

Canteen Management System

Developed by: Team Runtime Assassins

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1. Introduction

The **Canteen Management System**, developed by **Team Runtime Assassins**, is a comprehensive, technology-driven solution designed to streamline operations in canteen environments. Leveraging modern tools such as **ImGui** for an intuitive user interface and **SQLite3** for robust data management, the system addresses inefficiencies in traditional canteen workflows. With **SHA-256 password hashing**, **TOTP two-factor authentication**, and a feature-rich platform, it offers secure role-based access, automated billing, inventory tracking, and customer engagement tools. This report outlines the problem, solution, technical implementation, features, and innovations that make our system a standout choice for canteen management.

2. Problem Statement

Traditional canteen operations face several challenges that hinder efficiency and customer satisfaction:

- **Manual Processes:** Paper-based billing and order tracking lead to errors, delays, and long queues during peak hours, reducing operational efficiency.
- **Security Risks:** Weak authentication and unsecured data storage increase the risk of unauthorized access and data breaches, compromising sensitive financial and user information.
- **Inventory Mismanagement:** Lack of real-time stock tracking results in overstocking or shortages, disrupting service and increasing costs.
- **Limited Payment Flexibility:** Systems often lack support for guest transactions or modern payment methods, alienating non-registered customers.
- **Poor Customer Retention:** Absence of loyalty programs or promotional offers fails to encourage repeat visits, impacting revenue.
- **Audit and Accountability Gaps:** Without action logs, tracking user activities for troubleshooting or audits is nearly impossible.
- **Data Loss Vulnerabilities:** Lack of backup mechanisms risks losing critical data like bills, inventory, and wallet balances due to system failures.
- **Inefficient User Management:** Manual or insecure user account management processes are prone to errors and security lapses.

These issues create operational bottlenecks, security concerns, and dissatisfied customers. The **Canteen Management System** resolves each problem through targeted, innovative features, delivering a seamless, secure, and efficient management experience.

3. Solution Overview

The **Canteen Management System** addresses the identified challenges with a comprehensive set of features, each designed to solve specific issues:

- **For Manual Processes: Automated billing** with real-time tax calculations, wallet deductions, and order management eliminates errors and speeds up service (**Billing and Payment, Order Management**).
- **For Security Risks: SHA-256 password hashing and TOTP two-factor authentication** ensure robust protection against unauthorized access (**User Authentication and Role Management**).
- **For Inventory Mismanagement: Real-time stock tracking** with low-stock alerts optimizes inventory control (**Inventory Management**).
- **For Limited Payment Flexibility: Support for guest transactions** (cash/card) alongside wallet payments caters to all customers (**Billing and Payment**).
- **For Poor Customer Retention: Loyalty programs and time-limited combo deals** encourage repeat visits and boost sales (**Loyalty Program, Discount and Promotion Management**).
- **For Audit Gaps: A user activity log** records all actions for accountability and troubleshooting (**User Activity Log**).
- **For Data Loss: System backup and restore** functionality safeguards critical data (**System Backup**).
- **For Inefficient User Management: A secure console UI** for admin tasks like adding users, resetting passwords, and managing TOTP ensures streamlined and secure account management (**User Authentication and Role Management**).

By integrating these solutions, the system transforms canteen operations into an efficient, secure, and customer-focused process.

4. Theoretical Background

The **Canteen Management System** is built on several theoretical foundations:

- **Role-Based Access Control (RBAC):** Assigns permissions based on roles (**Admin, Manager, Biller**) to ensure secure and efficient operations, preventing unauthorized access.
- **Relational Database Management:** Uses **SQLite3** to organize data into tables (users, orders, wallets, etc.), ensuring efficient storage, retrieval, and integrity.
- **Cryptographic Security:** Implements **SHA-256** for password hashing and **TOTP** for two-factor authentication to protect user credentials and system access.
- **User Interface Design:** Employs **ImGui** for a responsive, intuitive graphical interface and a **console UI** for admin tasks, balancing usability with administrative efficiency.
- **Data Reliability:** Incorporates logging (**User Activity Log**) and backup mechanisms (**System Backup**) to maintain data integrity and recoverability.
- **Business Process Automation:** Automates billing, inventory updates, and customer engagement (loyalty, discounts) to reduce manual effort and errors.

These principles ensure the system is both theoretically robust and practically effective, addressing real-world canteen management needs.

5. Technical Implementation

5.1. System Architecture

The system follows a modular, layered architecture to ensure scalability and maintainability:

- **Frontend Layer:**
 - **ImGui UI** for operational tasks (orders, billing, inventory, analytics, etc.), providing an intuitive graphical interface.
 - **Console UI** for admin-specific user management tasks (adding users, resetting passwords, deleting users, resetting TOTP).
- **Backend Layer:**
 - **C++** logic handles core functionalities like order processing, payment calculations, inventory updates, and analytics.
- **Data Layer:**
 - **SQLite3** database stores all data (users, orders, wallets, bills, logs) in a lightweight, embedded format.
- **Security Layer:**
 - **SHA-256** hashing secures passwords.
 - **TOTP TFA** enforces two-factor authentication for all users.
- **Storage Layer:**
 - File-based storage for bill saving (text/PDF) and activity logs.

This architecture ensures seamless interaction between components, with clear separation of concerns for security, usability, and data management.

5.2. Technologies Used

- **C++:** Core programming language for high-performance backend logic.
- **ImGui:** Lightweight, customizable graphical user interface for operational tasks.
- **SQLite3:** Embedded relational database for efficient, serverless data storage.
- **SHA-256:** Cryptographic hashing algorithm for secure password storage.
- **TOTP:** Time-based one-time password protocol for two-factor authentication.
- **Console UI:** Text-based interface for secure admin user management tasks.

6. Features

The system includes 14 features addressing operational and user needs, detailed below with role permissions:

1. User Authentication and Role Management

- **Description:** Secure login system controlling access based on roles.
- **Details:** Uses **SHA-256**-hashed passwords and mandatory **TOTP TFA**. Admin manages accounts (add, reset passwords, delete, reset TOTP) via **console UI**. Roles: **Admin** (full access), **Manager** (operations), **Biller** (billing).
- **Role Permissions:**
 - **Admin:** Manages accounts via **console UI**; full feature access via **ImGui UI**.
 - **Manager:** Views user details; accesses menu, inventory, orders via **ImGui UI**.
 - **Biller:** Logs in for billing via **ImGui UI**.

2. Menu Management

- **Description:** Manages menu items (add, edit, delete, view) with name, price, availability.
- **Details:** Toggles availability; managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Full control over items and details.
 - **Manager:** Adds, edits, deletes, views items.
 - **Biller:** Views menu for orders.

3. Order Management

- **Description:** Creates, tracks, edits, cancels customer orders.
- **Details:** Includes items, quantities, totals; cancellations trigger refunds. Managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Views, edits, cancels all orders.
 - **Manager:** Views, edits, cancels orders.
 - **Biller:** Creates, views orders.

4. Billing and Payment

- **Description:** Generates bills with taxes; processes wallet or guest (cash/card) payments.
- **Details:** Shows itemized lists, taxes, discounts, totals; supports wallet top-ups. Managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Views, overrides payments.
 - **Manager:** Views bills, payments.
 - **Biller:** Generates bills, applies discounts, processes payments, tops up wallets.

5. User Wallet System

- **Description:** Manages cashless payments via wallets with balance tracking, top-ups, deletions.
- **Details:** Stores transaction history; Admin deletes wallets only if balance is 0. Managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Views, adjusts, deletes wallets (if balance is 0).
 - **Manager:** Creates wallets for new users.
 - **Biller:** Tops up wallets at checkout.

6. Loyalty Program

- **Description:** Rewards users with redeemable points for discounts/free items.
- **Details:** Earns points per purchase; redemption capped at order value. Managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Sets up program, manages rewards.
 - **Manager:** Views loyalty data.
 - **Biller:** Applies points, shows balances.

7. Discount and Promotion Management

- **Description:** Creates discounts, promos, time-limited combo deals.
- **Details:** Supports percentage, fixed, or combo discounts; combos set for durations. Managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Full control over discounts, promos, combos.
 - **Manager:** Creates, manages discounts, daily combos.
 - **Biller:** Applies active discounts/promos.

8. Inventory Management

- **Description:** Tracks stock, updates quantities, sets low-stock alerts.
- **Details:** Supports manual/order-linked updates; alerts for restocking. Managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Full control: updates stock, sets alerts, adjusts details.
 - **Manager:** Views, adds, deletes stock, sets alerts.
 - **Biller:** No access.

9. Analytics Dashboard

- **Description:** Reports sales, top items, user activity.
- **Details:** Shows daily sales, popular items, trends. Accessible via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Full analytics access.
 - **Manager:** Views basic data (e.g., top items).
 - **Biller:** No access.

10. System Settings and Configuration

- **Description:** Adjusts tax rates, discount rules, backup schedules.
- **Details:** Configures global options. Managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Full control over settings.
 - **Manager:** No access.
 - **Biller:** No access.

11. Bill Saving as Files

- **Description:** Saves bills as text/PDF for records/printing.
- **Details:** Bills saved locally or printable. Managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Saves, manages bill files.
 - **Manager:** No access.
 - **Biller:** Saves bills during billing.

12. **User Activity Log**

- **Description:** Logs user actions for auditing.
- **Details:** Tracks logins, orders, top-ups, refunds with timestamps, user IDs. Stored in file; viewable via **console UI**.
- **Role Permissions:**
 - **Admin:** Views log file.
 - **Manager:** No access.
 - **Biller:** No access.

13. **System Backup**

- **Description:** Backs up/restores data to prevent loss.
- **Details:** Backs up bills, inventory, wallets; supports manual/scheduled backups. Managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Creates, restores backups.
 - **Manager:** No access.
 - **Biller:** No access.

14. **Refund Option**

- **Description:** Reverses charges for canceled orders, crediting wallets.
- **Details:** Triggered by Manager cancellation; requires Manager approval. Managed via **ImGui UI**.
- **Role Permissions:**
 - **Admin:** Processes refunds post-Manager approval.
 - **Manager:** Cancels orders, approves refunds.
 - **Biller:** Requests refunds post-cancellation.

7. Innovations

The **Canteen Management System** introduces several innovative features that distinguish it from other solutions in the market:

- **Advanced Security Framework:**
 - **SHA-256 password hashing** and **TOTP two-factor authentication** for all users provide enterprise-level security, safeguarding sensitive financial and user data.
 - **Why Unique?:** Unlike many canteen systems with basic or no authentication, our system ensures robust protection against unauthorized access.
- **Dual-Interface Design:**
 - Combines an **ImGui graphical UI** for operational tasks with a **console UI** for secure admin user management, optimizing usability and administrative efficiency.
 - **Why Advanced?:** Most systems use a single interface, which can be cluttered or less secure for admin tasks; our dual approach streamlines workflows.
- **Flexible Payment Ecosystem:**
 - Supports **wallet-based payments** for registered users and **guest transactions** (cash/card) for walk-in customers, accommodating diverse payment preferences.
 - **Why Different?:** Enhances inclusivity, unlike wallet-only systems that exclude non-registered users.
- **Customer Engagement Tools:**
 - **Loyalty Program** with point redemption and **time-limited combo deals** drives customer retention and increases sales through personalized incentives.
 - **Why Innovative?:** Few canteen systems integrate dynamic engagement features, making ours more customer-centric.
- **Comprehensive Auditing:**
 - The **User Activity Log** tracks all actions (logins, orders, top-ups, refunds), enabling transparency and accountability.
 - **Why Unique?:** Provides audit capabilities rarely found in small-scale canteen systems, ensuring operational integrity.

- **Data Resilience:**

- **System Backup and Restore** functionality protects against data loss, supporting both manual and scheduled backups.
- **Why Advanced?:** Ensures business continuity, a critical feature often absent in competing solutions.

These innovations position our system as a secure, efficient, and customer-focused solution, setting a new benchmark for canteen management.

8. Conclusion

The **Canteen Management System** by **Team Runtime Assassins** is a transformative solution that addresses the inefficiencies, security risks, and customer engagement gaps in traditional canteen operations. With a modern technology stack (**C++**, **ImGui**, **SQLite3**), robust security (**SHA-256**, **TOTP TFA**), and a comprehensive feature set (authentication, billing, inventory, analytics, loyalty, and more), the system delivers unparalleled efficiency and user satisfaction. Its innovative features, such as dual UI design, flexible payments, and auditing capabilities, make it a unique and advanced solution compared to other canteen management systems in the market. We are confident that our system will enhance operational workflows, secure sensitive data, and elevate the customer experience in canteen environments.

9. Team Details

Team Name: Runtime Assassins

Section: D

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