SYSTEM REQUIREMENTS SPECIFICATION

PROJECT NAME: SMART VENDING MACHINE

COURSE NAME: INTEGRATED DESIGN PROJECT-01
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SECTION: A

GROUP MEMBERS:

Pratyusha Kundu (201814014)
Anika Zaman (201814018)
Sabrina Afreen Haque (201814020)
Md. Arr Rafi Islam (201814050)

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1. Introduction

Smart Vending Machine is an integrated system where a prevailing vending machine will be connected to a mobile app so that a customer can buy any product by remote control. The app will let the user to select the desired display chamber of the vending machine by using Bluetooth signal and purchase the product by mobile banking. The system will use sensors to detect if a product is dispensed perfectly and if the customer has received the product or not.

The availability of vending machines is very important at many areas in many countries because many people depend on them to access products conveniently.[1] They are normally used to dispense candy, drinks, food and other consumables that do not require a sales person's presence. The machine can be positioned in a location where there are no cafeterias in the vicinity. This makes it possible for people to access their favourite products such as fast food during their leisure or work. Considering the pace at which the world is working today, it is important to have fast-paced machines that dispense what consumers need.

The project Smart Vending Machine is proposed with the intension to better the performance of the prevailing vending machines around the world so that these machines may cater for the needs of consumers whenever they need them. Another purpose is to use these systems not only in normal times but also in emergency situations i.e., pandemic, war etc.

2. Scope of Project

Anyone who is interested to purchase from this smart vending machine will be able to use the system. A customer may install the android app from play store, register and log in to purchase from the machine.
An administrator will administer the system and keep the information accurate by using web portal. Furthermore, the system will need both Internet and Bluetooth connection to function accordingly. All system information will be maintained in a database.

3. Glossary

Vending Machine:
A vending machine is an automated machine that provides items such as snacks, beverages etc. to consumers after cash, a credit card, or a specially designed card is inserted into the machine.

User:
A person who is interested to use Smart Vending Machine.

Customer:
A person who is interested to purchase products from Smart Vending Machine.

Admin/Administrator:
System administrator who is given specific permission for managing and controlling the system.

Stakeholder:
Any person who has interaction with the system who is not a developer.

App Store:
An installed application on mobile phone which helps user to find new compatible applications with mobile phone platform and download them from Internet.

DBMS:
Database management system which is the collection of all the information stored in this system.

System Requirements Specification:
A document that completely describes all of the functions of a proposed system and the constraints under which it must operate.

Bluetooth:
A wireless technology to connect smart phone with the vending machine.

Take-out port:
A part of vending machine from where the products are dispensed to the user.

Items:
Commodities available and purchased from vending machine.

SVM:
Abbreviation for Smart Vending Machine.

4. Requirements discovery

Because of pandemic, it was not possible to carry out face to face interviews with stakeholders. That's why, some observations were carried out on some YouTube videos where youtubers uploaded videos on plethora of vending machines of Japan and Singapore and how they worked. Their opinions were considered while determining the requirements.[2][3] Moreover, the past history of purchasing products from the reigning vending machines in our campus is taken in consideration to discover the requirements as well.

5. User requirements

Through requirements discovery process we have found the following user requirements:

5.1 The app will be user friendly and free to use.

5.2 The user will be able to remote control the vending machine.

5.3 The user will pay as soon as he will receive the product from the take-out port.

5.4 The app will carry out online banking as it is preferred over cash transaction now-a-days.

5.5 The app will ensure strong security.

5.6 The system will provide compensation for providing a damaged product.

6. System Architecture

Layered architecture is adopted for Smart Vending Machine (SVM). This is designed to model the interfacing of subsystems. This architecture organizes the system into a set of layers, each of which provides a set of services. There are four layers for this architecture. There are presentation layer, authentication and services layer, application functionality layer and system support layer consecutively in first, second, third and the final layer in this architecture. Application interface is in the top most layer. Then Login, system administrator, Bluetooth controller etc. is in the next layer. Then distributed search, product retrieval, accounting and transaction in the next layer. Operating system, databases is in the lowest layer. The layered architecture is given below:

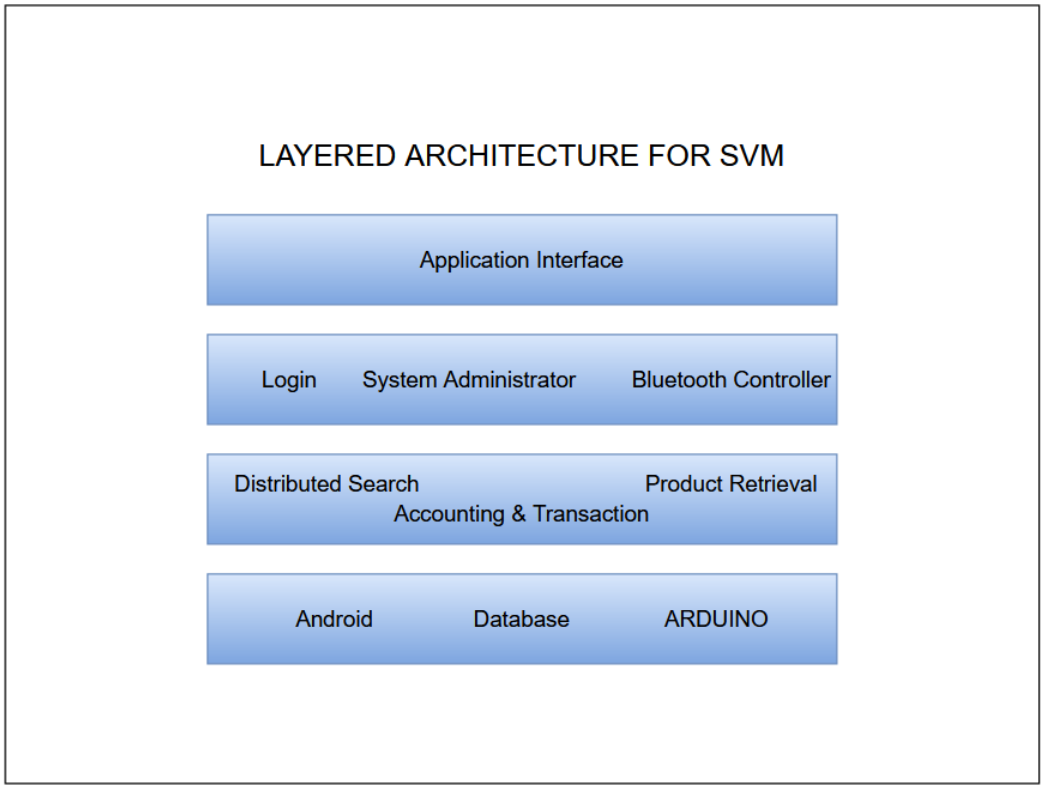


Fig-1: Layered Architecture for Smart Vending Machine (SVM)

7. System Requirements Specification

7.1 Functional requirements

This following table depicts the requirements that specify the fundamental actions of the system:

ID	Title	Description
FR1	Connecting Bluetooth Module	The available vending machine shall be connected with a Bluetooth module and this vending machine shall have a unique Bluetooth Device name to connect with the mobile app.
FR2	Show Available Bluetooth Devices	The app shall be able to show available devices around it.
FR3	Connect Bluetooth Device	The vending machine shall connect to a particular smart phone through the app.
FR4	Activate particular display chamber	The vending machine shall activate the certain display chamber to drop particular item after getting Bluetooth signal from the app.
FR5	Dispense Particular Item	The vending machine shall drop particular item correctly to the take-out port on the load sensor. The load sensor will calculate the weight to show that the item has been dropped correctly.
FR6	Online banking	As soon as a customer takes out his item, the system shall charge his credit/debit card by mobile banking.
FR7	Database in Back-end	The app shall have a good database management system in the back-end to manage the whole purchase procedure successfully.
FR8	Admin Registration	The admin shall be registered in the app using a unique user ID. He shall provide username, email address, phone number and password to register in the app.
FR9	Admin Log-In and manage DBMS	The admin shall use the username and password registered in the app to log in to the system and manage the database management system. He should be able to modify and update various information i.e., product name, launch date and time etc. related to the products launched in the particular vending machine.
FR10	Download mobile application	A customer shall be able to download the mobile application through either an application store or similar service on the mobile phone. The application shall be free to download.
FR11	User Sign-In - Mobile application	After downloading the mobile application, the customer shall create a user account by providing username, password, phone number, email address and credit/debit card credentials (i.e., card number, CVV, card validity) in the app.
FR12	User Log-in - Mobile application	Given that a customer has registered, then he shall be able to log in to the mobile application. The log-in information will be

		stored in the app so that in the future the user shall be logged in automatically. Customer log-in will be required to buy any product using the app.
FR13	Select Bluetooth connected vending machine	The customer shall select the available vending machine in the app using the Bluetooth device name given to the vending machine to start buying any product.
FR14	Show available products	The customer shall be able to see available products, option (where the product is available in the vending machine) and their amounts in the app.
FR15	Buy product by choosing option and amount	The customer shall be able to choose desired product option and their amounts in the app.
FR16	Receive product	The customer shall be able to receive desired product from take-out port
FR17	User profile page	On the mobile application, every registered user shall have a profile page. On the profile page a user will be able to edit his information, which includes the password, e-mail address etc. He shall be able to log out and delete his account from this profile.

7.2 Non-functional requirements

This following table depicts the requirements that specify the non-functional actions of the system:

ID	Non-functional requirements
NR1	Meaningful user Interface will be designed in the app.
NR2	Expired and damaged products will not be loaded in the vending machine.
NR3	The system will connect with the Bluetooth device within 3 seconds.
NR4	The time between receiving item and charging credit card will be less than 0.5 seconds.
NR5	If any user tries to log in to the app with a non-existing account then he will not be logged in. There will be a prompt to instruct the user to register first and then log in to the system.
NR6	If any customer provides wrong password 3 times a warning will be given to try to give password after some seconds.
NR7	If any customer wants to create an account and the desired user name is occupied, the customer will be asked to choose a different user name.
NR8	The vending machine will be connected to one device at a time.
NR9	The app will be connected to the Internet.
NR10	While using the app for the first time, there will be manual prompts to help the user to use the app easily.

NR11	The customer will be able to complaint if he gets an expired or damaged product. The customer will have to complaint within 3 minutes after his card has been charged. The complaint will be received by the admin and he will send a reply to the customer within one hour.

7.3 The relation among user requirements and system requirements

This following table depicts the relation among the system requirements and the user requirements:

No.	User requirement	Types of requirement		System Requirement IDs
		Functional	Non-Functional	
1	The app will be user friendly and free to use	✓	✓	FR10, NR1, NR11, NR13
2	The user will be able to remote control the vending machine	✓	✓	FR1, FR2, FR3, FR4, FR5, FR7, FR13, NR4
3	The user will pay as soon as the item will be received from the take-out port	✓	✓	FR6, NR7
4	The app will carry out online banking	✓	×	FR6
5	The app will ensure strong security	×	✓	NR8, NR9, NR10
6	The system will provide compensation for providing a damaged product	×	✓	NR2, NR14

8 System Models

To implement this system, four types of system models have been developed; each of them presents different perspective of the system. The four system models are given below:

i. Context Diagram
ii. Use case Diagram
iii. Sequence Diagram
iv. Activity Diagram

8.1 Context Diagram

Each customer will use this SVM system for opening an account, selecting items, providing payment information, receiving items. The system will give the customer confirmation and transaction receipt. A bank system will be connected to the SVM system which will take payment request and provide payment receipt. A vending machine will also be connected to the system which will take item selection information and dispense selected item.

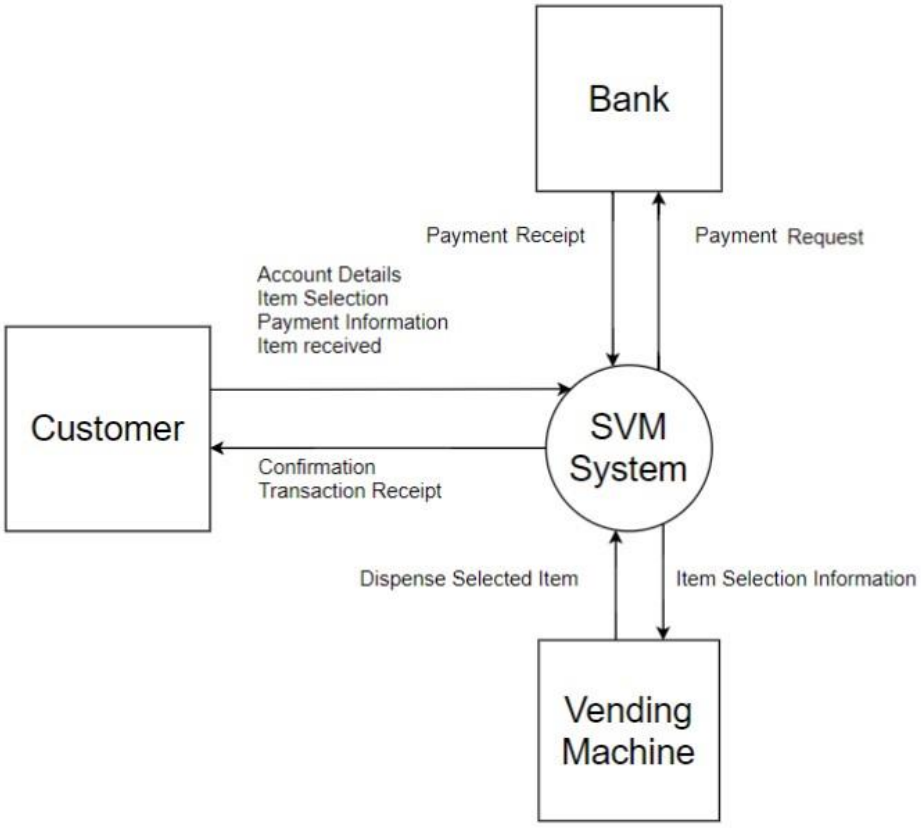


Fig-2: Context Diagram for Smart Vending Machine (SVM)

8.2 Use Case Diagram

Sign Up and Log In scenario:

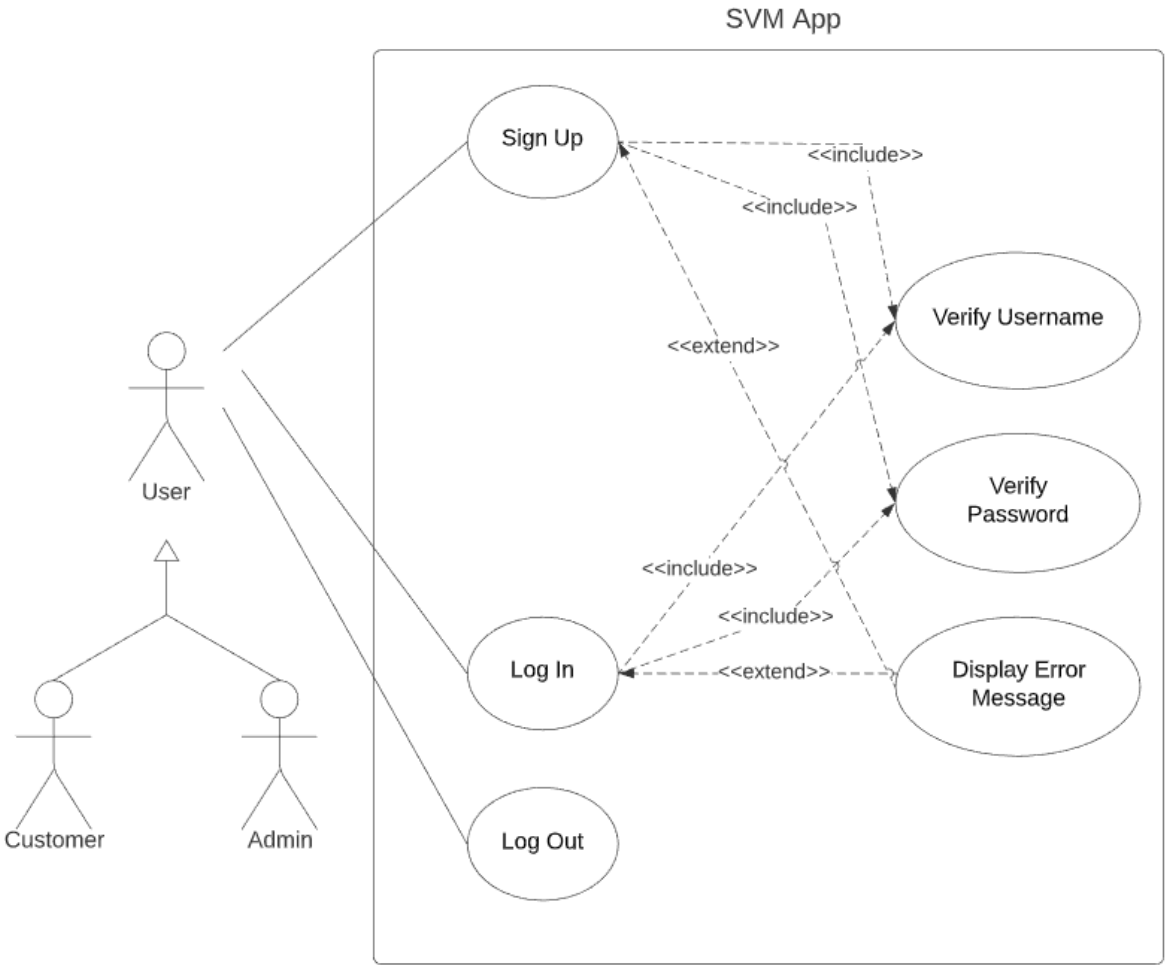


Fig-3: Use Case Diagram- Sign Up and Log in scenario

Tabular Description of the 'Sign Up and Log in Scenario' use-case

Use Case: Sign Up and Log in Scenario	
Actor(s):	User (Customer, Admin)
Description:	User may create a unique account which will record the user's username, password, email-id, phone number, credit/debit card information in the system. This account will be used for purchase by customer and for management by admin. He may log out from the app.

Data:	User's information.
Stimulus:	User command.
Response:	Confirmation that the user has created an account successfully.
Pre-condition:	User must have a smartphone with the SVM App installed.

Purchase scenario:

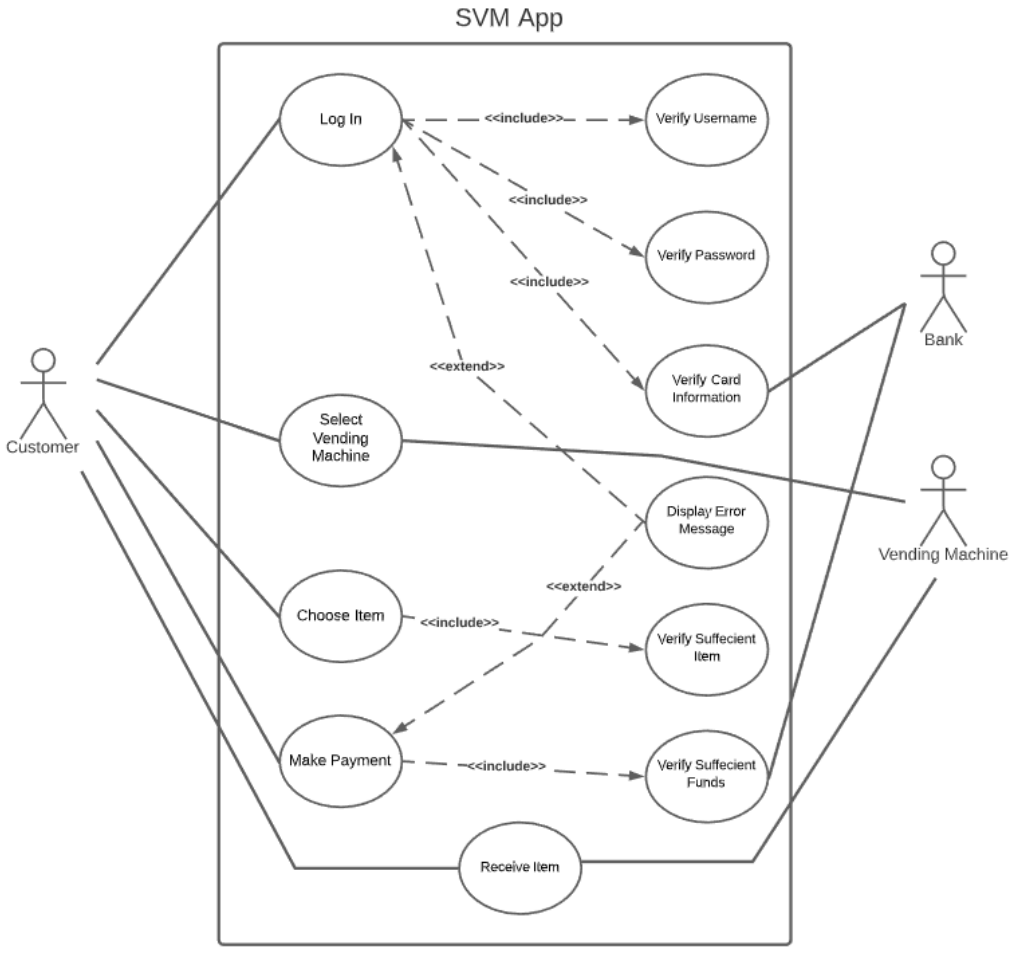


Fig-4: Use Case Diagram- Purchase scenario

Tabular Description of the 'Purchase Scenario' use-case

Use Case: Purchase Scenario	
Actor(s):	Customer, Bank, Vending Machine
Description:	A customer may select an available Bluetooth connected vending machine. He may choose an item from the vending machine. After that, he may make payment using credit card information and receive desired item dispensed by the vending machine. The bank will verify card information and check for sufficient balance and charge the customer's card.
Data:	Customer's account information, item choice, credit/debit card information.
Stimulus:	Touch command by customer.
Response:	Confirmation that the customer has purchased the item successfully.
Pre-condition:	Customer must have a user account and he must be logged in to access in the a for purchasing.

Administration scenario:

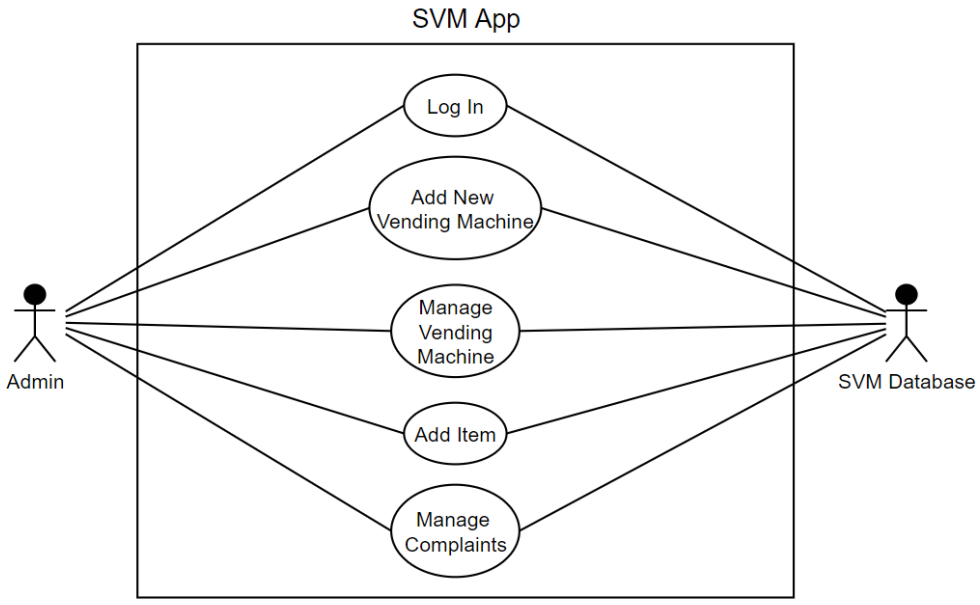


Fig-5: Use Case Diagram- Administration scenario

Tabular Description of the 'Administration Scenario' use-case

Use Case: Administration Scenario	
Actor(s):	Admin, SVM Database
Description:	Admin may create a unique account which will record the admin's username, password, email-id and phone number. This account will be used to add new vending machine and manage those by admin. He will also handle the addition of new items and manage the complaints.
Data:	Admin's information.
Stimulus:	Admin's command.
Response:	Confirmation if the admin has changed any information in the database

8.3 Activity Diagram

Activity Diagram from User Side:

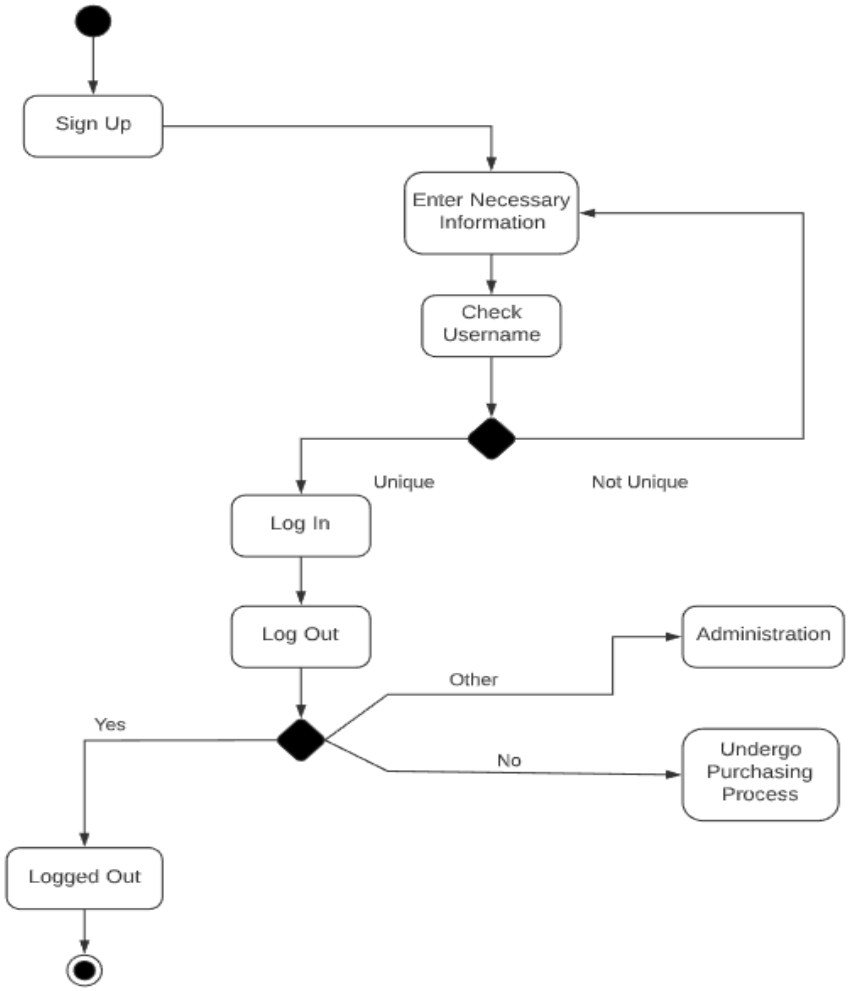


Fig-6: Activity Diagram for User Side for Sign Up and Log in

Activity Diagram from Administrator Side:

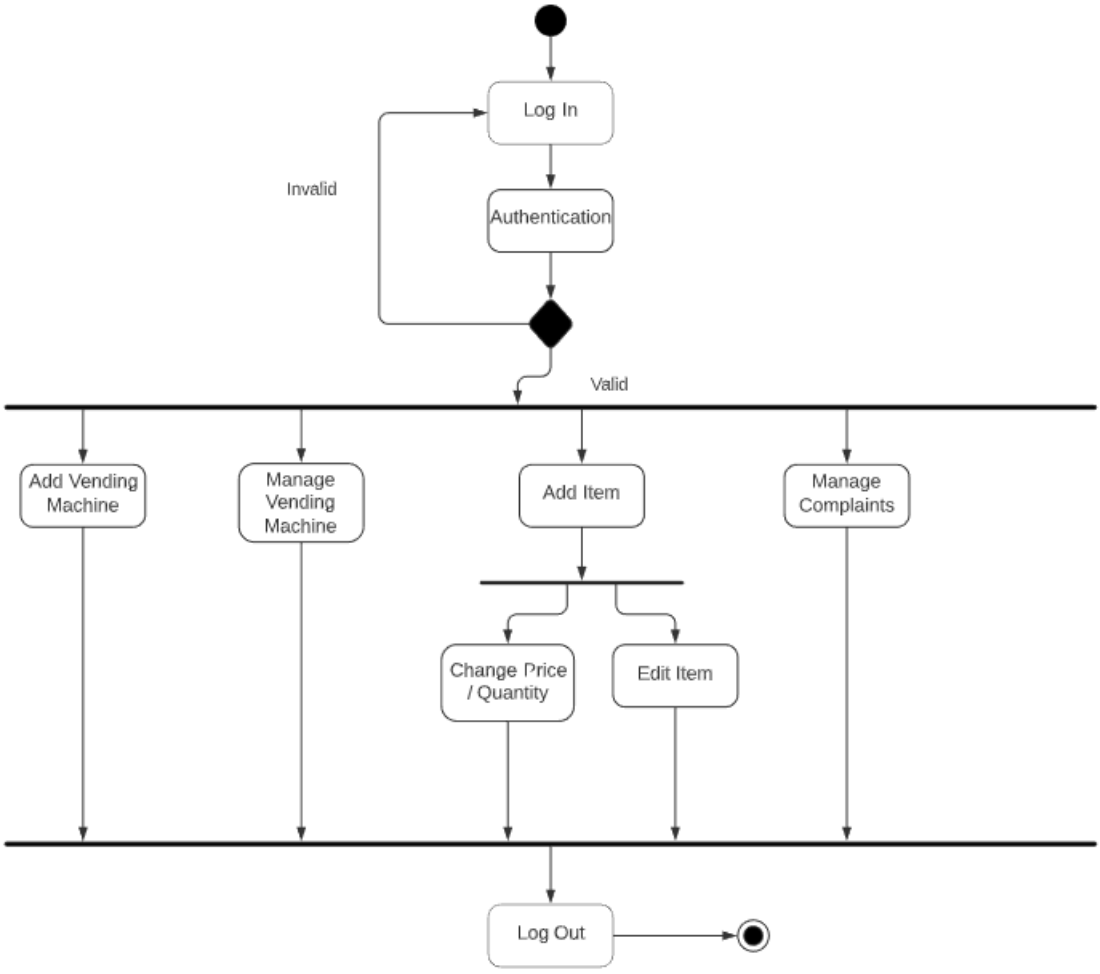


Fig-7: Activity Diagram for Administrator Side

Activity Diagram from Customer Side:

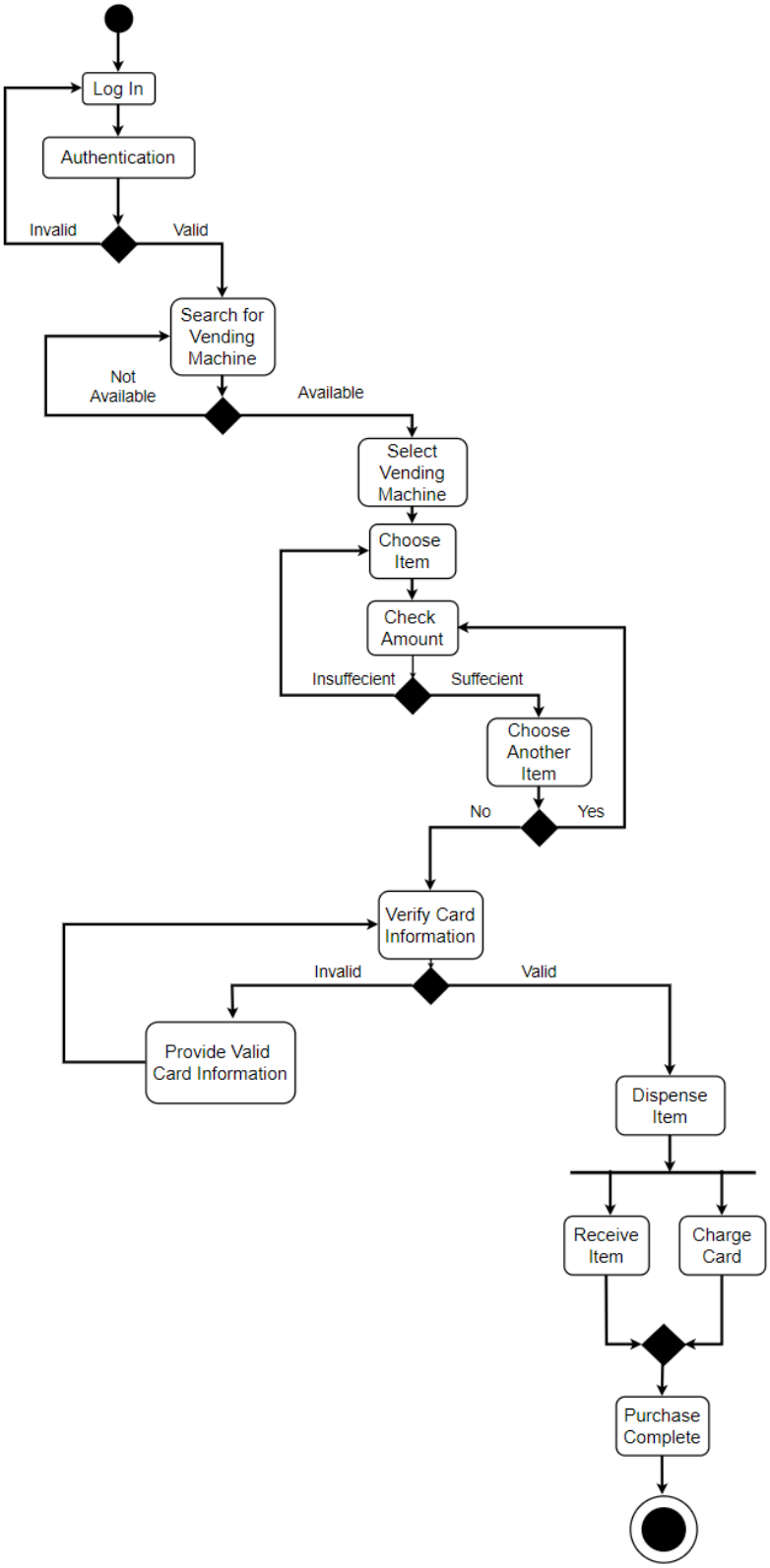


Fig-8: Activity Diagram for Customer Side for Purchasing Items

8.4 Sequence Diagram

Two sequence diagrams have been designed to represent the purchase procedure:

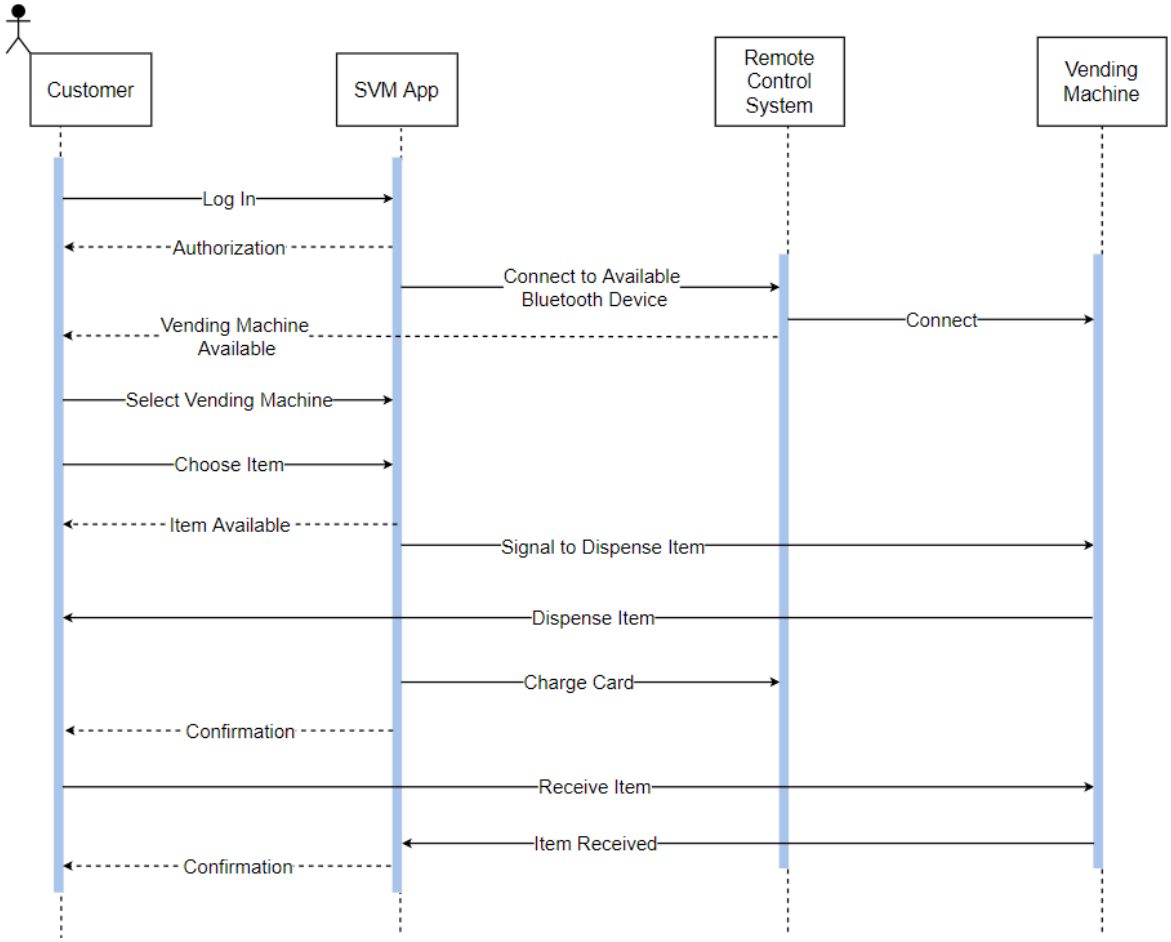


Fig-9: Sequence Diagram for Purchase Part-1- controlling the vending machine

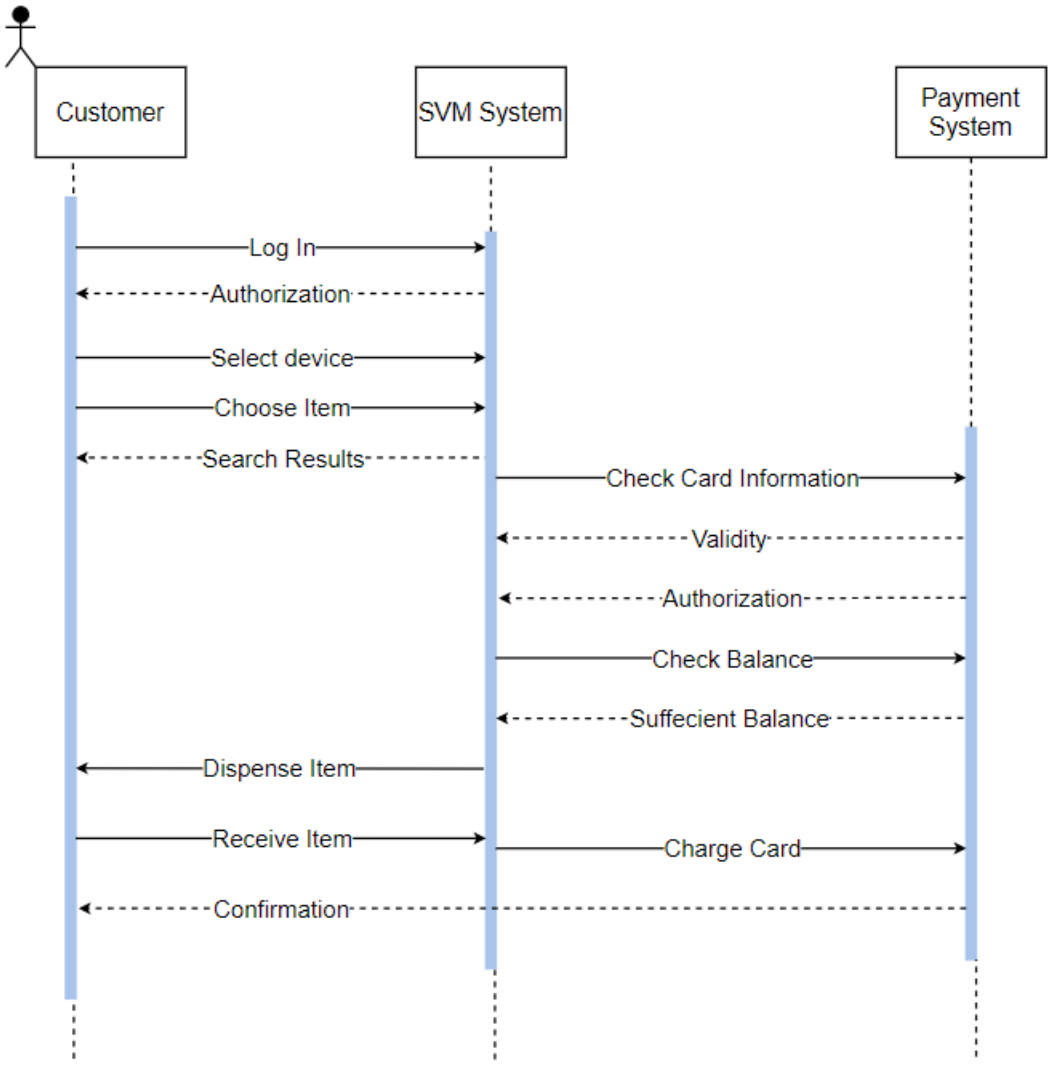


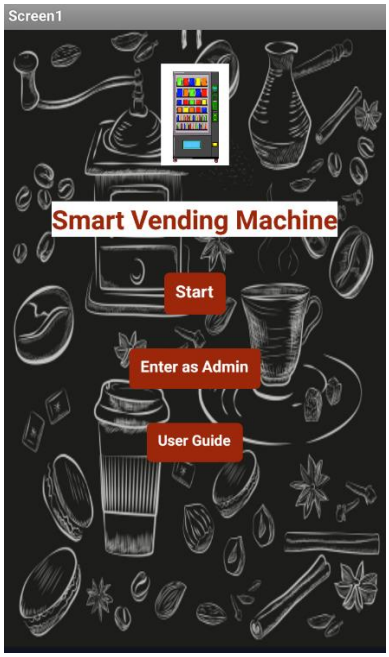
Fig-10: Sequence Diagram for Purchase Part-2- Payment Process

9. Specific Requirements

9.1 External Interfaces

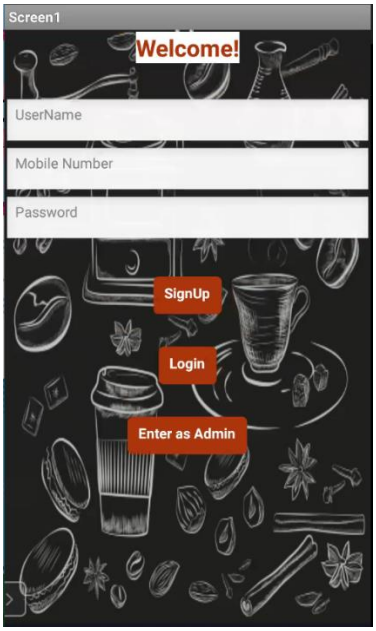
9.1.1 User Interface

9.1.1.1 Start Page



This is the start page which will open after opening the app every time. From this page, the user can go to Sign up page or Log in page or the admin can enter the system as admin.

9.1.1.2 Sign Up Page

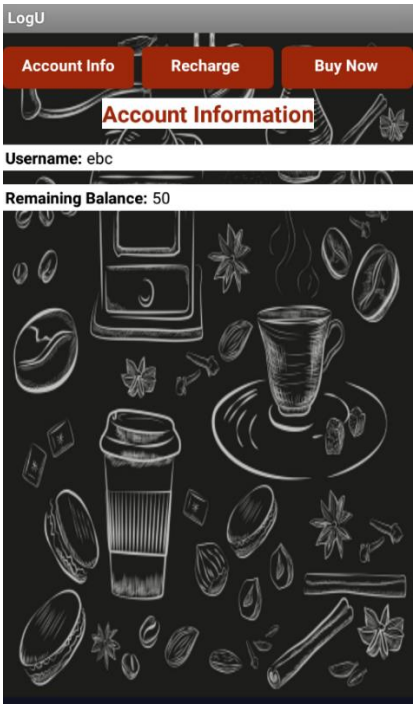


This is the sign-up page which will be used to register the user for this app. A user needs to provide a user name, mobile no, password to register into the system.

9.1.1.2 Login Page

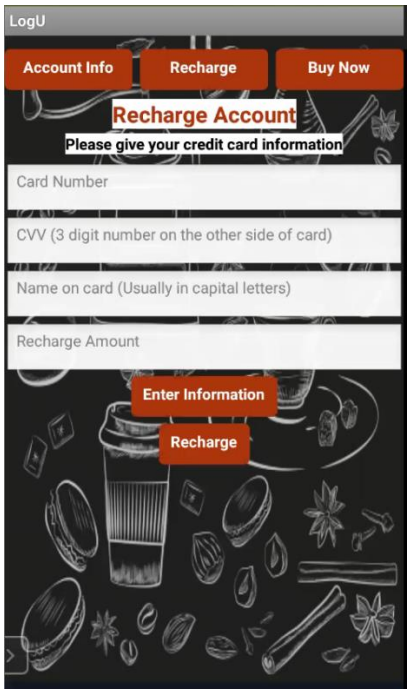
This is the login page where authorization is important which will be done by synchronizing system database. A user needs to provide a user name, mobile name and password to register into the system.

9.1.1.3 User Account Information Page



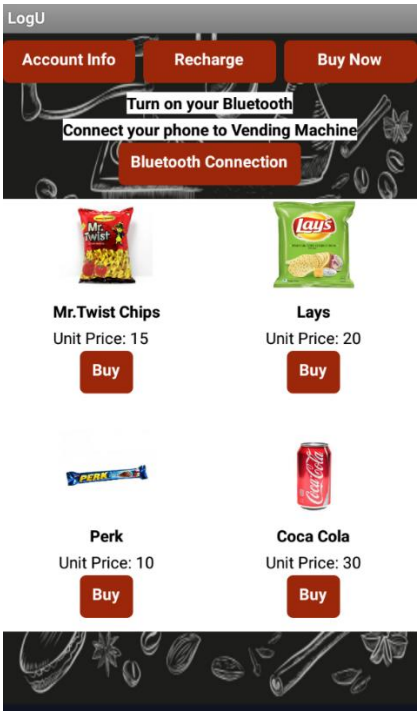
After logging in the app will take the user to the account information page to show the user name and account balance.

9.1.1.4 Account Recharge page



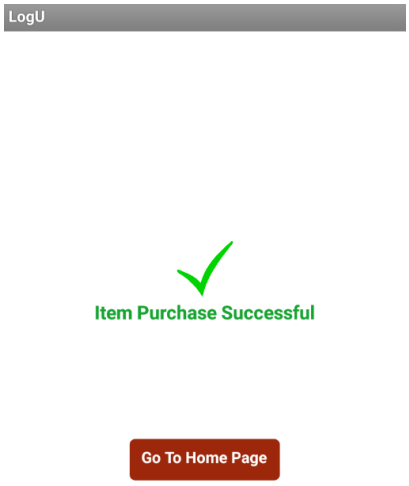
From account information page, the user can go to this recharge page by clicking in **"Recharge"**

9.1.1.5 Buy Now page



The user can go to buy now page by clicking on **"Buy Now"**. This page will show the available items in the vending machine. An user can select the desired item from this page.

9.1.1.6 Item Purchase Confirmation page



After the bought item is dropped and detected the confirmation page will be shown.

9.1.1.7 Admin Login page

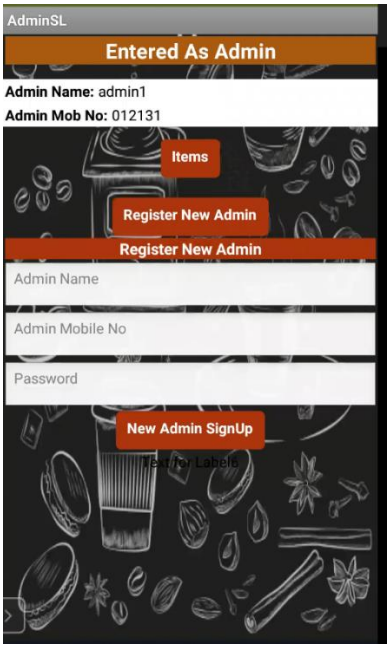
From the introductory page the Admin of the vending machine can enter by clicking **"Enter as Admin"**. The following page will be shown next:

9.1.1.8 Admin Information page

After the admin is logged in the following page (admin information page) is shown

9.1.1.9 Register New Admin page

From Admin information page by clicking **"Register New Admin"** the following section will be shown next:

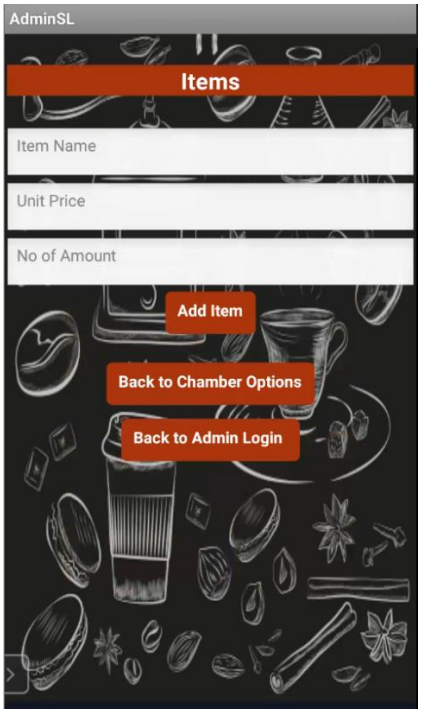


9.1.1.10 Select Chamber page

From Admin information page by clicking **"Items"** the following page will be shown next:

9.1.1.11 Adding Items

From Select Chamber page by clicking **“Chamber 1” or “Chamber 2” or “Chamber 3” or “Chamber 4”** the following page will be shown next:



9.1.2 Hardware Interface

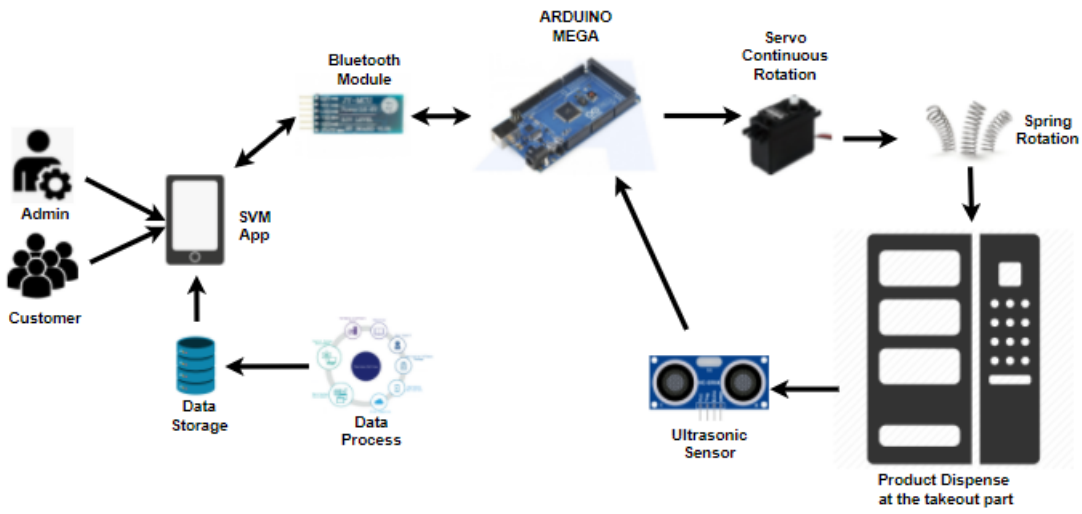


Fig: 9.1.2 System Architecture of Smart Vending Machine (SVM)

The important hardware interfaces used in our system are: **Bluetooth module, Arduino Mega, servo continuous rotation motor** and **ultrasonic sonar sensor.**

Firstly our SVM app is connected to the **Bluetooth module** and real-time data storage system. Then a signal passes from the Bluetooth module to the **Arduino Mega** from where a signal passes to the selected **servo continuous rotation motor** and with the help of the rotation of the motor and corresponding spring rotation the product in the vending machine is dispensed near the **Ultrasonic Sonar sensor** which senses the dropped product and sends a signal to the SVM app through Arduino Mega. In this time the related data in the data storage i.e., Database gets updated as well.

9.1.3 Software Interface

The software interface starts with a login page, which means the authorization of the user. Real-time Database is also required for the overall system. So, Firebase has been for the database. Signal from Ultrasonic Sonar sensor comes to the app and based on that signal the transaction happens and the database gets updated. After updating the database the user can get a confirmation prompt to ensure the product was bought without any error.

The Admin of the SVM also uses the database to update the items information.

9.1.4 Communication Interface

To use our system without any error, the wireless communication interfaces such as Wi-fi connection, and Bluetooth connection were mandatorily used.

9.2 System Design Constraints

There are some constraints in our system mentioned below:

- In our system anyone can get connected with the Bluetooth device while another user is using the device. This may hamper the Bluetooth connectivity with the user already using the vending machine.
- One user can buy one product at a time as our system needs to detect every time if a product has been dropped or not
- Our system does not have any lock system to release the product after it has been detected and dropped. Without this lock system the owner might face loss.

10 System Evolutions and Future Works

For the evolution of this project, following changes may be adopted in future:

- In this project Authentication system is a must for all users who might use this system. In future, some users might want to just install and explore this app before creating an account and providing their personal information in the app. Then, authentication might not be a compulsory action for new users who might install the app only to explore. In that case, a facility whether the user wants to create an account or not, may be introduced in future.
- Mitigating the prevailing limitations
- Ensure the Bluetooth Vending Machine can be connected to one user at one time
- Ensure that the user can buy more than one item at a time
- Creating review section so that the customers can complain about the damaged products
- Embedding real online banking system with the app
- This system may be installed in different vicinities where establishing a new restaurant or super shop may be quite difficult.

11. Reference(s)

[1] S. Rodney. “The Importance of Vending Machines.” EzineArticle.com. https://ezinearticles.com/?The-Importance-of-Vending-Machines&id=7975130 (Accessed Aug.12, 2020)

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[3] DancingBacons, Singapore. 24 Hours Vending Machine Cafe in Singapore. (Mar. 26, 2020). Accessed: Aug. 12, 2020. [Online Video]. Available: https://www.youtube.com/watch?v=7df3UPmtFZk