NSU Canteen Automation

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***Abstract* — North South University's (NSU) canteen has seen a major revamp in both appearance and in the way the cafeteria operates. Over the years it has been the go-to place for students and teachers alike for a quick meal or refreshments in between hectic schedules. The recent changes, however, has affected the average waiting times substantially. The current mode of operation relies on having to stand in long queues for payments and then taking the payment slip (receipt) to another terminal to receive the food. Since the first queue builds up during peak hours, it creates a backlog of customers waiting in frustration. The solution we have devised is to offload the manual payment process to an online payment system using a payment processor hosted on a mobile device using a web application and Android. This will enable users to order and pay inside the canteen without having to resort to long queues.**

Keywords — Canteen Automation, Digital Currency, Mobile, Web Application, Electronic Payments.

I. INTRODUCTION

The recent advent of technology has made it possible for the general masses to own a smart mobile device with relative ease and low cost. The Android platform has made significant advancements in both ease of use and usability and acts as an excellent pocket companion. The services provided through these mobile platforms is very rich and offers a diverse amount of options to the user base.

This serves as an excellent gateway for proposing the automation of payments inside the cafeteria using a mobile application preferably under the Android platform. This is achieved by the means of converting user credits into an electronic balance system which is maintained inside the application. The concept can be further applied to other intra-university services such as the photocopy center and the bookshops in order to reduce cash transactions.

The Android platform is relatively cheaper and is generally the more chosen platform, hence the application built for this project is using Android and Web Technologies at its core. The underlying principle of this project is to utilize a smartphone by using an online system which will replace the current model of payment interaction. The incentive is to provide the user with an intuitive user interface to order food from their smartphones and handle payments directly through the device. This will help eliminate payment queues and offload service onto food serving terminals. The user application will provide a menu for the cafeteria which is updated daily and track order status until the food is received which is confirmed after verification through QR code service using the device.

The intended effect is to reduce the load on the employees working inside the cafeteria while improving service and catering more efficiently during peak hours. The advantage of automating such a system also has an opportunity to track customer behaviors and food choices making way for personalized recommendations and promotions.

II. LITERATURE REVIEW

A. QR Based System

The use of a QR scanner for completing transactions can be a core component in mobile payment systems. [2] The idea stems from the fact that a certain cryptographic setup is needed to ensure security when completing payments. The idea of using a QR scanner using the smartphone's camera and an application which can detect QR is a cost-effective.

Public Key Cryptography can be used in securing payments through QR. [9] This concept has been heavily utilized by lots of applications in the real world for completing transactions and generating unique QR strings.

B. Touchscreens

The use of a touch screen based ordering system inside a restaurant is a probable solution. [3] This can be combined and used to develop web-centric applications that could be run on the user's own smartphone without having to install additional hardware inside the canteen.

Touchscreen are capable of showing food items along with their calorie content and other information which aids in the ordering process. After seeing food items on the screen, a customer can decide on what to order and make more informed decisions. [6] Many applications that has been developed uses this concept to aid the customer to have a healthy diet.

C. Wireless Ordering

Using GSM network technologies and Bluetooth for communication inside a restaurant or cafeteria premise for ordering is a new approach that is being embraced by a lot of companies. [8] The solutions that are devised uses basic Internet connectivity for all communications which is more robust compared to traditional pen and paper ordering.

III. PROPOSED SYSTEM

The idea is to use an Online Payment Processor (Gateway) using a Mobile Device. The end goal is to free the load on employees at the payment terminals to have an easier time processing payments. The net effect is such that more employees will be able to serve food through the terminals

instead of having to process payments manually. This will create a more efficient system where time wasted is less per customer.

A. Graphical User Interface

The application is mainly operated using a front-end which has the job of displaying food items in a friendly graphical user interface. This makes it easier for the customer to choose their desired items without much hassle. Another benefit of having such a system over classical methods is that the cafeteria does not have to waste resources when changing menus since it is all digital instead of hard-coded.

B. Online Push Notifications

The additional feature of having a push notification service allows the application to be more dynamic. Users can receive on the fly updates about their orders without ever stepping food inside the cafeteria premise. This is more efficient and saves space that would be otherwise wasted waiting to receive food.

C. External Payment Processor

The payment process is taken care of by an external payment processor, this is deliberately done so that payments are guaranteed through a secured channel using sophisticated technologies offered by the payment processor. This is advantageous because there is no reinventing the wheel when it comes to security as money transactions is a delicate subject where accountability is very important.

D. Electronic Balance

The system is designed to store the customer's cash as electronic credits. This enables the use of electronic balance transfer instead of face to face cash transactions. The end result is that it is faster, more reliable and less cumbersome.

E. QR Enabled Transactions

To make the electronic balance transfer more secure, the application will use QR to confirm its transactions instead of relying on other methods. The use of QR makes the application more reliant and dependable. Therefore the customers have more trust on the application when it comes to security.

IV. Design Methodology

The proposed system outlines all the important components that are needed to make a working solution. The important part when it comes to designing such a system depends in identifying the main user requirements.

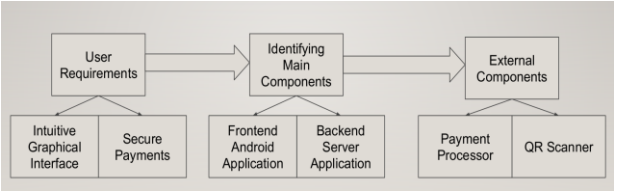

Fig. 1. Design Methodology

A. Identify User Requirments.

1) *Intuitive Graphical Interface*.
2) *Secure Payments.*
   a) *Accountability.*
   b) *Credibility.*

B. Identify Main Components.

1) *Hardware.*
   a) *Frontend devices.*
   b) *Servers.*
   c) *Internet Connectivity.*
2) *Software.*
   a) *Web applications.*

C. Identify External Components.

1) *Payment Processor.*
   a) *Subscription.*
2) *QR Devices.*
   a) *Displays Terminals.*
   b) *Monitors.*

The application therefore consists of multiple components working together and each loosely coupled with one another. The user requirements is a very important subject as the customers of the application will have a large impact on how it is perceived. Fulfilling these requirements will create the notion of a better product compared to the current mode of operation and increase the user base.

D. Estimated Cost

TABLE I. Estimated cost

Parts/Software	Cost (BDT)
Computer Device	10000
Monitor/Display Unit	5000
Peripherals	1000
Hosting/Domain	1000
SSL Certificate	4000
Total Cost	[a]21000

[a.] The prices are an estimate.

The estimated cost of system installation is depicted in the table above. The amount calculate might vary depending on system configuration and number of units purchased. The main cost in setting up the system lies in purchasing the server that will be responsible for handling all the purchase requests through the application.

Since there is no involvement of an external QR barcode device or specialized equipment, this approach is more efficient and cost effective.

V. System Design

A. System Architecture

The system architecture is comprised of all the external and internal components needed for a working solution. The architecture employs a basic integration of a frontend along with a backend system and central storage. The external payment processor is integrated with the backend server using the payment gateway's Application Programming Interface (API) in order to connect the application to their servers. The push

notification service is also an external part of the system architecture.

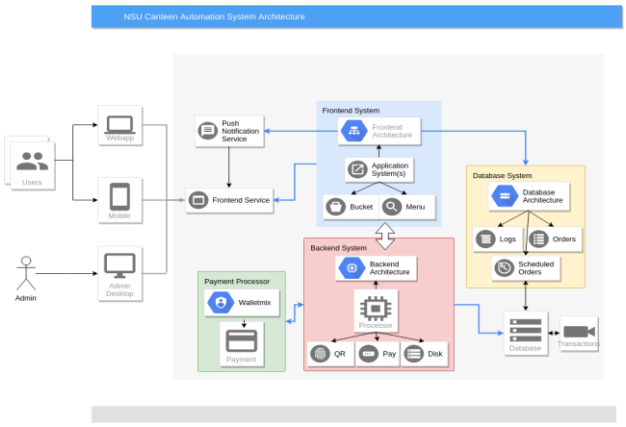

FIG. 2. SYSTEM ARCHITECURE

A basic rundown of the schematics used in figure 2 is explained.

1. Users – Students/faculties/university staff (employees)
2. Admins – Administrator enabled accounts for managing backend servers.
3. Web app – Web application running inside a browser (mobile/PC).
4. Mobile – Android
5. Admin Desktop – Interface for handling backend server (web application).

B. Frontend System

The frontend system houses the following application systems.

1. Bucket – Storing/saving temporary sessions/carts.
2. Menu – Daily menus (items/prices) from the server.
3. Displaying Electronic Balance.
4. Push Notification Service.

The "Bucket" component is using built-in JavaScript instances to store carts and receipt sessions while a customer is using the application through their mobile phone. The menu system is designed to be easy using buttons and on the fly, options to add/remove items to the cart.

The "Menu" component is being generated from the backend using an API to fetch data from the central database that the application is using underneath for storage purposes.

The Push Notifications is using an external service named "One Signal" which can be implemented inside a web application that is enforced through Hypertext Transfer Protocol of Secure Socket Layer (HTTPs). This is used heavily for relaying information about current orders that are active or in progress and also for changes to the active menu.

C. Backend System

The backend system is developed to primarily a web application for controlling server side orders through the application. The employees of the cafeteria are responsible handling order requests through this server. The kitchen is notified through the web application by the employee at the server. These requests are automatically sent from the client side (frontend). The main features of the backend system are listed below.

1. Prepare transaction details.
2. Generate QR images using unique strings.
3. Log completed payments.
4. Real-time menus.
5. User tracking.
6. Sales stats.

The transaction details are prepared from the data received by the external payment processor. Each deposit for a user is recorded both in the database system and in the external payment processor's detailed logs. Completed payments made through the application is logged by the internal disk (database system). This is done for credibility and to tackle future disputes if it arises in any such occasion.

The real-time menus are used to feature items on the fly and instantaneously on the client side applications through the means of an API. The generated data of items can be fetched easily by clients, and the administrator accounts can add, remove or update items easily through the dedicated router responsible for handling item inventory.

The backend system also has an option to generate sales information dynamically from all the receipts that are stored inside the database. This enables the system to draw pie-charts and bar graphs of sales stats seamlessly. This is useful for tracking the month-month or day-to-day output of sales and finding which items are best sold through the application.

One of the main tasks of the backend system is to generate unique QR strings based on the user details to keep each log identifiable from other logs. This is done to ensure privacy and security of transactions made so that users can easily confirm their transactions through scanning the QR code generated on the server side monitors/displays. Having each QR string unique means that no user will be able to confirm a separate order made through different smartphone/device that is not tied to their account. This makes it harder for fraudulent activities or erroneous attempts at the server terminal when collecting food.

D. Database System

The database system is responsible for acting as a permanent disk of all transactions, records, logs generated when using the system. This gives an added advantage of not having to waste additional space when managing storage. The database can query information on the fly. This makes it easy to access the database where the user/administrator can access information tied to their respected accounts in a fast and efficient manner.

The database system keeps track of sessions generated when a user (client/admin) logs into the system, the session generated is responsible for showing appropriate options depending on the user level and the appropriate router from

the backend is called whenever a user is operating within the application. The privilege level determines whether a user can access certain elements inside the application, only privileged users (administrators) can access other user accounts and modify if deemed necessary.

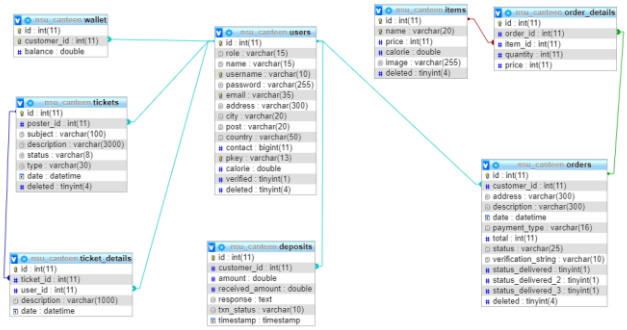

FIG. 3. DATABASE TABLES

In figure 3, a list of database tables are given to help visualize the connection between the different types of entities that exist inside the system and their relations to one another.

E. External Payment Processor

The external payment processor is responsible for all and any transactions that require the user to provide credentials for their cards or bank account numbers. The use of an external payment processor is primarily because of security concerns since it involves actual user bank accounts and card numbers as credentials. The choice of an external payment processor as a payment gateway is primarily because of maintain integrity of the application. Any fraudulent activities or any systematic errors regarding transactions can therefore be traced using such a system.

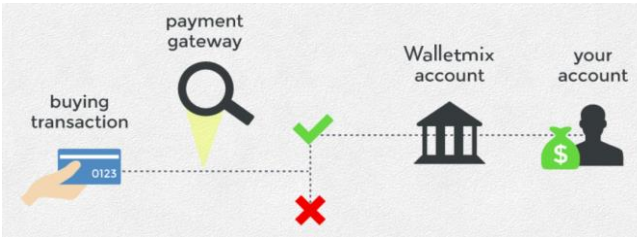

FIG. 4. WALLETMIX PAYMENT GATEWAY

The external payment processor is facilitated by **Walletmix** (https://www.walletmix.com/).

VI. EXTERNAL PAYMEN PROCESSOR

Walletmix is a local brand specialized in handling a massive amount of transactions and offers almost all sort of Bangladeshi payment methods available (except physical cash) till date (e.g. credit cards, online banking, debit cards, mobile payments, bKash, Rocket, Ucash, etc.). They already have a good reputation in the industry sector of Bangladesh for online payments and their variety of payment methods would certainly help attain a diversified customer base which would not have been possible otherwise.

The payment gateway offers a list of features that can be implemented in the application through their APIs, some of these can be accessed through their dashboard.

1. Merchant accounts.
2. Bank accounts.
3. Payment module.
4. Transaction status.
5. Customer details.

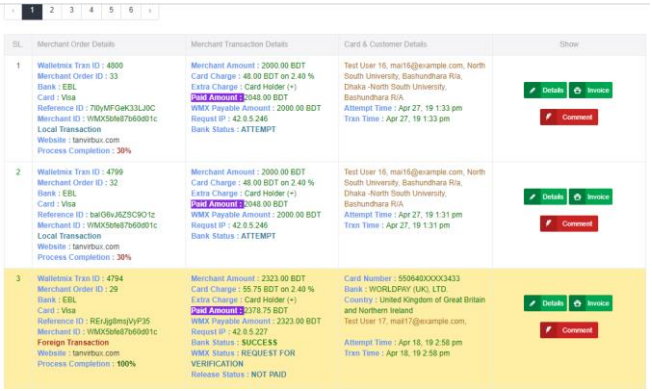

FIG. 5. WALLET MIX DETAILED LOGS

A. Detailed Logs

TABLE II. DETAILED LOGS

Merchant Order Details	Merchant Trxn Details	Card & Customer Details
Walletmix Trxn ID	Merchant Amount	Card Number
Merchant Order ID	Card Charge	Bank
Bank	Extra Charge	Country
Card	Paid Amount	Card Type
Reference ID	WMX Payable Amount	E-mail
Merchant ID	Request IP	Attempt Time
Transaction Type	Bank Status	Trxn Time
Website	Release Status	
Process Completion		

B. Security

The main security endpoints offered through Walletmix are as follows.

1. **Virtual Terminal** - Virtual terminal processing over the Internet.
2. **SSL** – SSL enables encrypted between client & server.
3. **CCV –** Card Code Verification against fraudulent transactions.
4. **AVS** – Address Verification Service.
5. **PSI DSS Compliant** – Payment Card Industry Data Security Standard.

VII. SYSTEM COMMUNICATION

The internal system communications that are inherent to the application is explained using detailed interaction diagrams and flowcharts along with explanations.

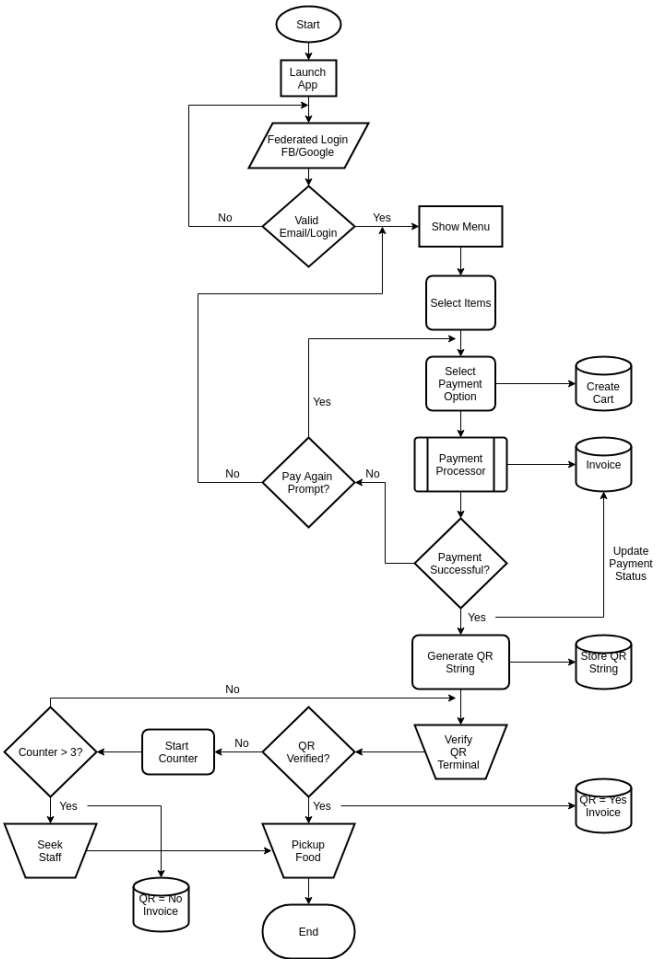

FIG. 6. SYSTEM FLOWCHART

The user first needs to sign-up to the application by registering for an account. Once the backend server sends the authentication successful response, the user would be logged in to the food ordering system and the menu should be displayed for all available food to order.

After selecting food items, the user is displayed with the payment options available by the payment processor. Once the user clicks checkout an invoice should be generated in the system and stored in the database along with a request to process the payment for that specific invoice would be sent to the payment processor where the user should be redirected to for completing the payment.

Once payment is successful, the payment processor should inform this status back to the server and this will generate a QR string in the database.

Once the order is processed by the servers and the user (customer) is ready to pick up the food, he/she should come in front of the counter and scan the generated QR code through the application. If he/she is the actual customer then the QR string should match and notification shall be sent to the server's terminal indicating the verification is complete and the server can handover the food.

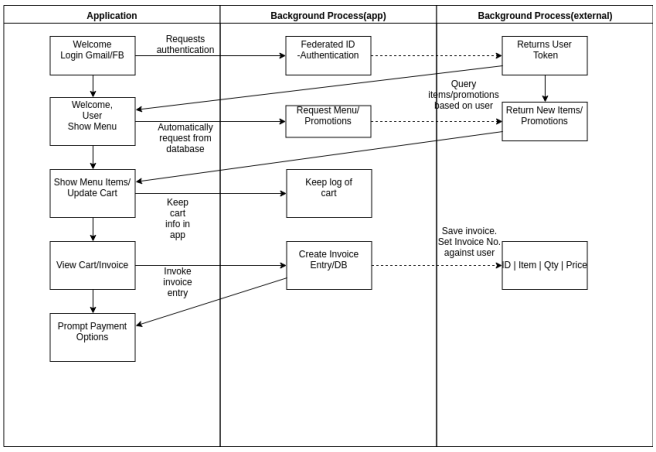

FIG. 7. SYSTEM INTERACTION PART 1

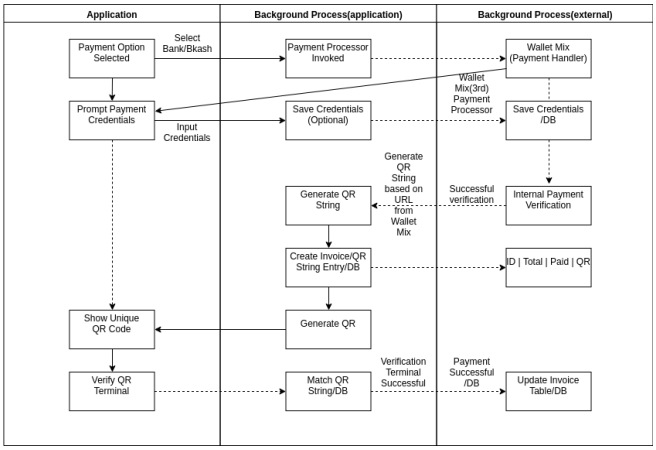

FIG. 8. SYSTEM INTERACTION PART 2

The system interaction diagrams are explained in a series of steps.

1. The frontend application grants the user a log-in to the system which is authenticated using the backend server.
2. A user token is turned, typically a JSON object containing names/uID or a PHP session variable.
3. Upon successful login, the frontend application automatically requests for the latest menu and returns a list of prices and promotions if available from a database query.
4. A user cart is generated and the session is stored on the device/browser.
5. When view cart/invoice is selected, the entry is pushed to the database against the user ID. The cart generated holds user-ID, Item, Quantity and Price.
6. The payment selection options are automatically prompted.
7. Selecting a payment option (bank/bKash) invokes the external payment processor.
8. Depending upon the payment type, the appropriate credentials are prompted on the frontend.
9. Once the payment is processed, Walletmix should trigger a callback URL to the server where they would send the status of the payment and invoice number through HTTP GET method.

10. Once the payment is verified, the server generates a unique QR string. The QR string is stored on the database against the receipt generated.
11. The QR pattern is then sent to the display/monitor at the food serving terminal based on the unique string.
12. Once the user matches the QR pattern against the terminal, the receipt is updated to status "paid" and the transaction is complete.

VIII. SYSTEM INTERFACE

The client and administrator interfaces are given below to give an idea about the structure of the application showing the actual user interface in action.

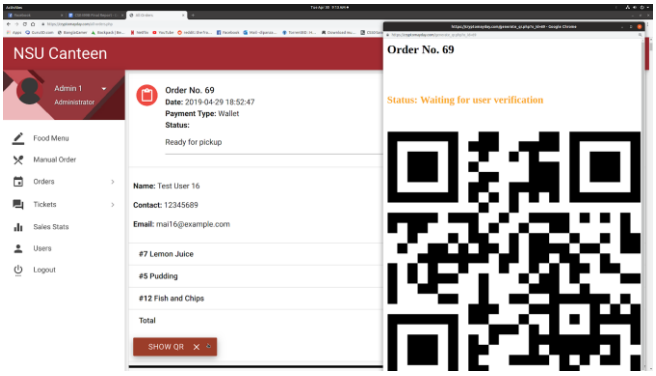

FIG. 9. ADMIN PANEL

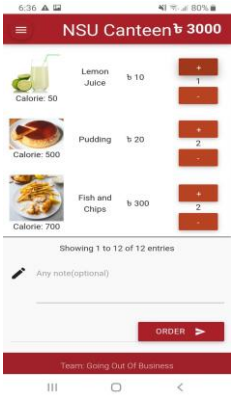

FIG. 9. CLIENT INTERFACE

IX. RESULTS

By testing the software through live demonstrations, it is found that it only takes around 1 to 2 minutes for completing a payment through the application.

FIG. 10. TIME ESTIMATES

There is a considerable amount of time saved as the usage of the application reduces the transaction period to 1 minute as opposed to an average wait time of 5 to 6 minutes for face-to-face transactions.

X. CONCLUSION

The long standing queues has been a major complaint after the overhaul of the cafeteria inside North South University. It is evident that the older way of getting food "first come first serve" basis was more efficient at the cost of a disruptive atmosphere. The rationale behind this project is to design a system that can tackle the problems of a busy cafeteria using available hardware and software to provide a viable solution which is cost effective. The solution even though very simple requires a multitude of thought since security is a big concern when it comes to public expenditure through a computerized or electronic-based system. The main focus is to reduce the waiting time in an organized manner using a systemic approach. The scope of this project aims to deliver a working product (mobile application) which will enable end users and canteen employees for smoother communication when making transactions reducing wait times. Still there are many scopes for future improvement which include a better support for a wider range of devices and more robust set of features.

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