

QR-based Canteen Management System

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Abstract

In recent years, the digitization of administrative and operational processes has transformed various sectors in the world, including food service management. This research presents the development and implementation of a QR-based canteen management system, designed to enhance the efficiency of canteen operations by leveraging contemporary technological advancements. The system employs a desktop application built with C# and the .NET framework, enabling users to order and pay for food items using a QR code-based login and cashless payment system. This solution addresses the inefficiencies of traditional pen-and-paper-based canteen management by automating order processing, payment, and sales record maintenance. The primary objective is to streamline canteen operations, reduce service time, and improve customer satisfaction through a user-friendly and reliable system.

Keywords: Desktop Application, QR-based Login, Self-Ordering, Cashless Payment, Billing System

1. Introduction

1.1 Background

In today's fast-paced world, time is precious, and expectations for efficient services are on the rise. Traditional canteen management systems based on manual processes, such as pen-paper records, cash transactions, and manual calculations, have become outdated and inefficient. These systems often lead to long queues, difficulties in rendering exact change, and

challenges in maintaining accurate sales records. To address these issues, the "QR-based canteen management system" has been developed as a modern solution. The proposed system is a desktop application that enables users to self-order their desired food items from a digital menu [11-15]. Users can log in to the system using a unique QR code or registration number, ensuring secure access. After selecting their food choices, users can proceed to pay using a virtual wallet, eliminating the need for cash transactions. The system automatically deducts the payment from the user's registered account balance. Additionally, the system generates printed order coupons, which users can present at the counter to collect their orders.

1.2 Objectives

The main objectives of the research are:

- To digitize payment system in canteen.
- To keep record of sales.

2. Literature Review

When there is no automated system of the ordering and billing, the tasks have to be carried about manually, making it time consuming and prone to errors. The existing system consists of the RFID chip and sensor to read it, but the cost of those electronics component is high, and they may wear out over time. So, the proposed system replaces the RFID reader with a QR-code. The transaction is secured using proper encryption and decryption methods. A lot of research work has been done in relation to automated canteen ordering and management system. This section discusses the self-service ordering in a canteen and reviews previous research and products in the field of automated canteen ordering system. Sadhana Dukre et al. [1] introduced Android application to record student attendance, ensuring that food is prepared only for those present, thereby minimizing waste. The application features options for adding and deleting student information, managing menu items, and scheduling mess timings. Muniraja et al. [2] identified drawbacks in traditional canteen payment processes, proposing an in-time billing process using recharge cards to enhance efficiency and accuracy in transactions.

Ambika et al. [3] described a cashless canteen management system utilizing ReactJs for frontend and NodeJS for backend operations. Their system automates order processing directly to the kitchen, schedules orders in advance, and facilitates card payments to streamline billing processes and reduce waiting times. In article [4], authors use complex device like ARM controller for the implementation of system design. The proposed in [5] is an intelligent canteen management system utilizing deep learning and computer vision for automated customer detection, food recognition, and environment monitoring to reduce human errors and enhance operational efficiency. The embedded systems-based canteen management system using RFID technology for customer identification, automated billing, and mobile application support, improving traceability and efficiency in canteen operations was introduced in [6,7]

Patil et al. [8] developed a smart canteen management system using IoT for RFID-based customer identification, automated billing, and real-time monitoring of food preparation and service to streamline operations and enhance customer satisfaction. In [9], author presents an automated mess management system that uses SMS authorization to streamline and secure the process of managing student attendance and stock inventory in academic institutions. The system provides real-time updates and authentication via SMS, enhancing efficiency and reducing manual errors. In [10], author presents the routing security in wireless sensors. For end to end security TLS or SSL is considered in the proposed QR-based canteen management system.

3. Requirements

3.1 Hardware Requirements

Development Machine: A standard desktop computer was used. The device was capable of integrating a webcam to read the unique QR code. The device had 8GB of RAM and a 500GB HDD.

Servers: Cloud-based servers were used for hosting the application and database. The server cost was based on the volume of the database

3.2 Software Requirements

Development Tools: Visual Studio, .NET Framework, C#, and Git

Database: SQL Server

4. Methodology

4.1 System Architecture

The architecture diagram in Figure 1 illustrates a client-server application designed with a clear separation of concerns, leveraging C#/.NET for server-side logic. At its core, a centralized database stores all necessary data, which is accessed by the Server (C#/.NET) layer. The server manages the business logic and data transactions, ensuring data integrity and security. The user interface (Desktop Application) serves as the presentation layer, providing an interactive interface for users to engage with the system and facilitating various functionalities. Customer can login with QR code and password, select the food items and receive a bill. For administrative tasks, the admin panel provides capabilities for registering users and updating products, allowing for new user creation, product updates and analysis. The communication flow from the database to the user interface ensures that data is consistently retrieved, processed, and presented in a user-friendly manner. This structured approach enhances maintainability, scalability, and robustness, adhering to industry best practices for enterprise-level software development.

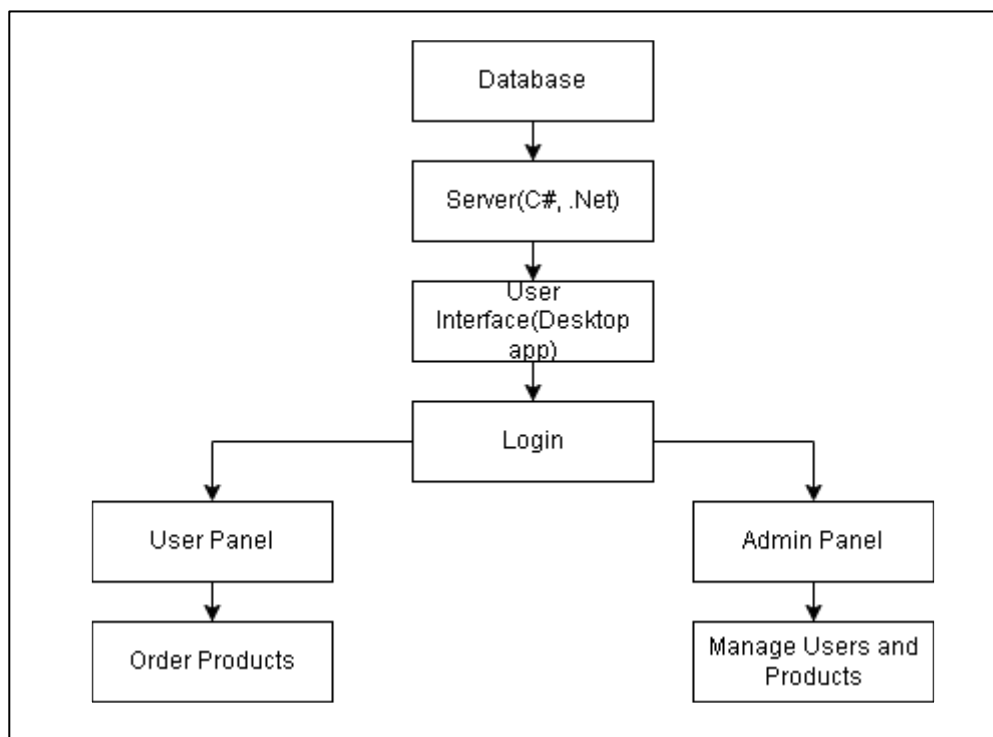


Figure 1. Architecture Diagram

4.2 Work Flow

For entering the system, the customers should be registered. The customers should first contact the admin (owner of canteen) by paying the amount through digital wallets. After the registration, the unique QR is provided to each registered customer. Unique registration number is also associated with each QR. The system allows registered customers to log in into the system by scanning a QR code in the computer interface and valid password. Once logged in, they can view the canteen menu which is divided into categories like snacks, lunch, drinks etc. Customers can select the desired food items, specify quantities, and the bill amount is calculated automatically. If they have sufficient balance in their prepaid account, they can pay the bill digitally without using cash. The payment gets deducted from their respective account balance. Printed bill serves as the food coupon. On the other hand, admin can manage all aspects - add/update/delete menu categories and items, set availability status, add new customers by providing QR cards, recharge customer balances, and view sales reports. The Figure 2 below shows how the system works for customer and the admin.

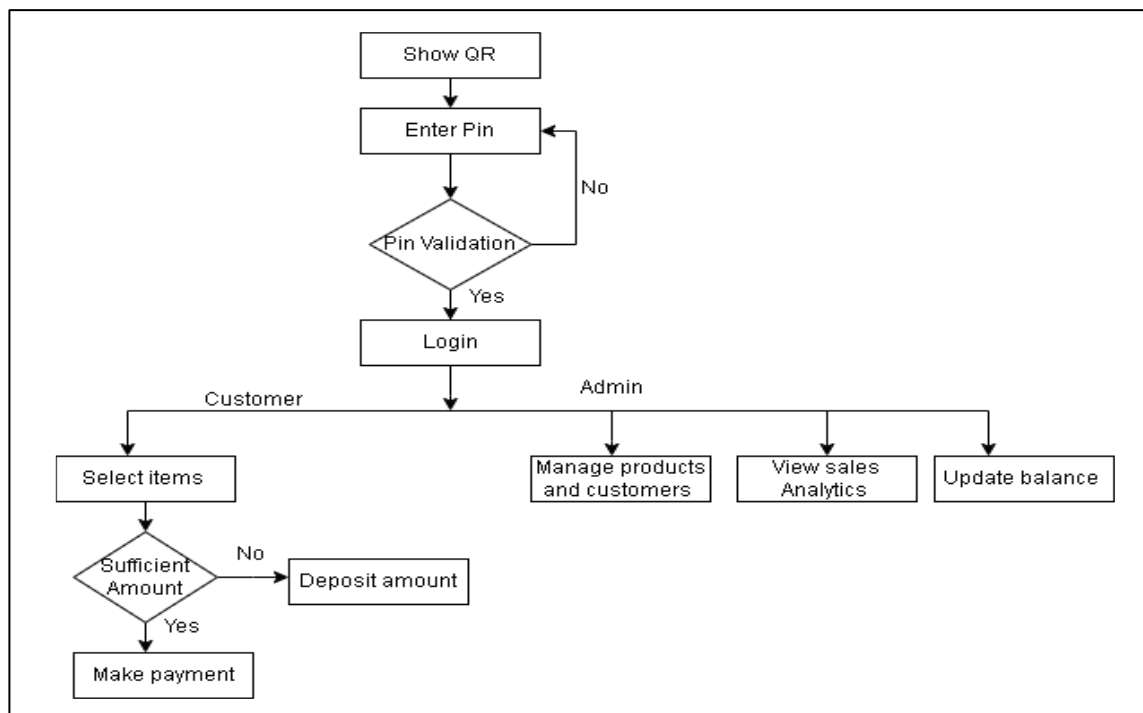


Figure 2. Workflow Diagram

4.3 Generation and Integration of QR-Code

QR is the essential part of the system. When the customer requests new registration, a QR code is automatically generated by the system. These unique QR codes are integrated into the canteen management system for each registered user. The QR code scanning is facilitated using a QR code reader connected to the system. The customer can simply show their QR code to the reader displayed on the screen to log in. Thus, QR serves as username or registration id. The QR reader appears as a small box on the screen as shown in Figure 3.



Figure 3. Login Page Showing QR Integration

4.4 Database Design and Data Dictionary

The Figure 4 shows that how different tables of the database are associated with each other. Each table has defined attributes and relationships. Users table consists of basic user information, the role field determines whether the user is admin or customer. Foods are categorized into different types and each category consists of the product associated with it. Categories, identified by a unique ID, contain multiple products, each linked by a foreign key (Product, Category ID). Products also have unique IDs and attributes such as name, price, description, and image. Each table have one to many or many to one relationship with other. The data type of each column in each table is mentioned in the figure below. The data dictionary ensures referential integrity with primary and foreign key constraints, enforces data types and sizes, and maintains domain integrity through check constraints, ensuring a robust and consistent data structure. The data type of each column in each table is mentioned in the figure below.

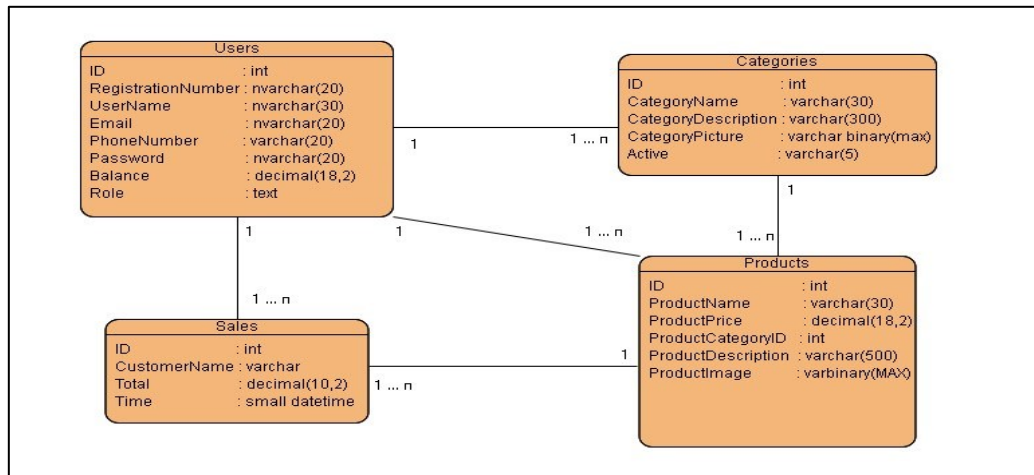


Figure 4. Database Design

4.5 Security and APIs

The payment is done explicitly of the system using the famous Nepalese payment gateway like Esewa, and Khalti. These gateway uses SSL/TLS encryption to secure data transfer between the client and server. Additionally, user authentication is done using secure passwords and QR code verification to ensure that only authorized users can access and make payments. Some program interface are used for the smooth operation of the system.

QR Code Generation API: For generating unique QR codes for users.

Email API: For sending order confirmations and receipts to users.

Database API: For interacting with the SQL Server database to perform CRUD (Create, Read, Update, Delete) operations.

5. Results and Discussion

The result of this system provides a computerized version of canteen management system which will benefit the customers as well as the owners of the canteen. Customers can login, view menu, and order on their own. They can pay using virtual cash instead of physical money and food coupon that can be shown at counter to obtain the desired food. It automates the order preparation, sales recording activities performed by the canteen staff. There is no

need to return the exact change. Canteen owners can analyse the sales, manage the food items and manage the customer details. In this way it benefits both the owner and customers.

Figure 5 below demonstrates how the system interface looks like after login. It shows total bill amount, and current balance and details about product brought.

CANTEEN MANAGEMENT SYSTEM

Username: Nitesh Registration Number: PAS075BCT024

Your Bill 490

ID	Name	Price	Qty	Total	Delete
19	Muffin	50.00	3	150	
23	Chicken	120.00	2	240	
22	Cake	50.00	2	100	

Current Balance: 320.00
Total Cost: 490
Remaining Balance: -167.20

PAY

Figure 5. Customer UI

The admin has the responsibility of monitoring all products and make the updates as per the necessity as shown in Figure 6.

ADD CATEGORIES ADD PRODUCTS VIEW ALL PRODUCTS REGISTER VIEW SALES VIEW CATEGORIES

Categories

Muffin Chicken Cake

Products

Chicken Muffin

Figure 6. Admin Page

Admin creates the new user on the request of the customer with digital deposit as shown in Figure 7. The personal details are filled and the QR is generated. The generated QR is forwarded to specific user.

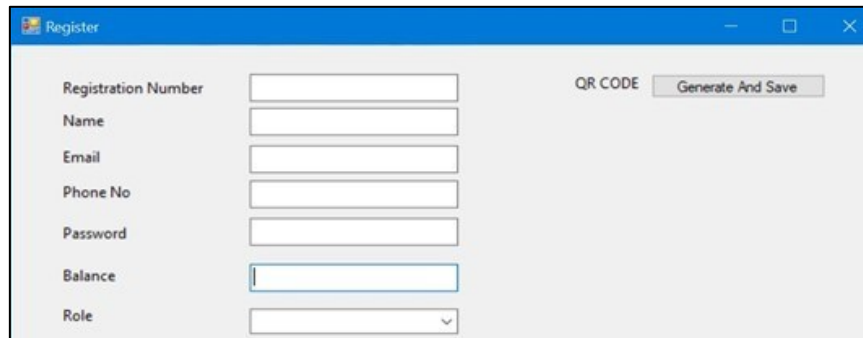
The image shows a software window titled 'Register'. It contains a form with the following fields: 'Registration Number', 'Name', 'Email', 'Phone No', 'Password', 'Balance', and 'Role'. The 'Role' field is a dropdown menu. To the right of the form, there is a 'QR CODE' label and a 'Generate And Save' button. The window has standard Windows-style window controls (minimize, maximize, close) in the top right corner.

Figure 7. New User Registration and QR Generation

6. Conclusion

Automating the canteen operations offers numerous advantages for both customers and owners alike. For customers, it streamlines service, eliminating queues and the need for exact change. Payments made through virtual platforms enhance convenience. On the other hand, for canteen owners, automation ensures reliable record-keeping and enhances security by minimizing cash handling. These advancements not only improve efficiency but also elevate the overall experience for all involved.

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