VISVESVARAYA TECHNOLOGICAL UNIVERSITY
"Jnana Sangama", Belagavi-590018

PROJECT REPORT
ON

AGILE AUTOMATED STORE MODEL AND APPLIED NAVIGATION USING RFID SYSTEMS

Submitted in partial fulfillment of the requirements of the degree of

BACHELOR OF ENGINEERING
in
INFORMATION SCIENCE & ENGINEERING
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GLOBAL ACADEMY OF TECHNOLOGY

Ideal Homes, Rajarajeshwari Nagar, Bengaluru-560098
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CERTIFICATE

Certified that the Project work entitled **'AGILE AUTOMATED STORE MODEL AND APPLIED NAVIGATION USING RFID SYSTEMS'** is a work carried out by **VIBHUTI BISHT [1GA19IS059],** bonafide students of **Global Academy of Technology, Bengaluru** in partial fulfillment for the award of the degree of Bachelor of Engineering in **Information Science & Engineering** of the **Visvesvaraya Technological University, Belagavi** during the year **2022-2023**. It is certified that all corrections/suggestions indicated for the Internal Assessment have been incorporated in the report deposited in the departmental library. The project Phase-II report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said degree.

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DECLARATION

I, **VIBHUTI BISHT [1GA19IS059],** students of Eighth Semester B.E, Department of Information Science and Engineering, Global Academy of Technology, Rajarajeshwari Nagar Bengaluru, declare that the Project entitled **"AGILE AUTOMATED STORE MODEL AND APPLIED NAVIGATION USING RFID SYSTEMS"** has been carried out by us and submitted in partial fulfilment of the course requirements for the award of degree in **Bachelor of Engineering** in **Information Science and Engineering** from **Visvesvaraya Technological University, Belagavi** during the academic year **2022-23**. The matter embodied in this report has not been submitted to any other university or institution for the award of any other degree.

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Place: Bengaluru
Date: 12/05/2023

ABSTRACT

In the fast-paced world of retail shopping, customer satisfaction is paramount. Traditional checkout systems can be a source of frustration for customers, as each item must be scanned individually, leading to long wait times and unoccupied times feels longer than occupied time. However, the advent of RFID technology has revolutionized the convenience store experience. By replacing cumbersome barcodes with RFID tags, multiple items can now be scanned at once, streamlining the checkout process. RFID readers communicate with RFID tags using radio waves, making it unnecessary for the tag to be in the reader's field of view to be scanned. This innovation has enabled customers to move quickly and efficiently through the store, with the convenience of a one-stop-shop for all their needs. By eliminating the need for time-consuming barcode scanning, the RFID system has significantly reduced wait times, making it possible to keep the line moving even during peak hours. The future of retail shopping is bright, with RFID technology poised to continue driving progress and revolutionizing the shopping experience.

ACKNOWLEDGEMENT

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of the people who made it possible, whose constant guidance and encouragement crowned our effort with success.

We are grateful to our institution, **Global Academy of Technology**, with its ideals and inspirations for having provided us with the facilities, which has made this project a success.

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We would like to express our sincere thanks to our internal guide **Dr. Kiran Y C, Prof. & Head, Department of Information Science & Engineering, GAT**, for his able guidance and valuable advice at every stage, which helped us in the successful completion of the project.

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(1GA19IS059)

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CHAPTER 1

INTRODUCTION

1.1 Overview

A convenience store is a place where merchandise of different categories is housed under the same roof, with interconnected aisles, allowing customers to move easily to different sections. In traditional malls, during checkout, each item is scanned individually and the time for billing increases. In recent years the concept of convenience store has undergone a phase of evolution due to the vital changes in the consumer's lifestyle. Studies show that on an average, customers believe 5-10 minutes is the maximum tolerable amount of time they are willing to wait in the line. Customers feel that unoccupied time feels longer than occupied time. During rush hour it is important to keep the line moving. To drive this process forward, it is recommended to streamline the checkout process.

The existing checkout systems use the concept of Bar-codes which is time consuming. Replacing Barcodes with RFID tags, multiple items can be scanned thereby saving time. Each product in the convenience store is associated with a distinct RFID tag. During billing, when the items are stacked one upon the other and when they are moved over the RFID scanner, it scans all the items at once. When the tag is within range of the reader, the tag automatically sends its EPC code to the reader, which will send it to the database. The tag associated with the product has complete details of it.

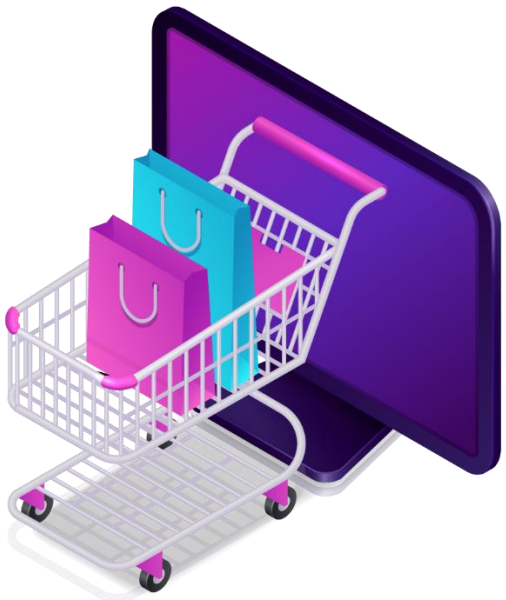

Figure 1.1: Smart shopping cart

1.2 Objectives:

1. The smart navigation feature integrated on the mobile application, to help the user navigate to the coordinates of the shelf through the 2-Dimensional blueprint of the store.
2. Save billing time by scanning multiple items at once when the customer passes the cart via an RFID reader.
3. Billing details to be displayed on the user's mobile application.
4. Gives customers the flexibility to choose the mode of payment as per their convenience.
5. An anti-shoplifting mechanism is to be achieved by placing scanners at exit points of the store which detect unscanned items.

1.3 Motivation

When customers visit a store, they expect a seamless and convenient shopping experience. However, long waiting times at the checkout can significantly impact the customer's overall experience. Studies have shown that customers are willing to wait for a maximum of 5-10 minutes in line. If the waiting time exceeds this limit, it can lead to frustration and dissatisfaction among customers.

Finding products in a convenience store can be tedious and time-consuming. Customers may have to walk through the entire store, trying to locate the products they need. This can result in a frustrating experience for customers, and it can also lead to decreased sales for the store if customers are unable to find the products they need.

Traditional malls often have a checkout process where each item is scanned individually, increasing the time required for billing. This process can lead to long waiting times, which can be frustrating for customers, especially when they are in a hurry or have a busy schedule.

The store owners desire a system that can improve inventory management and reduce the likelihood of theft. RFID tags can provide real-time information on inventory levels, enabling store owners to quickly restock popular products and remove products that are not selling well.

CHAPTER 2

LITERATURE SURVEY

Martinusa et al. [1] discusses a system consisting of a smart shopping cart, a smartphone application, a cashier application, and a database, where people can scan the items themselves and the cashier performs the payment. Each item in the supermarket will have an RFID tag containing the item's identifier and price. The database includes all information about each and every smart cart as well as each and every transaction that the supermarket's system has triggered. Before proceeding to the cashier, the consumer inputs the One Time Password into the web application to obtain the relevant transaction list and finish the checkout process. Some of the advantages are tracking the current location of the cart, self-scanning and simplifying things by a factor of 2. One of the limitations is in the flexibility of payment.

RFID technology is used in study [2] as proposed by Shaikh Farhan Shahnoor et al. to monitor purchased products for billing purposes. The checkout locations can confirm the customer's purchases. It uses an RFID Reader, a Wi-Fi module, and an LCD Screen. The technology has an impact on crowd management and effectively automates billing and saves customers' time. It does not have a phone-based optional app which would further reduce the time and give more customer satisfaction.

The components employed in [3] Thashini Krishna et al. work is, an Arduino Uno, an RFID reader, an RFID tag, and a Bluetooth module. A web-based supermarket management system and an android mobile application that comprises user authentication.

The Arduino, LCD Display, ZigBee, Wi-Fi Module, and RFID Reader are the devices utilized in study [4] proposed by Rahul Chauhan et al. It assists consumers in locating the top offers on well-liked goods. The rating of the product is given according to its popularity and preference. It lacks security safeguards like verification and authentication that the shop and the client may both employ.

An RFID-based Smart Shopping Automation System (SSAS) with an automatic bill calculator is employed in article [5] by F. Piyush Raj Rouniyar et al. All the merchandise in the mall have RFID tags attached, and the exit gate is a location within the mall with a modern RFID reader, LCD displays, sensor equipment, a microcontroller, and a backend server connection for computations. It focuses on saving the customers time and money. It is more trustworthy since it solely focuses on the exit gate.

[6] by Miss. Shubhangi et al. uses RFID Reader, Transmitter and receiver, Power supply, Arduino Nano. It helps in tracking detailed versions of product information. A significant benefit is that it suggests things for customers to purchase based on previous user purchases from a centralized system.

Ng Xin Jie et al. [7] describes the latest and sophisticated RFID technology in order to minimize the theft problem by making use of the tracking technology. It uses RFID to track the necessary information and then transmit it to the host system. Moreover, it aids in the provision of a self-checkout system and provides a payment feature so that customers may pay conveniently. It has been proposed that it can also be used for parking systems in supermarkets.

The product unique identifier is produced by the RFID in [8] by the author, Sakorn Mekruksavanich et al. Server's database is compared to the product identifier that was generated. Furthermore, suggested the promotional materials as a means of assisting customers in making an effective purchase. During the purchasing action, the billing information is updated, and the bill is simultaneously displayed. All the IoT components in the store may easily connect with one another using Zigbee. Also, it offers a comparison button that allows to evaluate all the store's comparable products.

Introduction of a smart queue system defined by Naresh Babu Muppalaneni et al. [9] seeks to cut down waiting times. It also provides a useful means of having a flexible, minimal effort, and extreme framework for assisting with purchasing. It has an LCD display and an RFID reader, which increase the system's security measures. Using information like time, date, and product characteristics, it stores the data in databases in csv format.

In [10] Shreya Kothavale et al. describes shopping recommendations, product search, indoor navigation, and voice-based shopping assistants. Shopping recommendations are based on an a priori algorithm that recommends products to customers based on their valuable shopping history and current items in their shopping cart. Use Bluetooth Low Energy (BLE), Random Forest Regression, and RFID modules. Indoor navigation is supported by Wi-Fi and BLE networks, as traditional GPS services are best suited for outdoor services.

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The author Ruchi Gupte et al. of [11] explains how collaborative clustering can be used to enhance the shopping experience and satisfy client requests. The RFID reader and a Zigbee module used to upload user data are in the trolley. The customer must scan the item once again to remove it. It has been able to identify groups of related products and determine the connection between any two products by utilizing K-Means clustering.

The study [12] by Parameswaran Ramesh et al. discusses the smart trolley, which has an RFID reader, RFID tag, voice board, LCD display, QR online payment scanner, and childcare unit. The major objective of this work is to enhance the RFID-enabled payment process that is used on the trolley. It also concentrates on developing a model for automatic billing by including a daycare center and QR scanner in the shopping cart.

CHAPTER 3

HIGH LEVEL DESIGN

3.1 Existing System

A convenience store is a place where merchandise of different categories is housed under the same roof, with interconnected aisles, allowing customers to move easily to different sections. In traditional malls, during checkout, each item is scanned individually and the time for billing increases. In recent years the concept of convenience store has undergone a phase of evolution due the vital changes in the consumer's lifestyle. Studies show that on average, customers believe 5-10 minutes is the maximum tolerable amount of time they are willing to wait in line. Customers feel that unoccupied time feels longer than occupied time. During rush hour it is important to keep the line moving. To drive this process forward, it is recommended to streamline the checkout process.

The existing checkout systems use the concept of Barcodes which is time consuming. Replacing Barcodes with RFID tags, multiple items can be scanned thereby saving time. Each product in the convenience store is associated with a distinct RFID tag. During billing, when the items are stacked one upon the other and when they are moved over the RFID scanner, it scans all the items at once. When the tag is within range of the reader, the tag automatically sends its EPC code to the reader, which will send it to the database. The tag associated with the product has complete details of it.

One of the main problems for customers in the current system occurs during the identification of the aisle where the product is present. This can be solved by implementing a smart way to navigate to the required aisle.

3.2 Proposed System

The proposed methodology aims at achieving a self-billing and anti-theft mechanism using RFID to assist a person in everyday shopping in terms of reduced time spent while purchasing. The idea of the model starts when the user enters the convenience store. The users have the application installed on their phone which helps in smart navigation within the store. The Application provides a menu for the categories of products to choose from, on selecting a particular category, the navigation feature helps the user navigate to the coordinates of the shelf through the 2-Dimensional blueprint of the store. Each product present in the store has an RFID label associated with it. The RFID label has complete details about the product such as its manufacturer, price, manufacturing, and expiry date.

Customers first authenticate themselves by scanning their membership card on the scanner placed on the cart. They do not need to take items out of the cart and place them on a tracked conveyor belt. Instead, the customers scan the items using the scanners placed on the cart at the time of shopping. The softcopy of the final bill is generated and sent to the mobile application. The user can add/remove products from the list. The application gives the customer the convenience to choose the mode of payment. Once the payment is done using the mobile app, the customer can walk out of the store.

3.3 System Requirements

These are the following requirements for the system:

3.3.1 Software Requirement Specification

A software requirements specification (SRS) is a detailed description of a software system to be developed with its functional and non-functional requirements. The SRS is developed based the agreement between customer and contractors. It may include the use cases of how user is going to interact with software system. The software requirement specification document consistent of all necessary requirements required for project development. To develop the software system, we should have clear understanding of Software system. To achieve this, we need to continuous communication with customers to gather all requirements. A good SRS defines the how Software System will interact with all internal modules, hardware, communication with other programs and human user interactions with wide range of real-life scenarios. Using the SRS document on QA lead, managers create test plan. It is very important that testers must be cleared with every detail specified in this document in order to avoid faults in test cases and its expected results.

3.3.2 Functional Requirements

A functional requirement defines a function of a system or its component, where a function is described as a specification of behaviour between outputs and inputs. Functional requirements may involve calculations, technical details, data manipulation and processing and other specific functionality that define what a system is supposed to accomplish.

A typical functional requirement will contain a unique name and number, a brief summary, and a rationale. This information is used to help the reader understand why the requirement is needed, and to track the requirement through the development of the system.

3.3.3 Non-functional RequirementsA non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviours. They are contrasted with functional requirements that define specific behaviour or functions.

3.3.4 Hardware Requirements

- Components : Arduino UNO, RC522 RFID reader, RFID Tags

3.3.5 Software requirements

- Operating system : Windows 7 and above
- Coding Language : Python, Dart and PHP
- Software : Visual Studio Code or PyCharm
- Server : MySQL server

3.4 System Architecture

System architecture is the conceptual model that defines the structure, behaviour, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviours of the system. System architecture conveys the informational content of the elements consisting of a system, the relationships among those elements, and the rules governing those relationships.

The architectural components and set of relationships between these components that an architecture description may consist of hardware, software, documentation, facilities, manual procedures, or roles played by organizations or people. A system architecture primarily concentrates on the internal interfaces among the system's components or subsystems, and on the interface(s) between the system and its external environment, especially the user.

Various organizations can define systems architecture in different ways, including:

- The fundamental organization of a system, embodied in its components, their relationships to each other and to the environment, and the principles governing its design and evolution.

- A representation of a system, including a mapping of functionality onto hardware and software components, a mapping of the software architecture onto the hardware architecture, and human interaction with these components.
- An allocated arrangement of physical elements which provides the design solution for a consumer product or life-cycle process intended to satisfy the requirements of the functional architecture and the requirements baseline.
- Architecture consists of the most important, pervasive, top-level, strategic inventions, decisions, and their associated rationales about the overall structure (i.e., essential elements and their relationships) and associated characteristics and behaviour.
- A description of the design and contents of a computer system. If documented, it may include information such as a detailed inventory of current hardware, software and networking capabilities; a description of long-range plans and priorities for future purchases, and a plan for upgrading and/or replacing dated equipment and software.

3.5 Data Flow Diagram

A data-flow diagram is a way of representing a flow of a data of a process or a system (usually an information system). The data-flow diagram also provides information about the outputs and inputs of each entity and the process itself. A data-flow diagram has no control flow; there are no decision rules and no loops. Specific operations based on the data can be represented by a flowchart.

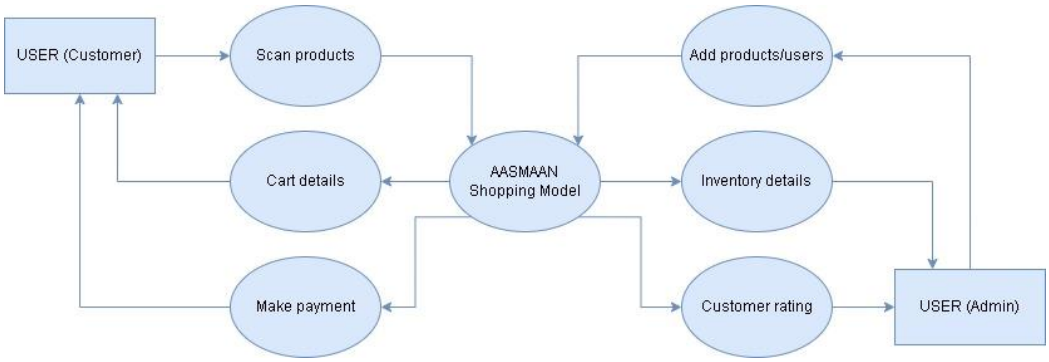


Figure 3.1: Dataflow Diagram

Components:

1) Process:

The process (function, transformation) is part of a system that transforms inputs to outputs. The symbol of a process is a circle, an oval, a rectangle or a rectangle with rounded corners (according to the type of notation). The process is named in one word, a short sentence, or a phrase that is clearly to express its essence.

2) Data Flow:

Data flow (flow, dataflow) shows the transfer of information (sometimes also material) from one part of the system to another. The symbol of the flow is the arrow. The flow should have a name that determines what information (or what material) is being moved. Exceptions are flows where it is clear what information is transferred through the entities that are linked to these flows.

3) Warehouse:

The warehouse (data store, data store, file and database) is used to store data for later use. The symbol of the store is two horizontal lines; the other way of view is shown in the DFD Notation. The name of the warehouse is a plural noun (e.g., orders) - it derives from the input and output streams of the warehouse. The warehouse does not have to be just a data file.

4) Terminator:

The Terminator is an external entity that communicates with the system and stands outside of the system. It can be, for example, various organizations (e.g., a bank), groups of people (e.g., customers), authorities (e.g. a tax office) or a department (e.g. a human-resources department) of the same organization, which does not belong to the model system. The terminator may be another system with which the modelled system communicates.

In the above shown Figure 3.2, the user browses through the category of products in the mobile application and selects the desired category. The application displays the aisle number and rack number where the category is present. The user then scans the membership card given to them during the registration. The user then has to scan the products using the reader placed on the cart. The product details like name, price and

expiry date will be displayed in the application. The user can select the mode of payment and checkout of the store after payment.

CHAPTER 4

LOW LEVEL DESIGN

4.1 System Architecture

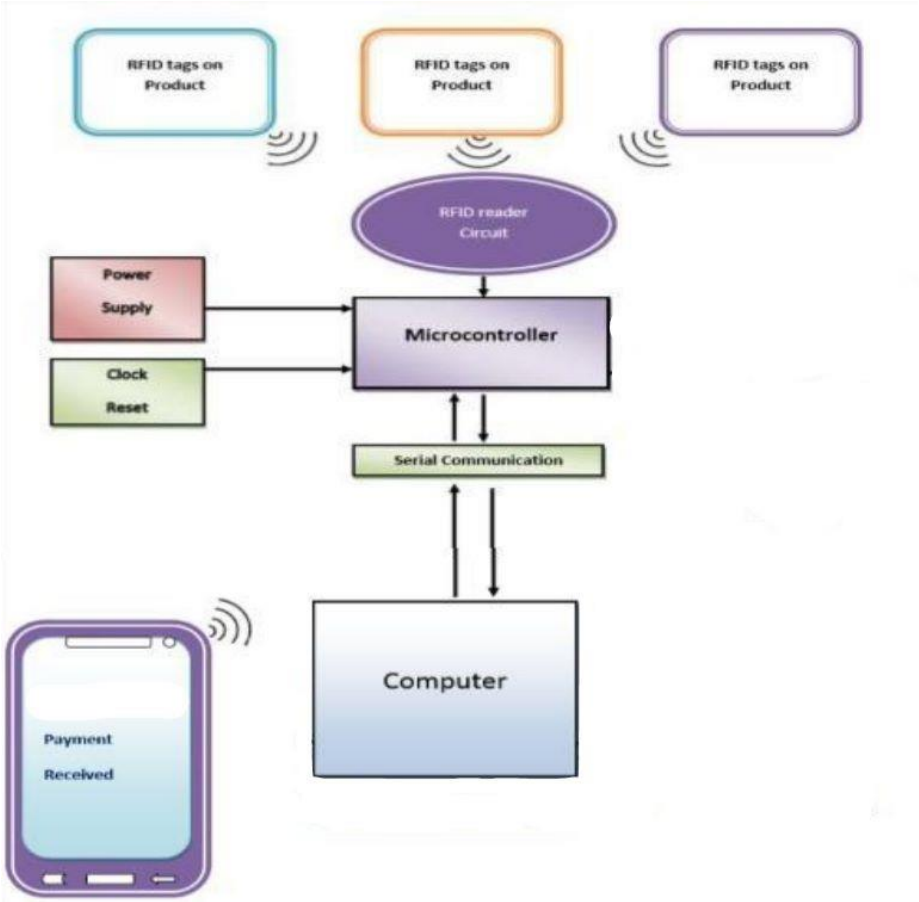


Figure 4.1: System Architecture Diagram

4.1.1 Module-1 (Customer)

Customer begins shopping by scanning his membership card. The customer then scans the products using the RFID scanners placed on the cart. As he scans, the respective database table of the customer gets updated. The database information gets reflected on the user's cart page in the mobile application.

The customer then uses their mobile number and the given password to login to the mobile application. After logging in, the customer is taken to the category page, where they can browse through the various product categories available in the shop. The Homepage displays three most frequently bought items by that customer. Using mobile application

customer, can navigate to the respective aisle and rack number of a product category. When customer scans the product and puts it into the cart the product details are shown on the application. The purchased cart can be customized by the customer if the products must be removed before billing. Customers can check out after payment using the payment gateway. Customers can provide their valuable rating to tell their shopping experience.

4.1.2 Module-2 (Admin)

Admin registers the customer by giving him a unique membership card and a password. A new cart table created for every new customer upon registration. By logging into the mobile app, the admin can access detailed information about the products in the shop. The admin keeps track of product stock, expiry date and user database. The admin is responsible for the smooth working of the entire store. Admin is responsible for adding new categories and products to the system and keep track of the inventory. Admin can view the ratings provided by the customers to further improve their shopping experience.

4.2Data Flow Diagram Level-0

Figure 4.2: Data Flow Diagram Level 0

1. User scans the products.
2. Each user is provided with own cart details.
3. Admin can add a new user or the products.
4. Admin is provided with inventory details.

4.3 Data Flow Diagram Level-1

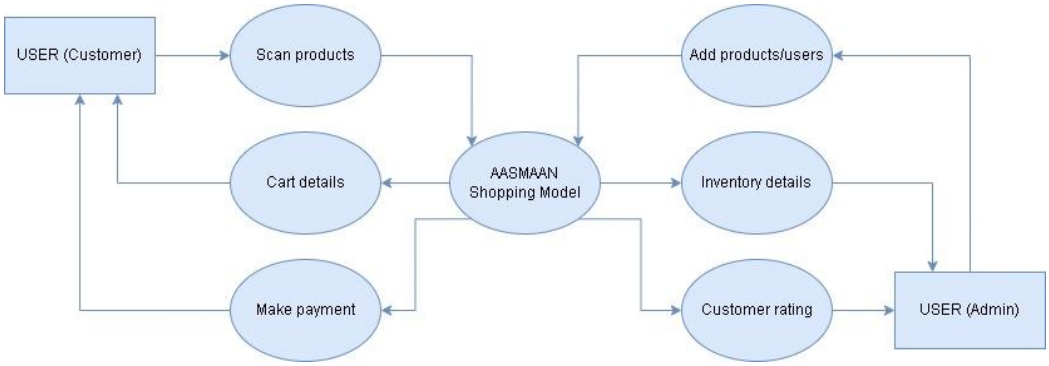


Figure 4.3: Data Flow Diagram Level 1

1. User scans the products and places it in the trolley.
2. User logs in to the mobile application to view the cart details.
3. After the products are placed into the cart the user can choose the payment gateway through mobile application and have easy checkout.
4. Admin can add new users or any product which comes into the store.
5. Admin can see information about the inventory.
6. The admin has access to the customer ratings shown on the mobile application.

4.4 Sequence Diagram

A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development.

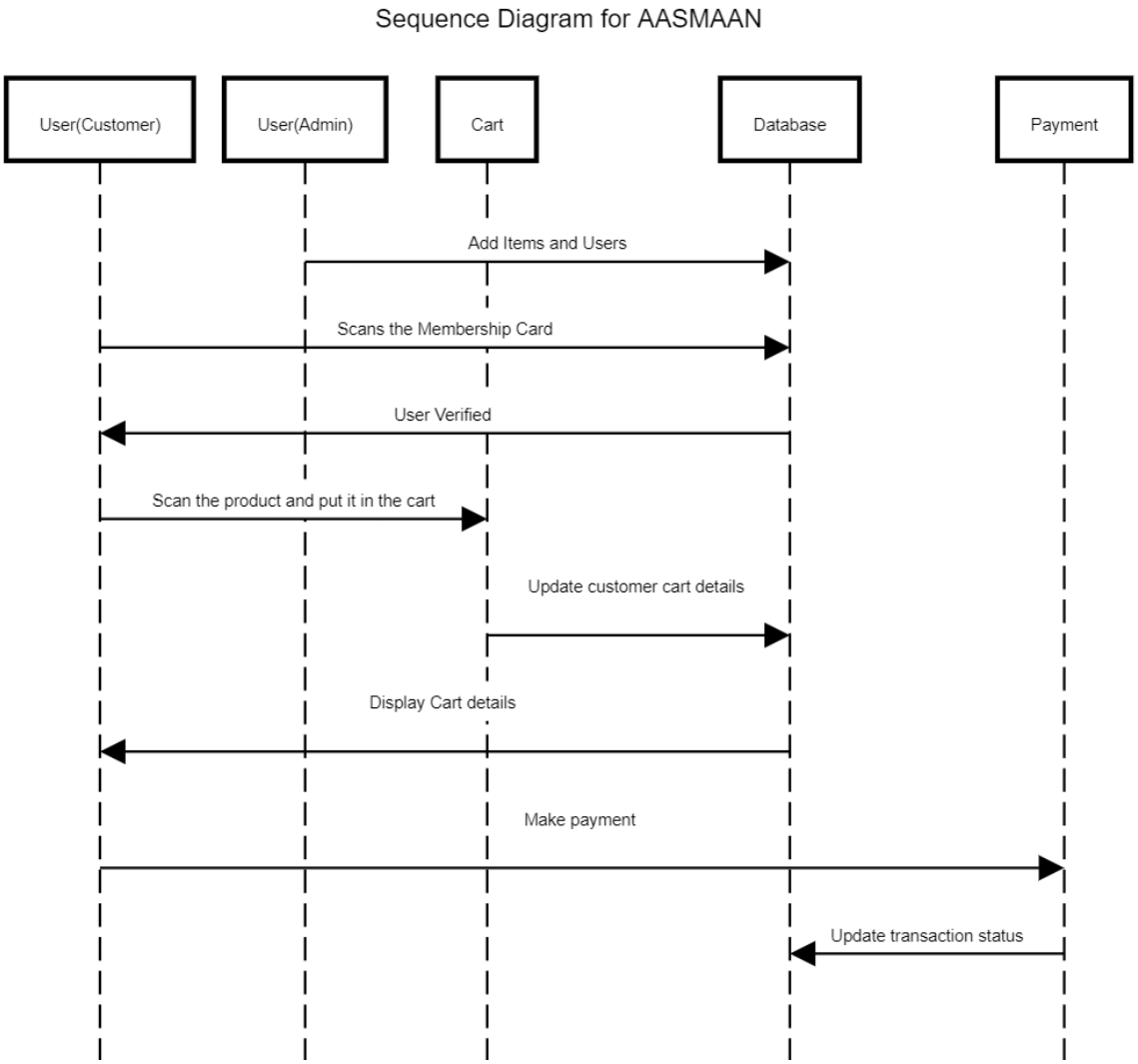


Figure 4.4: Sequence Diagram

1. Admin can add a new user and products which comes to the store.
2. User scans the membership card.
3. The scanners in the shopping cart help users to scan the products.
4. Each user has his own cart details displayed in the mobile application.
5. The cart details are retrieved from the database and displayed.
6. After the products are selected the user can choose the payment gateway.
7. Admin has the information about inventory like product expiry and price.

4.5 Use Case Diagram

A use case diagram at its simplest is a representation of a user's interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. A use case diagram can identify the different types of users of a system and the different use cases and will often be accompanied by other types of diagrams as well. The use cases are represented by either circles or ellipses.

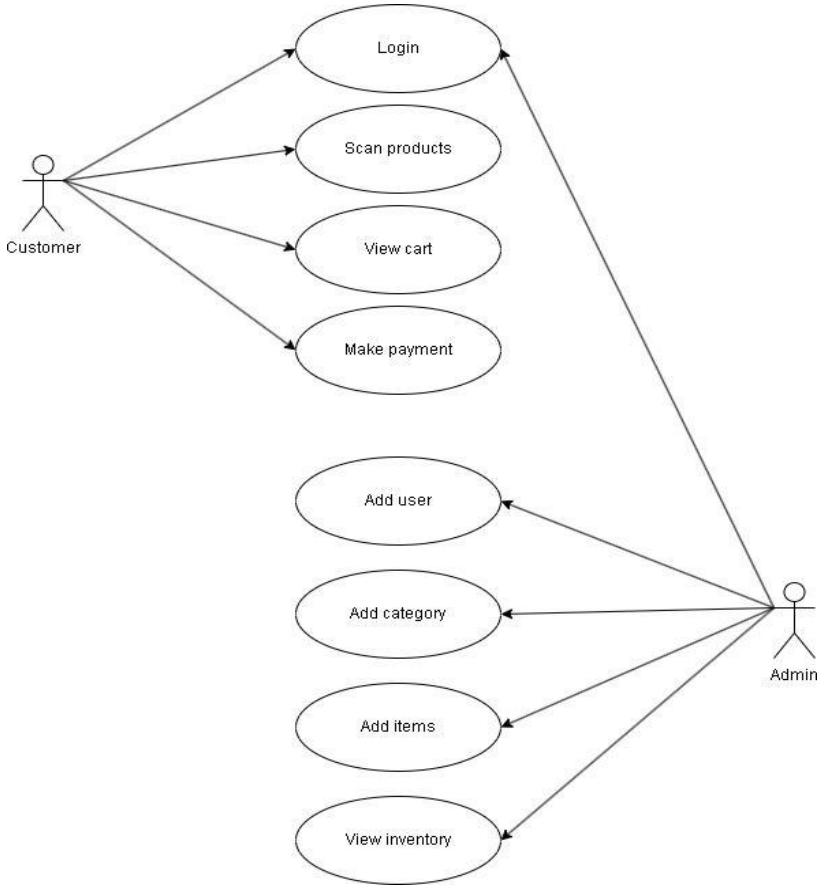


Figure 4.5: Use Case Diagram

The user can perform tasks for actions in a store management system, the admin has the authority to add new users and products to the store's inventory. When a user visits the store, they can scan their membership card using a designated scanner. In the shopping cart, there are scanners available to help users scan the products they wish to purchase. Each user has their own cart details displayed in the mobile application, which are retrieved from the database and displayed to the user. The admin has access to important information about the inventory, such as the product expiry date and price. After the user has selected the desired products, they can choose a payment gateway for the transaction.

CHAPTER 5

IMPLEMENTATION DETAILS

5.1 Domain and Architecture

1) Internet of Things (IoT)

The Internet of Things (IoT) is a network of physical devices, vehicles, buildings, and other objects that are connected to the internet and can exchange data with each other and with other digital systems. IoT devices can range from simple sensors that detect environmental conditions like temperature and humidity, to more complex devices like medical equipment and autonomous vehicles.

IoT is transforming the way we interact with the world around us, enabling new levels of automation, efficiency, and innovation across a wide range of industries.

In the manufacturing industry, IoT sensors can be used to monitor equipment performance and detect potential problems before they occur, reducing downtime and improving overall efficiency. In the healthcare industry, IoT-enabled medical devices can collect patient data and transmit it to healthcare providers in real-time, enabling faster and more accurate diagnoses and treatment plans.

IoT also has the potential to transform the way we live and work on a more personal level. For example, smart homes equipped with IoT-enabled devices like thermostats, lighting systems, and security cameras can be controlled remotely through mobile applications, making it easier to manage and monitor home systems from anywhere.

Advantages of IoT:

1. Personalized shopping experiences: IoT sensors can collect data on customer behaviour and preferences, allowing retailers to offer personalized recommendations and promotions based on each customer's individual interests and buying history.
2. Improved inventory management: IoT sensors can track inventory levels in real-time, enabling retailers to better manage their stock levels and reduce waste.
3. Enhanced customer service: IoT-enabled devices like smart mirrors and interactive kiosks can provide customers with personalized product recommendations and information, and enable them to easily make purchases from anywhere in the store.

4. Increased efficiency: IoT sensors can automate many routine tasks in the shopping process, such as checkout and restocking, allowing store employees to focus on providing better customer service.
5. Reduced costs: IoT devices can help retailers optimize their supply chain operations and reduce costs associated with inventory management and order fulfilment.
6. Better product tracking: IoT sensors can track the location of products within a store or warehouse, making it easier to locate and retrieve items quickly.

2) Mobile Application Development

Flutter is an open-source mobile application development framework created by Google that allows developers to build natively compiled applications for mobile, web, and desktop from a single codebase. Flutter uses the Dart programming language, which is a client-optimized language for fast development and execution.

With Flutter, developers can build high-performance, visually appealing, and responsive applications with a faster development cycle. Flutter offers a rich set of customizable widgets that can be used to build beautiful user interfaces, and the framework provides a hot reload feature that allows developers to see the results of their code changes instantly. Flutter also offers features like built-in animations and easy integration with other platforms like Firebase, which simplifies app development and improves app functionality. Furthermore, Flutter is highly customizable and can be easily integrated with other programming languages and third-party tools.

Mobile Application development is being used today in a wide variety of real-world applications, which include:

- E-commerce: Mobile applications are used to provide customers with easy access to online stores, product, and payment gateways.
- Transportation: Mobile applications are used for booking rides, tracking and monitoring vehicles, and facilitating payments.
- Healthcare: Mobile applications are used for monitoring patient health, providing telemedicine services, and managing electronic health records.
- Education: Mobile applications are used for providing access to online courses, study materials, and educational games.

- Entertainment: Mobile applications are used for gaming, streaming video and music, and social media.
- Banking and finance: Mobile applications are used for managing personal finances, budgeting, and online banking services.
- Social networking: Mobile applications are used for connecting people with similar interests, sharing photos and videos, and communicating with friends and family.

5.2 Requirements Planning

5.2.1 Tools

1) Arduino IDE

The Arduino Integrated Development Environment (IDE) is a software application used to program Arduino boards. Arduino boards are microcontrollers that can be programmed to control a wide range of electronic devices and systems.

The Arduino IDE provides a user-friendly interface for writing, compiling, and uploading code to the Arduino board. It is available for Windows, Mac, and Linux operating systems and can be downloaded for free from the Arduino website.

The IDE is based on the Processing programming language and uses a simplified version of the C++ programming language. It also includes a number of built-in libraries and functions that can be used to control various sensors, motors, and other electronic components.

The Arduino IDE allows users to write and test code in a simulated environment before uploading it to the Arduino board. This can help to identify and correct errors before running the code on the physical board.

Overall, the Arduino IDE is a powerful and user-friendly tool for programming Arduino boards, making it a popular choice among hobbyists, students, and professionals alike.

2) VS Code

The Visual Studio integrated development environment is a creative launching pad that you can use to edit, debug, and build code, and then publish an app. An integrated development environment (IDE) is a feature-rich program that can be used for many aspects of software development. Over and above the standard editor and debugger that most IDEs provide, Visual Studio includes compilers, code completion tools, graphical

designers, and many more features to ease the software development process. Visual Studio offers a suite of tools that enable you to easily create cloud-enabled applications powered by Microsoft Azure which can be used to configure, build, debug, package, and deploy applications and services on Microsoft Azure directly from the IDE.

4.2.2 Libraries

1. Flutter Material Design (material.dart):This library provides pre-built widgets and components that implement the Material Design guidelines for mobile applications.

2. Flutter Widgets (widgets.dart): This library provides a wide range of basic widgets for building user interfaces in Flutter, including buttons, text fields, images, and more.

3. Dart SDK: The core library for Dart, the programming language used in Flutter. It includes many basic tools and features for building app logic and managing state.

4. HTTP: A library that provides tools for making HTTP requests and working with RESTful APIs in Flutter.

5. Secure Storage: It is a library that allows developers to store sensitive information securely on the device. It provides a simple key-value store interface for storing and retrieving data securely, and uses platform-specific encryption algorithms to protect the data from unauthorized access.

6. MFRC522: This library provides support for the popular MFRC522 RFID reader module. It allows you to read and write to MIFARE Classic tags and cards.

5.3 Programming Resources

5.3.1 Source Code for Module-1: User

```
import 'dart:ffi';

import 'package:flutter/material.dart';

import 'package:fluttertoast/fluttertoast.dart';

import 'package:google_fonts/google_fonts.dart';

import 'package:groceryapp/pages/feedback.dart';

import 'package:groceryapp/pages/fruitspage.dart';
```

```
import 'package:groceryapp/pages/login.dart';
import 'makeuppage.dart';
import 'cart.dart';
import 'package:flutter_secure_storage/flutter_secure_storage.dart';
import 'package:url_launcher/url_launcher.dart';
import 'package:url_launcher_platform_interface/url_launcher_platform_interface.dart';

class HomePage extends StatefulWidget {
  const HomePage({
    Key? key,
  }) : super(key: key);
  @override
  State<StatefulWidget> createState() {
    return _HomePageState();
  }
}

class _HomePageState extends State<HomePage> {
  final List<Map<String, dynamic>> _allCategories = [
    {
      "image": "lib/images/fruits.png",
      "category_id": 1,
      "category_name": "Fruits & Vegetables",
      "aisle_no": 1,
```

```
  "rack_no": 2,
  "page": FruitsPage()
},
{
  "image": "lib/images/makeup.png",
  "category_id": 2,
  "category_name": "Makeup & Skincare",
  "aisle_no": 1,
  "rack_no": 4,
  "page": MakeupPage()
},
{
  "image": "lib/images/chicken.png",
  "category_id": 3,
  "category_name": "Chicken & Eggs",
  "aisle_no": 2,
  "rack_no": 1,
  "page": MakeupPage()
},
{
  "image": "lib/images/water.png",
  "category_id": 4,
  "category_name": "Beverages",
  "aisle_no": 2,
```

```
    "rack_no": 5,
    "page": MakeupPage()
  },
];
List<Map<String, dynamic>> _initial = [
  {
    "image": " ",
    "category_id": " ",
    "category_name": "Search category",
    "aisle_no": " ",
    "rack_no": " ",
    "page": HomePage()
  }
];
List<Map<String, dynamic>> _foundCategories = [];
@override
initState() {
  _foundCategories = _initial;
  super.initState();
}

void _runFilter(String enteredKeyword) {
  List<Map<String, dynamic>> results = [];
  if (enteredKeyword.isEmpty) {
```

```
    results = _initial;
  } else {
    results = _allCategories
        .where((category) => category["category_name"]
            .toLowerCase()
            .contains(enteredKeyword.toLowerCase()))
        .toList();
  }
  setState(() {
    _foundCategories = results;
  });
 }
 Future<void> _launch(String url) async {
  await canLaunchUrl(Uri.parse(url))
      ? await launchUrl(Uri.parse(url))
      : Fluttertoast.showToast(msg: 'could_not_launch_this_app');
 }
final scaffoldKey = GlobalKey<ScaffoldState>();
```

5.3.2 Source Code for Module-2

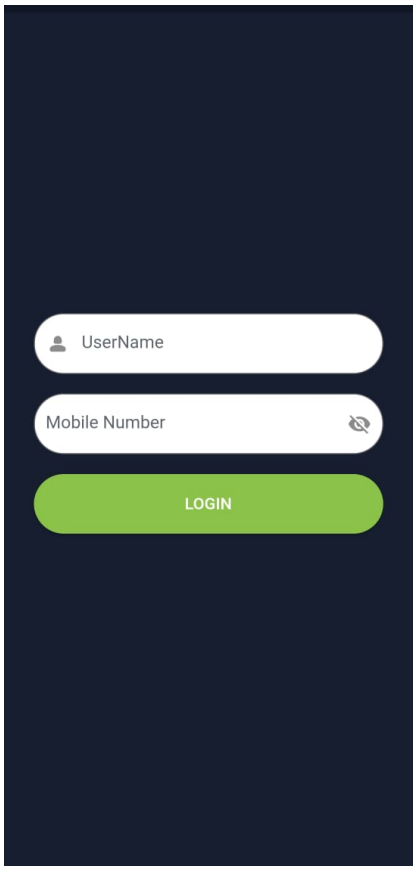
```
import mysql.connector
import serial
mydb = mysql.connector.connect(host="localhost", user="root", password="password", database="project_data")
mycursor = mydb.cursor()
```

```
def execQuerry1(str,n,p,phno):
    sql = """INSERT INTO admins VALUES
("{0}","{1}","{2}","{3}")""".format(str,n,p,phno)
    mycursor.execute(sql)
    mydb.commit()
ser = serial.Serial('COM3', 9600)
def obtainContents1(contentString):
        contents = contentString.split("UID:")
        contents = contents[-1].strip()
        print(contents)
        return contents
def execQuerry2(str,ph,n,p):
    sql = """INSERT INTO customers(cuid,cnumber,cname,cpass)  VALUES
("{0}","{1}","{2}","{3}")""".format(str,ph,n,p)
    sql2="""CREATE TABLE cust_{0}(pid varchar(20) primary key, FOREIGN KEY
(pid) REFERENCES products(pid))""".format(ph)
    mycursor.execute(sql)
    mycursor.execute(sql2)
    mydb.commit()
def obtainContents2(contentString):
        contents = contentString.split("UID:")
        contents = contents[-1].strip()
        print(contents)
        return contents
```

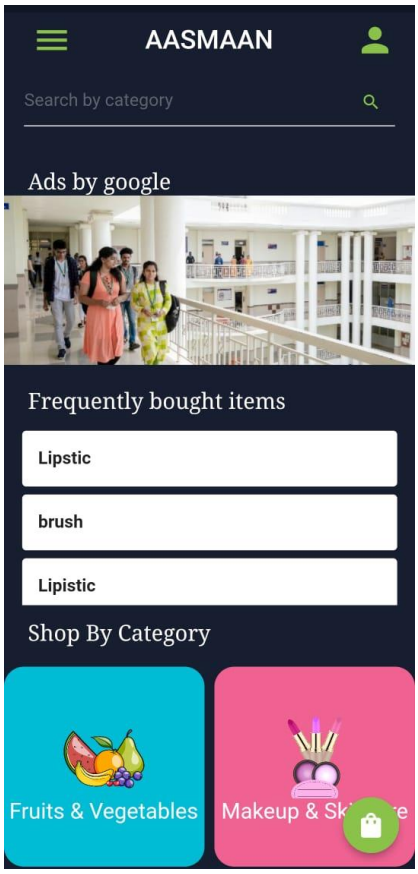
CHAPTER 6

EXPERIMENTAL RESULTS

6.1 Module-1 Snapshots

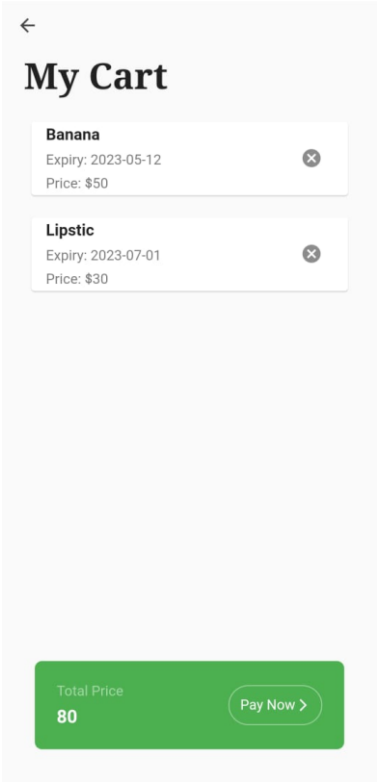


Snapshot 6.1: Customer Login Page

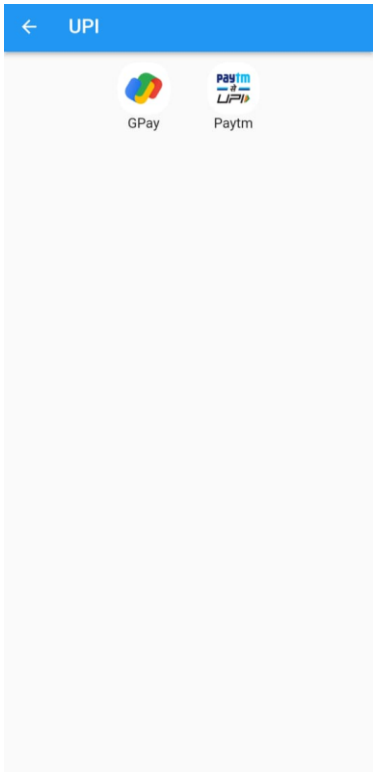


Snapshot 6.2: Homepage

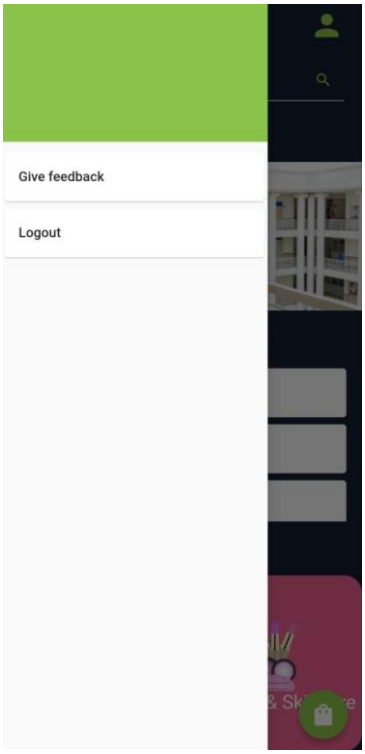
Snapshot 6.3: Navigation Page



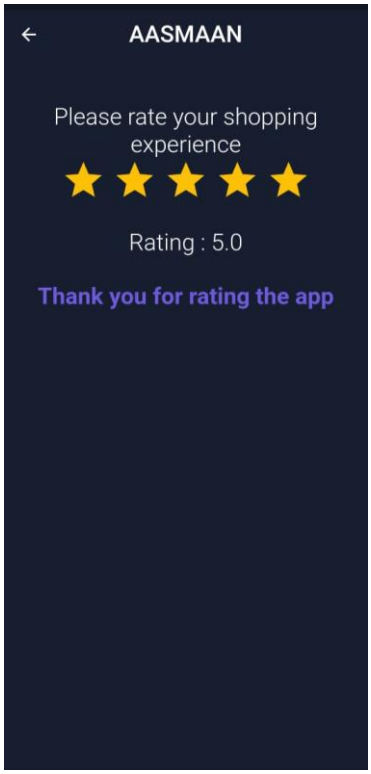
Snapshot 6.4: Cart Page



Snapshot 6.5: Payment Gateway



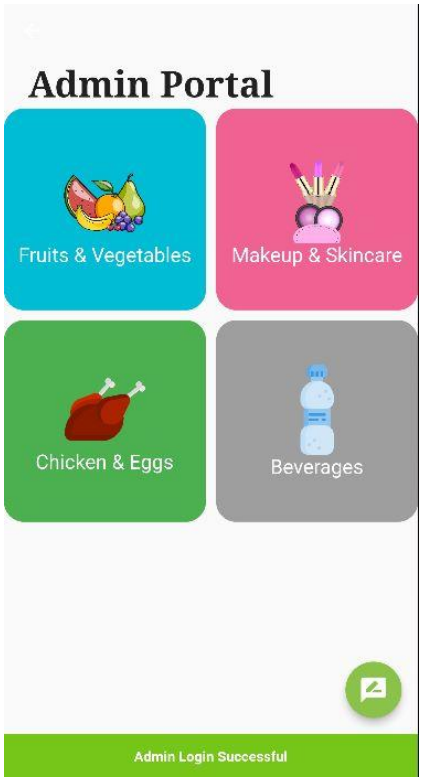
Snapshot 6.6: Feedback and Logout Option



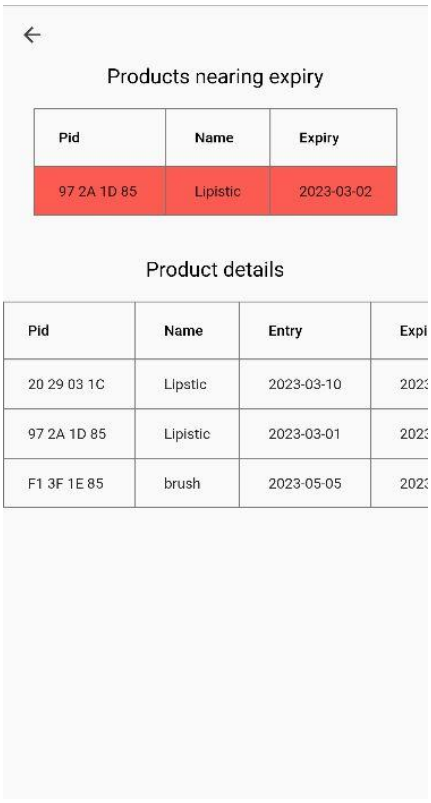
Snapshot 6.7: Rating Page

Figure 6.1: Shopping Trolley

6.2 Module-2 Snapshots



Snapshot 6.8: Admin Homepage



Snapshot 6.9: Product Details Page

Snapshot 6.10: Customer Review Page

CHAPTER 7

TESTING

7.1 Software Testing

Software Testing is a process of evaluating the functionality of a software application to find any software bugs. It checks whether the developed software met the specified requirements and identifies any defect in the software in order to produce a quality product. It is basically executing a system in order to identify any gaps, errors, or missing requirements in contrary to the actual requirements. Software testing is now a very significant and integral part of software development. Ideally, it is best to introduce software testing in every phase of software development life cycle. A majority of software development time is now spent on testing. It is also stated as the process of verifying and validating a software product. It checks whether the software product:

- Meets the business and technical requirements that guided its design and development
- Works as per the requirement
- Can be implemented with the same characteristics

7.1.1 Principles of Software Testing

Testing of software is exceptionally imaginative and an intellectual task for testers to perform. Testing of software or applications consist of some principles that play a significant role for a software tester while testing the project.

The Principles of Software Testing are as follows:

a) **Software testing can help in detecting bugs**: Testing any software or project can help in revealing a few or some defects that may or may not be detected by developers. However, testing of software alone cannot confirm that your developed project or software is error free. Hence, it's essential to devise test cases and find out as many defects as possible.

b) **Testing with effectiveness is impossible**: Until your project or application under test has a straightforward structure having limited input, it won't be likely or achievable to check and test all feasible sets of data, modules, and scenarios.

c) **Early testing**: The earlier you will begin to test your project or software the better you will find to utilize your existing time.

d) **Defect in clustering**: At the time of testing, you can observe that majority of the defects or bugs reported are because of a small number of modules inside your software or system.

e) **Software testing is context-dependent**: Various methods, procedures, and kinds of testing are there which defines the type and characteristics of the application. For example, an application related to health device needs more testing and doctor-based feedbacks than a game or small software.

f) **Error free or Bug-free software is a myth**: Just because when a tester tested an application and didn't detect any defects in that project, doesn't indicate or imply that your software is ready for shipping.

7.2 TYPES OF TESTING

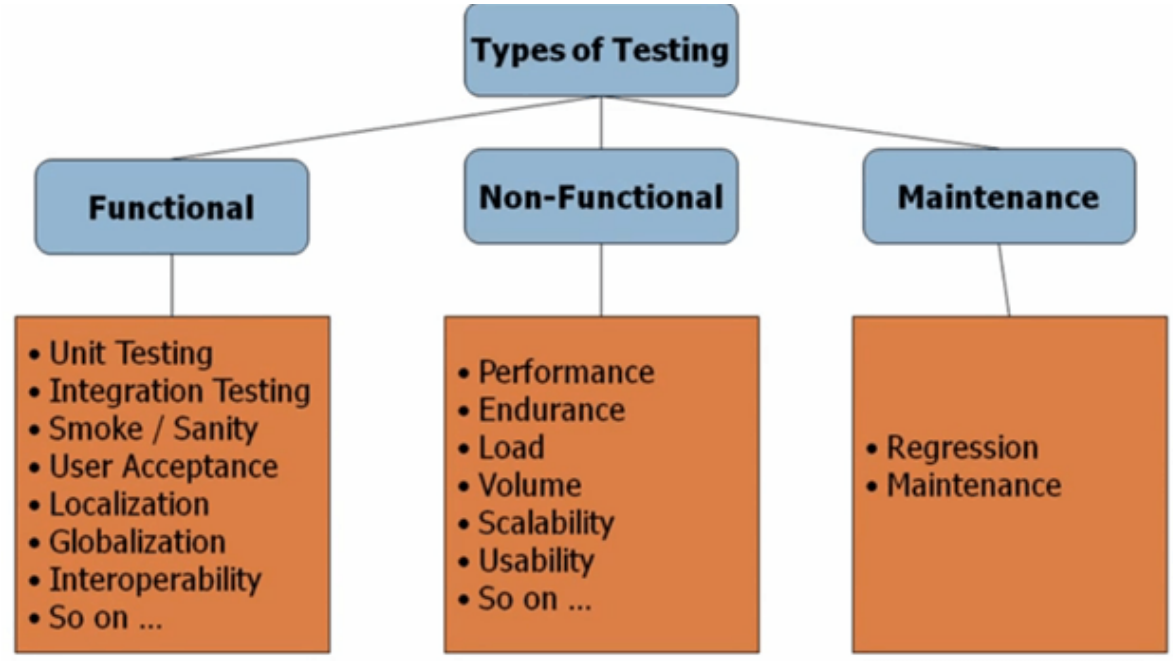


Figure 7.1: Types of Testing

a) **UNIT TESTING:** Testing of an individual software component or module is termed as Unit Testing. It is typically done by the programmer and not by testers, as it requires detailed knowledge of the internal program design and code. It may also require developing test driver modules or test harnesses.

b) **USABILITY TESTING:** Under Usability Testing, User-friendliness check is done. The application flow is tested to know if a new user can understand the application easily or not, Proper help documented if a user gets stuck at any point. Basically, system navigation is checked in this testing.

c) **INTEGRATION TESTING:** Testing of all integrated modules to verify the combined functionality after integration is termed as Integration Testing. Modules are typically code modules, individual applications, client and server applications on a network, etc. This type of testing is especially relevant to client/server and distributed systems.

d) **SYSTEM TESTING:** Under System Testing technique, the entire system is tested as per the requirements. It is a Black-box type Testing that is based on overall requirement specifications and covers all the combined parts of a system.

e) **REGRESSION TESTING:** Testing an application as a whole for the modification in any module or functionality is termed as Regression Testing. It is difficult to cover all the system in Regression Testing, so typically Automation Testing Tools are used for these types of testing.

f) **RECOVERY TESTING:** It is a type of testing which validates how well the application or system recovers from crashes or disasters. Recovery Testing determines if the system is able to continue the operation after a disaster.

g) **PERFORMANCE TESTING:** This term is often used interchangeably with ‘stress' and ‘load' testing. Performance Testing is done to check whether the system meets the performance requirements. Different performance and load tools are used to do this testing.

h) **SECURITY TESTING:** It is a type of testing performed by a special team of testers. A system can be penetrated by any hacking way.Security Testing is done to check how the software or application or website is secure from internal and external threats. This testing includes how much software is secure from the malicious program, viruses and how secure and strong the authorization and authentication processes are. It also checks how software behaves for any hackers attack and malicious programs and how software is maintained for data security after such a hacker attack.

i) **LOAD TESTING**: It is a type of Non-Functional Testing and the objective of Load Testing is to check how much load or maximum workload a system can handle without any performance degradation. Load Testing helps to find the maximum capacity of the system under specific load and any issues that cause software performance degradation. Load testing is performed using tools like JMeter, LoadRunner, Web Load, Silk performer, etc.

7.3 Test Cases

7.3.1 Module-1

Sl no	Input (Customer)	Expected Result	Actual Result	Correctness
1.	User Membership card	User Identified	User Identified	Yes
2.	Scan product	Product Scanned	Product Scanned	Yes
3.	User Login (Wrong Credentials)	Wrong Credentials	Wrong Credentials	Yes

4.	User Login (Valid Credentials)	User Logged in	User Logged in	Yes
5.	Click on Profile Icon	Display Profile Details	Not Displaying	No
6.	Click on Cart Icon (MySQL server off)	Display Cart Details	Does not display Cart Details	No
7.	Click on Cart Icon (MySQL server on)	Display Cart Details	Display Cart Details	Yes
8.	Select Category (MySQL server off)	Display Aisle and Rack Number	Does not display Aisle and Rack Number	No
9.	Select Category (MySQL server on)	Display Aisle and Rack Number	Display Aisle and Rack Number	Yes
10.	Search Category in Search Bar	Category Found	Category Found	Yes
11.	Click on Pay	No UPI Apps Installed	No UPI Apps Installed	Yes
12.	Click on Pay	Display UPI Apps	Display UPI Apps	Yes
13.	Draw Sidebar	Open Sidebar	Open Sidebar	Yes
14.	Rating	Update Rating	Update Rating	Yes

15.	Click on Logout	User Logged Out	User Logged Out	Yes

Table 7.1: Tests for module 1

7.3.2 Module-2

Sl no.	Input (Admin)	Expected Result	Actual Result	Correctness
1.	Select Add Customer	Customer Registered Successfully	Customer Registered Successfully	Yes
2.	Add Category	Category Added	Category Added	Yes
3.	Add Product	Product Added	Product Added	Yes
4.	Admin login (Wrong credentials)	Wrong Credentials	Wrong Credentials	Yes
5.	Admin Login (Valid credentials)	Admin Logged in	Admin Logged in	Yes
6.	Select Category (MySQL server off)	Display available products and products nearing expiry	Does not display available products and products nearing expiry	No
7.	Select Category (MySQL server on)	Display available products and products nearing expiry	Display available products and products nearing expiry	Yes

8.	Click on Rating Button (MySQL server off)	Display Customer Rating	Does not display Customer Rating	No
9.	Click on Rating Button (MySQL server on)	Display Customer Rating	Display Customer Rating	Yes
10.	Click on Logout	Admin Logged Out	Admin Logged Out	Yes

Table 7.2: Tests for module 1

CHAPTER 8

COST ANALYSIS

8.1 COST ANALYSIS

Parameters	MFRC522	M6E Nano
		
1) Cost	Rs. 100.00	Rs. 17,000
2) Average scanning time (in ms)	20 ms per tag	2 ms per tag
3) Performance	• Shorter read range • Less efficient in scanning multiple tags.	• Accurate and reliable • Resistant to interference from other electronic devices.

Table 8.1: Cost Analysis

8.2 RELEVANCE OF APPLICATION

1. **Improved Customer Satisfaction:** In the fast-paced world of retail, customer satisfaction is crucial. Traditional checkout systems that rely on individual barcode scanning can be frustrating for customers due to long wait times. By implementing RFID technology, multiple items can be scanned simultaneously, reducing wait times and enhancing the overall shopping experience.

2. **Streamlined Checkout Process:** RFID tags replace cumbersome barcodes, enabling the scanning of multiple items at once. This streamlines the checkout process and eliminates the need for manual scanning of each item individually. As a result,

customers can move quickly through the store, minimizing their waiting time and improving efficiency.

3. **Non-Line-of-Sight Scanning:** RFID readers communicate with RFID tags using radio waves, eliminating the requirement for the tag to be in the reader's field of view. This feature allows for efficient scanning, as items can be quickly recognized and processed without the need for precise alignment or direct visibility. It simplifies the scanning process for both customers and store staff.

4. **Reduced Wait Times:** By eliminating the time-consuming process of barcode scanning, RFID technology significantly reduces wait times at the checkout counter. Even during peak hours, the system enables a steady flow of customers, preventing long queues and enhancing overall customer satisfaction.

5. **Navigation:** In store management, an important task is assigning specific locations to products. Administrators use a 2D model with aisles represented on the X-axis and racks on the Y-axis. Factors like product categories, popularity, and accessibility are considered to strategically assign aisles and racks for each item. When a user wants to find a specific product, they initiate a search and the system provides the aisle and rack information. This helps users navigate the store more easily and locate the desired item.

CHAPTER 9

CONCLUSION

In conclusion, the proposed mobile application for customers and store administrators provides an innovative and seamless shopping experience. By offering a user-friendly interface with detailed product information and smart navigation features, customers can easily locate and purchase their desired products with minimal effort. The inclusion of a rating feature and personalized product recommendations enhances the overall shopping experience and encourages customer loyalty. Additionally, the inventory management feature streamlines the store's operations, ensuring the availability of fresh and high-quality products. Overall, the proposed system's implementation is an excellent example of how technology can improve traditional business models and enhance the customer experience. As the retail industry continues to evolve, it is vital to embrace innovative solutions like this mobile application to remain competitive and offer customers the best shopping experience possible. With continued development and refinement, this system has the potential to revolutionize the way we shop and interact with retail stores.

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APPENDIX:

PUBLICATIONS

REVIEW PAPER

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A Survey on RFID Based Smart Shopping System and Automated Billing

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Abstract - *In traditional malls, during checkout each item is scanned individually, this increases the time for billing. In recent years the concept of convenience store has undergone a phase of evolution due to the vital changes in the consumer's lifestyle. Studies show that on an average, 5-10 minutes is the maximum tolerable amount of time customers are willing to wait in line. Customers feel that unoccupied time feels longer than occupied time. The existing checkout systems use Bar-codes. Replacing Bar-codes with RFID tags, multiple items can be scanned thereby saving time. Radio Frequency Identification System (RFID) concept uses communicating with the RFID tag at different frequencies. RFID readers communicate with RFID tags using radio waves. Therefore, it is not necessary that the tag is in the reader's field of view to be scanned. The aim of this survey is to create a design for a smart shopping cart based on RFID technology.*

Key Words: Radio Frequency Identification (RFID) reader, RFID tags, Barcodes, flutter application.

1.INTRODUCTION

The advancement in technology makes use of the concept of sensors. This is the underlying notion in IoT in which the data can be sent from one place to another in no time with the help of Internet. Earlier, RFIDs were used in warehouse management. RFID has led to a refinement in information technology that has profoundly altered people's lives. RFIDs have a much more complex mechanism than barcodes which provide more security. RFIDs possess the advantage of reusing it thereby saving money. So, tagging each item with an RFID and scanning it while shopping, speeds up the entire process and therefore eradicating queues.

RFID has an edge over standard barcodes. This is owing to a severe drawback of line-of-sight technology as well as the short lifespan of these barcode tags. RFID tags, on the other hand, are resistant to tampering and can read and write encrypted data. These tags can store large amounts of data, such as product information like unique product identifier, product name, price, and expiry date.

RFID can locate and track tags affixed to things using electromagnetic waves. An RFID system can be identified in three parts: a transceiver, a scanning antenna, and a transponder. An RFID reader or interrogator is produced when the scanning antenna and transceiver are joined. The transponder is present on the body of the RFID tag. There are two distinct types of tags: Active and Passive.

An active RFID tag has its own power source, which is often a battery. Electromagnetic waves from the reading antenna generates a current in the passive RFID tag's antenna, energizing the tag.

Attempting to read many tags at once may result in signal collision and finally data loss. At an extra cost, anti-collision techniques can be employed to prevent this. These techniques, which seek to minimize overall read time while increasing the number of tags read concurrently, are still under development.

The overall problem of RFID collisions may be divided into two categories:

1. When a reader tries to interact with tags that are in another reader's seeing range, a reader collision occurs.

Signal interference occurs when the fields of two or more readers interact and overlap with each other. By setting each reader's reading schedule to occur at a little different time, this problem can be solved.

2. Multiple reads of the same tag occur when it is read by each overlapping reader more than once.

In a normal store, the products are placed in different shelves and racks. Keeping track of these in-memory would be a hectic task. By storing all this information in the database can decrease the work for the in-house associates. Taking a 2-Dimensional map of the entire store, the coordinates of the products can be marked by the respective aisle number and the rack number they are present in.

Due to numerous utilities, smartphones have become an indispensable part of our lives. Google's Flutter software development kit is a tool that helps in developing native cross-platform (Android and iOS) applications using one programming language and one code base.

2. OBJECTIVES OF THE SURVEY

1. Identify and describe the key technologies, components and architectures employed in RFID-based smart shopping and automated billing systems.

2. Review the advantages and shortcomings of RFID-based smart billing and shopping systems, considering how they impact consumer satisfaction, operational efficacy, and cost-effectiveness.

3. Analysis and contrast different strategies and solutions for RFID-based smart shopping and payment systems.

3. LITERATURE REVIEW

Martinusa et al. [1] discusses a system consisting of a smart shopping cart, a smartphone application, a cashier application, and a database, where people can scan the items themselves and the cashier performs the payment. Each item in the supermarket will have an RFID tag containing the item's identifier and price. The database includes all information about every smart cart as well as each transaction that the supermarket's system has triggered. Before proceeding to the cashier, the consumer inputs the One Time Password (OTP) into the web application to obtain the relevant transaction list and finish the checkout process. Some of the advantages are tracking the current location of the cart, self-scanning and simplifying things by a factor of 2. One of the limitations is in the flexibility of payment.

RFID technology is used in study [2] as proposed by Shaikh Farhan Shahnoor et al. to monitor purchased products for billing purposes. The checkout locations can confirm the customer's purchases. It uses an RFID Reader, a Wi-Fi module and an LCD Screen. The technology has an impact on crowd management, effectively automates billing and saves customers' time. It does not have a phone-based optional application which would further reduce the time escalate customer satisfaction.

The components employed in [3] Thashini Krishna et al. work is, an Arduino Mega, an RFID reader, an RFID tag and a Bluetooth module. It implements an autonomous cart that can move without being pushed using multiple ultrasonic sensors. The scanning is incorporated into the shopping cart itself, and the scanned items are sent via a Wi-Fi module to a computer installed in the supermarket. The significant benefit of using an automated cart is that customers can quickly navigate through the cash counter and check out themselves.

The Arduino, LCD Display, ZigBee, Wi-Fi Module, and RFID Reader are the devices utilized in study [4] proposed by Rahul Chauhan et al. It assists consumers in locating the top offers on well-liked goods. The rating of a product is given according to its popularity and preference. It lacks security safeguards such as verification or authentication that the shop and the client may both employ.

An RFID-based Smart Shopping Automation System (SSAS) with an automatic bill calculator is employed in article [5] by F. Piyush Raj Rouniyar et al. All the merchandise in the mall have RFID tags attached, and the exit gate is a location within the mall with a modern RFID reader, LCD displays, sensor equipment, a microcontroller, and a backend server connection for computations. It focuses on saving the customers time and money. It is more trustworthy since it solely focuses on the exit gate.

[6] By Miss. Shubhangi et al. uses RFID Reader, Transmitter and receiver, Power supply, and Arduino Nano. The recommended system helps in tracking detailed versions of product information and gives product suggestions based on the user's purchase history from a centralized system. Total bill details are transferred to the personal computer (PC) at the checkout counter, through wireless transmitter and receiver modules. This futuristic approach cultivated in this project is echo friendly as it eliminates usage of paper.

Ng Xin Jie et al. [7] describes the latest and sophisticated RFID technology in order to minimize the theft problem by making use of the tracking mechanisms. It uses RFID to track the relevant information and then transmit it to the host system. Moreover, it aids in the provision of a self-checkout system and provides a payment feature so that customers may pay conveniently. It has been advised that it can also be used in supermarket parking systems.

The product unique identifier produced by the RFID in [8] by the author, Sakorn Mekruksavanich et al. Server's database is compared to the product identifier that was generated. Furthermore, the promotional materials are a means of assisting customers in making an effective purchase. During the purchasing action, the billing information is updated, and the bill is simultaneously displayed. All the IoT components in the store may easily connect with one another using Zigbee. Also, it offers a comparison button to rate all comparable products on the store.

Introduction of a smart queue system defined by Naresh Babu Muppalaneni et al. [9] seeks to cut down waiting times. It also provides a useful means of having a flexible, minimal fuss and extreme framework for convenient means of purchasing support. It features an LCD display and an RFID reader to enhance the system's security measures. With information like time, date, and product characteristics, it stores the data in database in .csv (comma-separated values) format.

In [10] Shreya et al. describes shopping recommendations, product search, indoor navigation, and voice-based shopping assistants. Shopping recommendations are based on Apriori algorithm that recommends products to customers based on their valuable shopping history and current items in their shopping cart. Use Bluetooth Low Energy (BLE), Random Forest Regression, and RFID modules. Indoor navigation is supported by Wi-Fi and BLE networks, as traditional GPS (Global Positioning System) services are best suited for outdoor services.

The author Ruchi Gupte et al. of [11] explains how collaborative clustering can be used to enhance the shopping experience and satisfy client requests. The RFID reader and a Zigbee module used to upload user data are in the trolley. The customer must scan the item once again to remove it. It has been able to identify groups of related products and determine the connection between any two products by utilizing K-Means clustering.

The study [12] by Parameswaran Ramesh et al. discusses a smart trolley, which has an RFID reader, RFID tag, voice board, LCD display, QR online payment scanner, and childcare unit. The major objective of this work is to enhance the RFID-enabled payment process that is used on the trolley. It also concentrates on developing a model for automatic billing by including a childcare unit and QR scanner in the shopping cart.

Aarthi Rameshkumar et al. defines [13] that customers can add or remove items from their carts by using the membership card that has been allotted to them. Cards can be recharged and used for payment for successful and quicker transactions, reducing customer wait time at the billing counter. Using collision detection technology, the system can prevent labels from being recognized repeatedly. To ensure a successful and easy shopping experience, the scanned products and their prices are displayed.

The author [14] Manikandan T et al. describes how an RFID reader, operated by a micro-controller is installed in a shopping cart to scan each item that is loaded into it. A distinctive RFID customer card containing all necessary details about the consumer and the amount they have previously deposited will be given to each new customer. Customers must scan their smart card with the RFID reader included in the shopping cart to collect and assign shopping carts. After proper analysis, the customer will be prompted a password for authentication.

Ms. Rupali Sawant et al. [15] discusses an RFID-based smart shopping cart concept in the retail field. The proposed system would replace UPC codes with RFID tags that communicate with an infrared sensor that detect each item in a cart. This reader would be connected to a large network that would send product information to retailers and product manufacturers via a ZigBee module. When a customer enters the aisle with a shopping cart, the cart encounters the infrared receiver and the microcontroller looks for the aisle information code. The aisle information code is transmitted wirelessly from the cart to the server via ZigBee. The database is queried based on the aisle number received. The product can be placed in the cart and the RFID reader will read the tag.

S. Sai Ganesh et al. [16] described a customer picking up a shopping trolley. Each trolley consists of an RFID reader as well as a barcode reader. When a customer buys a product, they first scan the label with an RFID reader before adding it to their trolley. Price of the product is retrieved and stored in the system's memory when the customer scans the product label. The product name and price are displayed on the screen.

[17] By Ankush Yewatkar et al. suggests equipping each cart with an RFID reader and ZigBee Module. An online billing method is implemented. If a product is removed from the cart, it will be erased from the invoice. The RFID reader installed at the exit door adopts anti-theft mechanism. Offers/discounts are available based on customers` shopping habits.

Tejas Patil et al. [18] defines an intelligent shopping cart to display the total price of the products present in the shopping cart. This allows customers to pay the amount directly at the application or billing counter. The components used are an Arduino Uno, an RFID reader module, and a buzzer.

Amruta Pokale et al. designed a smart trolley that facilitates the customer's shopping experience [19]. With the help of the application, carts are assigned to customers. Product details such as the product name and price are displayed on the screen mounted on the trolley. Payment can be made using various payment options provided at checkout.

The system proposed [20] by Gogikar Bharath Kumar et al. contains Radio Frequency Identification (RFID) sensors, Arduino little regulator, a Bluetooth module, and a Mobile application. The data is shown in the mobile application when the user scans the product at the billing counter. This structure suggests replacing standard and monotonous systems with the use of emerging technologies such as IoT and Android.

4. CONCLUSION

RFID has a wide range of applications in retail that go beyond straightforward operational advantages to actively enhance the consumer experience. In its simplest form, it involves actions like boosting product availability and providing convenient services by allowing shop employees to spend more time serving consumers. A comprehensive and existent picture of everything makes it feasible to improve customer service and elevate sales. The smart navigation feature is one among the sophisticated features that could be enabled in the application.

Overall, the use of RFID speeds-up the billing process, thus enhancing customer shopping experience.

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IMPLEMENTATION PAPER

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AUTOMATED STORE MODEL AND APPLIED NAVIGATION (AASMAAN) USING RFID SYSTEMS

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Abstract: In the fast-paced world of retail shopping, customer satisfaction is paramount. Traditional checkout systems can be a source of frustration for customers, as each item must be scanned individually, leading to long wait times and unoccupied times feels longer than occupied time. However, the advent of RFID technology has revolutionized the convenience store experience. Byreplacing cumbersome barcodes with RFID tags, multiple items can now be scanned at once, streamlining the checkout process. RFID readers communicate with RFID tags using radio waves, making it unnecessary for the tag to be in the reader's field of viewto be scanned. This innovation has enabled customers to move quickly and efficiently through the store, with the convenience of aone-stop-shop for all their needs. By eliminating the need for time-consuming barcode scanning, the RFID system has significantlyreduced wait times, making it possible to keep the line moving even during peak hours. The future of retail shopping is bright, withRFID technology poised to continue driving progress and revolutionizing the shopping experience.

INDEXTERMS - RFID READER, MFRC522, ARDUINO, FLUTTER, MOBILE APPLICATION DEVELOPMENT.

I. INTRODUCTION

In recent years, there has been a remarkable increase in the use of technology across various industries. The retailindustry has seen an upsurge in the implementation of cutting-edge technology to enhance customer experience and streamline business operations. One of the most promising technologies that has taken the retail industry is Radio Frequency Identification (RFID).

RFID is a wireless technology that uses radio waves to transfer data from a tag attached to an object to an RFID reader. RFID technology has been widely used in various applications, including warehouse management, asset tracking, and supply chain management. However, the application of RFID in the retail industry is relatively new and has been gaining momentum in recent years.

The retail industry is highly competitive, and retailers are constantly looking for ways to improve their operationsto enhance customer experience and increase profitability. In this regard, RFID technology offers several benefits that can help retailers achieve their goals. RFID allows retailers to track inventory in real-time, reduce out-of-stock situations, and prevent theft. Additionally, RFID technology can help retailers streamline their operations by automating various processes such as inventory management, product tracking, and checkout.

The traditional retail checkout process involves scanning each item individually, which can be time-consuming, especially during peak hours. This process can lead to long queues and dissatisfied customers. However, RFID technology offers a solution to this problem by allowing retailers to scan multiple items simultaneously, thereby reducing checkout time and improving customer satisfaction.

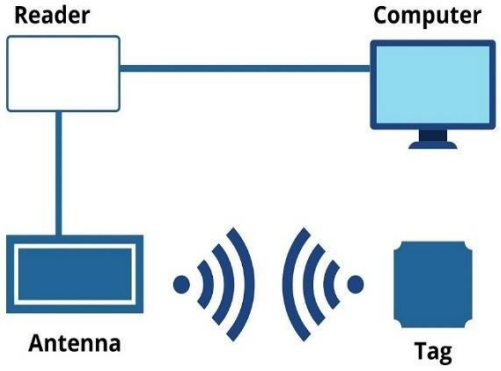

Fig. 1. Working of an RFID Tag Antenna

Additionally, with the increasing use of smartphones in our daily lives, developing native cross-platform applications using Google's Flutter software development kit will help customers interact with retailers and access product information.

In this paper, we present an implementation of an RFID-based inventory management system for a retail store. The system uses RFID technology to track inventory in real-time, automate the checkout process, and enhance customer experience. The rating and recommendation features make the shopping experience more personalized, while the inventory management feature helps store administrators manage their stock levels efficiently. We also discuss the design and implementation of the system, including the hardware and software components. Finally, we evaluate the system's performance and effectiveness in a real-world retail environment.

II. EXISTING SYSTEM

RFID technology has revolutionized the existing shopping systems, providing enhanced efficiency and improved inventory management. In prevailing systems, RFID tags are attached to products or packaging, enabling accurate tracking throughout the supply chain. Real-time inventory updates are achieved through RFID readers strategically placed in warehouses and retail stores. The automation of checkout processes is another notable application of RFID, where products with RFID tags can be swiftly identified and scanned at the point of sale, eliminating the need for manual barcode scanning. Additionally, RFID tags serve as anti-theft devices, preventing unauthorized removal of products from stores. Overall, the utilization of RFID technology in shopping systems has ushered in a new era of streamlined operations, reduced checkout times, and heightened security measures.

III. METHODOLOGY

The proposed system is implemented using a mobile application for both customers and store administrators. Upon entering the store, customers can use the app to access a menu of product categories and select the desired category. The app displays a list of products in that category, and the navigation feature helps the customer locate the product by displaying the shelf and aisle number. Each product in the store has an RFID label that contains complete details such as the product name, product ID, price, entry, and expiry date.

To purchase a product, customers need to scan the product's RFID label using the app and add it to their cart. The app displays the details of the cart on the customer's phone, including the product name, price, and quantity. The final bill is generated as a softcopy and sent to the app, and customers can choose their preferred mode of payment.

In addition, the app includes a rating feature that allows customers to provide feedback on their shopping experience. Based on the frequency score, the app recommends products to customers, making it easier for them to find what they need.

The system also includes an inventory management feature for store administrators, which enables them to monitor the expiry date of products and manage their stock levels effectively. This feature ensures that the store always has fresh and high-quality products available for customers.

Overall, the proposed system provides a seamless shopping experience for customers by providing a smart navigation system, detailed product information, and an easy-to-use payment system. The rating and recommendation features make the shopping experience more personalized, while the inventory management feature helps store administrators manage their stock levels efficiently.

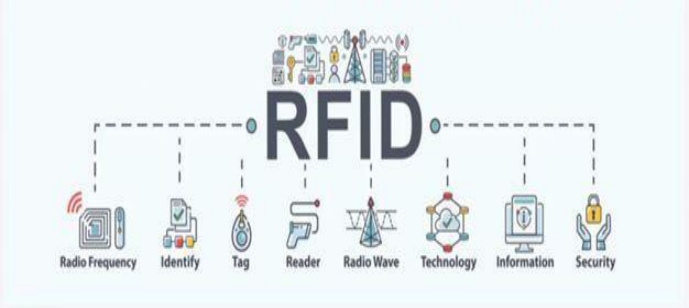

Fig. 2. Features of RFID Technology

QUEUELESS BILLING

The process of scanning multiple items using the MFRC522 scanner involves the utilization of two scanners and incorporates an anti-collision mechanism. Each cart in the store is equipped with RFID scanners and each product is attached with an RFID tag. As new stock enters the store, administrators scan the products and update the database with product details using a dedicated terminal. The user first scans the membership card issued during registration. Membership cards also use RFID technology. When scanning cards, a shopping cart is assigned to them. The user then scans the products whose UID will be stored in the user's cart table in the MySQL database. The user is provided with a mobile application that can be used to view details of the products in the cart like, price and expiry date. They can also remove products from the cart. Once the cart is finalized, they can click checkout to get a list of all the UPI apps installed on their device. Upon checkout, the status of the transaction is sent to the database.

This app is built using a framework called 'Flutter'. Flutter is a Google UI toolkit for building native apps. With the implementation of reduced code in the native application, apps will be developed faster than traditional apps approach.

NAVIGATION

In the process of managing products in a store, an important aspect is the mapping of each product's designated location. When the products arrive at the store, the administrator takes the responsibility of assigning specific positions for each item. To accomplish this, the administrator utilizes a 2D model, where the X-axis represents the aisles, and the Y-axis represents the racks. By carefully considering factors such as product categories, popularity, and accessibility, the administrator strategically assigns the appropriate aisle and rack for each product.

When a user wants to search for a particular product within the store they initiate a search, and the system displays the corresponding aisle and rack information to the user, making it easier for them to navigate through the store and find the specific item they are looking for.

RECOMMENDATION SYSTEM

The recommendation system in our mobile application is a technology that provides customers personalized product suggestions. The system displays the three most frequently bought items of each customer in descending order, making it easy for customers to find products they may want to purchase. As customers continue to make purchases, the system continuously updates and refines its predictions, resulting in increasingly accurate and relevant product suggestions. This leads to a more enjoyable and convenient shopping experience for customers, as they can quickly and easily find products that match their preferences and needs.

INVENTORY MANAGEMENT

By employing RFID tags on products, businesses can accurately track and manage their inventory in real-time. When it comes to inventory management, the administrator plays a central role in overseeing the process.

To begin with, the administrator receives a comprehensive table that lists all the products within the inventory. This table contains important details such as the product name, product UID, expiry date, price, and other relevant information. This provides a holistic view of the available products, enabling the administrator to make informed decisions regarding stock replenishment, ordering, and overall inventory control.

One critical feature of this inventory management system is the ability to identify products that are approaching their expiry dates. By logging into the mobile application, the admin can view a list of products that will expire within the next 30 days.

IV. RESULTS

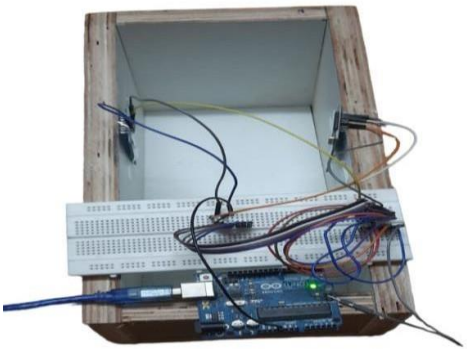

Fig. 3. Cart embedded with RFID readers.

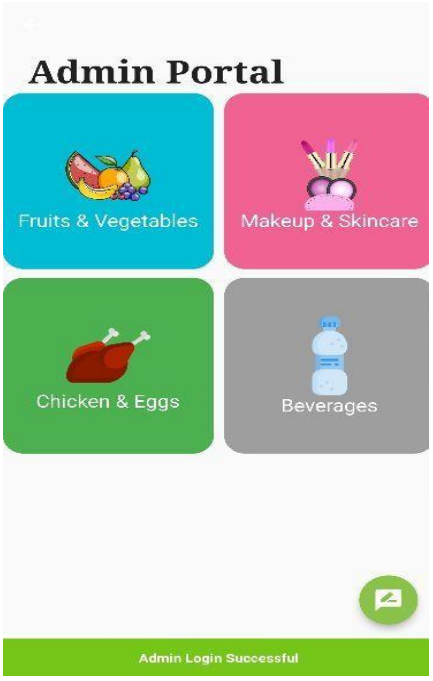

Fig. 6. Admin portal home page

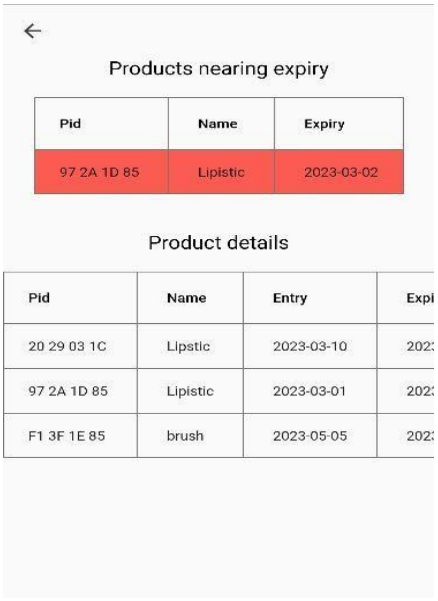

Fig. 7. Inventory details

V. CONCLUSIONS AND FUTURE ENHANCEMENTS

In conclusion, the proposed mobile application for customers and store administrators provides an innovative and seamless shopping experience. By offering a user-friendly interface with detailed product information and smart navigation features, customers can easily locate and purchase their desired products with minimal effort. The inclusion of a rating feature and personalized product recommendations enhances the overall shopping experience and encourages customer loyalty. Additionally, the inventory management feature streamlines the store's operations, ensuring the availability of fresh and high-quality products. Overall, the proposed system's implementation is an excellent example of how technology can improve traditional business models and enhance the customer experience. As the retail industry continues to evolve, it is vital to embrace innovative solutions like this mobile application to remain competitive and offer customers the best shopping experience possible. With continued development and refinement, this system has the potential to revolutionize the way we shop and interact with retail stores.

Based on the proposed system, there are various future enhancements that can be implemented to improve the shopping experience for customers and store administrators. One possible enhancement is the integration of augmented reality (AR) technology, which can allow customers to visualize products in real-time before making a purchase. This feature can enable customers to see how a product will look in their home or outfit before they buy it, reducing the likelihood of returns and increasing customer satisfaction.

Another future enhancement can be the incorporation of machine learning algorithms to analyze customer data and provide personalized recommendations. This feature can allow the app to learn about a customer's preferences, shopping behavior, and previous purchases to recommend products they are likely to purchase. It can also enable store administrators to optimize their product offerings and promotions based on customer data.

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