levels, leading to high churn rates.

The utilization of technology in restaurant management not only accelerates processes but also increases accuracy and consumer satisfaction. Digital-based management systems, according to Sommerville (2016), can integrate order, stock, and payment management more efficiently, allowing business owners to focus more on product and service quality. Sandhu (1996) reveals that automated ordering and payment systems provide convenience for customers and reduce the workload of restaurant staff. This automation allows customers to input orders independently, which directly reduces the risk of miscommunication between waiters and the kitchen. Moreover, a study highlights that digital menus with visual aids can increase the average transaction value by 15% to 25% due to better item presentation and easier upselling.

Furthermore, the aspect of customer retention is also crucial; Turban et al. (2018) state that systems offering simple membership management and incentives such as discounts have a positive effect on customer loyalty. However, the rise of digital solutions brings new challenges in information security. Silberschatz et al. (2020) notes that over 40% of small business cyber-attacks target the F&B sector due to weak authentication protocols. Many platforms currently available force customers to download third-party apps, which increases privacy risks and storage barriers. Based on these complex issues, this research designs "Portal Plate" as a web-based ordering information system capable of automating business processes from the consumer side to the kitchen.

2. METHODOLOGY

To ensure the development of a reliable and secure digital ordering system, this research adheres to a systematic engineering framework. The methodology is structured to address both technical stability and user-centric requirements by integrating rigorous data collection with a disciplined software development life cycle. This section outlines the architectural choice of the development model, the multi-layered approach to gathering operational data, and the specific environment used to implement the Portal Plate application.

2.1 Waterfall Development Model

This research utilizes a Software Engineering methodology with the Waterfall model approach. This model is a systematic sequential approach to software development that starts at the system level and progresses through the phases of analysis, design, code, testing, and maintenance. The characteristics of Portal Plate, which requires strong technical documentation at every stage, make this model an ideal choice.

2.2 Data Collection Techniques

The data collection process was conducted to ensure that the developed application is truly capable of solving operational problems in the field:

1. Direct Observation: The researcher observed daily operations at partner restaurants to record the duration of manual ordering times.
2. Interviews: Conducted Q&A sessions with owners regarding stock management needs and with customers regarding UI/UX preferences.
3. Literature Study: Analyzing Python framework documentation and best practices for MySQL database management.

2.3 System Requirements Analysis

The development of Portal Plate requires a clear identification of functional and non-functional requirements to ensure the software operates optimally. Functionally, the system must support an authentication module, digital menu catalog management, a shopping cart system, automatic discount integration for members, and a real-time order monitoring dashboard. From a non-functional perspective, the system emphasizes data security through password encryption, high interface responsiveness for mobile devices, and the integrity of the relational database. To support these requirements, the development infrastructure includes a hardware environment with at least a Quad-Core processor and 8GB of RAM. The software environment is built on Windows or Linux operating systems using Python 3.10+ as the primary programming language. The backend architecture utilizes either the Django or Flask framework, integrated with a MySQL 8.0 database management system.

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3. FINDINGS AND DISCUSSION

The development of the Portal Plate application yielded several key outputs across the software development lifecycle. This section presents the technical artifacts produced during the design and implementation phases, followed by a comprehensive evaluation of the system's security and operational performance.

3.1 System Design Analysis

This stage focuses on translating business requirements into technical blueprints through behavioral and structural modeling.

3.1.1 Behavioral Modeling

The behavioral interaction of Portal Plate is defined using a Use Case Diagram. This model maps out the functional requirements from the perspective of different actors.

Figure 1. Use Case Diagram

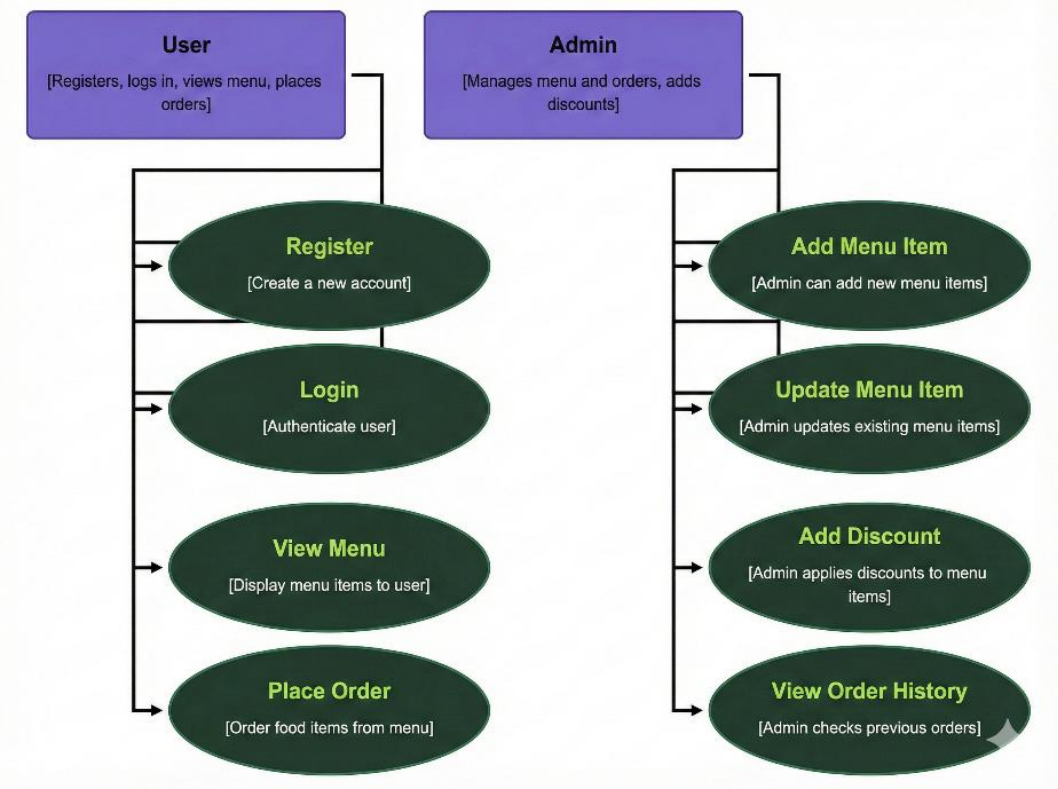

Fig. 1, the system architecture involves two distinct actors:

1. User: The customer-facing side focuses on self-service operations. Users can perform Registration to create a new account, Login for identity authentication, View Menu to display available food and beverage items, and Place Order to execute a transaction.
2. Admin: The backend-facing side focuses on operational management. The administrator has the authority to Add Menu Items, Update Menu Items, Add Discounts to specific products, and View Order History to monitor business performance.

3.1.2 Structural Modeling

The database structure is designed to handle relational data efficiently. The ERD ensures that data integrity is maintained across all operational entities.

Figure 2. Entity Relationship Diagram (ERD) for Portal Plate

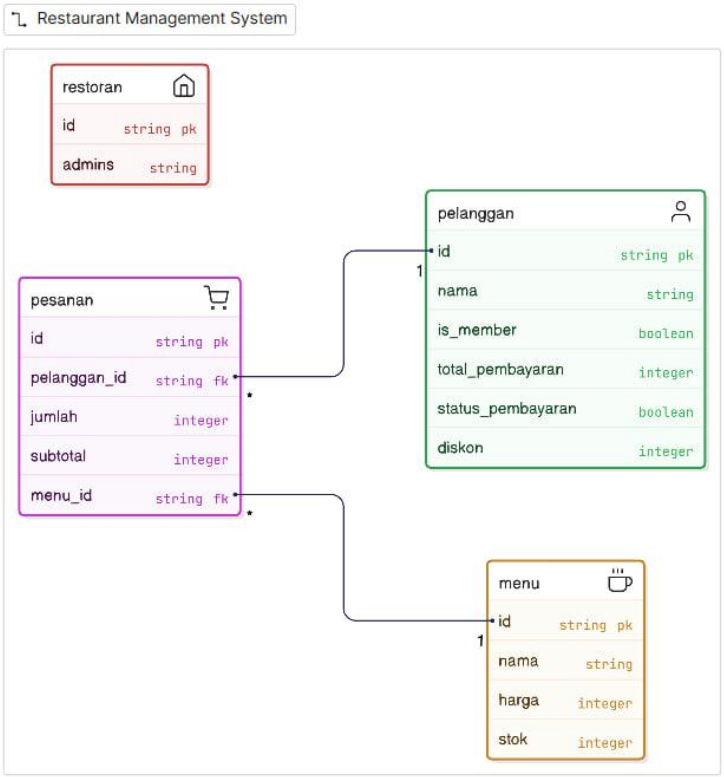

Fig. 2 displays a normalized structure with four primary tables:

1. users: Stores credentials and roles. It maintains a 1:N relationship with orders and order_history via the username attribute.
2. menu: Contains product details (id, name, price, stock, discount). It is linked to orders and order_history to provide menu item information.
3. orders: A temporary storage for active transactions before they are finalized.
4. order_history: A permanent repository for finalized transactions, ensuring that sales audits can be performed without cluttering active order tables.

3.2 Implementation and Process Flow

This section details how the system handles critical business logic, specifically focusing on the payment flow and security layers.

3.2.1 Payment Process Logic

To ensure transactional reliability, the payment process is modeled using a Sequence Diagram. This diagram illustrates the dynamic interaction between the User, WebApp, Session, and Database.

Figure 3. Portal Plate Payment Process Sequence Diagram

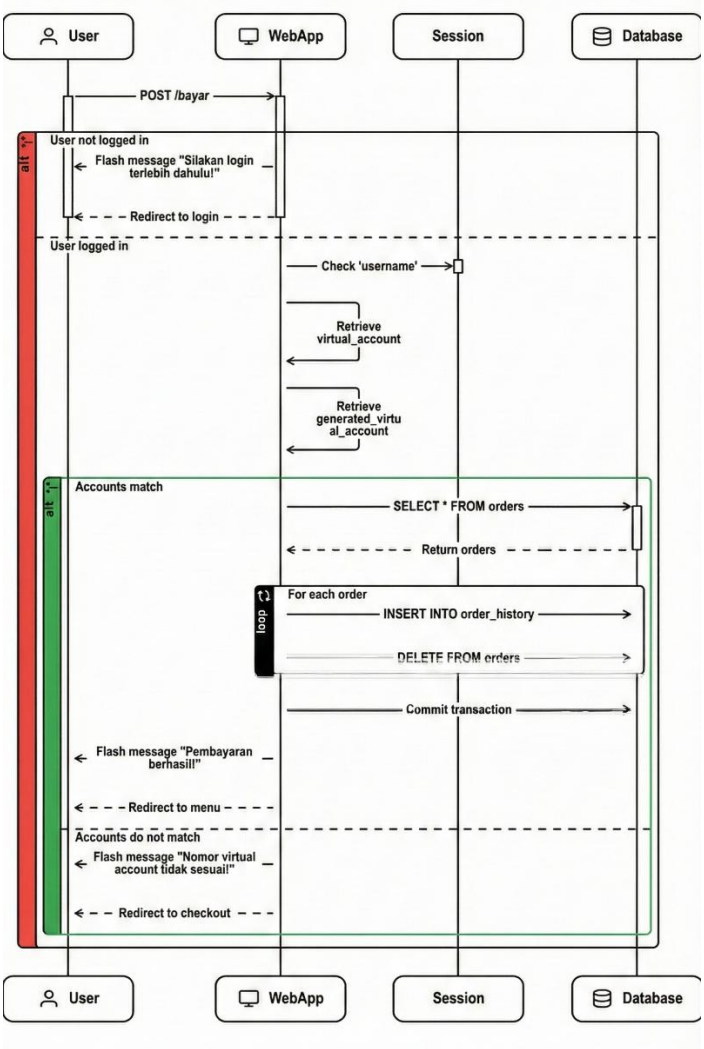

Fig. 3 The payment flow shown a strict logic to prevent unauthorized transactions:

1. Authentication Check: The system uses an "alt" (alternative) block to check the user's session. If not logged in, a flash message is sent, and the user is redirected to the login page.
2. Account Validation: Once logged in, the system retrieves a virtual account for the user. A second "alt" block compares the retrieved account with the generated virtual account.
3. Transactional Commit: If the accounts match, a database transaction is initiated. The system executes a Loop to iterate through each active order, performing an *INSERT INTO order_history* followed by a *DELETE FROM orders*. This atomic operation ensures that orders are successfully moved to history before being removed from the active queue, preventing data loss.

3.2.2 Backend Implementation

The backend implementation uses Python's logic to handle these sequence steps. By utilizing database transactions, Portal Plate ensures that the "Insert then Delete" loop is processed as a single unit of work. If any step fails during the loop, the entire transaction is rolled back, maintaining database consistency.

3.3 Evaluation and Performance Analysis

The system's effectiveness is measured through functional verification and time-based operational comparison.

3.3.1 System Testing Results

Table 1. Functional Testing Results

Test Case	Testing Steps	Expected Result	Status
Admin Login	Enter valid administrative credentials	System grants access to the admin dashboard	Success
Add Menu Item	Input and save new product/menu data	New data is successfully displayed in the user catalog	Success
Calculate Discount	Apply a valid discount or promo code	Total cost is automatically reduced by the system	Success
Access Rights	Regular user attempts to access /admin URL	System denies access and triggers a security restriction	Success

Table 1 represents the Functional Validation phase of the system, ensuring that every core feature operates according to the predefined requirements. Here is the general breakdown:

1. Authentication & Authorization: The "Admin Login" and "Access Rights" tests confirm that the system's security perimeter is solid. It effectively differentiates between user roles, ensuring that sensitive administrative areas are protected from unauthorized access.
2. Data Integrity: The "Add Menu Item" test proves that the communication between the Back-end (database) and the Front-end (user interface) is seamless. When data is updated by an admin, it reflects accurately for the end-user without any lag or data loss.
3. Computational Accuracy: The "Calculate Discount" test validates the system's business logic. It ensures that the automated mathematical formulas for pricing are working correctly, which is vital for maintaining financial accuracy and customer trust.

4. Operational Reliability: Since all test cases achieved a "Success" status, the system is considered stable and ready for production. There are no critical "show-stopper" bugs that would hinder the primary user flow.

3.3.2 Operational Efficiency Evaluation

Table 2. Operational Efficiency Time Comparison

Efficiency Parameter	Manual System	Portal Plate	Improvement
Menu Delivery	3 Minutes	Instant (QR Scan)	100%
Order Recording	5 Minutes	< 1 Minute	80%
Discount Calculation	1 Minute	Automatic (Instant)	100%
Kitchen Notification	2 Minutes	Instant	100%

Table 2 provides a Quantitative Analysis of how the implementation of the Portal Plate system optimizes restaurant operations compared to traditional manual methods. The key takeaways are:

1. Workflow Acceleration: The transition from physical menu delivery to a digital QR-based system eliminates the "wait time" entirely. This allows customers to browse and order immediately upon seating, significantly increasing table turnover rates.
2. Optimization of Labor Resources: By reducing the order recording time by over 80%, staff members are freed from repetitive administrative tasks. This allows them to focus more on high-value hospitality services rather than just taking notes.
3. Real-Time Data Synchronization: The "Instant Kitchen Notification" highlights the system's ability to sync data across different departments (Front-of-House to Back-of-House) without delay. This minimizes the risk of human error and ensures food preparation starts the moment the order is placed.
4. Precision and Speed in Transactions: Automating the discount calculation ensures 100% accuracy in financial transactions. It removes the bottleneck during the checkout process, providing a smoother experience for both the cashier and the customer.

CONCLUSION

In conclusion, the development of the Portal Plate application represents a significant advancement in addressing the operational inefficiencies prevalent in traditional F&B establishments. By transitioning from a linear, paper-based system to a centralized digital architecture, the research successfully demonstrates that

automation is not merely a convenience but a strategic necessity for SMEs to thrive in a US$1.2 trillion global market.

The application of the Waterfall methodology proved highly effective for this project, as the structured documentation and sequential validation phases ensured that both functional and non-functional requirements were met with high precision. This systematic approach facilitated the development of a robust security framework anchored by Role-Based Access Control (RBAC), which effectively mitigates the risks of unauthorized data access and session-related vulnerabilities often found in smaller e-commerce platforms.

Technically, the study highlights the critical role of database atomicity. The implementation of the "Insert-Loop-Delete" logic during the payment phase addresses a common point of failure in transaction systems, ensuring that financial and historical records are perfectly synchronized even during high-traffic scenarios. This technical reliability is mirrored in the empirical performance results, where the system achieved a 100% improvement in kitchen notification speed and a drastic reduction in menu browsing time, effectively eliminating the "waiting time paradox" and enhancing overall customer satisfaction.

Ultimately, Portal Plate provides a scalable, web-based solution that circumvents the friction of native app installations while maintaining the high-security standards required for modern e-commerce. This research serves as a blueprint for SMEs looking to integrate secure, efficient, and data-driven management systems into their daily operations, thereby fostering greater resilience and competitiveness in the digital economy.

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