

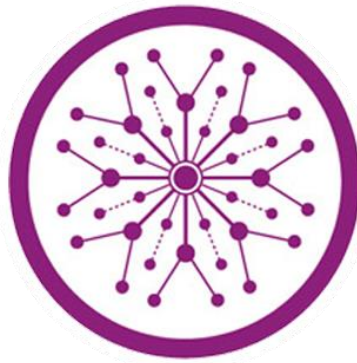
GS-1 Based Track and Trace Solution

Final Year Project

Session 2018-2022

A project submitted in partial fulfillment of the degree of

BS in Computer Science



Department of Computer Science

Faculty of Computer Science & Information Technology

Superior University, Lahore

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*The candidates confirm that the work submitted is their own and appropriate credit has been given where reference has been made to work of others

Plagiarism Free Certificate

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Project Report

GS-1 Based Track and Trace Solution

Change Record

Author(s)	Version	Date	Notes	Supervisor's Signature
Ambreen Kanwal, Muhammad Ammar, Hafiza Tayyeba	1.0	14 th July 2022	<Original Draft>	

APPROVAL

PROJECT SUPERVISOR

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Name: _____

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HEAD OF THE DEPARTMENT

Comments: _____

Date: _____ Signature: _____

Dedication

First of all, we dedicate our project to Allah Almighty and to whom the world owes its existence Muhammad (Peace Be upon Him). This humble effort is dedicated to Our beloved parents who brought us to the level of excellence where we are studying today looking for most promising and gleaming future ahead for which they scarified most of the time of their life & to our respected and genius teachers who guided us throughout academic career, and all those people who have remembered us in their prayers. A lot of thanks for all our teachers!

Acknowledgements

We would like to thank Allah, for letting us through all the difficulties. We have experienced Allah's guidance throughout.

We would like to acknowledge and give our warm thanks to our supervisor Miss Maryam who made this work possible. Her guidance and advice carried us to all the stages, her suggestions have served as a major contributor towards the completion of our project.

Special gratitude with the deepest sense of respects to our parents whose love and affections kept us steep fast and enabled us to attain targets and goals of academic life. We are extremely indebted to their brothers and sisters whose constant encouragement provides us with the impetus that was necessary for attaining academic initiatives.

The success and accomplishment of this project stems from efforts and dedication offered by many individuals whose support was either direct or indirect. We thank all of them for their devotion.

Executive Summary

GS-1 track and trace solution is an android-based application used for tracing and tracking items based on the GS-1 standards. GS-1 standards help the tracking and tracing process to be error free and less time consuming. It makes cross-border trade easy as the trading partners are using the same language for tracking.

It is a general-purpose application that can be used in any industry. This application is made for End-User as well as the businesses involved in the supply chain. Businesses can access the dashboards through the admin to send order, shipping and reviewing status of order. The application is a common platform to end-user, manufacturer, distributor, retailer and shipper. We are providing tracing facility to end-user which enables them to verify the product authenticity like manufacturing date, expiry date etc. Tracking module is made for the businesses specifically. Businesses can track the orders they have made to other businesses. Shipping, viewing order status like features are also available for businesses.

All of the users can access Artificial Intelligence based customer support available 24/7 to answer their queries. Application includes how it works feature to let users understand how application is working.

This application is built keeping in view the GS-1 standards.

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Chapter 1

Introduction

Chapter 1: Introduction

The GS1 Global Traceability Standard is intended for use across supply chains and is relevant to all events that span the lifecycle of a traceable object.

The objective of the GS1 Global Traceability Standard (GTS) is to assist organizations and industries in the design and implementation of traceability systems based on the GS1 system of standards. At a strategic level, this standard aims to provide key insights and knowledge for organizations or industries that are developing long-term traceability goals.

GS1's approach to enabling supply chain traceability is focused on the use of open standards to provide visibility of objects that are relevant to supply chains.

Supply chain and logistics management has become increasingly important in recent years as its perspective has led the industry to see through the process integration from upstream to downstream. [1]

Traceability is a well-known aspect in numerous industries since decades. In logistics, traceability refers to the capability for tracing goods along the distribution chain, from the suppliers to the retailers. [2]

1.1. Background

Under GS1, the global international standards organization EPC has approved the EPC network standard. It systematizes the syntax and semantics of supply chain events, as well as secure ways to selectively share supply chain events with your trading partners. These tracking and tracking standards have been successfully used in many industries and there are now a wide range of products certified to comply with these standards.

A wave of software, hardware, consulting, and system providers has emerged in recent years in response to more and more recall cases (food, pharmaceuticals, toys, makeup, etc.), providing the industry with a variety of traceability solutions and tools.

1.2. Motivations and Challenges

The amount of traceability data collected over time is very important and presents time and cost challenges in collecting, storing, and providing access to the data. Today's supply chains are long and complex. They often overlap with various other supply chains, making traceability a multi-party, multi-chain challenge. Creating and maintaining quality traceability data is a major challenge. Some important aspects are:

- Completeness
- Accuracy
- Consistency
- Validity

1.3. Goals and Objectives

The objective of the GS1 based Tracking and Tracing is to assist organizations and industries in the design and implementation of traceability systems based on the GS1 system of standards. This standard aims to provide key insights and knowledge for organizations or industries that are developing long-term traceability goals i.e., trace the history and track location of an object.

If we talk about an item or a product, GS-1 based tracking and tracing includes:

- Origin of product.
- Authenticity of product.
- Supply chain visibility.

1.4. Literature Review/Existing Solutions

The GS1 Global Traceability Standard defines a minimum set of traceability requirements within a business process for complete chain traceability, regardless of technology. For supply chain visibility, we need to proactively collect and manage information about where the product has been manufactured and when it was manufactured to its expiry date, and through which shipper it has been shipped to the user. The GS1 label should be used for tracking and tracing.

1.5. Gap Analysis

Customer, partner, and supplier communication is an important aspect of any organization. However, when there are several processes and systems in place, even communicating basic information can be time-consuming and error-prone. To make things easier, a standard language is required that provides end-to-end traceability, tying information flow to physical objects, and providing internationally unique identification as well as data capture of trade items, assets, logistic units, parties, and places.

1.6. Proposed Solution

The GS1 Global Traceability Standard defines a minimum set of traceability requirements within business processes to achieve full chain traceability, independent of any technology. Must actively collect and manage information regarding what has been done in manufacturing processes from acceptance of raw materials and parts to shipment of products to the end user enabling complete supply chain visibility. GS1 labels must be used for tracking and tracing.

1.7. Project Plan

The project will be managed by dividing the whole into smaller chunks which will be described and solved in the work breakdown structure. It also includes a Gantt chart which will describe step by step completion of the project with all the milestones.

1.7.1. Work Breakdown Structure

1. Project Management

- 1.1. Work Breakdown Structure (WBS)
- 1.2. Roles & Responsibility Matrix
- 1.3. Change Control System

2. Reports / Documentation

- 2.1. Final Documentation Introduction
- 2.2. Literature Review
- 2.3. Requirements Analysis
- 2.4. System Design
- 2.5. Implementation
- 2.6. Testing & Performance Evaluation

3. System

- 3.1. Development Environment
 - 3.1.1. IDE (Android Studio)
 - 3.1.2. Version Control (1.0)
 - 3.1.3. Server (Firebase)
 - 3.1.4. Database (Firebase Real-time database)

1.7.2. Roles & Responsibility Matrix

The purpose of roles & responsibility matrix is to identify who will do what.

WBS #	WBS Deliverable	Activity #	Activity to Complete the Deliverable	Duration (# of Days)	Responsible Team Member(s) & Role(s)
1	Requirement Gathering	1	Completed	14 days	All Members
2	Literature Review	2	Completed	21 days	Tayyeba, Ambreen
3	Feasibility	3	Completed	14 days	Ammar
4	Planning	4	Completed	28 days	All members
5	Initiation	5	Completed	28 days	All members
6	Design	6	Completed	28 days	Ambreen, Tayyeba
7	Build and Execution	7	Completed	28 days	All members
8	Review and Analysis	8	Completed	28 days	Ammar
9	Closure	9	Completed	14 days	All member

Table 1.1. Roles and Responsibility Matrix

1.1.1. Gantt Chart

GS-1 based Track and Trace Solution
Company Name: Zaya Group
Project Lead: Ambreen Khatun

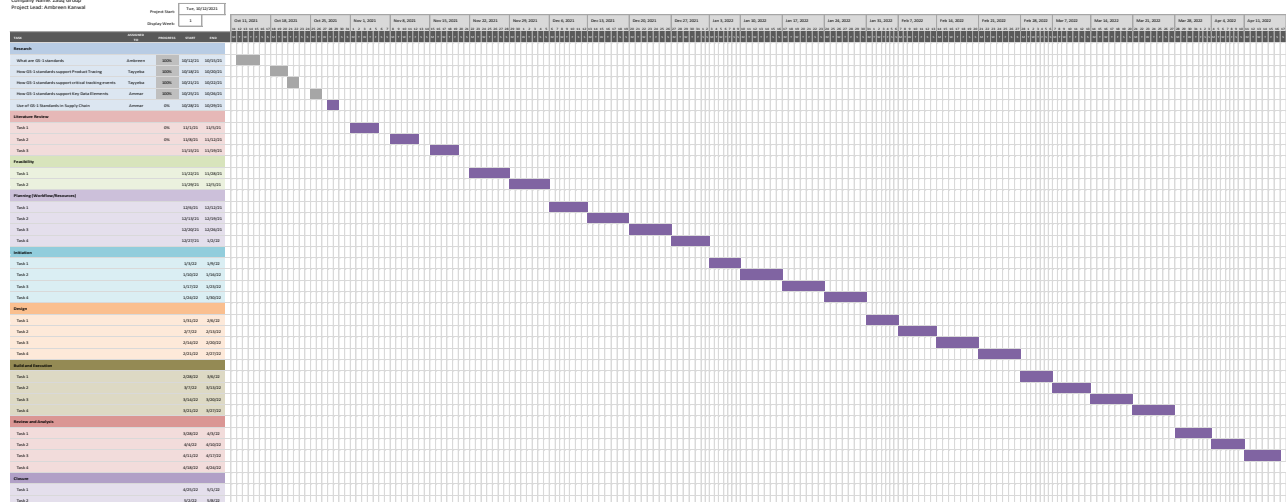


Figure 1.1. Gantt Chart

1.2. Empathy Map

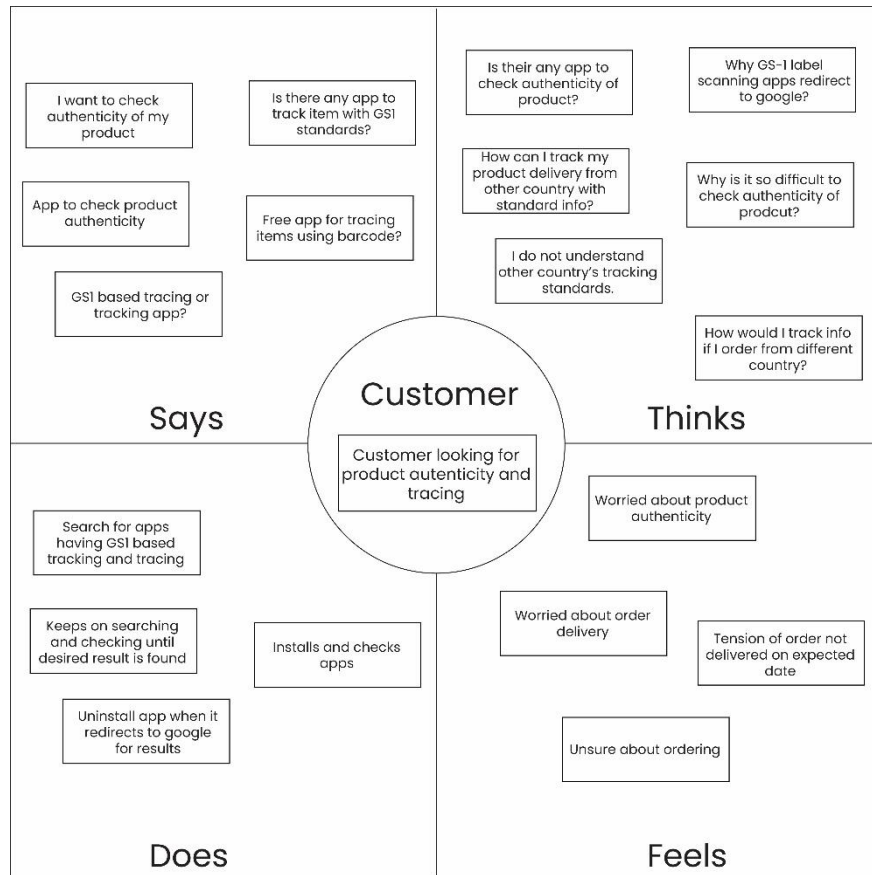


Figure 1.2. Empathy Map

Chapter 2

Software Requirement Specifications

Chapter 2: Software Requirement Specifications

1.1. Introduction

1.1.1. Purpose

We are developing an application in which GS-1 based tracking and tracing can be done. The GS-1 Tracking and Tracing gives all parties within a supply chain, a common business language so that a traceability system can be designed and implemented that works for all.

1.1.2. Document Conventions

We are using Calibri font for both headings and their description along with bold. Heading is using style heading 2. Font size for heading is 16, sub-heading is 14 and for description is 12. The description paragraphs are justified.

1.1.3. Intended Audience and Reading Suggestions

This project is an application for GS-1 based tracking and tracing. This document is intended for developers; to understand the requirements of the app to make it up to the mark, testers; who verifies that the product meets the functional, performance, design, and implementation requirements identified in the SRS, Users; who are going to use the application, marketing staff; who promotes the product and generate revenue for an organization.

1.1.4. Product Scope

The GS-1 Global Traceability Standard is intended for use across supply chains and is relevant to track and trace the traceable objects, including:

- Verifies authenticity of product.
- Origin of the product.
- Follows and monitors the progress of deliveries.
- Common language tracking of transport and distribution that is also useful among cross-border trade.

- Easy Communication among traders.
- Tracking of product.

1.2. Overall Description

1.2.1. Product Perspective

The product is a commercial software and is a follow-on member of existing GS-1 based tracing apps. It includes a new feature that is GS-1 based tracking. The existing apps of tracing based on GS-1 standards only covers the specific industries, like pharma. This product will cover the whole supply chains' tracking and tracing.

1.2.2. Product Functions

1. End-User End:

The major functionality of user end is given below:

- Registration and Login
- Scanning of GS-1 label
- Tracing products to enable the end user check the authenticity of product
- How it works
- About App
- Chatbot
- Logout

2. Admin End:

The major functionality of user end is given below:

- Admin login
- Add Business-User
- Update Business-User
- Delete Business-User

3. Manufacturer End:

The major functionality of user end is given below:

- Login
- Trace Item
- Dispatch Order
- See Order Status
- Manage Items: Add, Update, Delete
- How it works
- About App
- Chatbot
- Logout

4. Shipper End:

The major functionality of user end is given below:

- Login
- Deliver Dispatched Order
- See Order Status
- Update Order Status
- How it works
- About App
- Chatbot
- Logout

5. Distributer End:

The major functionality of user end is given below:

- Login
- Trace Item
- Track Item
- Dispatch Order

- See Completed Orders
- How it works
- About App
- Chatbot
- Logout

6. Retailer End:

The major functionality of user end is given below:

- Login
- Trace Item
- Track Item
- See Order Status
- How it works
- About App
- Chatbot
- Logout

1.2.3. User Classes and Characteristics

Following are the user classes:

- **Manufacturer**

A manufacturer can manage item i.e., add items, update items or delete items that will be traced by the end user.

For Sending order, every manufacturer is assigned a GLN (Global Location Number). The primary use of GLN is to identify the company in business transactions, such as sending orders and invoices. If the company has buildings in different locations, it may need to assign the GLN to each object. This is especially important in the loading and delivery process to factories, warehouses, distribution centers and stores. [3]

GLN enables companies to efficiently perform various operations and implementation processes without the need to repeatedly transmit the address or other location data. [4]

The product that is to be sent to the receiver is assigned a GTIN (Global Trade Item Number). Manufacturer sends the order to the shipper and when the order delivery has been done, the manufacturer can see that the order has been completed.

Manufacturer can access the customer care chatbot.

- **Retailer**

Shipper can access the order detail and can proceed with it by scanning the GS-1 label. Then he can add the Serial Shipping Container Code and can send it to the receiver.

- **Distributor**

For tracking, Distributors have the Serial Shipping Container Code, in addition to the information of Manufacturer and Order's detail, that is updated by the shipper that helps in better tracking. Distributor can track the order through tracking ID. It can also see the order status. Distributor also has the right to send the order to retailer through shipper with all the GS-1 standards-based details.

Distributor can also do tracing and can take help from Chatbot.

- **Retailer**

The order is delivered to the retailer and retailer can track it by using the tracking ID and see the order status.

Retailer can do tracing and access the chatbot.

- **End User**

End User will be able to trace the items by scanning GS-1 label.

1.2.4. Operating Environment

Our application will run on smart phones. It will support Android operating system. This application needs android version greater than 5.0.

The hardware requirement of this application is camera of the smart phone for scanning purpose. Internet access is must to connect the application with real-time database and provide result on scanning and to access the Chatbot Services.

1.2.5. Design and Implementation Constraints

The accessing and assigning of GLN and GTIN from GDSN (Global Data Synchronization Network) is a challenging task. Another constraint in the application development is to maintain the quality of image captured by the integrated camera.

Android Studio and Firebase database will be used to develop the application. Language used will be Java and Kotlin. PyCharm and Python will be used for the implementation of AI based Chatbot. Chatbot will be integrated, in android studio, with application using Kotlin.

1.2.6. User Documentation

The user documentation will include the following:

- User manual
- Tutorial

1.2.7. Assumptions and Dependencies

The GS1 Global Traceability Standard is based on the use of global, voluntary GS1 business standards. The following definition is considered as the reference definition of traceability in this document:

Traceability is the ability to track forward the movement through specified stage(s) of the extended supply chain and trace backward the history, application or location of that which is under consideration.

The ISO 9001:2000 definition of Traceability has been used as basis and leveraged in order to suit the context of the supply chain.

For practical reasons, “trace” or “track and trace” may be used as equivalent terms to designate the action of ensuring the traceability. [5]

1.3. External Interface Requirements

1.3.1. User Interfaces

The application will start with a splash screen followed by a login page. If the user has already logged in then he will be directed automatically to the home screen that contains the tracing option for the end user. The home screen will also contain a side menu in which we will have account info, how it works, about app, and Chatbot. For tracing user have to scan the GS-1 label. For the business users like manufacturer shipper etc. there will be slight changes in the user interface. It has to be user friendly and everything easy to access.

1.3.2. Hardware Interfaces

The application uses camera and the internet, it includes all the hardware to connect internet and camera. As for e.g., Modem, WAN – LAN.

1.3.3. Software Interfaces

- The application uses internet for login.
- The camera is used for scanning GS-1 labels.
- The firebase database will be used for cloud services.
- Application will be android OS compatible.
- Android Studio and PyCharm is the tool used for development.

1.3.4. Communications Interfaces

The application shall use the HTTP protocol for communication over the internet. Android platform includes the HttpsURLConnection client.

1.4. System Features

Following are the features provided by our application:

1.4.1. Registration and Login

1.4.1.1. Description and Priority

Register a new user or login an existing user.

1.4.1.2. Stimulus/Response Sequences

- A user will open the application.
- Application will show the registration page.
- If the user is new, he will fill out the registration form. The existing user will switch to the login page.
- The application will authenticate the login details and allow the user to proceed to the home page if the login is successful otherwise it will show unsuccessful login dialog box.

1.4.1.3. Functional Requirements

REQ-SF1-1: Application must login or register a user before showing home page.

REQ-SF1-2: The integrity of data must be contained.

1.4.2. Tracking

1.4.2.1. Description and Priority

Tracking of shipment of orders. Follows and monitors the progress of deliveries.

1.4.2.2. Stimulus/Response Sequences

- The user will enter the Tracking ID in the tracking section.
- Application will get the ID from user and search for related results from the database.
- Once a related data is found against the ID, database will return the data to the application.
- Application will provide the data to the User.

1.4.2.3. Functional Requirements

REQ-SF1-1: The tracking ID should provide tracking details.

REQ-SF1-2: Details should tell when the product was shipped and now where it is.

1.4.3. Tracing

1.4.3.1. Description and Priority

Trace products to enable the end user complete supply chain

1.4.3.2. Stimulus/Response Sequences

- The user will scan the GS-1 label with the scanning feature.
- Application will search for the related result from the database.
- Once a related data is found against the GS-1 label, database will return the data to the application.
- Application will provide the data to the User.

1.4.3.3. Functional Requirements

REQ-SF1-1: The scanner should scan the GS-1 label.

REQ-SF1-2: Show the available data, against the GS-1 label, stored in the database.

1.4.4. Chatbot

1.4.4.1. Description and Priority

Chatbot provides its services as customer chat support.

1.4.4.2. Stimulus/Response Sequences

- The user will open the chatbot that is customer support.
- User can ask questions in the text field.
- Chatbot will search for the answers of the asked question.
- Chatbot will return answer according to the questions.

1.4.4.3. Functional Requirements

REQ-SF1-1: Replies to user queries.

REQ-SF1-2: Respond according to the questions asked.

1.5. Other Nonfunctional Requirements

1.5.1. Performance Requirements

The internet speed and the integrated camera image capturing quality should be good, otherwise it will affect the performance of the application. The internet speed is important for authentication and searching data from firebase database. The camera quality should be good so that the code is scanned clearly without taking time.

1.5.2. Safety Requirements

Terms and conditions should be defined. User should accept that and then use the application to avoid any inconvenience later.

1.5.3. Security Requirements

User authentication offered by the firebase is used as the safety mechanism for login. So that a user can only access its own data.

1.5.4. Software Quality Attributes

Following are the software quality attributes:

- Adaptability
- Availability
- Correctness
- Maintainability
- Reliability

1.5.5. Business Rules

User can only track, trace and ship orders. Whereas the Admin can add, remove, update and, manage the business users. End-User can only see the results from the database.

Chapter 3

Use Case Analysis

Chapter 3: System Analysis

In this chapter, we will discuss about the use cases regarding the actors which includes customer, technician and bank separately and also full use case diagram of the system. The visual representation of the use cases are given. Also, the fully dressed use case is described as per template with all the attributes which are essential for a fully dressed use case.

3.1. Use Case Model

It is a graphical representation of a user's potential interactions with a system. It depicts multiple use cases and various user types such as end user, manufacturer, distributor, retailer, shipper and admin. These models are providing a higher-level view of our system.

Use Case (Complete):

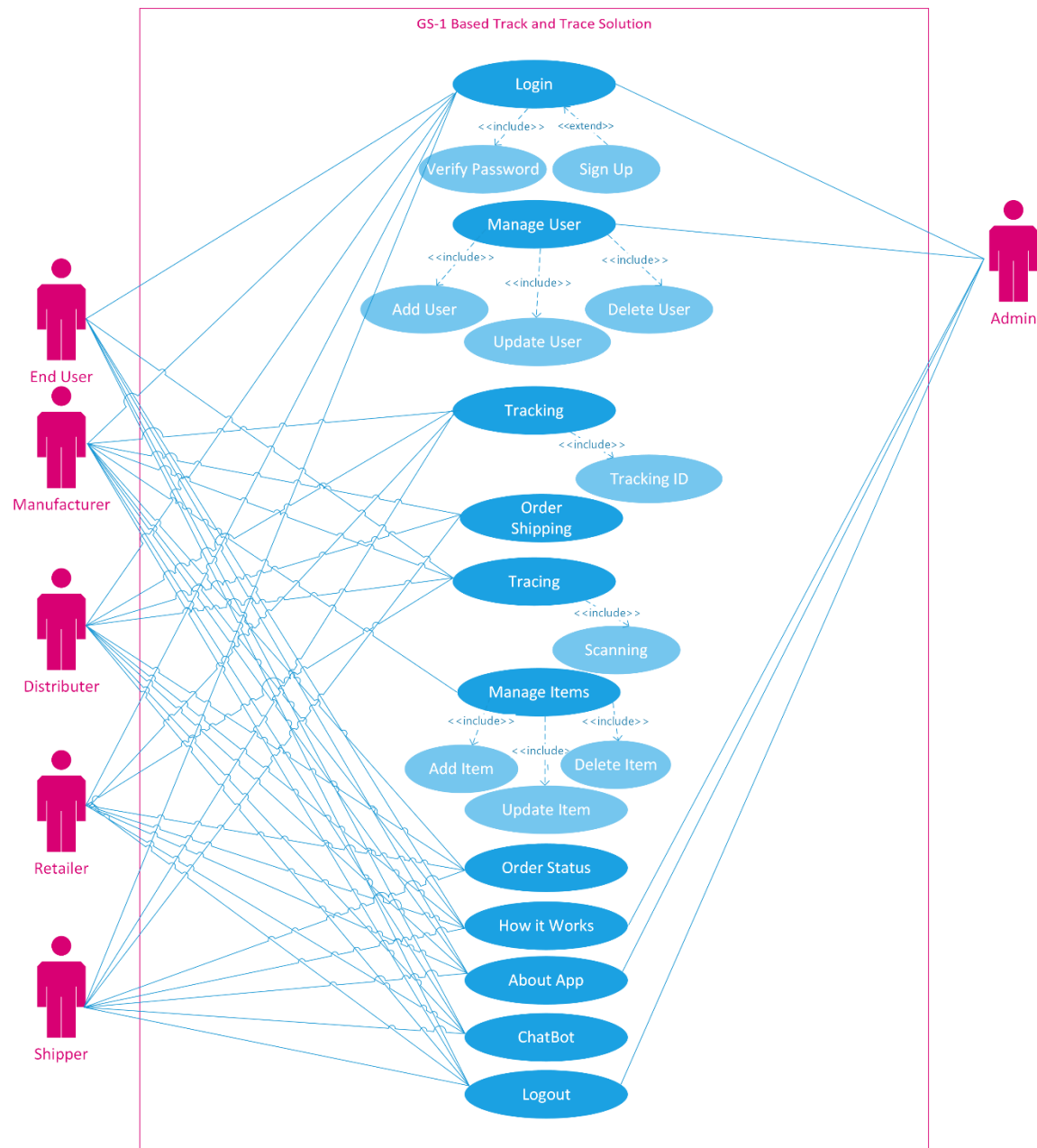


Figure 3.1.1 Complete Use Case Diagram

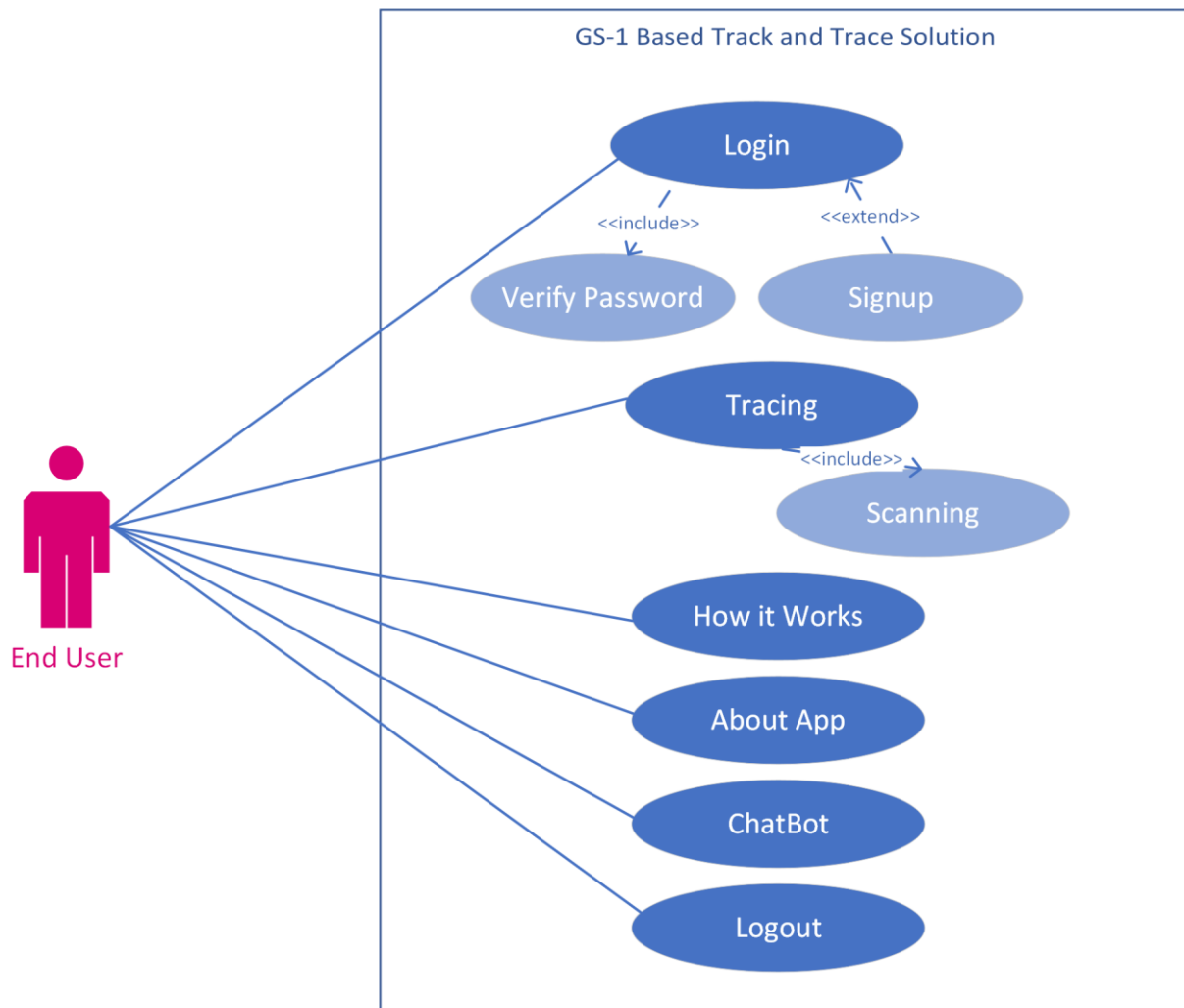
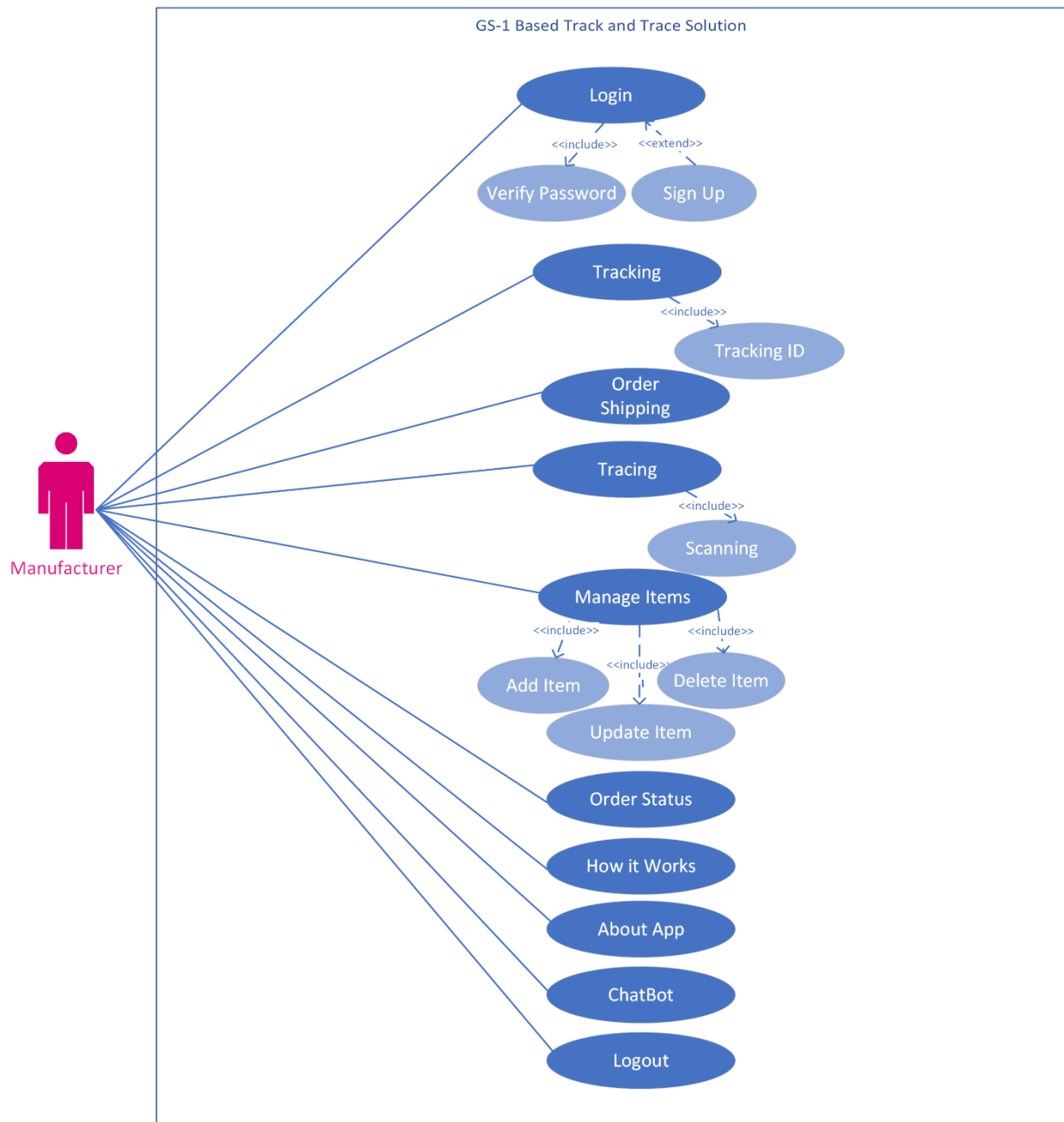
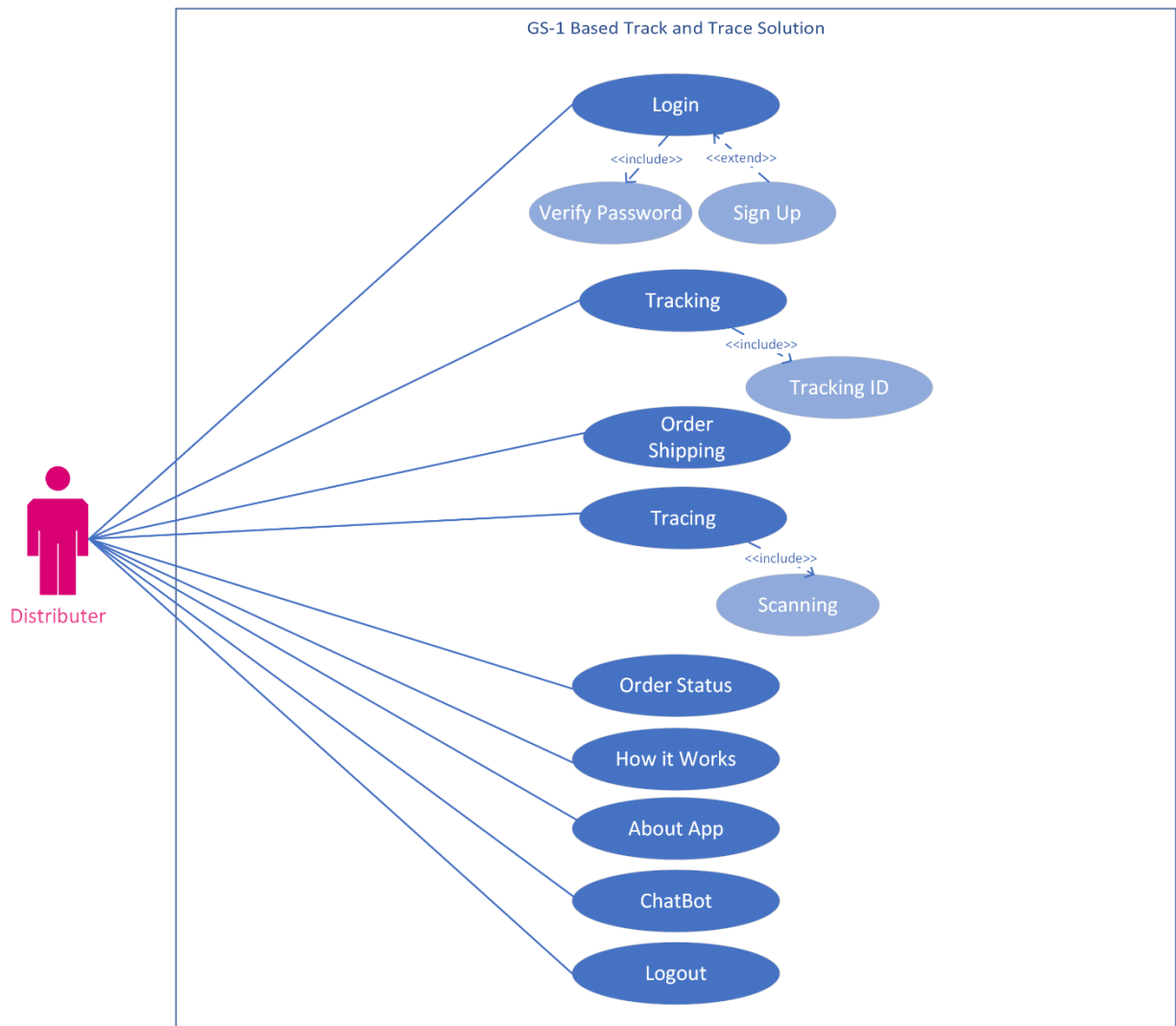
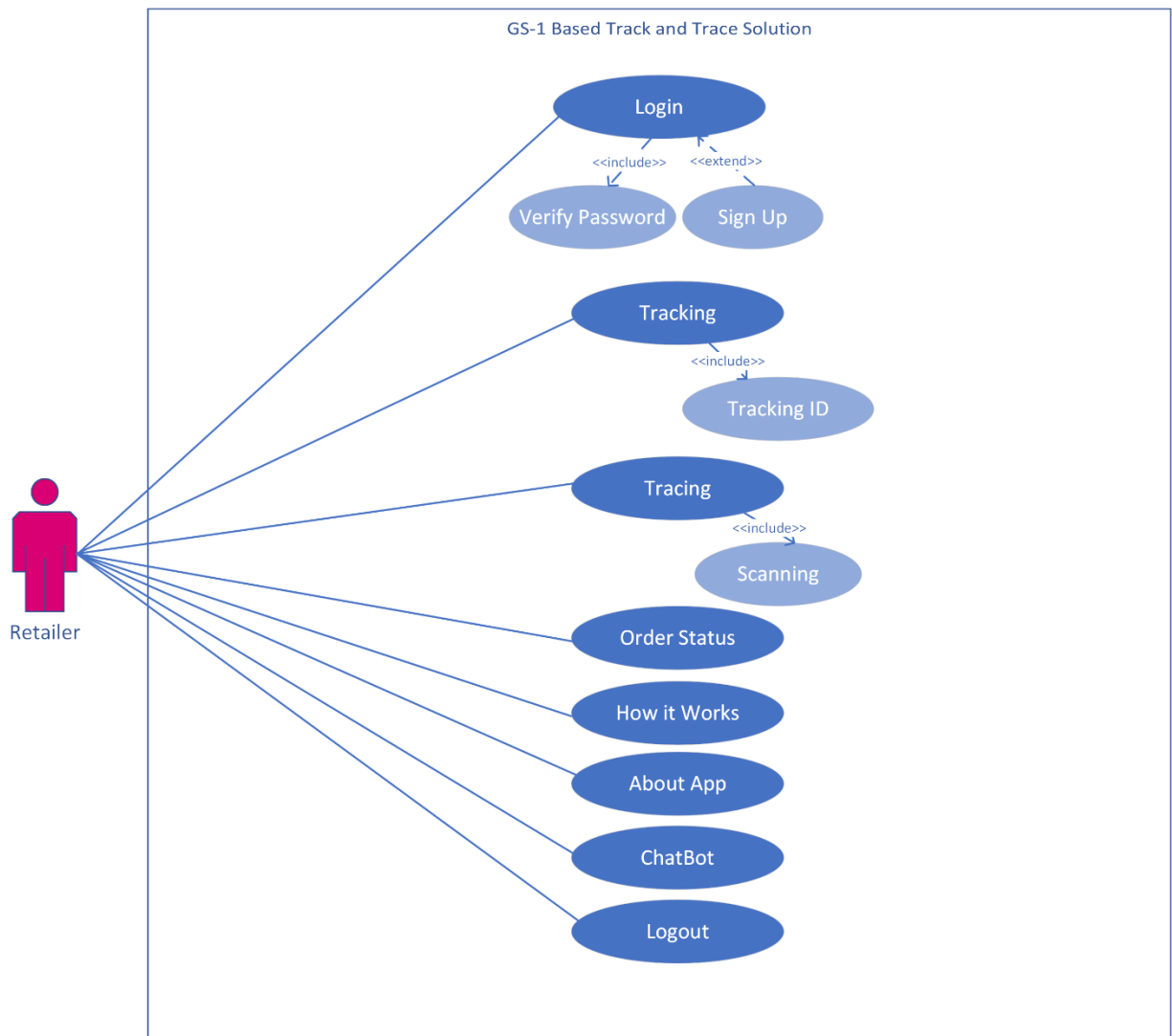
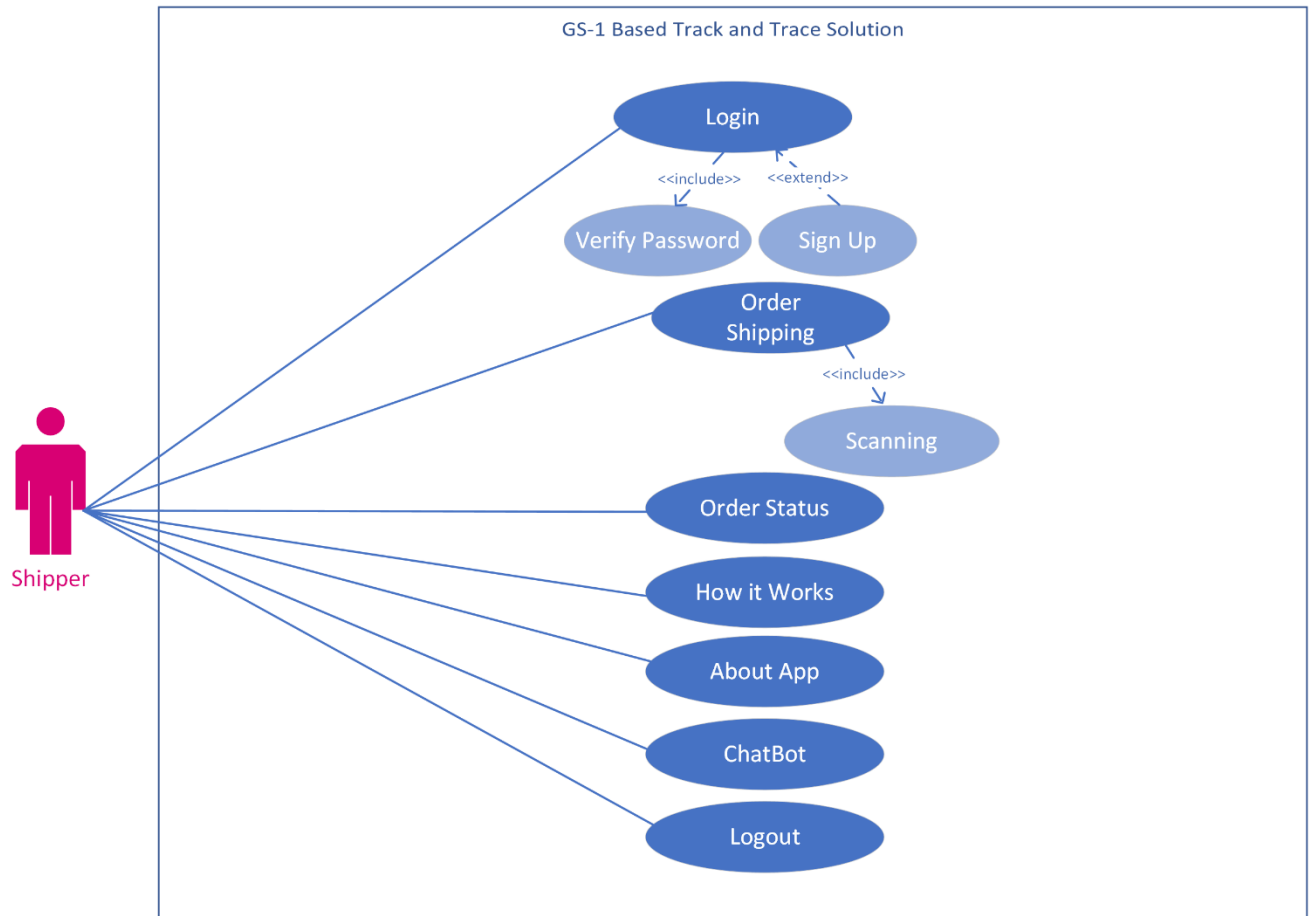
Use Case (End-User):

Figure 3.1.2 End User Use Case

Use Case (Manufacturer):**Figure 3.1.3. Manufacturer Use Case**

Use Case (Distributor):**Figure 3.1.4. Distributor Use Case**

Use Case (Retailer):**Figure 3.1.5. Retailer Use Case**

Use Case (Shipper):**Figure 3.1.6. Shipper Use Case**

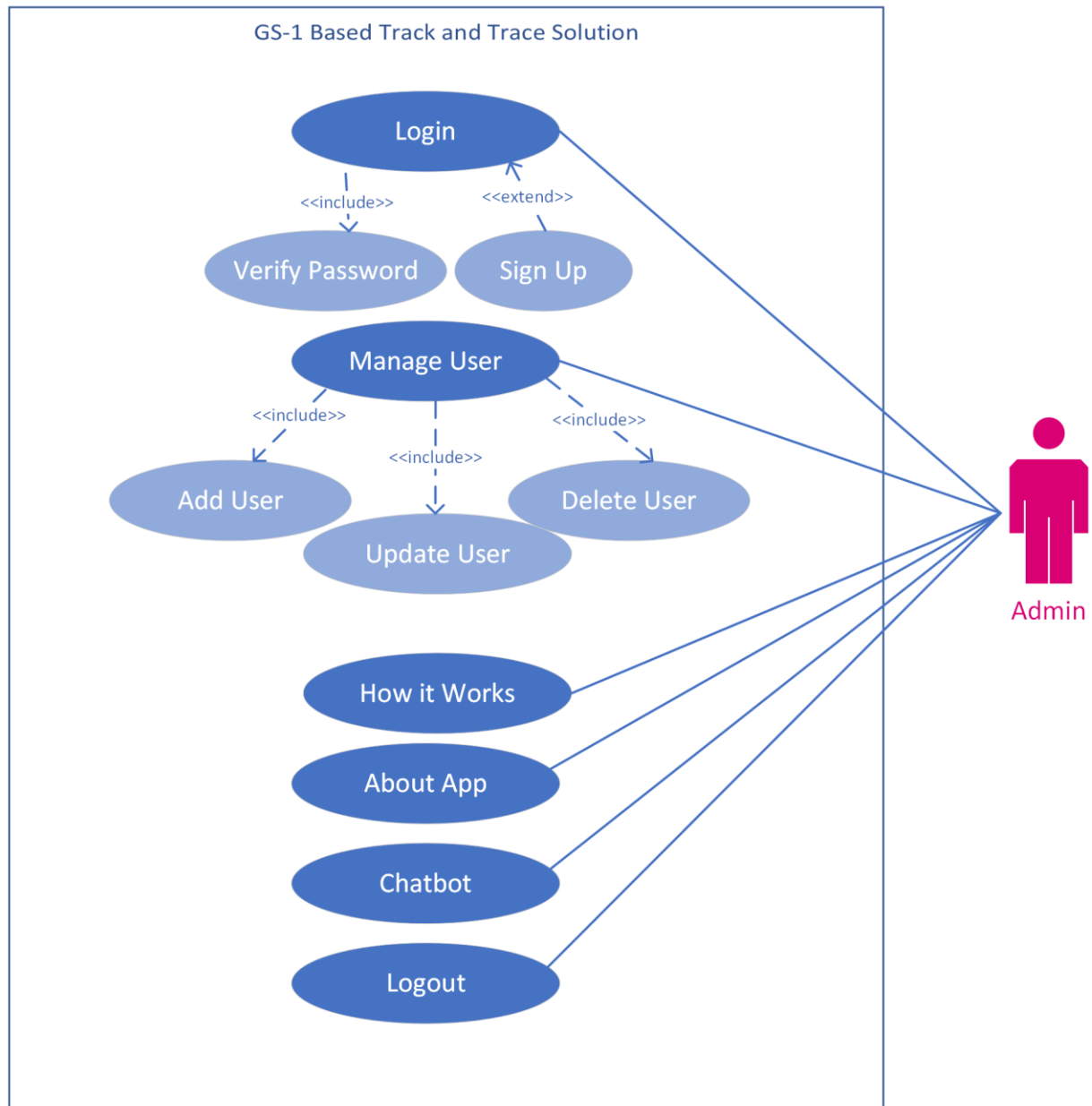
Use Case (Admin):

Figure 3.1.7. Admin Use Case

3.2. Use Case Descriptions

Register:

Table 3.1.1 Register - Use Case Description

Number	1	
Name	Registration	
Summary	User will register before going to home page	
Priority	5	
Preconditions	User must have installed the application and have internet connection	
Post conditions	Authentic Information	
Primary Actors	User	
Secondary Actors	Owner, Admin	
Trigger	User choose to have an account	
Main Scenario	Step	Action
	1.	System will ask for login or signup
	2.	User will choose an option
	3.	System will show form according to the selection
	4.	User will enter email and password
	5.	System will authenticate the information
	6.	On success, application will further proceed. On Failure, system will ask to re-enter the information.

Tracing:

Table 3.1.2. Tracing - Use Case Description

Number	2	
Name	Tracing	
Summary	User can trace an object	
Priority	5	
Preconditions	User must have logged in	
Post conditions	Must have camera access	
Primary Actors	User	
Secondary Actors	Owner	
Trigger	User choose to scan a GS-1 label.	
Main Scenario	Step	Action
	1.	System will ask for camera permission. (Only on 1 st time)
	2.	User will give permission
	3.	System will show the camera interface
	4.	User will scan the code
	5.	System will authenticate the information from database
	6.	System will return the result.

Tracking:*Table 3.1.3 Tracking - Use Case Description*

Number	3	
Name	Tracking	
Summary	Business User can track an object	
Priority	5	
Preconditions	User must have logged in	
Post conditions	Must have tracking ID.	
Primary Actors	User	
Secondary Actors	Owner, Admin	
Trigger	User choose to track an object	
Main Scenario	Step	Action
	1.	System will ask for Tracking ID
	2.	User will provide the ID
	3.	System will check the status of object
	4.	System will return the current location of object with GLN.

Admin:*Table 3.1.4. Admin - Use Case Description*

Number	5	
Name	Admin	
Summary	Admin can add business users.	
Priority	5	
Preconditions	Admin must have logged in	
Post conditions	Must have access to database	
Primary Actors	None	
Secondary Actors	Owner	
Trigger	Admin manage the user	
Main Scenario	Step	Action
	1.	System will ask for login
	2.	User will provide the credentials
	3.	System will authenticate and provide access according to rights.
	4.	Admin can manipulate the data

How it works:*Table 3.1.5. How it works - Use Case Description*

Number	6	
Name	How it works	
Summary	User can view the manual for software use	
Priority	3	
Preconditions	User must installed the app	
Post conditions	Must have basic English knowledge	
Primary Actors	User	
Secondary Actors	Owner	
Trigger	User choose to view manual	
Main Scenario	Step	Action
	1.	User will select the manual option from the menu
	2.	System will provide the User manual

Chapter 4

System Design

Chapter 4: System Design

This chapter includes the architecture and design of the entire application. Its operational working with class diagram and domain model. The Entity Relationship Diagram which describes the relations of all the entities in the project. It also shows the sequence of all the activities performed using activity and sequence diagrams. The component and state transition diagrams demonstrate the working of each component in every state.

4.1. Architecture Deployment Diagram

This diagram is a visual representation of all the elements and various components that make up our app. It will help the engineers, designers, stakeholders and people involved in the project understand app's layout.

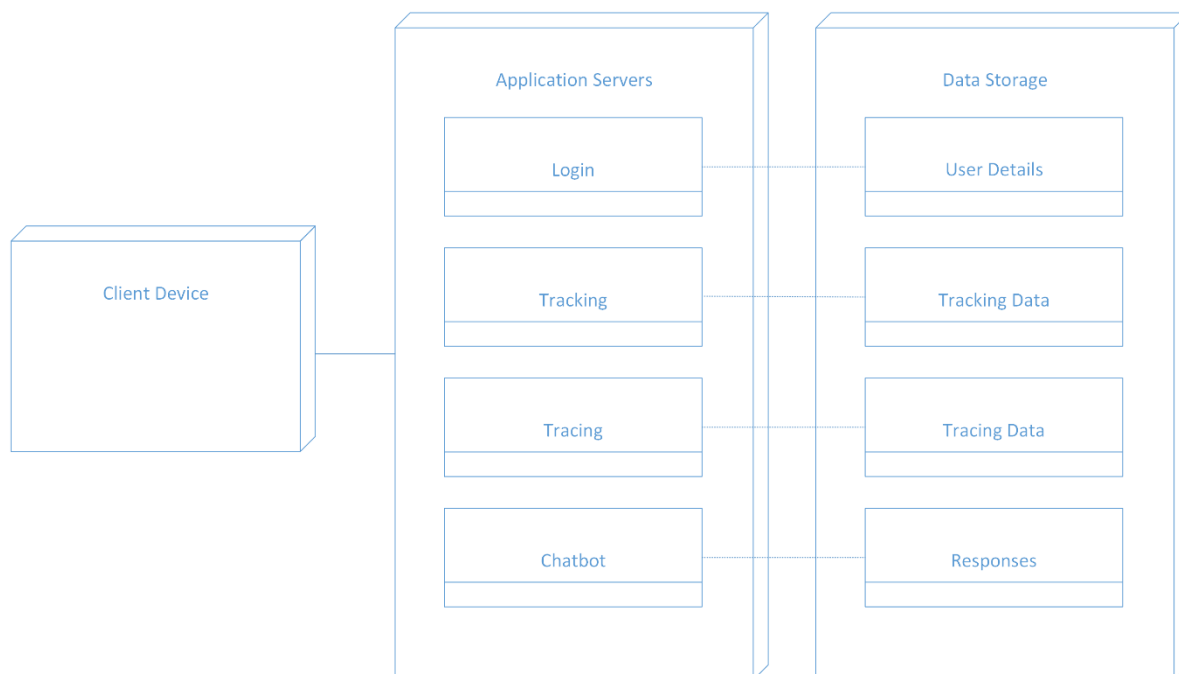


Figure 4.1. Architecture Diagram

4.2. Domain Model

This domain model is a conceptual model that illustrates the set of class diagrams without methods. It describes and models real world entities and the relationships between them, which collectively describe the problem domain space.

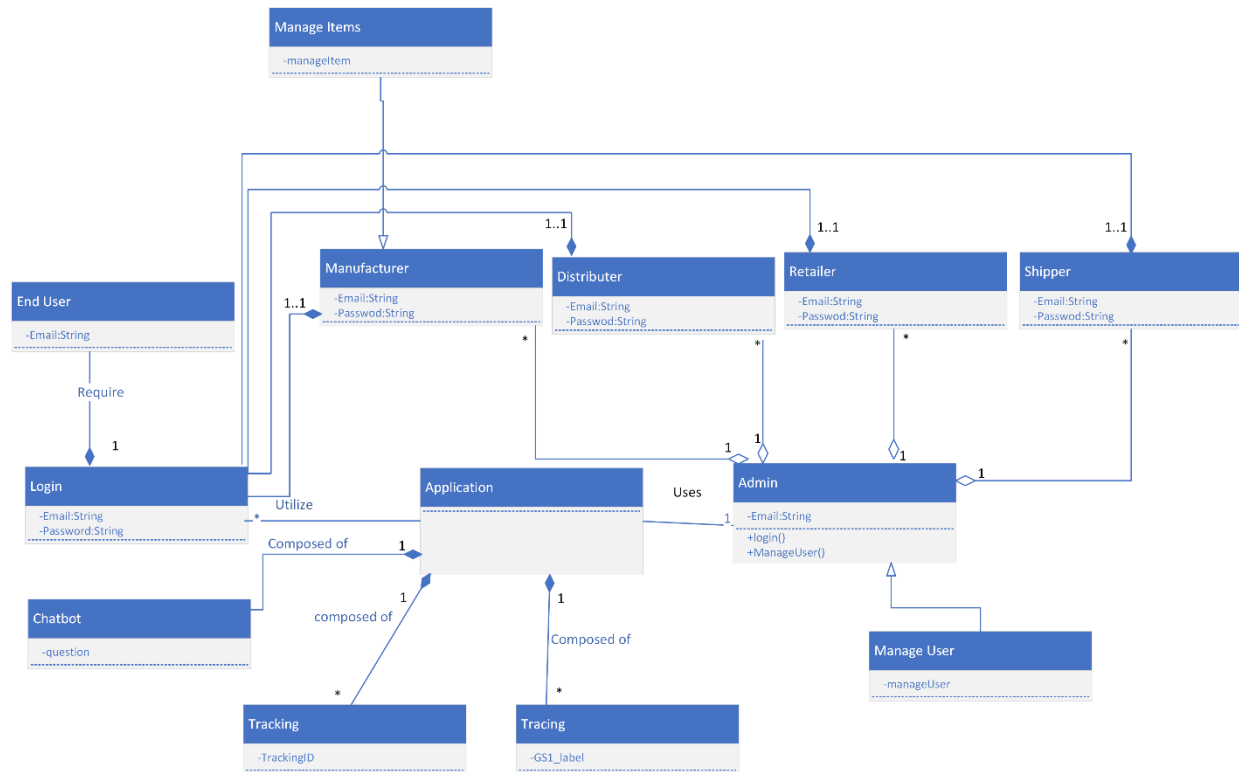


Figure 4.2. Domain Model

4.3. Class Diagram

This diagram of our system is used to represent the relationships between the system's components' relationships, model the components' interactions, and define the functions and services of the components.

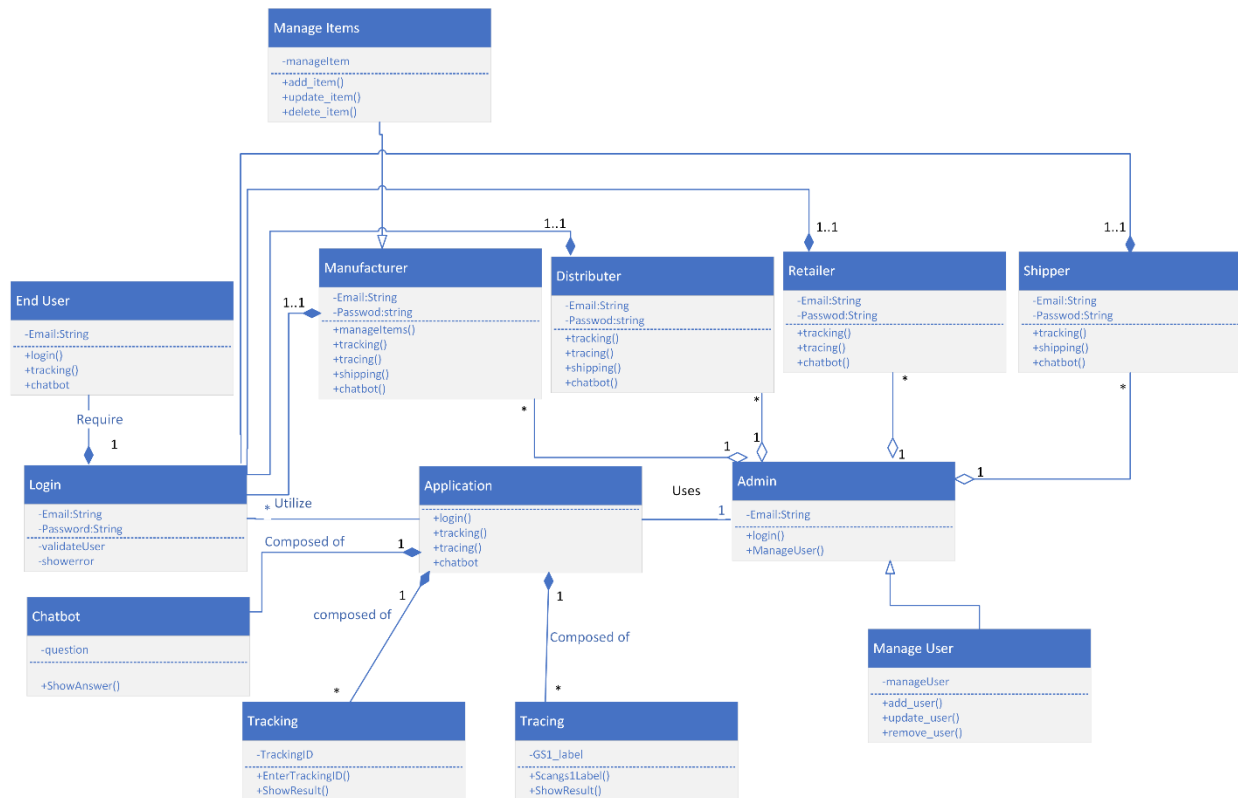
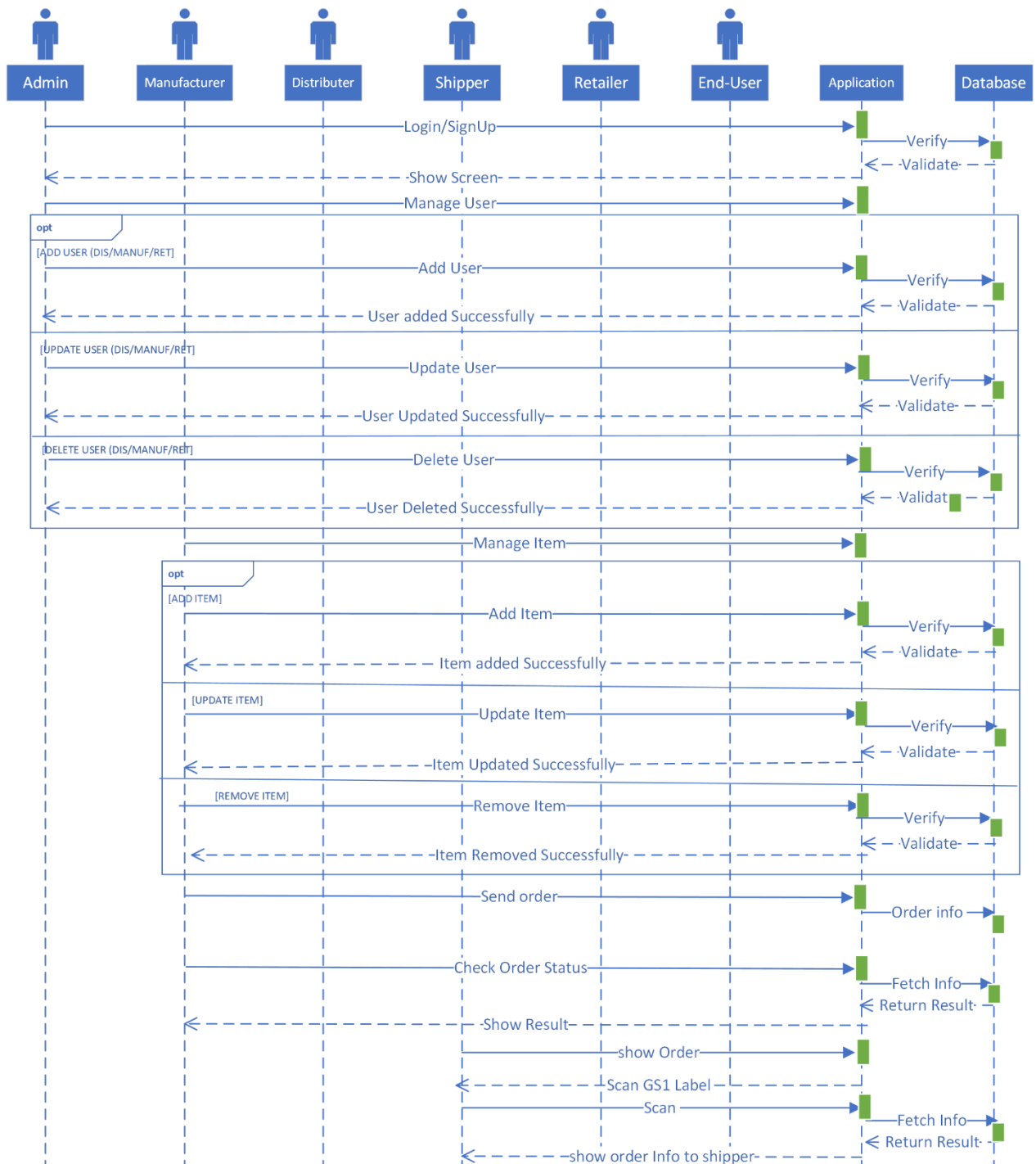


Figure 4.3. Class Diagram

4.4. Sequence / Collaboration Diagram



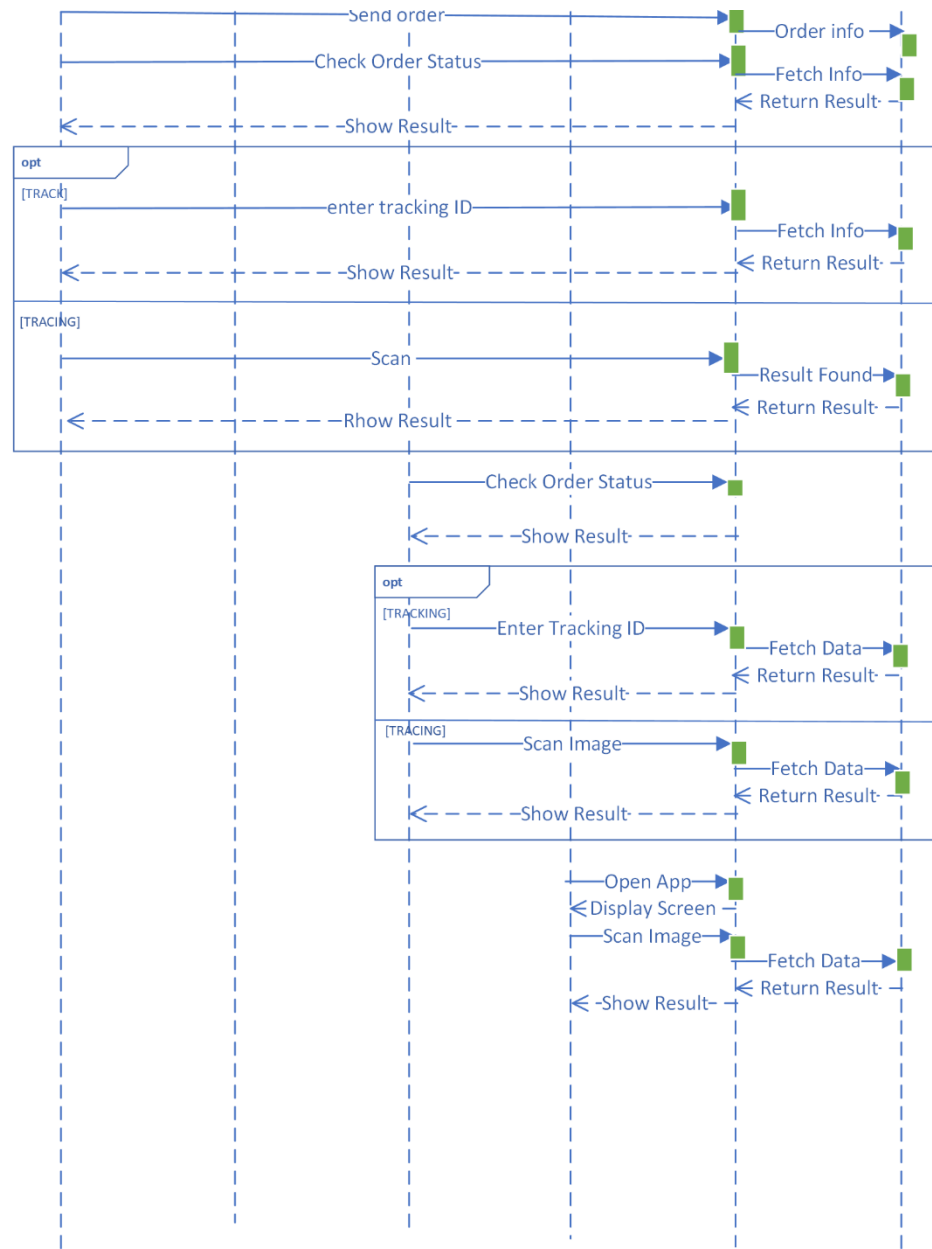


Figure 4.4 Sequence Diagram

4.5. Operation contracts

These operation contracts describe detailed changes to objects in a domain model, as the result of a system operation made when user perform operations.

Operation Contract 1:

Name	Login
Responsible	User is logged in
Reference	Use case Login
Pre-Condition	User must be registered
Post Condition	Home Screen

Operation Contract 2:

Name	Register
Responsible	User must sign up
Reference	Use Case Register
Pre-Condition	Main Menu
Post Condition	Home Screen

Operation Contract 3:

Name	Home Screen
Responsible	Display the options
Reference	Use case Complete
Pre Condition	Login
Post Condition	Select an Option

Operation Contract 4:

Name	Tracking
Responsible	User will add the tracking ID
Reference	Use case Tracking
Pre Condition	Home Screen
Post Condition	Tracking Result

Operation Contract 5:

Name	Tracing
Responsible	User will scan GS-1 label
Reference	Use case Tracing
Pre Condition	Home Screen
Post Condition	Tracing Result

Operation Contract 6:

Name	Chatbot
Responsible	User select customer Support
Reference	Activity Chatbot
Pre Condition	Navbar
Post Condition	AI based chat support

Operation Contract 7:

Name	Dispatch Order
Responsible	User select to dispatch order
Pre Condition	Manufacturer or Distributer Dashboard
Post Condition	Order sent to shipper

Operation Contract 8:

Name	Order Status
Responsible	View Order Status
Pre Condition	Dashboard is accessed
Post Condition	Order status check

Operation Contract 9:

Name	Shipping
Responsible	Ship order to receiver
Pre Condition	Shipping Dashboard is accessed
Post Condition	Order shipper

4.6. Activity Diagram

The activity diagram of our system visually presents a series of actions or flow of control in a system. It also describes the steps in a use case diagram.

- **Admin:**

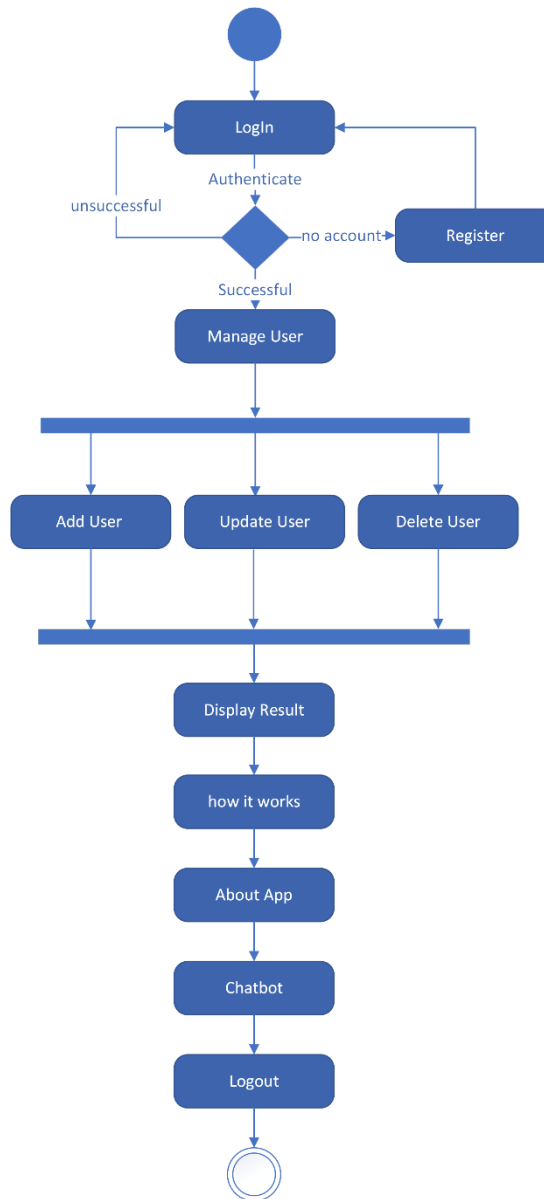


Figure 4.5.1. Admin Activity

- Tracking:

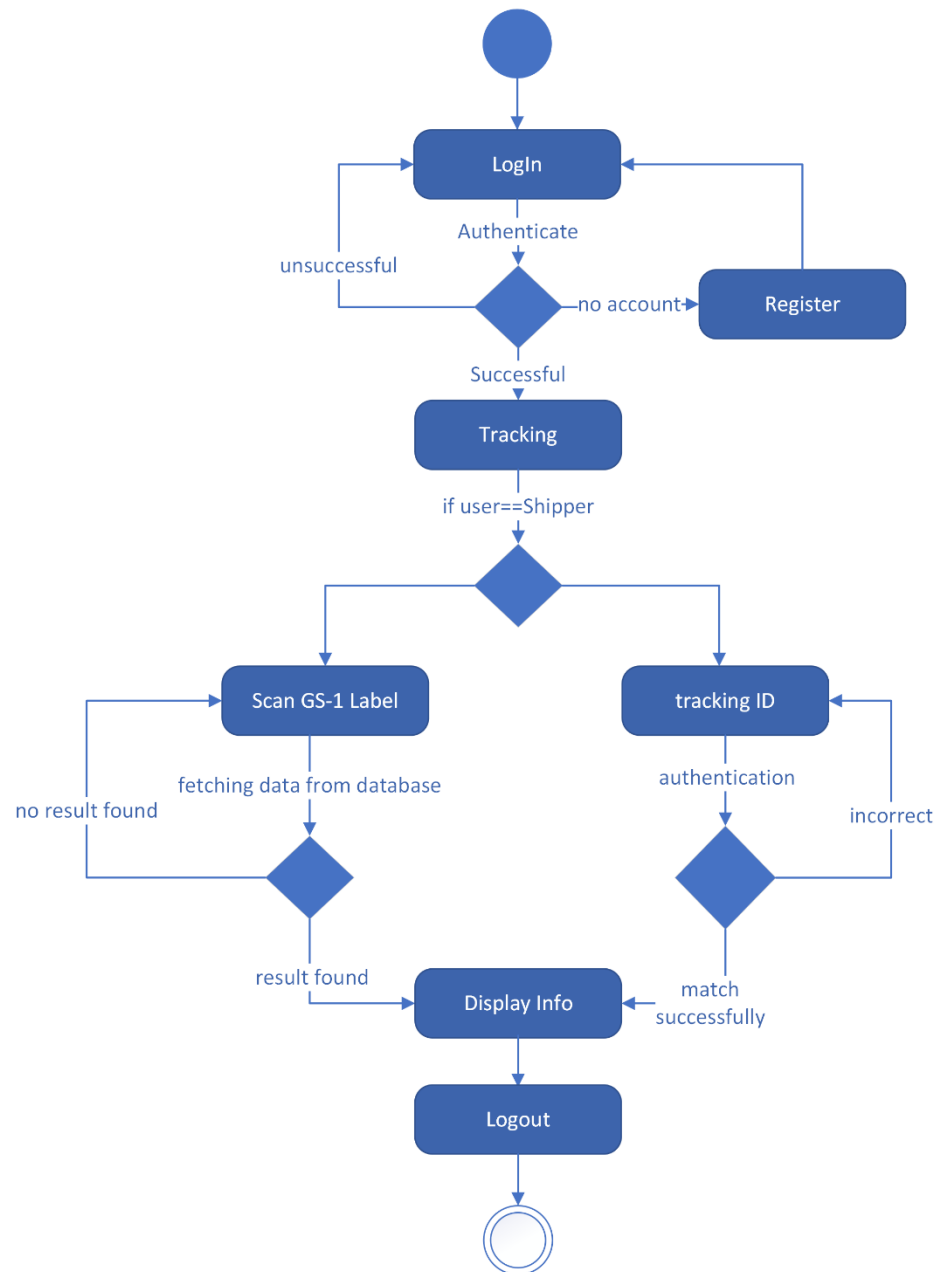


Figure 4.5.2. Tracking Activity

- **Tracing:**

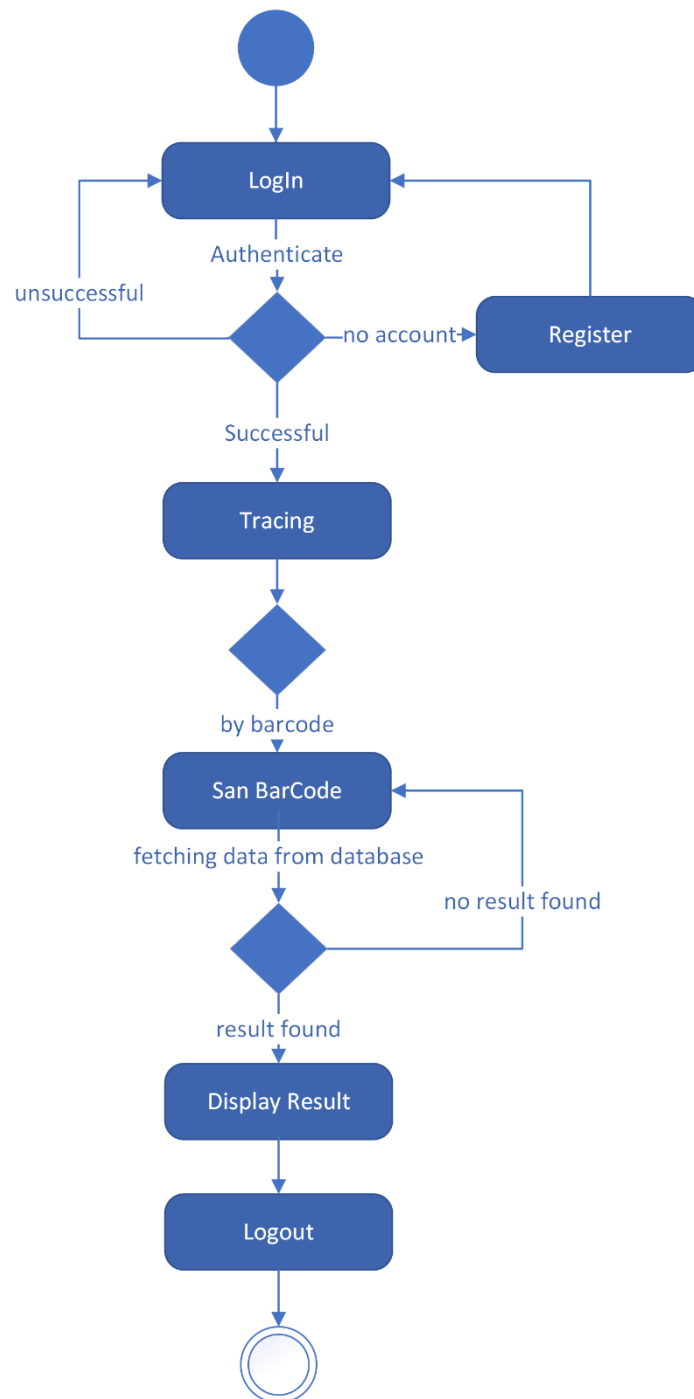


Figure 4.5.3. Tracing Activity

4.7. State Transition Diagram

A finite state machine is represented by this state transition diagram. It models the objects whose interactions with the outside world can be explained by changes in state in response to variations in the number of events. These objects have a finite number of possible states.

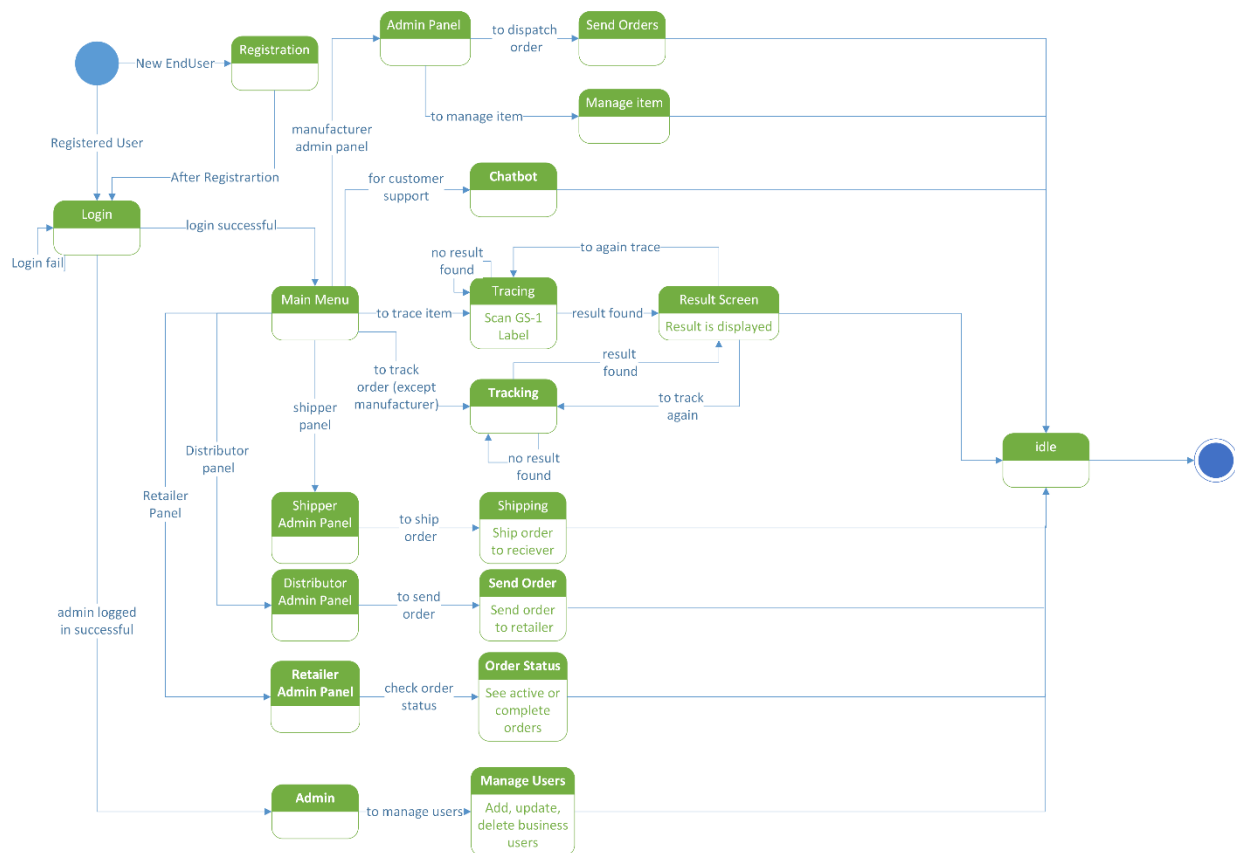


Figure 4.6. State Machine Diagram

4.8. Component Diagram

This component diagram is showing the relationship between different components in a system.

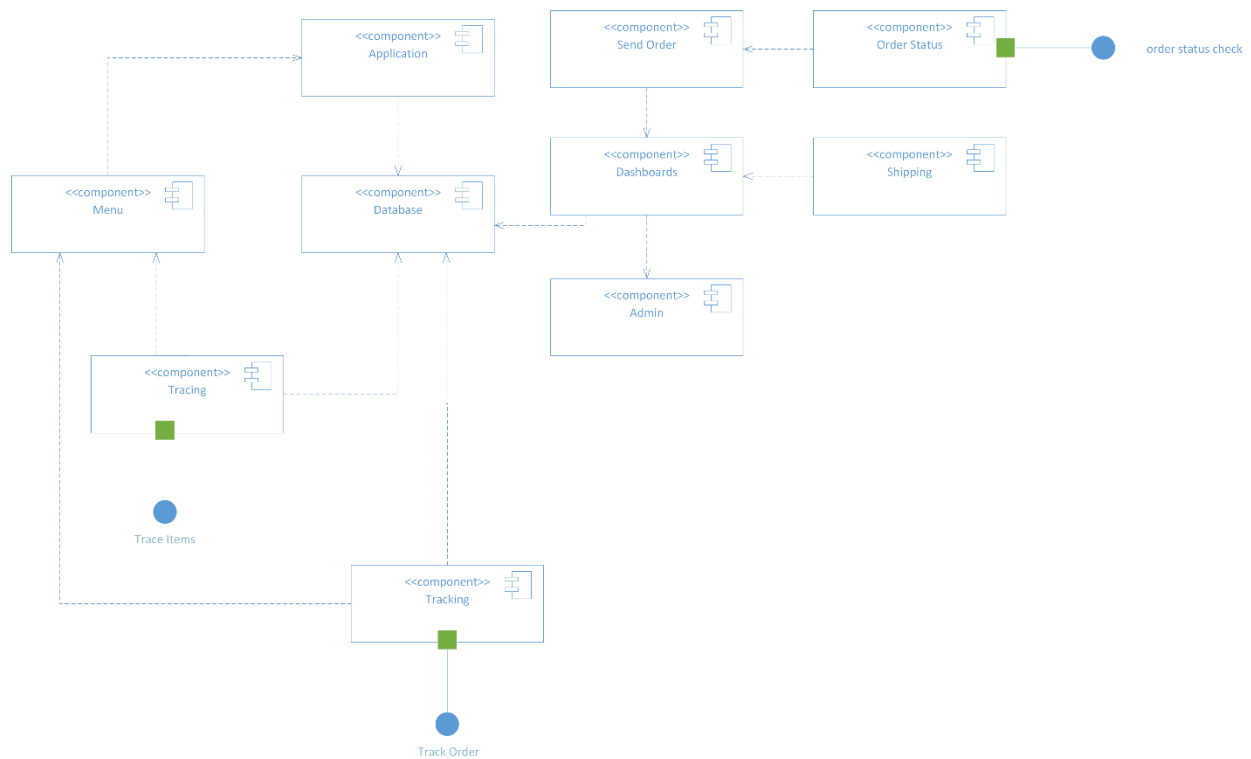


Figure 4.7. Component Diagram

Chapter 5

Implementation

Chapter 5: Implementation

This chapter describes the project implementation for developing the project GS1 based Track and Trace Solution's mobile application. The project implements Android, Java, Kotlin, Python and other technologies like Firebase Database. The project will be able to run on Android phones. The interface for the project will provide a single platform where you can track and trace products using GS1 labels.

5.1. Important Flow Control

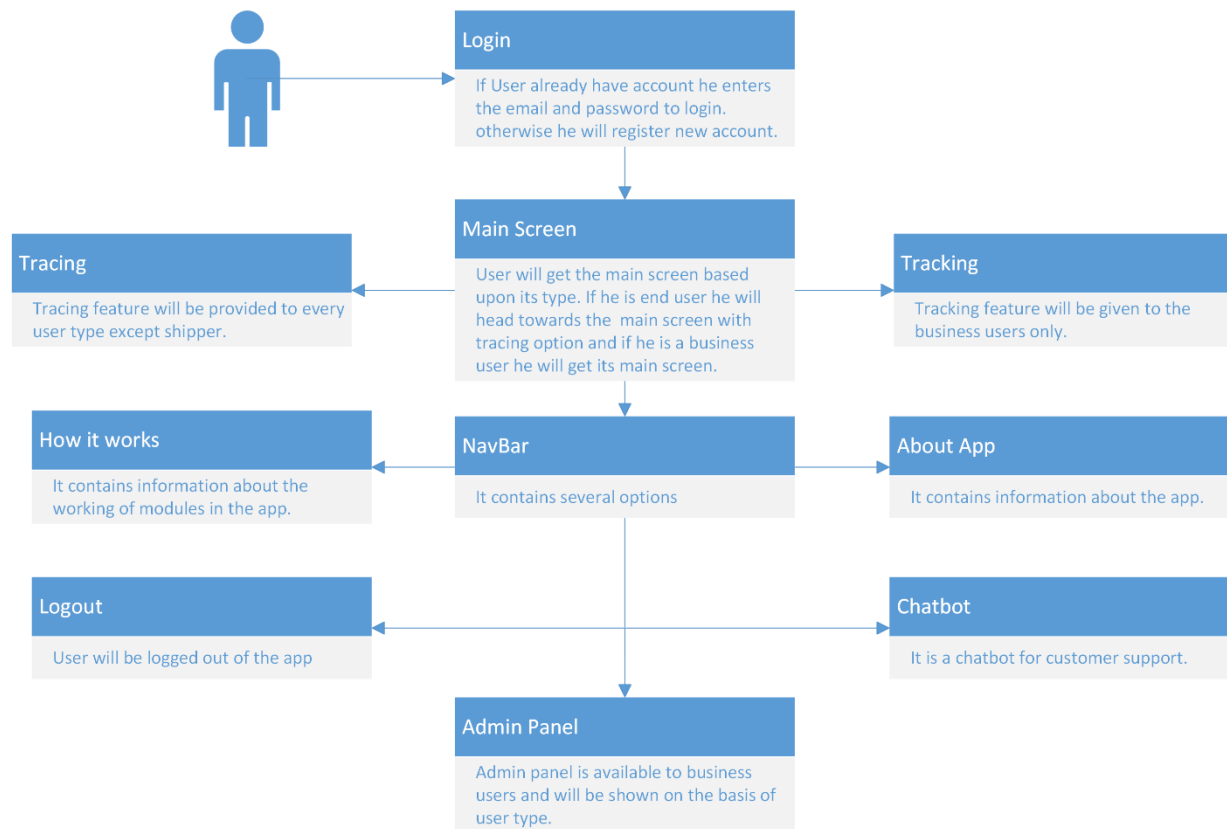


Figure 5.1. Flow Control

5.2. Components, Libraries, Web Services and stubs

Firebase is a Google backed database which is a cloud hosted NoSQL database that enables you to store sync and query app data at globe scale. We are using Firebase Authentication for User and Admin login which verifies the credentials of the users. Firebase Realtime Database will hold all the data used for tracking, tracing, shipping, and users.

5.3. Deployment Environment

We developed this project in Windows 10 using the Android Studio which is an open-source application for android app development and PyCharm for AI chatbot development. We are providing the solution which is mobile application using Android.

5.4. Tools and Techniques

The tools and techniques that are required are listed below:

- **Frontend of App:**
Android Studio (XML)
- **Backend of App:**
Firebase Database (Cloud Store)
Python Flask (Chatbot)
Application(Java and Kotlin)
- **Designing:**
Adobe Illustrator
Microsoft Visio
- **API Testing:**
Postman

5.5. Best Practices / Coding Standards

- Defined life cycle and milestone
- Stable requirements and scope

- Defined organization, systems and roles
- Quality Assurance
- Plan Commitments
- Scope and mission

5.6. Version Control

We are currently working on the version 1.0 of the application. The changes will occur and effect the version by the time as the app is still in development stage.

Chapter 6

Testing and Evaluation

Chapter 6: Testing and Evaluation

6.1. Use Case Testing

Table 6.1.1. Login Use Case Testing

Main Success Scenario	Steps	Description
Login A: Actor S: System	1.	A: Enter Email and Password
	2.	S: Validate Email and Password
	3.	S: Allow Account Access
Extensions	2a.	<u>Email not Valid</u> S: Try again or register new account
	2b.	<u>Password not Valid</u> S: Try again or click forget password to get new one

Table 6.1.2. Register Use Case Testing

Main Success Scenario	Steps	Description
Register A: Actor S: System	1.	A: Enter new Email and Password
	2.	S: Check Email pattern and Password Length
	3.	S: Create new account and allow account access
Extensions	2a.	<u>Email Pattern not Correct</u> S: Write correct pattern of email
	2b.	<u>Password Length is short</u> S: Set password with length greater or equal to 6

Table 6.1.3. Tracking Use Case Testing

Main Success Scenario	Steps	Description
Tracking A: Actor S: System	1.	A: Enter Tracking ID
	2.	S: Check for results in database against Tracking ID
	3.	S: Show results based on Tracking ID
Extensions	2a.	<u>Invalid Tracking ID</u> S: System asks for valid Tracking ID

Table 6.1.4. Tracing Use Case Testing

Main Success Scenario	Steps	Description
Tracing A: Actor S: System	1.	A: Scan GS-1 label
	2.	S: Check for results in database against GS-1 label scanned
	3.	S: Show results based on Tracking ID
Extensions	2a	<u>No result found</u> S: System asks for valid Tracking ID

Table 6.1.5. Chatbot Use Case Testing

Main Success Scenario	Steps	Description
Chatbot A: Actor S: System	1.	A: Asks Question
	2.	S: Searches for answer against question
	3.	S: Gives Answer

Table 6.1.6. Order Dispatch Use Case Testing

Main Success Scenario	Steps	Description
Order Dispatch A: Actor S: System	1.	A: Fill form
	2.	S: Checks for validations
	3.	S: Order dispatched to specific receiver on app
Extensions	2a.	<u>Empty Field</u> S: Please enter in this field.
	2b.	<u>Invalid Entry</u> S: Please Enter a valid entry.

Table 6.1.7. Shipping Use Case Testing

Main Success Scenario	Steps	Description
Shipping A: Actor S: System	1.	A: Scans GS1 label
	2.	S: Shows Order Details
	3.	S: Order dispatched to specific receiver on app
Extensions	2a.	<u>Empty Field</u> S: Please enter in this field.
	2b.	<u>Invalid Entry</u> S: Please Enter a valid entry.

6.2. Equivalence partitioning

In **Register activity**, it is defined that the password must be greater than 5 digits and less than 20. If the password entered is less than 6 digits that will be an invalid password. But if the password will be greater than 5 digits, then the equivalence partitioning will show valid password.

Table 6.2.1. Register Activity EP

Equivalence partitioning		
Invalid	Valid	Invalid
Digit < 6	Digit > 5	Digit<20

In **tracing activity**, each of the product has specific code against the GS1 label. We can search for product by scanning the GS1 label which contains that specific code for the product.

Here is the list of products, and user wants to find Dumore. Here we have some products with their codes.

Table 6.2.2.1 Tracing Activity Reference Table

Product	Code
Dumore	9867555559
Panadol	9456732145
Flagyl	6783265713
Pallete-red-01	1297458324
Grater-ch	4512384563

If user will write any code other than 9867555559 there will be an error. If user will enter the code 9867555559 then equivalence partitioning method will show a valid code.

Table 6.2.2.2. Tracing Activity EP

Equivalence Partitioning		
Invalid	Invalid	Valid
1297458324	4512784563	9867555559

In **tracking activity**, each of the order has specific tracking ID. We can track order by giving the exact tracking order.

Suppose user wants to track an order with Tracking ID 22322315265855.

If user will write any code other than 22322315265855 there will be an error. If user will enter the code 22322315265855 then equivalence partitioning method will show a valid code.

Table 6.3. Tacking Activity EP

Equivalence Partitioning		
Invalid	Invalid	Valid
12974583242356	45127845639878	22322315265855

6.1. Boundary value analysis

Boundary Value Analysis is based on testing the boundary values of valid and invalid partitions.

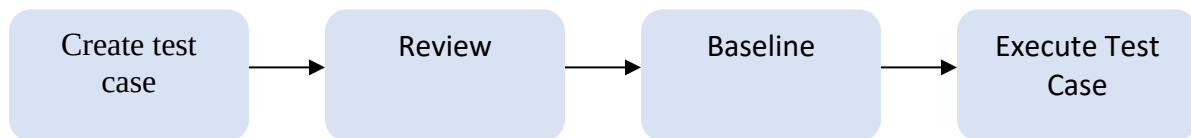
For Register,

Table 6.4. Register Activity BVA

Boundary Value Analysis		
Invalid(min-1)	Valid(min, min+1, nominal, max-1, max)	Invalid(max+1)
5	6,7,12,18,19	20

6.2. Unit testing

Workflow of Unit Testing:



Unit Testing tools for this application will be:

- Jtest
- Junit

6.3. Integration testing

The testing between two or more modules of a system is called integration testing.

For the integration testing of this system, we will use:

- Protractor
- Steam
- TESSY

6.4. Performance testing

Performance testing is done for checking the performance of the application. We will do the performance testing to check the Speed, Scalability, Stability and Reliability of the app.

Performance testing tools used will be:

- Jmeter
- Open STA

6.5. Stress Testing

Stress testing will be done for checking the robustness of the system. It will be done using these tools:

- Jmeter

Chapter 7

Summary, Conclusion and Future Enhancements

Chapter 7: Summary, Conclusion & Future Enhancements

7.1. Project Summary

The application GS-1 based Track and Trace Solution is made for tracking and tracing through GS-1 labels and GS-1 standards. There will be the features of tracking, tracing, chat support and shipping. The app is developed for both end-user who uses the product and needs to know the authenticity of the product and for business-to-business shipping and tracking. The main users of the application are: end-user, manufacturer, distributor, shipper, and retailer. The business-to-business users which are using the app mainly for the tracking and shipping will be allotted logins made by the admin. Admin will be responsible for making the logins of these users. Manufacturer is also responsible for adding the items details for tracing purposes. All the users have access to the chat support that is an AI based Chatbot.

7.2. Achievements and Improvements

We have successfully achieved a system that is performing the tracking, tracing and shipping. All the functions are working and basic validations are applied.

Improvements are required in the User-Interface to make it more friendly to the users.

7.3. Critical Review

This application is providing a common language between the businesses so that the business processes become less time consuming and error free. It also helps the businesses in trading across the border as every country as the same GS-1 standards and there will be no problem in trading. App has executed all the features based on the GS-1 standards.

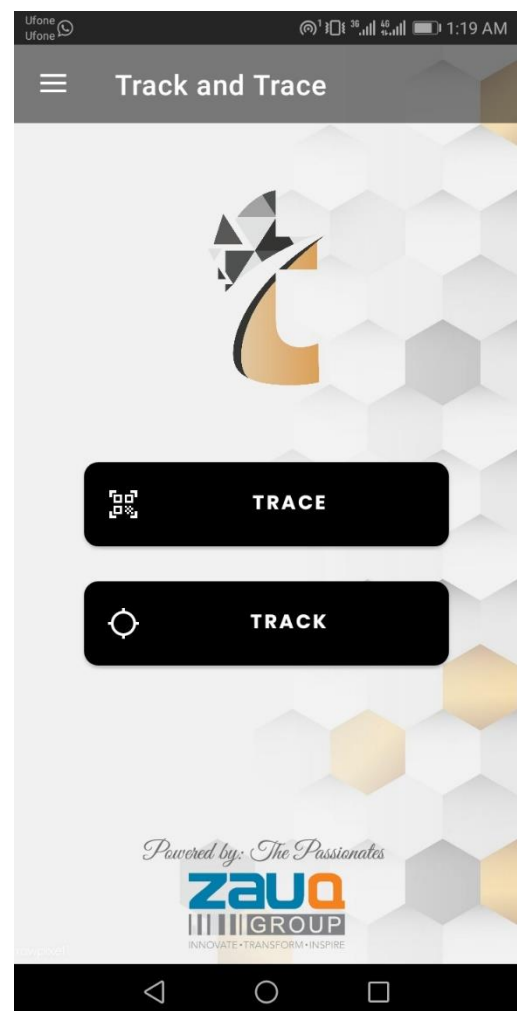
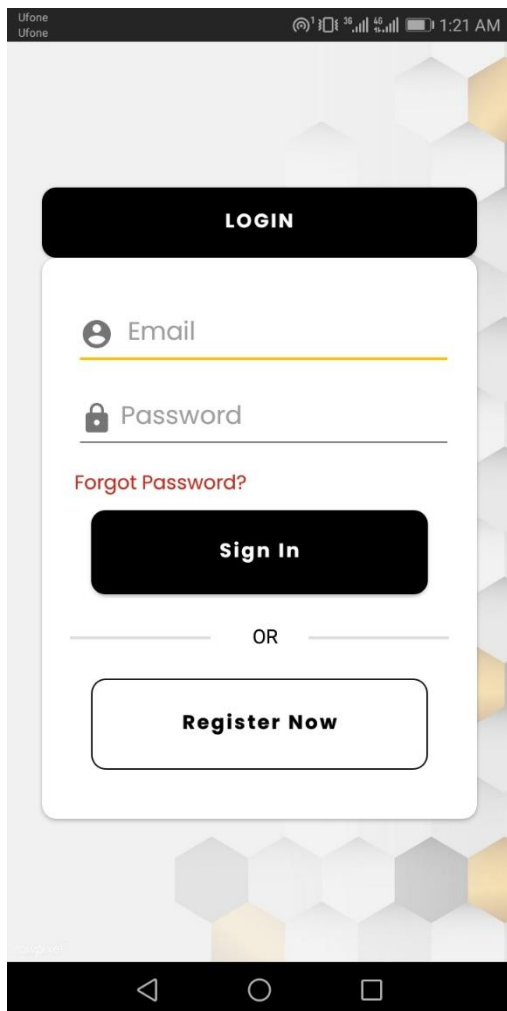
7.4. Lessons Learnt

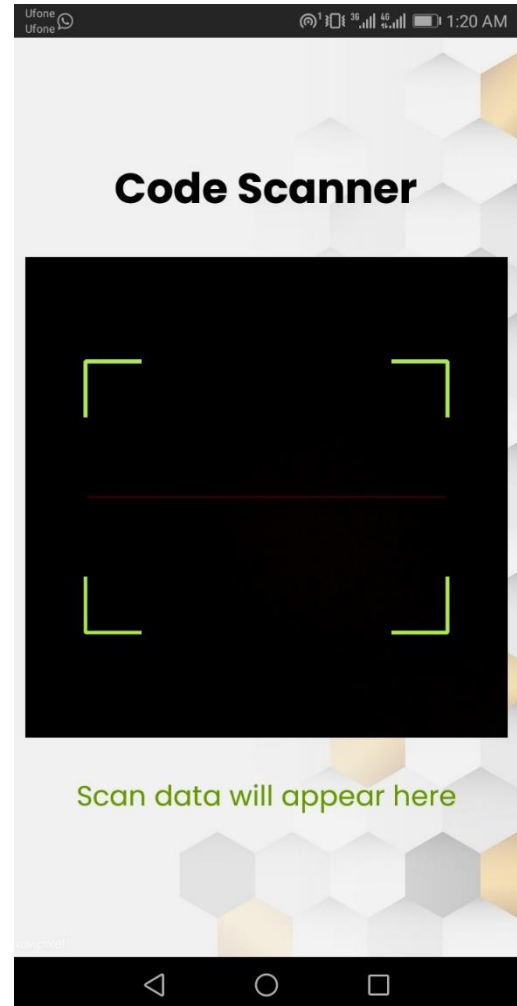
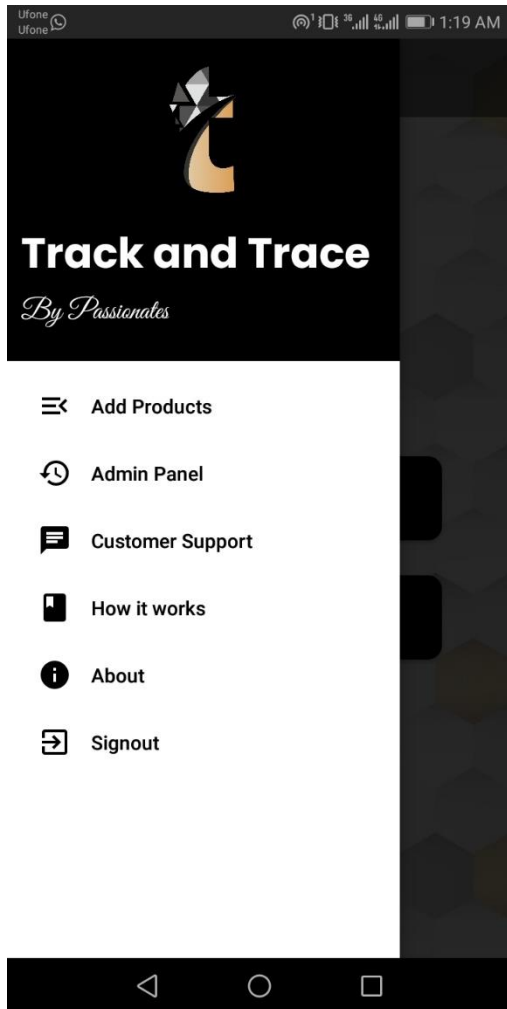
When you start working on a module, complete its functionalities and validations and then move towards the next module. So, in case if two modules are working with each other, one module do not disturb the working of another module.

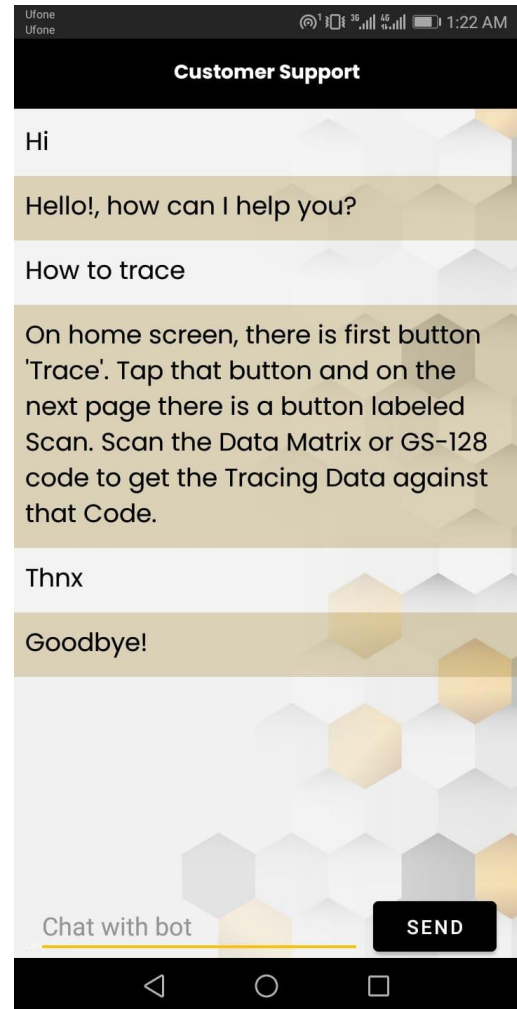
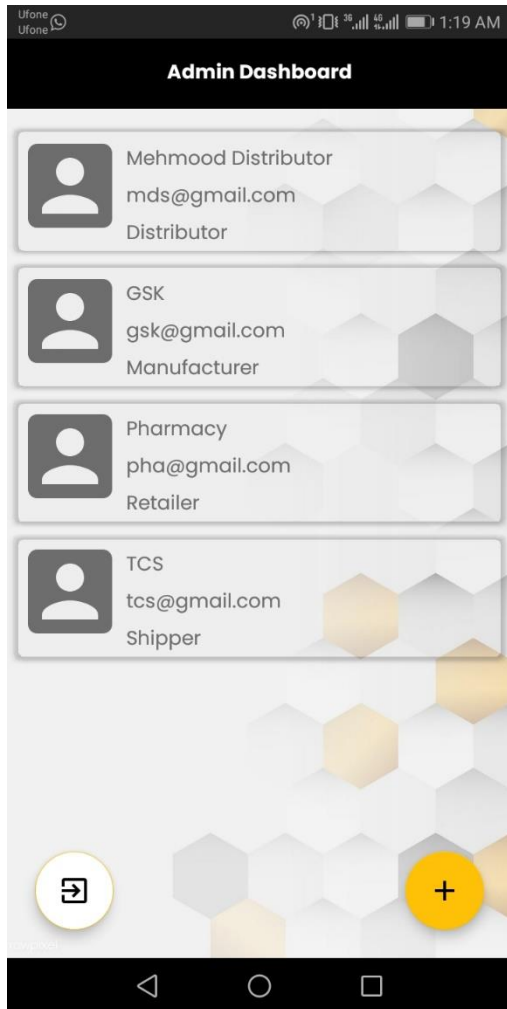
7.5. Future Enhancements/Recommendations

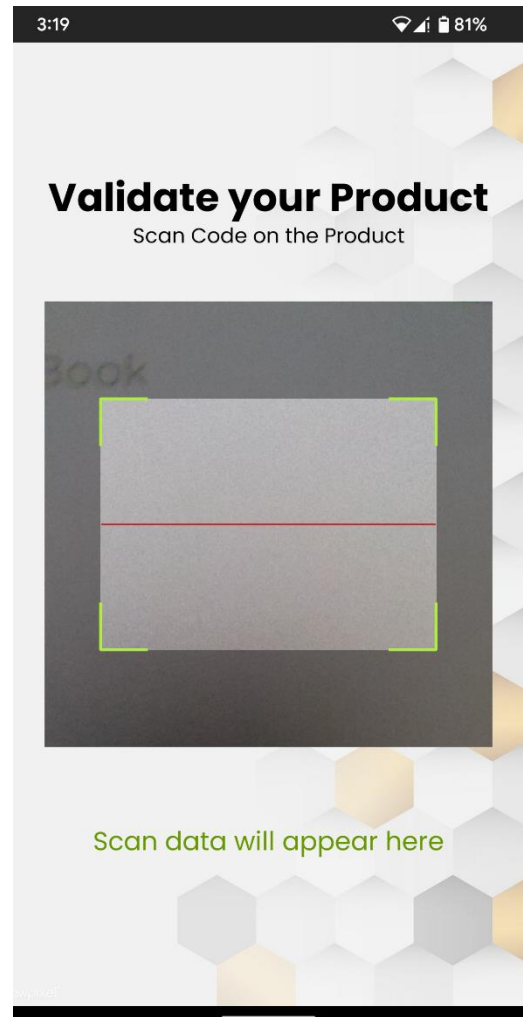
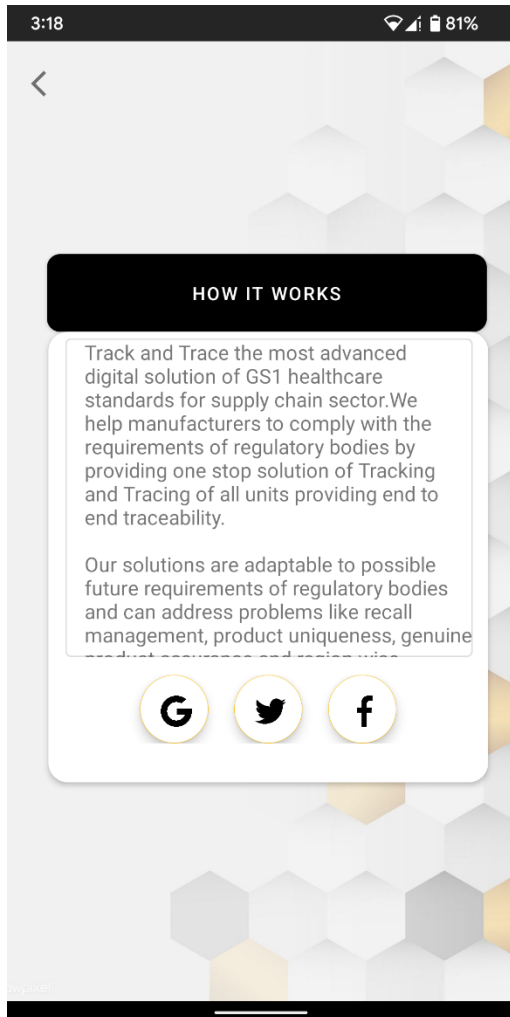
The tracking feature is restricted for businesses till now. In future, the scope of the app will be enhanced by making the tracking feature available for the end-user.

7.6. Screenshots









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