



# SMART CONTAINER

## CCIT 521 Final Report

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## Abstract

City administrations and waste management organizations in various major cities are faced with the challenge of providing an efficient and effective waste collection, disposal and recycling system while respecting health and environmental standards. In waste management, collection, transportation, and transportation practices are negatively affected by improper garbage collection systems, lack of information about the collection schedule, ineffective route planning, insufficient resources, and other factors. Moreover, waste facilities greatly influence the way waste is disposed of. Inadequate supplies, appropriately stored waste containers, and long distances to these containers increase the potential for waste to be dumped in open areas and elsewhere.

The smart bin helps to collect waste faster, as there is a digital map inside the application in which the bins are located, and when the bin is full, its color will be changed, which helps to dispose of it professionally and more quickly. The container also divides the waste, making it easier for the competent authorities to recycle, which helps reduce the waste of resources. The application determines the optimal path for the collection of containers, which helps to avoid road congestion .



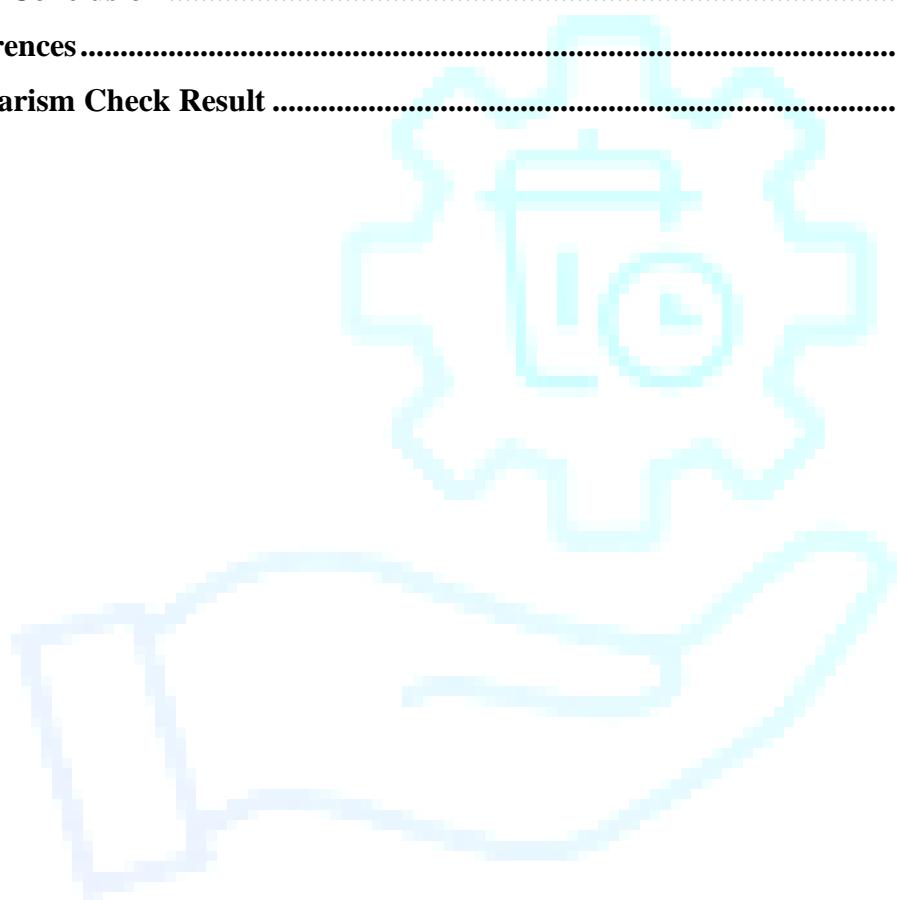
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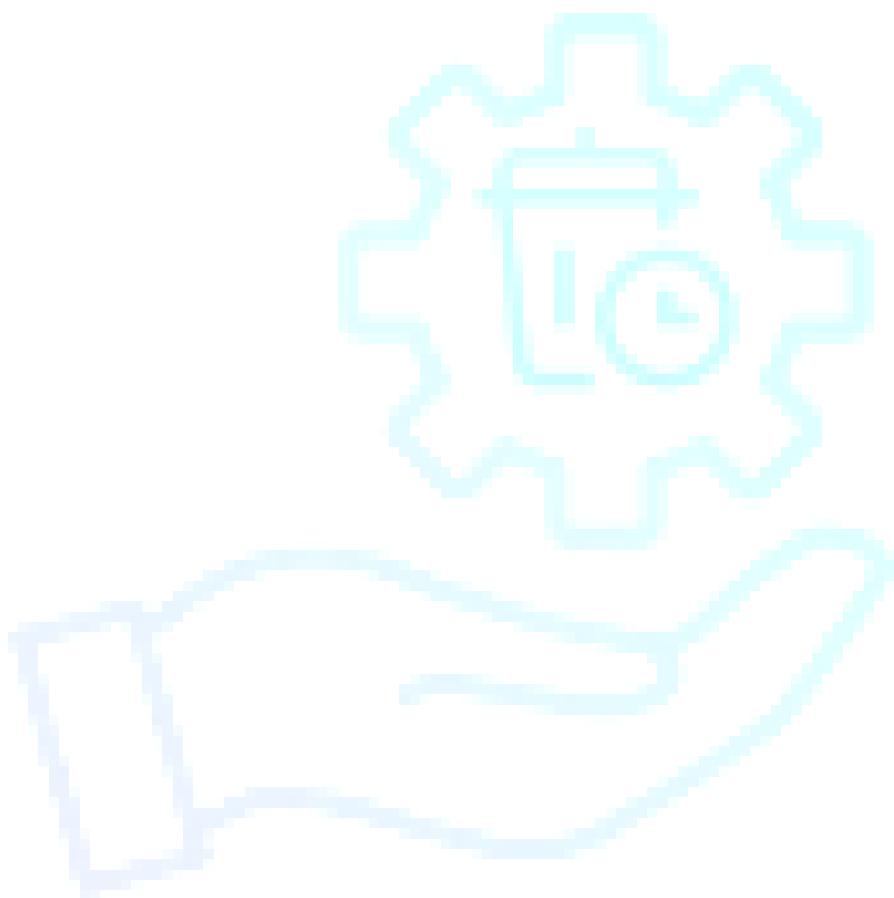


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# Chapter I: Project Planning



## 1.1. Introduction

The Kingdom of Saudi Arabia is witnessing an increase in population growth and an increase in the number of new cities so that has led to an increase in waste so Waste management has become a major challenge with a population of nearly 34 million people. So now we cannot Waste management traditionally and manually because it leads to a waste of time, effort and money, its also does not comply with the vision of the Kingdom of

Saudi Arabia 2030 and the progress it is making! So managing waste smartly will overcome the waste of time, money and effort and it will be In line with the vision of the Kingdom, so we present to you the Smart Container, which in turn will work on waste management in an intelligent manner! The smart waste management system can be implemented in all smart places and cities in the Kingdom of Saudi Arabia, and the collection of containers will be high, and the places will be clean, tidy and free of unpleasant odors with less effort, time and money.



## 1.2. Problem definition

smart container management is an idea by which we can control a lot of problems Preserving the environment from pollution and disease. Among the problems caused by traditional waste management are:

- 1- There are no easy and flexible ways to know when to empty a container
- 2- It may be time to collect the waste and the container is not full yet
- 3- Different types of waste may be placed in the same container and those responsible are not aware of this
- 4- A waste of human time and effort.

## 1.3. Recommended solution

To solve this problem, we use the smart container management system.

Smart container management is characterized using technology to make containers more efficient

The system calculates the percentage of the container's fullness to know when it should be emptied of waste and plans more easier paths for waste collection and classification of materials for recycling



### 1.3.1 include Smart bin

- specify the type of waste entering the bin. If the waste matches the type of bin, it is entered. If the waste does not match the type of bin, it will not be entered.
- Detergent is notified if the container is full to be emptied

### 1.3.2 Optimizing the path

- Place all smart container locations inside the map
- Identification of trucks that collect waste
- Collect containers that change color on the map
- Distribute containers in neighborhoods in a specific order

### 1.3.3 Recycling and disposal

- The type of containers filled with colors is specified in the application
- Metal (Red) Plastic (Green) Other (Yellow)

### 1.3.4 Resource management

- Monitor all containers
- Find out the most used waste
- Find out what waste is being consumed
- Find out if the waste inside the container is of the same type or not
- Know the peak days and times of waste collection



## 1.4.Scope and aims of the project

This project aims to increase the preservation of the environment and reduce pollution through:

- Encouraging community members to recycle unwanted items and waste effectively Using the intelligent container management system
- The application will be developed on the mobile phone
- The application facilitates for officials the process of managing containers and controlling the tracks of trucks for unloading containers in a way that saves time and effort for workers
- It facilitates the recycling process by separating the materials from each other
- The application produces more efficient containers for preserving the environment
- Disposing of waste in professional and smart ways that help preserve the environment
- Intelligent human resource management
- Having an intelligent system for collecting smart containers





## 1.5 Objective

smart container management is an idea by which we can control a lot of problems It disturbs society in pollution and disease and facilitates recycling for professionals The authorities split the container. Waste management must be done immediately, otherwise it will lead to irregular administration which will have negative effect in nature.

### The main objectives:

- 1-include smart bin
- 2-optimizing the path
- 3-Recycling and disposal
- 4-Resource management

## 1.6.Target users ( stakeholders ) :

- 1- Amanah Jeddah
- 2- container collectors
- 3- Administrator



## 1.7 Project phase :

### 1-Planning phase

- 1.1. Choose the idea and collect the relative information.
- 1.2. Determine problem.
- 1.3. Determine a solution.
- 1.4. Determine project goals and aims.
- 1.5. Create the Gantt chart
- 1.6. Specify target users.

### 2-Analysis phase

- 2.1. Find similar application.
- 2.2. Comparison between similar application and our application
- 2.3. Requirement Gathering(interview).
- 2.4 Literature Review

### 3-Design phase

- 3.1 Prototype Design.
- 3.2 User Interface Design.
- 3.3 Design Sequence Diagram.
- 3.4 Design Class Diagram
- 3.5 Design usecase Diagram.



## 4-Implementation phase

- 4.1. Write the code.
- 4.2. Implement the database.

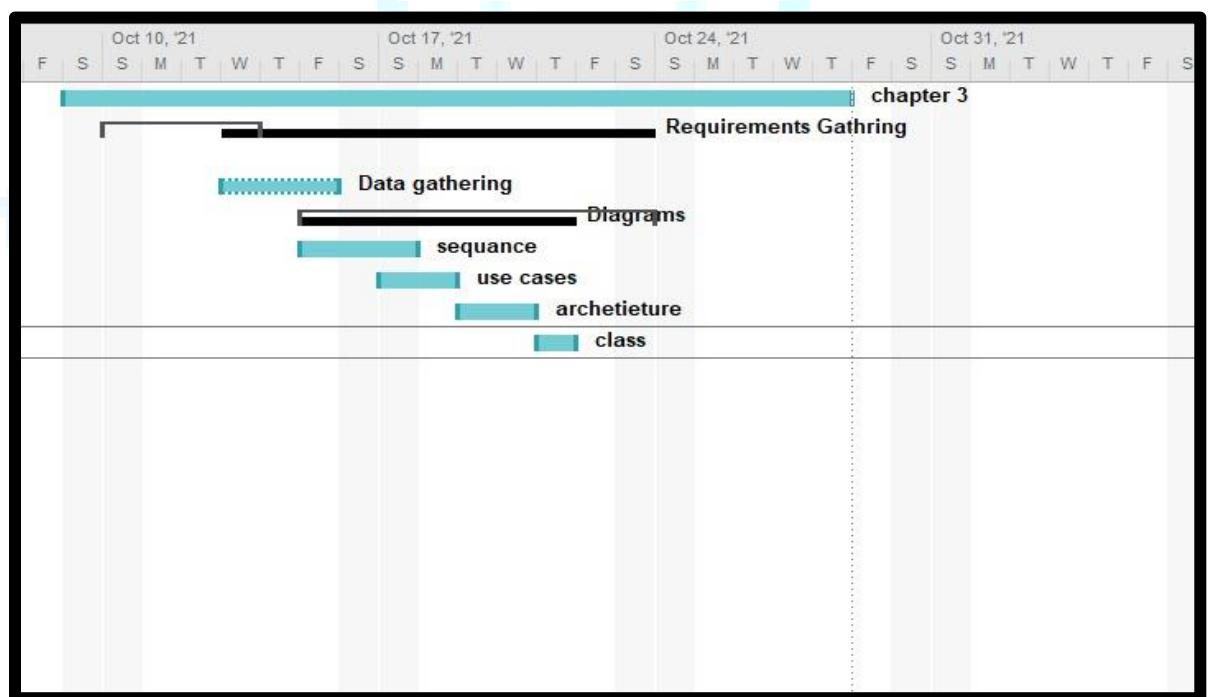
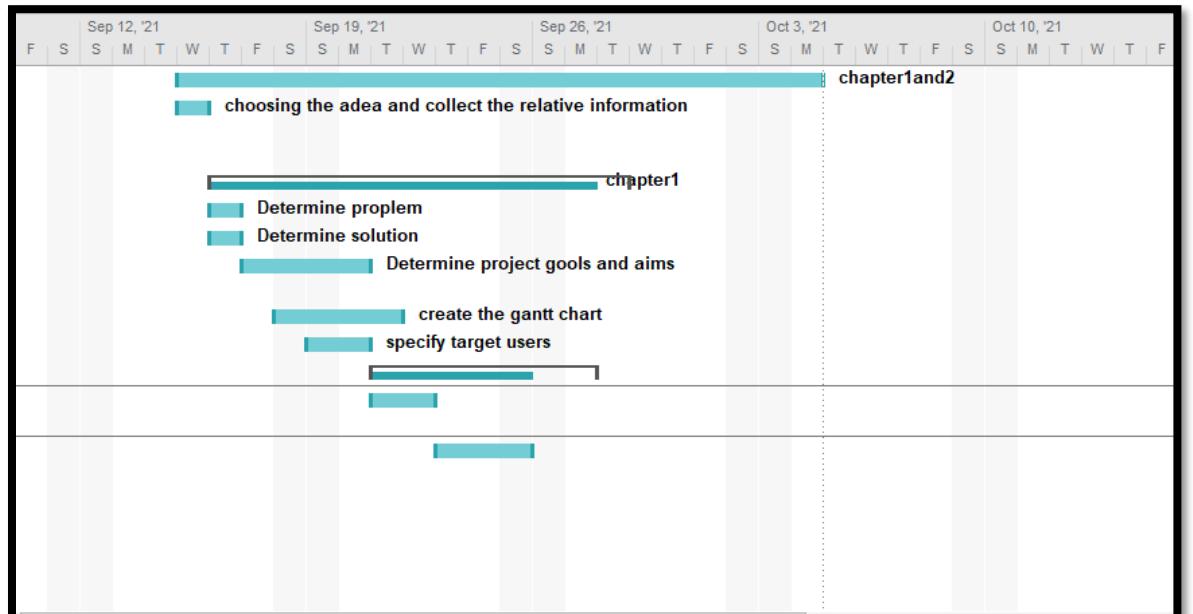
## 5-Testing phase

- 5.1. Define the test cases.
- 5.2. Perform the test cases.

## 6-Maintenance phase

- 6.1. Solving problems.
- 6.2. Modify the application to meet new requirements.

## 1.8 Gantt Chart



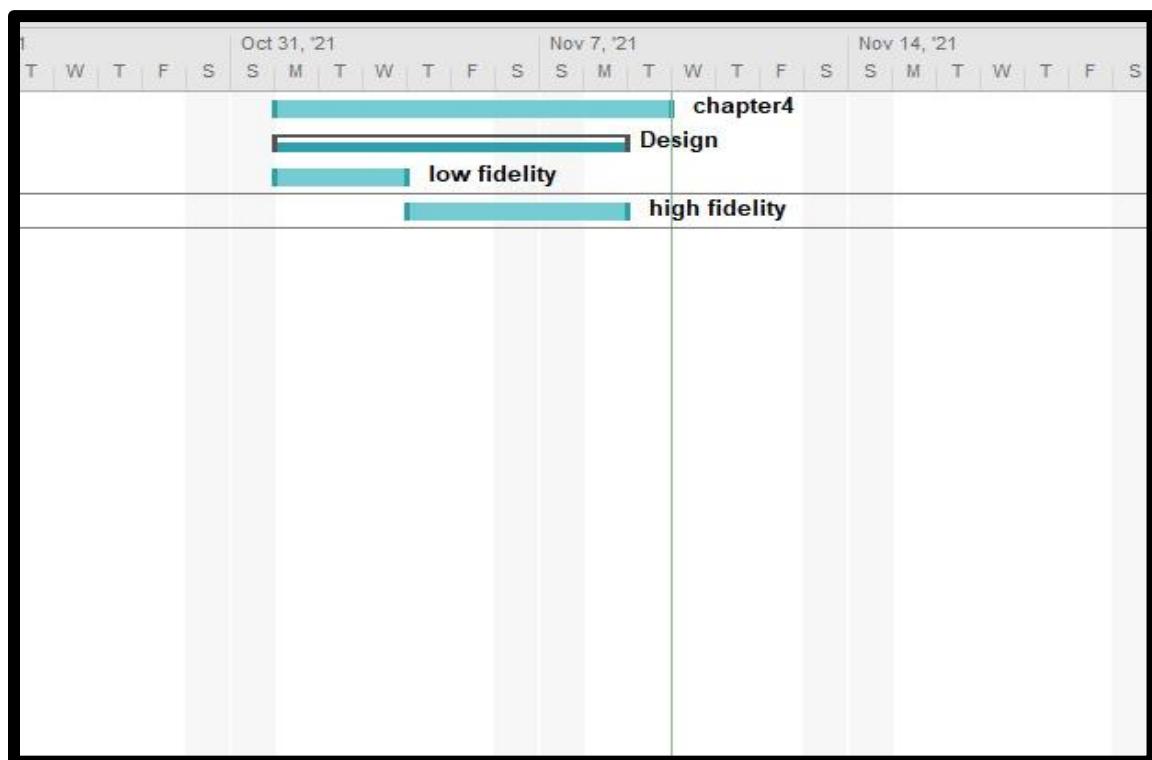
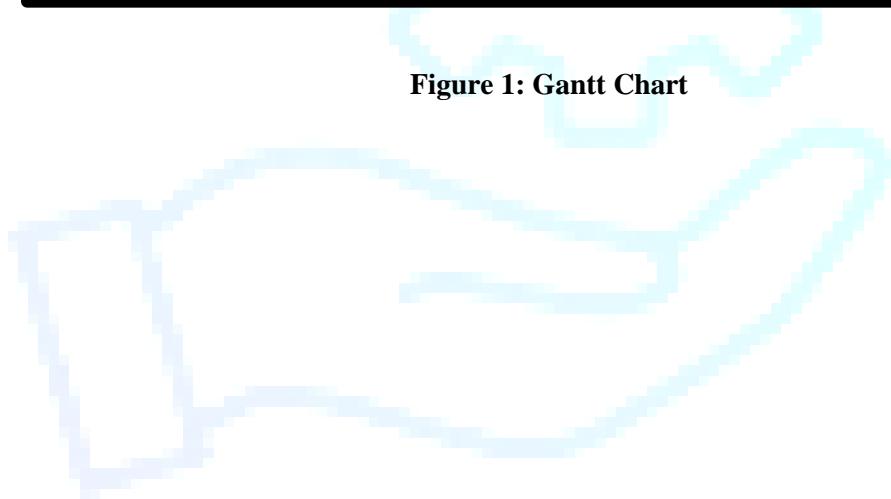


Figure 1: Gantt Chart



## 1.9 Tools :

### 1.9.1 Software requirements:

#### Operating system

- Microsoft Window (Windows 10/11)

#### Software to prepare document

- Microsoft office word
- Microsoft office PowerPoint
- Microsoft office project

#### Software to draw diagram

- StarUML

#### Software to share the files

- Email using

#### Software to meet

- Zoom
- TeamViewer

#### Software to design prototype

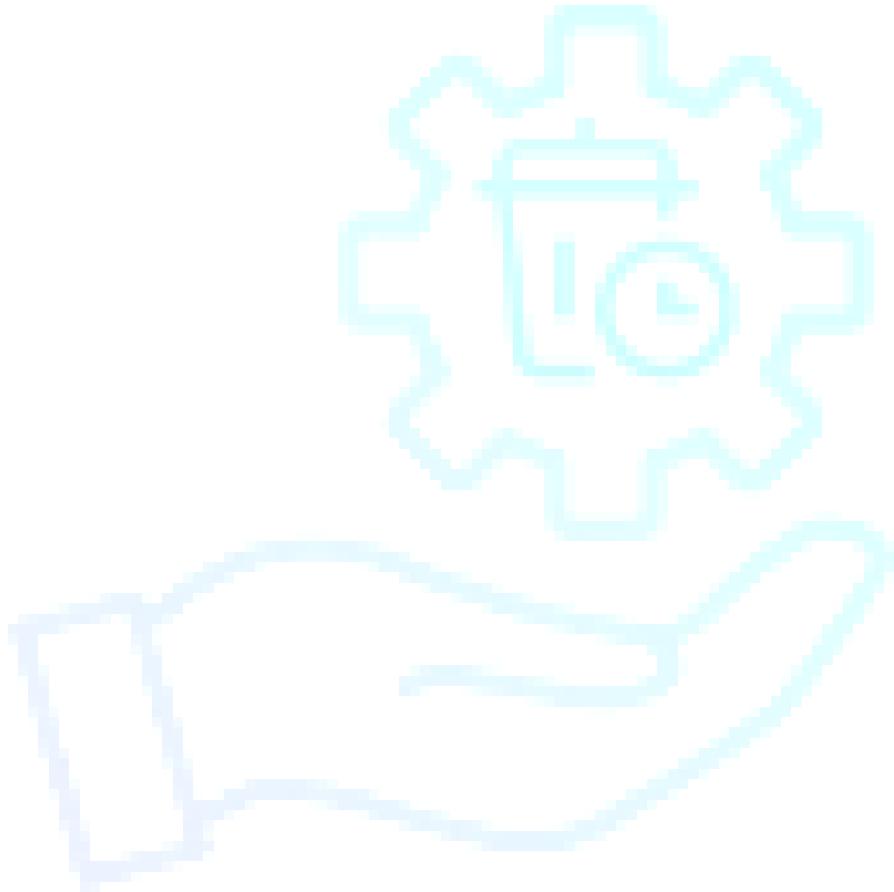
- Figma

### 1.9.2 Hardware requirements:

- Mobile phone
- Smartphone based on Android
- Smart Containers with sensor technology

## 1.10 Conclusion

As we have seen, there are many problems that we face through waste management traditionally, so we approached waste management in a smart, flexible, and more effective way through the application of the smart container, which is in line with the vision of the Kingdom of Saudi Arabia 2030.





## Chapter II: Literature Review



## 2.1 smart container:

It aims to improve waste management using the Internet of Things where the discarded waste from the smart bin is continuously monitored by sensors that reach the level of filling each compartment in real time. This data is stored and processed in an IoT middleware that provides information for collection using improved methods and generates important statistical data to accurately monitor waste collection in terms of managing the resources and services provided to the community. Operators can easily access information about public waste bins through the web or mobile application. The creation of the real smart container prototype, waste management application development and verification show that the proposed system can effectively change the way people deal with their garbage and improve economic and material resources [1]

## 2.2 The need of smart containers

The world is looking for more efficient ways to increase productivity and reduce error and effort. This makes the adoption of innovative technologies essential.

The best solution for this is a system that provides an orderly flow of information. This should be done simply and standardize waste collection procedures in a more systematic and professional way, the application knows the number of filled containers and knows the type of waste coming, the application also determines the ideal path for trucks to collect waste



## 2.3 Stakeholders

### Amanah Jeddah

Where the application provides for Amanah Jeddah with a clear plan and an integrated system for waste collection and classification

### Container collectors

The application provide the time of waste collectors as it tells them how many wastes are filled

### Administrator

Is a person who responsible of the department in Amana Jeddah

## 2.4 Smart containers provide information about :

- Determine the location of containers,
- Determine the type of waste you are entering
- Inform operators when the container is full
- Identify trucks collecting waste
- Optimizing the path of collecting container
- Type of color filled containers specified in the application
- Types of waste you consume

## 2.5 The benefits of the smart container

- preserving the environment
- Monitoring waste management.
- Providing smart technology for smart container management system
- Regular recycling
- Reducing time and human effort
- Preserving resources from misuse

## 2.6 The impact of smart containers on the organization of waste collection

Smart containers save time and effort as operators know the number of containers that must be collected per day and the number of trucks that go to collect containers, in addition to saving time in classifying waste by type, making it easier for workers to send them to the competent authorities for recycling



## 2.7 Literature Review :

In this section, we will present some research that is similar to the idea or purpose of our project

### 2.7.1 SMART WASTE MANAGEMENT SYSTEM [2]

the idea of “Smart waste management system”, mainly concentrates on Monitoring waste management, providing smart technology for waste systems, avoiding human intervention, reducing human time and effort.

There will be two separate buttons for user and authority.

the User inserts trash into the bin, Bin checks for threshold level, Bin sends the status and coordinates to the Control center on reaching the appropriate level, Control center uses the coordinates sent by multiple Bins and provides an optimal path to the garbage vehicle, The bin is emptied by the vehicle, a notification is sent by it to Control center.

### 2.7.2 WASTE MONITORING SENSOSEO [3]

The waste monitoring solution combines smart sensors, a smart waste management system, and a citizen app. Smart sensors use ultrasound technology to measure the filling levels in boxes and containers several times a day and send data to the waste management system. This process is similar to our project where the sensor sends the container information to the application and more than that, our project divides the container into several sections. Each section contains a sensor Its own so that it is easy for collectors to know what kind of container was collected



### 2.7.3 SMART PALSTIC CONTAINER[4]

the idea of a special container for storing plastic, with sensors inside, iot-ready. This container is able to keep track of stocks stored inside it and react sending reports to the cloud .

turn an alarm led on when the stocks are low.

An LCD show information on the container like label or setup information.

Through a web interface is possible to control the status of all the registered smart containers. This process is similar to our project, where the sensor sends information inside the container to the application and more. Our project divides the container into several sections: plastic, metal and other types. Each section contains its own sensor so that it is easy for collectors to know the type of container that has been assembled

### 2.7.4 Spatial smart waste management system[5]

This system determines the level of fullness of the container using wireless sensors and then starts a waste collection plan through trucks based on timetables that in turn determine the most efficient ways in terms of speed and distance

This system good and helps to preserve the environment

It needs some additions to be more useful, such as classifying materials according to their type in the garbage. Our application is developing these features, which will facilitate the waste recycling process and reduce unwanted odors.

## 2.8 Similar application:

App Name	Description	Features
<b>Dawar</b>  	<p><i>The online application is designed to help the public report the piles of rubbish they see on the roads through a platform that brings them together with relevant authorities.</i></p>	<p>1-The app allows users to take a picture of the trash and upload it to the platform. 2-The time and geographic location are added to it. 3-The competent authorities send a campaign to collect waste 4-The person who sent the trash photo receives a photo of the same location after it has been cleaned.</p>

Table 1 SIMILAR APPLICATION : DAWAR[6]

App Name	Description	Features
<b>Greenjo</b>  	<p><i>A certified application that recycles the main materials used in the packaging of groceries and haberdashery, targeting people of all ages, and helping them earn more money</i></p>	<p>1-It works to raise people's awareness of recycling and reuse. 2- buys materials that can be recycled 3- sells materials to companies that need them</p>

Table 2 SIMILAR APPLICATION : GREENJO [7]

<i>App Name</i>		<i>Description</i>	<i>Features</i>
<i>Sensoneo Driver Navigation</i> 		<p><i>The Smart Route Planning function automates the management of waste collection routes based on precise, pre-defined data about fleets, depots, and landfills. It optimizes the use of collection vehicles and FTEs and helps you find the most efficient process in terms of time and costs.</i></p>	<ol style="list-style-type: none"> <li>1- See all best routes for the vehicle</li> <li>2- Choose the route to execute and follow step-by-step navigation</li> <li>3- Collect bins and report any problem with the bin on-site</li> </ol>

Table 3 SIMILAR APPLICATION : SENSONEO DRIVER NAVIGATION [8]

<i>App Name</i>	<i>Description</i>	<i>Features</i>
<i>Smart Bin</i> <i>ArPi</i> 	<p><i>this project will be able to gather fill-level data from waste containers hence providing a waste monitoring and collection solution that brings up savings in waste collection costs.</i></p>	<p>1- monitoring module consists of fill level detection</p> <p>2- The fill level reading will be displayed on the LCD display with LEDs.</p> <p>3- collection module consists of sensors and actuators to receive waste into the smart bin</p>

**Table 4 SIMILAR APPLICATION : SMART BIN ARPI [9]**



App Name	Description	Features
<b>SmartBin</b> 	<i>It displays the level of filling containers and displays a map of all the containers in the city and also shows the filling rates and warnings.</i>	<ol style="list-style-type: none"> <li>1- shows the current status of all the bins in the city</li> <li>2- SmartBin App provides dashboard, Map View as well as List View about all the Dustbins in the city</li> <li>3- This App also shown the previous hours records for each bin as Graphical View and all the details such as Fill Percentage, Fire Alarm, Alerts, Temperature</li> </ol>

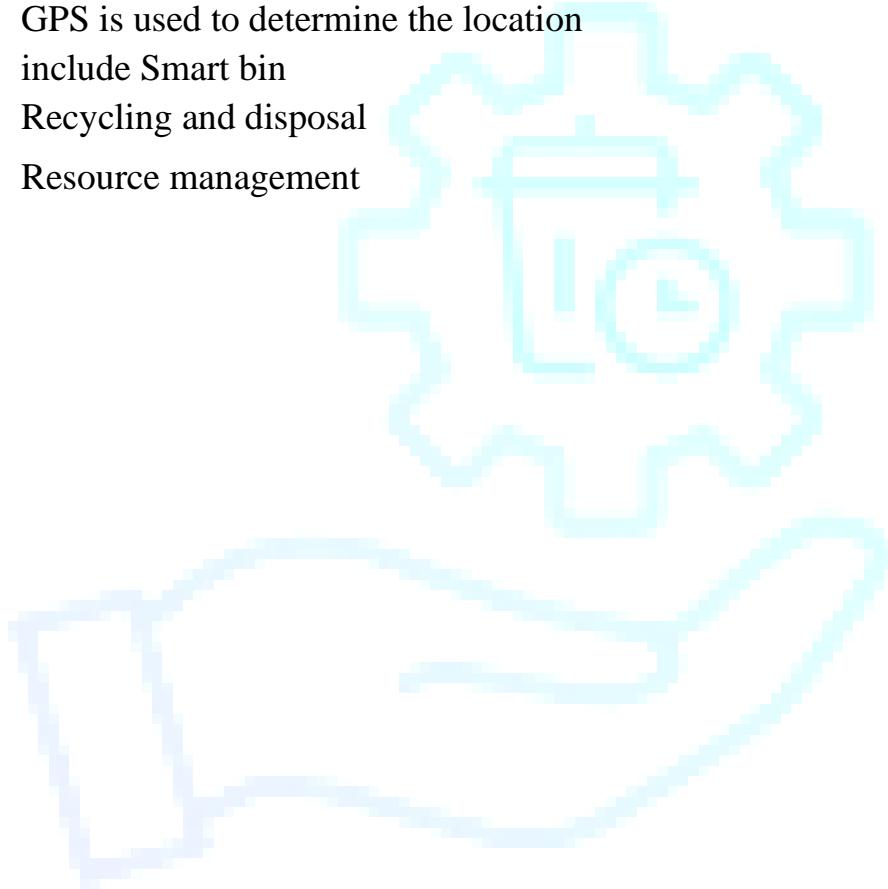
Table 5 SIMILAR APPLICATION: SMARTBIN [10]



## 2.9 Comparison of smart container apps

The next table compares functions of 5 smart waste management systems with Smart container, such as:

- Intelligent route planning
- Detection of container fullness
- Helping people recycle
- GPS is used to determine the location
- include Smart bin
- Recycling and disposal
- Resource management



App	Intelligent route planning	Detection of container fullness	Helping people recycle	GPS is used to determine the location	include Smart bin	Recycling and disposal	Resource management
<i>Dawar</i>			✓	✓		✓	✓
<i>Greenjo</i>			✓	✓		✓	✓
<i>Sensoneo Driver Navigation</i>	✓			✓			
<i>Smart Bin ArPi</i>		✓			✓		
<i>Smart Bin</i>				✓	✓		
<i>Smart container</i>	✓	✓	✓	✓	✓	✓	✓

Table 6 COMPARISON OF SMART CONTAINER



## Chapter III: Analysis



### 3.1 Interview

#### 3.1.1 Interview Questions

1. What is the current waste collection process?
2. Is the waste collection process easy to manage?
3. Is there a tracking of waste collection trucks?
4. Is the waste emptied periodically or is there a specific time?
5. Are the types of waste separated?
6. Does the waste collection process take a lot of time?

#### 3.1.2 Primary data collected:

These questions were answered by the Janitorial Projects Department manager

Q1-The city is divided into a certain number of projects and operational plans are established for that

Q2-The problem is not the collection, but the different times of throwing garbage and some wrong behavior

Q3-All equipment is monitored with tracking devices

Q4-Containers are unloaded in the internal streets once a day and in the main streets twice a day

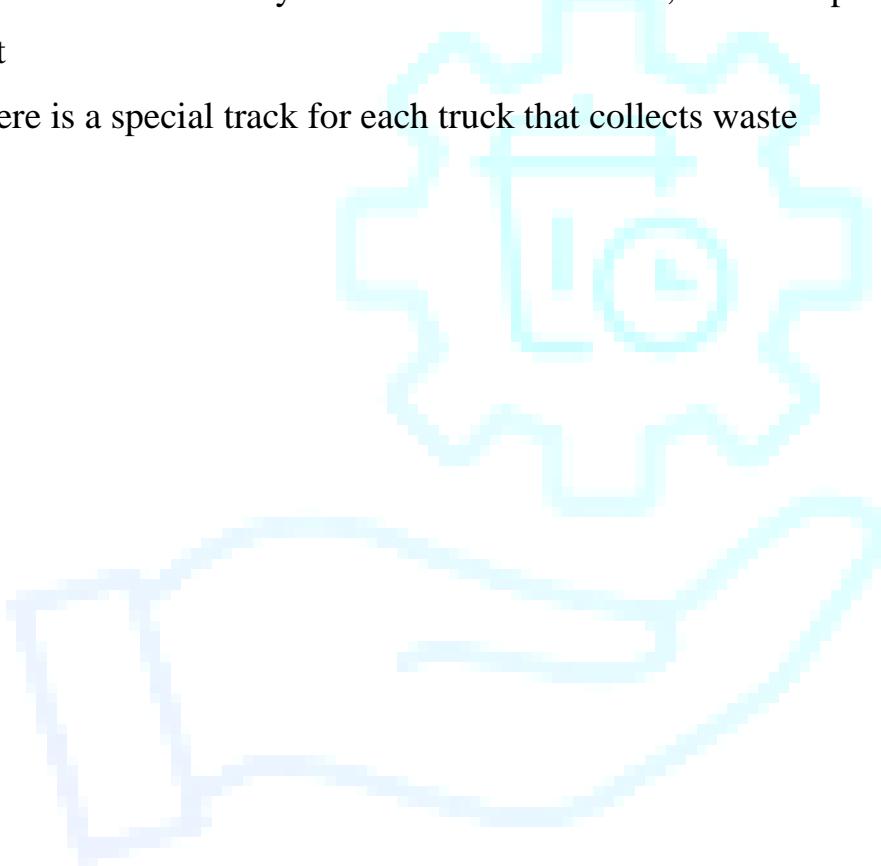
Q5-There are specific waste sorting plants

Q6-Yes, in some of the narrow neighborhoods due to overcrowding and the difficulty of entering equipment during crowding and the density of the population in it

### 3.1.3 What we found after the interview:

Our application is similar to the operations of Amana Jeddah in the presence of tracking devices and the division of the city into several projects, but our application provides many other features such as

- 1-Waste is collected when the container is full, whether the container is located in a main or secondary road
- 2-Waste is automatically sorted into the smart bin, which helps save time and effort
- 3-There is a special track for each truck that collects waste





## 3.2 Requirements

In this section we are spectating the functional for all the application which involves functional and nonfunctional requirements.

### 3.2.1 Functional requirements:

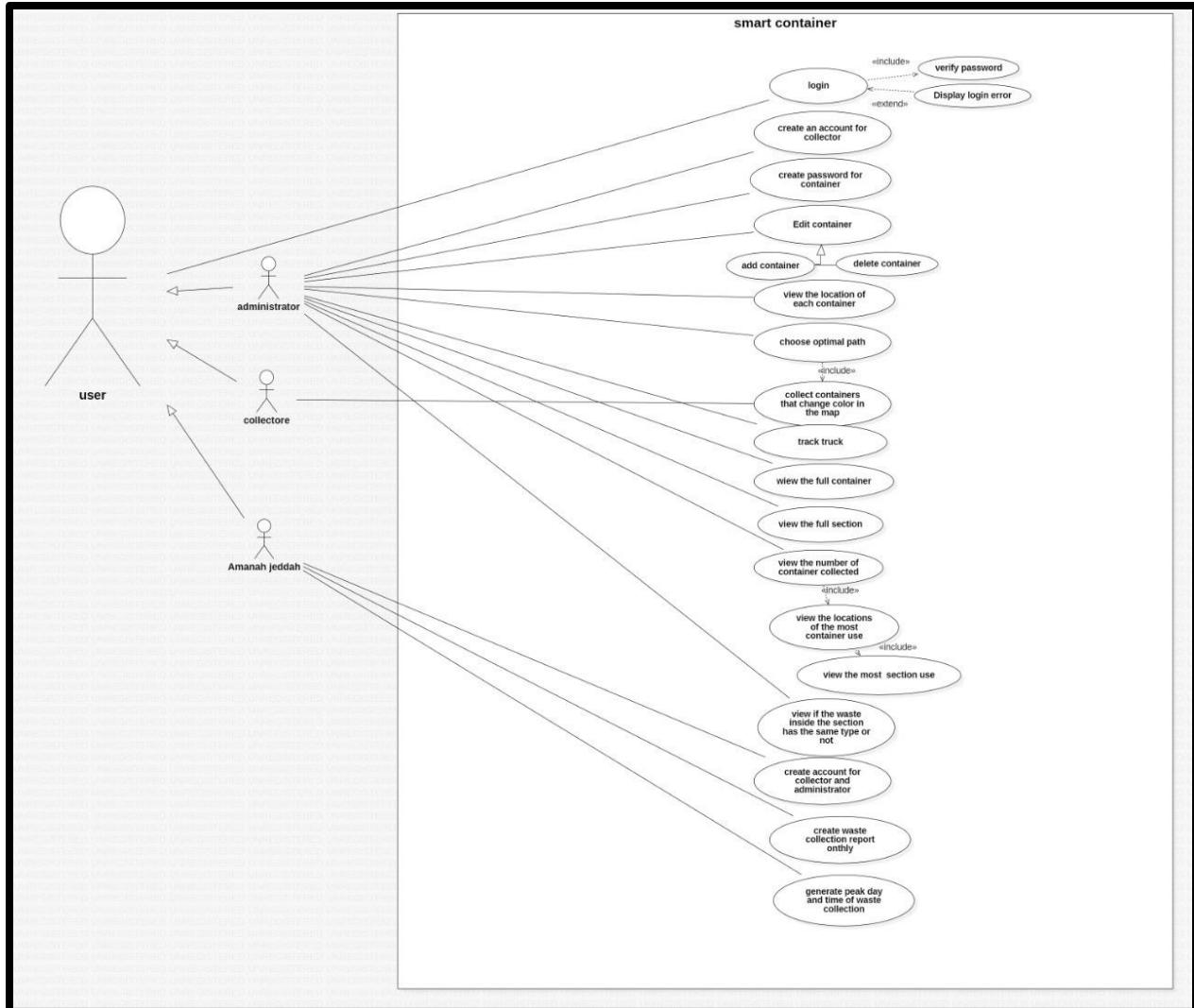
- The user (administrator - collector – amana Jeddah) can login to the system
- The administrator create an account for collector
- The administrator set a password for each container
- The administrator can edit container in the system
- The administrator can add more container.
- The administrator can delete container
- The administrator shall be able to view the location each container
- The administrator chooses the optimal path to collect containers and send information to collector
- The collector can collect containers that change color in the map
- Administrator can tracking truck location
- The administrator shall be able to view the full container
- The administrator shall be able to view the full section.
- The administrator can view the number of each container collected
- The administrator shall be able to view the most used section in the container
- The administrator shall be able to view the locations of the most frequently used containers
- The administrator must be able to view if the waste inside the section has the same type or not.
- Amana Jeddah can create account for collector and administrator
- Amana Jeddah can create waste collection report monthly
- Amana Jeddah can generate peak day and time of waste collection.



### 3.2.2 Non-functional requirements:

- **Availability:**
  - the application available for use 24/7.
- **Security:**
  - Each container contains a password
- **Scalability:**
  - Admin can add more containers if necessary
- **Interoperability:**
  - The full container is emptied in no more than 12 hours
  - The color of the container on the map is changed when emptying in a time not exceeding 5 minutes
- **Usability:**
  - The user can navigate between the pages of the program easily
  - users can easily determine what a feature of icon on the Interface and what it can do
- **Manageability:**
  - In each district there is a manager who directs the trucks

### 3.3 Use Case Diagram



**Figure 2 : use case**

the use case diagram summarizes the details of a system and who will use the system.



### 3.4 Use Case Description

Use Case Name	Log in									
Scenario	The user opens the application and enters the username and password.									
Triggering Event	Open the application.									
Brief Description	When the user enters the application, it must login first to be able to access its information.									
Actors	Smart container application user									
Related Use Case	-									
Stakeholders	Smart container application user									
Preconditions	You should have an account at the application database.									
Post conditions	Login successfully in the application.									
Flow of Activities	<table border="1"> <thead> <tr> <th>Actor</th> <th>System</th> </tr> </thead> <tbody> <tr> <td>1- Open the application.</td> <td>1-Request Username and password.</td> </tr> <tr> <td>2- Click the "Login button"</td> <td>2- Validate username and password</td> </tr> <tr> <td>3- Enter username and password.</td> <td></td> </tr> </tbody> </table>	Actor	System	1- Open the application.	1-Request Username and password.	2- Click the "Login button"	2- Validate username and password	3- Enter username and password.		
Actor	System									
1- Open the application.	1-Request Username and password.									
2- Click the "Login button"	2- Validate username and password									
3- Enter username and password.										

Table 7 Log in



Use Case Name	Create account for collector and administrator											
<b>Scenario</b>	The user opens the application and writes the requested information's to be registered in the application.											
<b>Triggering Event</b>	Make an account in the application.											
<b>Brief Description</b>	When the Amanah Jeddah enters the application, writes the name, ID, and other information displayed in the sign-up page in the application to be registered in personalized tourism application.											
<b>Actors</b>	Amanah Jeddah											
<b>Related Use Case</b>	-											
<b>Stakeholders</b>	collector and administrator											
<b>Preconditions</b>	Enter all required information's.											
<b>Post conditions</b>	Register successfully in smart container application.											
<b>Flow of Activities</b>	<table border="1"> <thead> <tr> <th>Actor</th> <th>System</th> </tr> </thead> <tbody> <tr> <td>1- Open the App.</td> <td>1- Have a new account in smart container application database</td> </tr> <tr> <td>2- Click "sign in" button.</td> <td></td> </tr> <tr> <td>3- Write the required information.</td> <td></td> </tr> <tr> <td>4- Click "sign up" button.</td> <td></td> </tr> </tbody> </table>	Actor	System	1- Open the App.	1- Have a new account in smart container application database	2- Click "sign in" button.		3- Write the required information.		4- Click "sign up" button.		
Actor	System											
1- Open the App.	1- Have a new account in smart container application database											
2- Click "sign in" button.												
3- Write the required information.												
4- Click "sign up" button.												

Table 8 Create account for collector and administrator



**Use Case Name**      **Create waste collection report monthly**

<b>Scenario</b>	The Amana Jeddah open application and display the statistics for each section	
<b>Triggering Event</b>	Create report	
<b>Brief Description</b>	Each waste entering the (metal - plastic - other ) section is counted and then a generated monthly report that contains the number of each waste entered inside each section	
<b>Actors</b>	Amana Jeddah	
<b>Related Use Case</b>	-	
<b>Stakeholders</b>	Recycling agencies	
<b>Preconditions</b>	counting each waste enter in each section	
<b>Post conditions</b>	Create report	
<b>Flow of Activities</b>	Actor 1- Open the app. 2- Choose display map view	System 1- display report

**Table 9 Create waste collection report monthly**

**Use Case Name**      **Track Truck**

<b>Scenario</b>	The administrator can tracking truck location	
<b>Triggering Event</b>	Track truck	
<b>Brief Description</b>	The administrator tracks the truck through the system and if the truck is going on the optimal path or not	
<b>Actors</b>	administrator	
<b>Related Use Case</b>	-	
<b>Stakeholders</b>	Amana Jeddah – administrator	
<b>Preconditions</b>	Login in the application	
<b>Post conditions</b>	Track truck	
<b>Flow of Activities</b>	Actor	System
	1- open the application	1- display path
	2- click "track truck" button	

**Table 10 Track Truck**



Use Case Name	View the full container							
<b>Scenario</b>	The administrator can see the full container							
<b>Triggering Event</b>	Open the map in app							
<b>Brief Description</b>	When the administrator open the app and view the map to display container information							
<b>Actors</b>	Administrator							
<b>Related Use Case</b>	-							
<b>Stakeholders</b>	Administrator							
<b>Preconditions</b>	You should have an account in the application							
<b>Post conditions</b>	view the map							
<b>Flow of Activities</b>	<table border="1"> <tr> <td>Actor</td> <td>System</td> </tr> <tr> <td>1- Open the app.</td> <td>1- Show all containers</td> </tr> <tr> <td>2- Choose display map view</td> <td>2- Show the full container in a different color</td> </tr> </table>	Actor	System	1- Open the app.	1- Show all containers	2- Choose display map view	2- Show the full container in a different color	
Actor	System							
1- Open the app.	1- Show all containers							
2- Choose display map view	2- Show the full container in a different color							

Table 11 View the full container



Use Case Name	View the full Section	
<b>Scenario</b>	The administrator can see the percentage of all Section in container	
<b>Triggering Event</b>	Open the map in app	
<b>Brief Description</b>	When the administrator open the app and view the map to display container information	
<b>Actors</b>	Administrator	
<b>Related Use Case</b>	-	
<b>Stakeholders</b>	Administrator	
<b>Preconditions</b>	You should have an account in the application	
<b>Post conditions</b>	view the map	
<b>Flow of Activities</b>	Actor	System
	1- Open the app.	1- Show all Section in containers
	2- Choose display map view	2- Show the percentage of the Section

Table 12 View the full Section



Use Case Name	View the number of containers collected							
<b>Scenario</b>	administrator can see how many containers have been collected							
<b>Triggering Event</b>	Display the containers information							
<b>Brief Description</b>	administrator can view the containers information and see how many containers are collected							
<b>Actors</b>	Administrator							
<b>Related Use Case</b>	<b>include</b> -View the location of the most container use <b>include</b> -View the most section use							
<b>Stakeholders</b>	Administrator							
<b>Preconditions</b>	You should have an account in the application							
<b>Post conditions</b>	-							
<b>Flow of Activities</b>	<table border="1"> <thead> <tr> <th>Actor</th> <th>System</th> </tr> </thead> <tbody> <tr> <td>1- Open the app.</td> <td>1- Show all containers</td> </tr> <tr> <td>2- Choose Display the containers information</td> <td>2- Show number of containers collected</td> </tr> </tbody> </table>	Actor	System	1- Open the app.	1- Show all containers	2- Choose Display the containers information	2- Show number of containers collected	
Actor	System							
1- Open the app.	1- Show all containers							
2- Choose Display the containers information	2- Show number of containers collected							

Table 13 View the number of containers collected



Use Case Name	View the location of the most container use	
<b>Scenario</b>	administrator can see most container use and view the location	
<b>Triggering Event</b>	Display the containers information	
<b>Brief Description</b>	administrator can view the most used containers information and see the location	
<b>Actors</b>	Administrator	
<b>Related Use Case</b>	<b>Extend - View the number of containers collected</b>	
<b>Stakeholders</b>	Administrator	
<b>Preconditions</b>	You should have an account in the application	
<b>Post conditions</b>	Display location	
<b>Flow of Activities</b>	Actor	System
		1- Show all containers
	1- Open the app.	2- Show location of containers
	2- Choose Display the containers information	

Table 14 View the location of the most container use



Use Case Name	View the most section use							
<b>Scenario</b>	Administrator can see the most section used in containers							
<b>Triggering Event</b>	Display the containers information							
<b>Brief Description</b>	Administrator can view all section in containers and see the most section use							
<b>Actors</b>	Administrator							
<b>Related Use Case</b>	<b>Extend -</b> View the number of containers collected							
<b>Stakeholders</b>	Administrator							
<b>Preconditions</b>	You should have an account in the application							
<b>Post conditions</b>	-							
<b>Flow of Activities</b>	<table border="1"> <tr> <th>Actor</th> <th>System</th> </tr> <tr> <td>1- Open the app.</td> <td>1- Show all containers section</td> </tr> <tr> <td>2- Choose Display the containers information</td> <td>2- Show most section is used</td> </tr> </table>	Actor	System	1- Open the app.	1- Show all containers section	2- Choose Display the containers information	2- Show most section is used	
Actor	System							
1- Open the app.	1- Show all containers section							
2- Choose Display the containers information	2- Show most section is used							

Table 15 View the most section use

Use Case Name	Generate peak day and time of waste collection							
<b>Scenario</b>	Amana Jeddah Determine day to collect west							
<b>Triggering Event</b>	Peak time							
<b>Brief Description</b>	Jeddah Amana determines the most day that containers are full to be collected							
<b>Actors</b>	Amana Jeddah							
<b>Related Use Case</b>	-							
<b>Stakeholders</b>	Amana Jeddah							
<b>Preconditions</b>	When Most containers are full							
<b>Post conditions</b>	-							
<b>Flow of Activities</b>	<table border="1"> <thead> <tr> <th>Actor</th> <th>System</th> </tr> </thead> <tbody> <tr> <td>1- Open the app.</td> <td>1- Show all containers Statistics</td> </tr> <tr> <td>2- Choose Statistics</td> <td></td> </tr> </tbody> </table>	Actor	System	1- Open the app.	1- Show all containers Statistics	2- Choose Statistics		
Actor	System							
1- Open the app.	1- Show all containers Statistics							
2- Choose Statistics								

Table 16 Generate peak day and time of waste collection



Use Case Name	Add new container							
<b>Scenario</b>	The user will open the application and log in, then add the new container							
<b>Triggering Event</b>	Add new container							
<b>Brief Description</b>	When there is a new neighbourhood, the admin can add a new container							
<b>Actors</b>	Waste department admin							
<b>Related Use Case</b>	Extend: Edit							
<b>Stakeholders</b>	Amana Jeddah and waste collectors							
<b>Preconditions</b>	The admin must know the new neighbourhoods in the city.							
<b>Post conditions</b>	Information added successfully in map							
<b>Flow of Activities</b>	<table border="1"> <thead> <tr> <th>Actor</th> <th>System</th> </tr> </thead> <tbody> <tr> <td>1. Enter username and password</td> <td>1- Request Username and password.</td> </tr> <tr> <td>2. Add the required information.</td> <td>2- Validate username and password. 3- Store new information in the map for later use in the collection process.</td> </tr> </tbody> </table>	Actor	System	1. Enter username and password	1- Request Username and password.	2. Add the required information.	2- Validate username and password. 3- Store new information in the map for later use in the collection process.	
Actor	System							
1. Enter username and password	1- Request Username and password.							
2. Add the required information.	2- Validate username and password. 3- Store new information in the map for later use in the collection process.							

Table 17 Add new container



Use Case Name	Delete container									
<b>Scenario</b>	The user will open the application and log in, then delete the container									
<b>Triggering Event</b>	delete container									
<b>Brief Description</b>	When the container is unused, we delete it									
<b>Actors</b>	Waste department admin									
<b>Related Use Case</b>	Extend: Edit									
<b>Stakeholders</b>	Amana Jeddah and waste collectors									
<b>Preconditions</b>	The admin must know the unused containers									
<b>Post conditions</b>	Update information on the map									
<b>Flow of Activities</b>	<table border="1"> <thead> <tr> <th>Actor</th> <th>System</th> </tr> </thead> <tbody> <tr> <td>1. Enter username and password</td> <td>1- Request Username and password.</td> </tr> <tr> <td>2. Add the required information.</td> <td>2- Validate username and password.</td> </tr> <tr> <td></td> <td>3- update new information in the map.</td> </tr> </tbody> </table>	Actor	System	1. Enter username and password	1- Request Username and password.	2. Add the required information.	2- Validate username and password.		3- update new information in the map.	
Actor	System									
1. Enter username and password	1- Request Username and password.									
2. Add the required information.	2- Validate username and password.									
	3- update new information in the map.									

Table 18 Delete container



Use Case Name	Edit								
<b>Scenario</b>	The administrator can update some map information such as adding a container or deleting a container								
<b>Triggering Event</b>	Edit and update container on the map								
<b>Brief Description</b>	When the administrator opens the application, he can edit and update the information of containers on the map								
<b>Actors</b>	Waste department admin								
<b>Related Use Case</b>	-								
<b>Stakeholders</b>	Amana Jeddah and waste collectors								
<b>Preconditions</b>	The user must know all the new neighborhoods and also know the unused containers								
<b>Post conditions</b>	Information updated successfully in map								
<b>Flow of Activities</b>	<table border="1"> <thead> <tr> <th>Actor</th> <th>System</th> </tr> </thead> <tbody> <tr> <td>1. Enter username and password</td> <td>1- Request Username and password.</td> </tr> <tr> <td>2. Update the required information.</td> <td>2- Validate username and password.</td> </tr> <tr> <td></td> <td>3- Make the edit and update it on the map</td> </tr> </tbody> </table>	Actor	System	1. Enter username and password	1- Request Username and password.	2. Update the required information.	2- Validate username and password.		3- Make the edit and update it on the map
Actor	System								
1. Enter username and password	1- Request Username and password.								
2. Update the required information.	2- Validate username and password.								
	3- Make the edit and update it on the map								

Table 19 Edit



Use Case Name	Set password							
<b>Scenario</b>	The administrator can set the password for each container							
<b>Triggering Event</b>	Container insurance							
<b>Brief Description</b>	When the administrator opens the application, he can set password for the container							
<b>Actors</b>	Waste department admin							
<b>Related Use Case</b>	-							
<b>Stakeholders</b>	Amana Jeddah and waste collectors							
<b>Preconditions</b>	The user must know all the container							
<b>Post conditions</b>	Set password successfully in the containers							
<b>Flow of Activities</b>	<table border="1"> <tr> <td>Actor</td> <td>System</td> </tr> <tr> <td>1. Enter username and password</td> <td>1- Request Username and password.</td> </tr> <tr> <td>2. Click "set password" button</td> <td>2- Validate username and password. 3-Set password for each containers</td> </tr> </table>	Actor	System	1. Enter username and password	1- Request Username and password.	2. Click "set password" button	2- Validate username and password. 3-Set password for each containers	
Actor	System							
1. Enter username and password	1- Request Username and password.							
2. Click "set password" button	2- Validate username and password. 3-Set password for each containers							

Table 20 Set password



Use Case Name	Display location of container	
<b>Scenario</b>	The administrator can show container locations on the map	
<b>Triggering Event</b>	Locating the container	
<b>Brief Description</b>	When the administrator opens the application, he can see container locations on the map	
<b>Actors</b>	Waste department admin	
<b>Related Use Case</b>	-	
<b>Stakeholders</b>	Amana Jeddah and waste collectors	
<b>Preconditions</b>	The user must know all the container	
<b>Post conditions</b>	Containers have been successfully located on the map	
<b>Flow of Activities</b>	Actor	System
	1. Enter username and password 2. Click "map" button 3- Click “display containers” button	1- Display the location of containers

Table 21 Display location of container



Use Case Name	Chooses the optimal path	
<b>Scenario</b>	The administrator chooses the optimal path to collect containers and send information to collector	
<b>Triggering Event</b>	Chooses optimal path and shortest path	
<b>Brief Description</b>	When the administrator opens the application, he can chooses the optimal path to collect containers	
<b>Actors</b>	Waste department admin	
<b>Related Use Case</b>	-	
<b>Stakeholders</b>	waste collectors	
<b>Preconditions</b>	The user must know all the paths to collect containers	
<b>Post conditions</b>	the optimal path has been selected successfully	
<b>Flow of Activities</b>	Actor	System
	1. Enter username and password 2. Click "map" button 3- Click “ display paths” button 4- Determine the optimal path	1- Display the all paths on the map

Table 22 Chooses the optimal path



Use Case Name	Collect the full containers	
<b>Scenario</b>	The collector can collect the containers that change color in the map	
<b>Triggering Event</b>	Collect the full containers	
<b>Brief Description</b>	When the collector sees the change of color of the container on the map, he collects it	
<b>Actors</b>	waste collectors	
<b>Related Use Case</b>	-	
<b>Stakeholders</b>	Amana Jeddah and waste collectors	
<b>Preconditions</b>	The user must update the map periodically	
<b>Post conditions</b>	The container has been successfully collected	
<b>Flow of Activities</b>	Actor	System
	1. Enter username and password 2. Click "map" button 3- Click "display container" button 4- collect containers that change color	1- Display the full containers

Table 23 Collect the full containers

### 3.5 Sequence Diagram

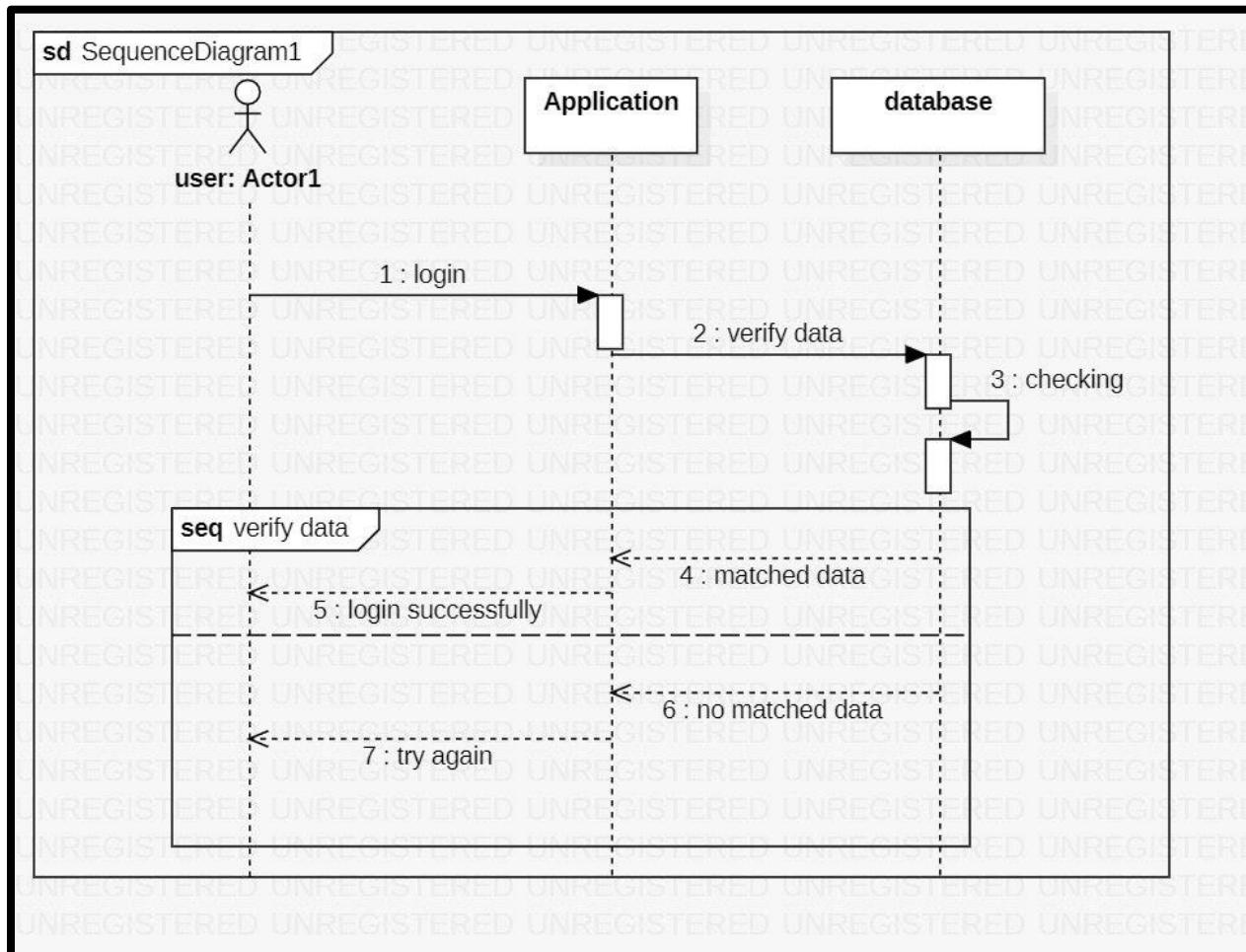
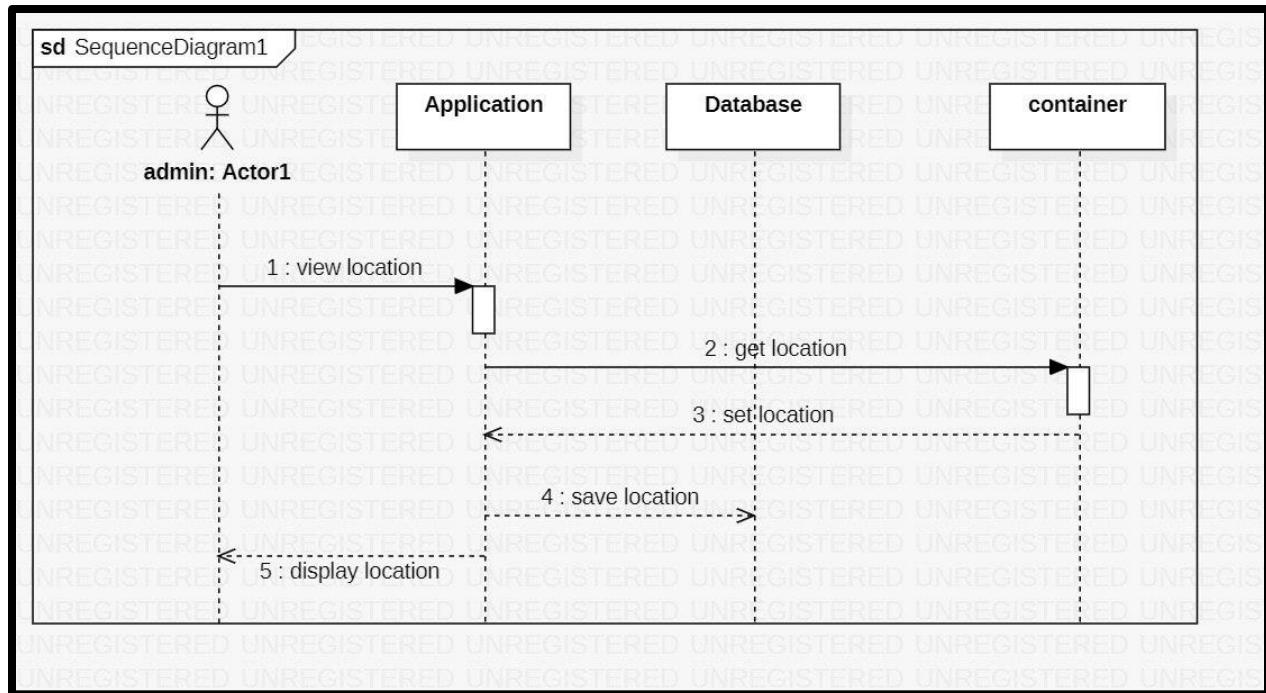


Figure 3 Sequence Log in

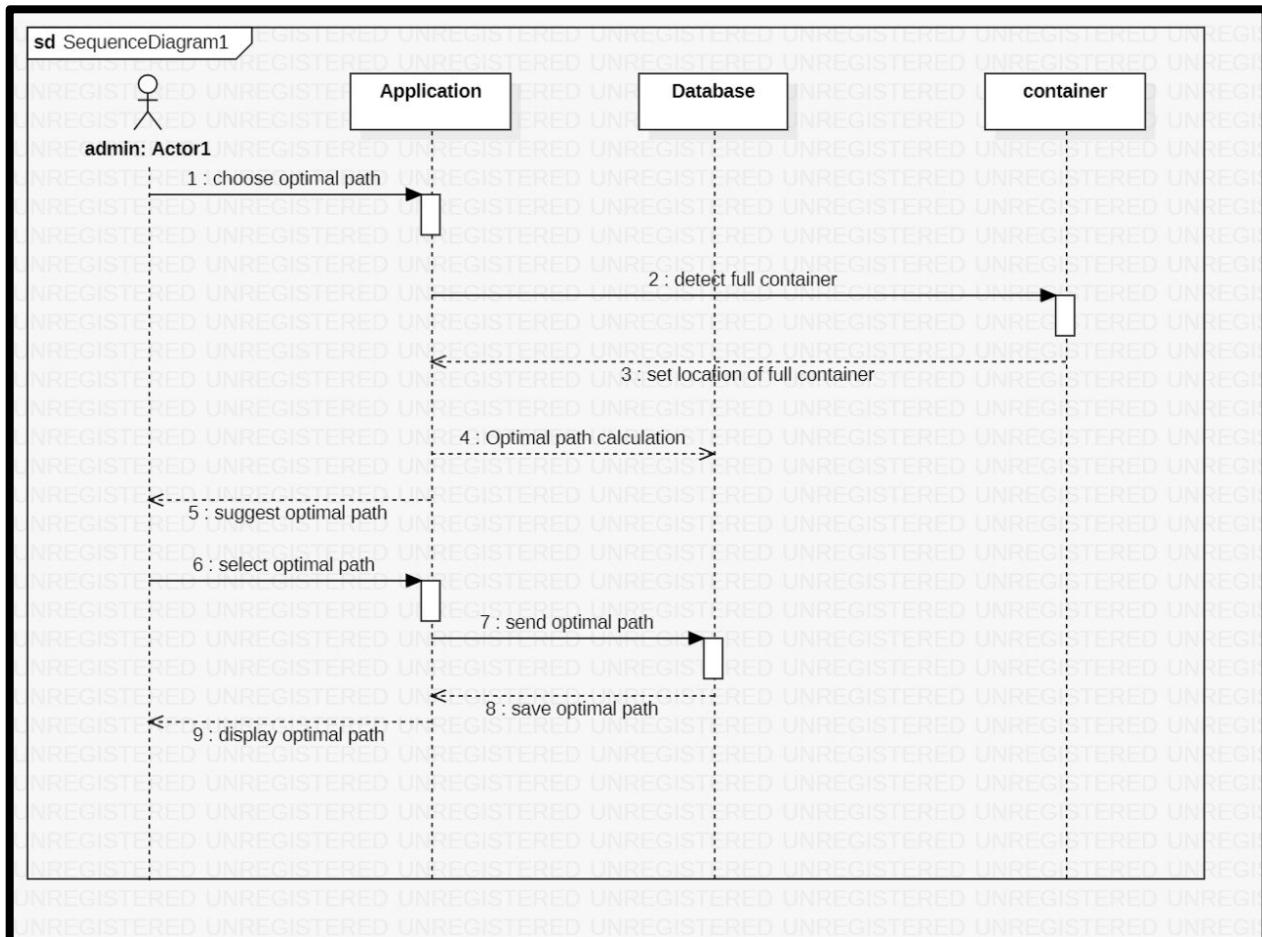
Here the user will be logged in (Amana jeddah , administrator and the collector)



**Figure 4Sequence for view location**

Her the a administrator can view the location of each container





**Figure 5 Sequence for choose path**

the system will display many paths to collect containers and then will recommend to the administrator the optimal path



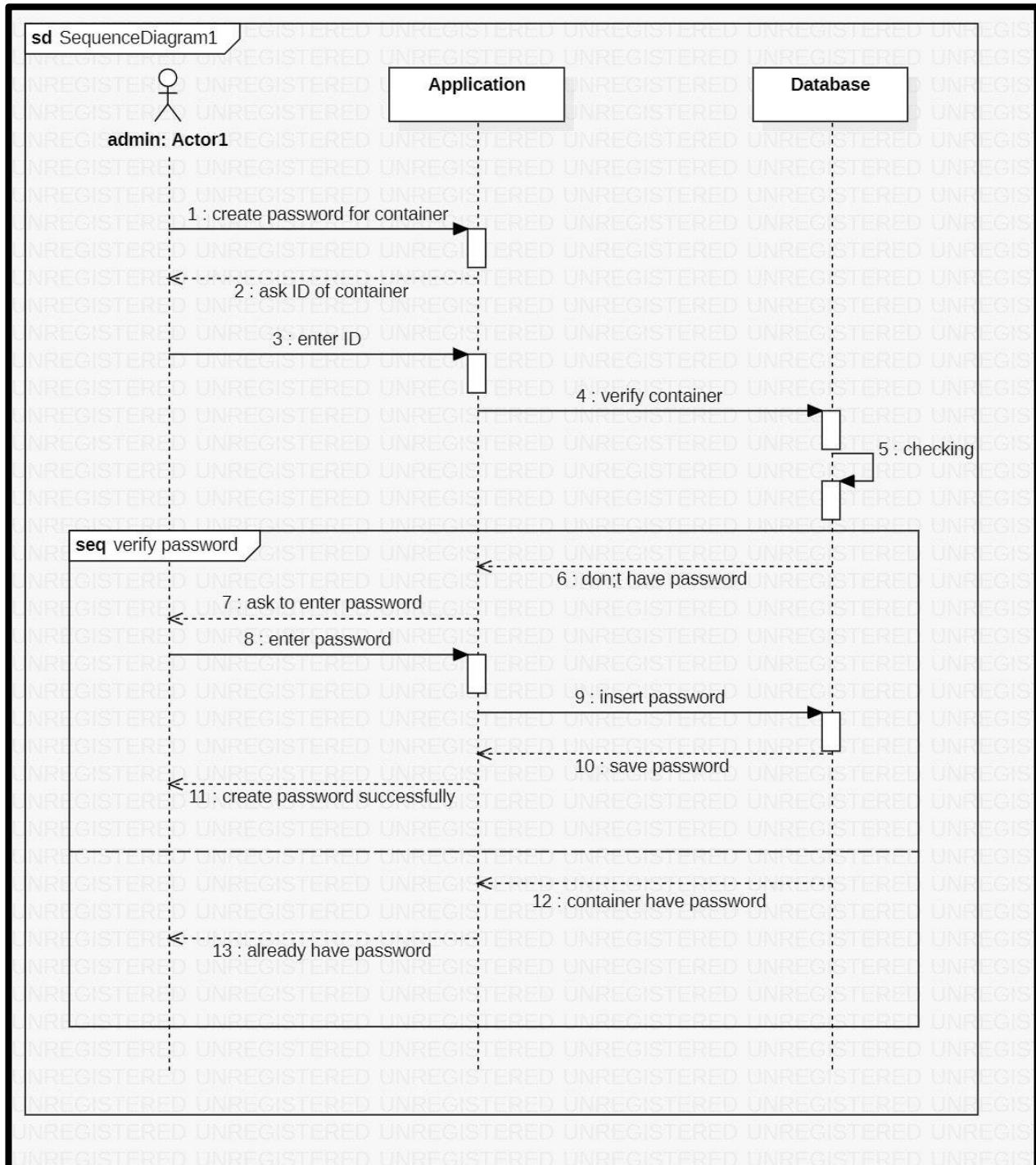


Figure 6 Sequence create password

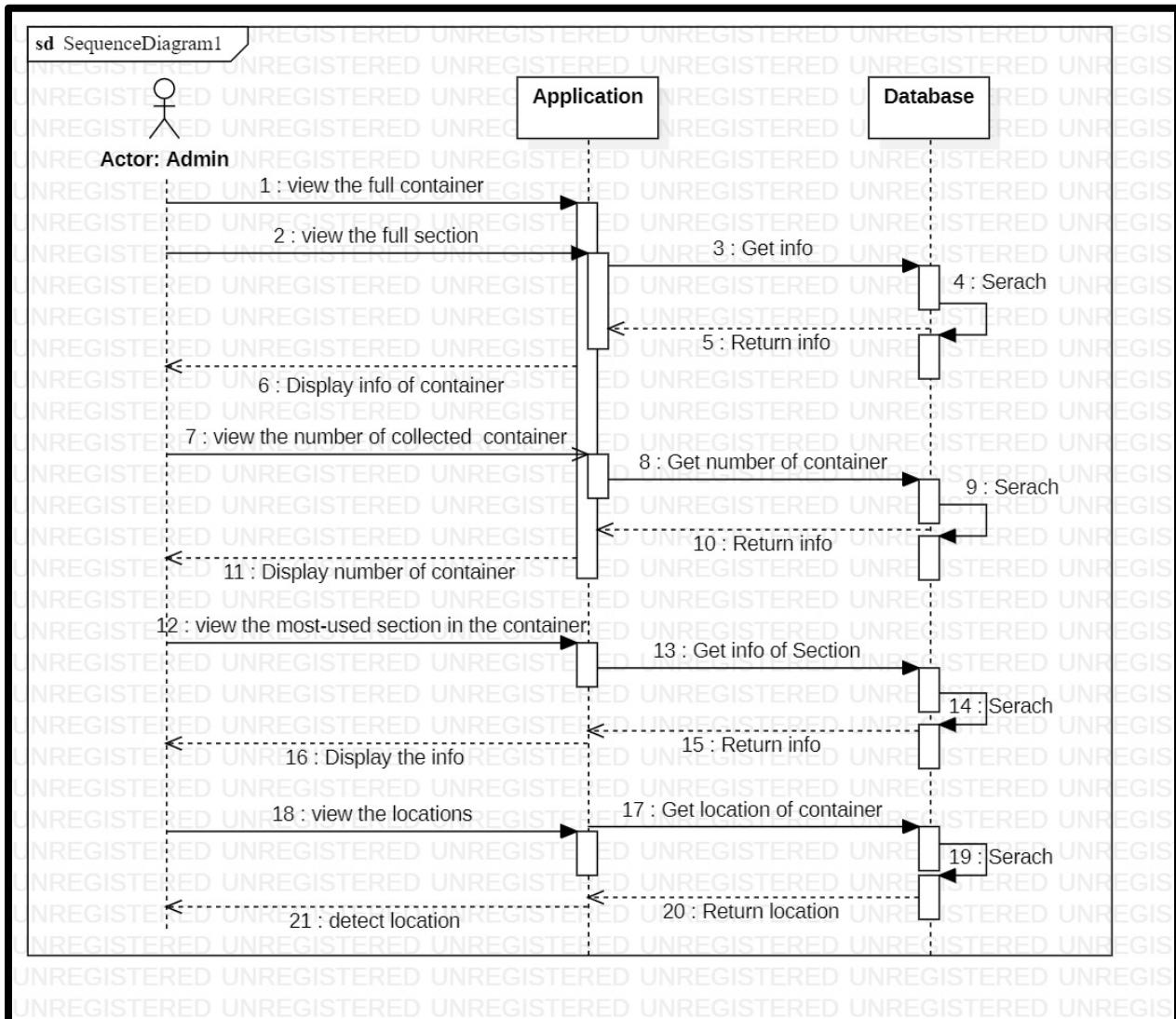
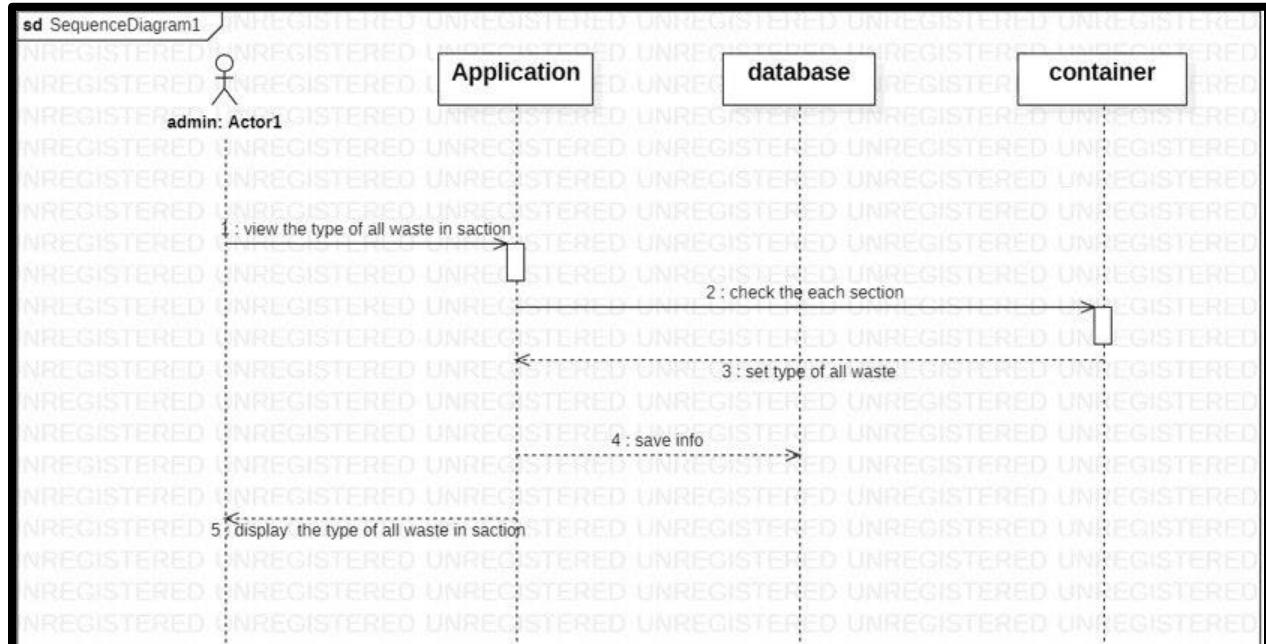


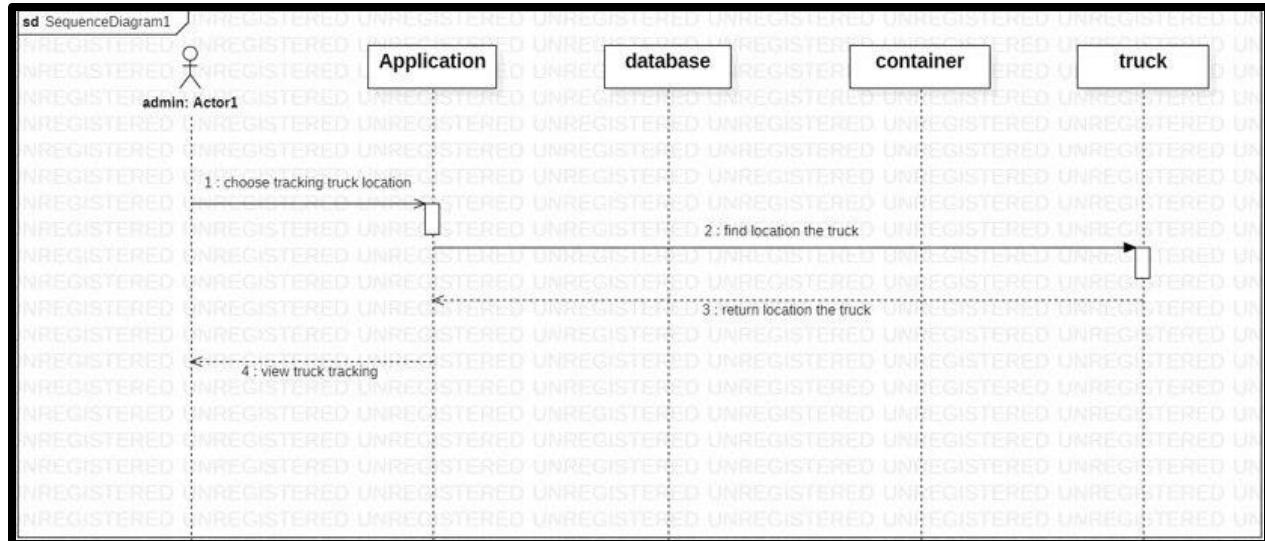
Figure 7 Sequence for view container info

Her a administrator can view all container information  
 by show full container and full section and number of collected containers and most used section



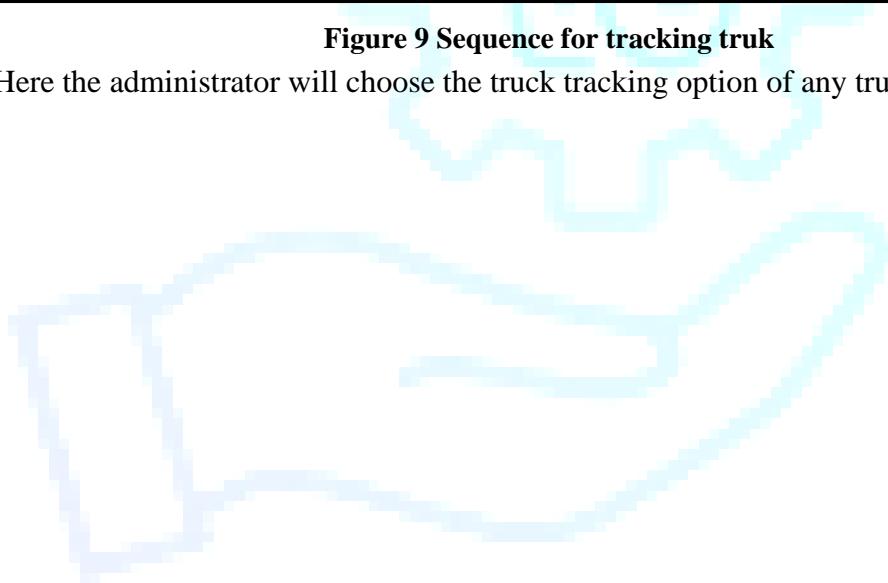
**Figure 8 Sequence for view type of waste**

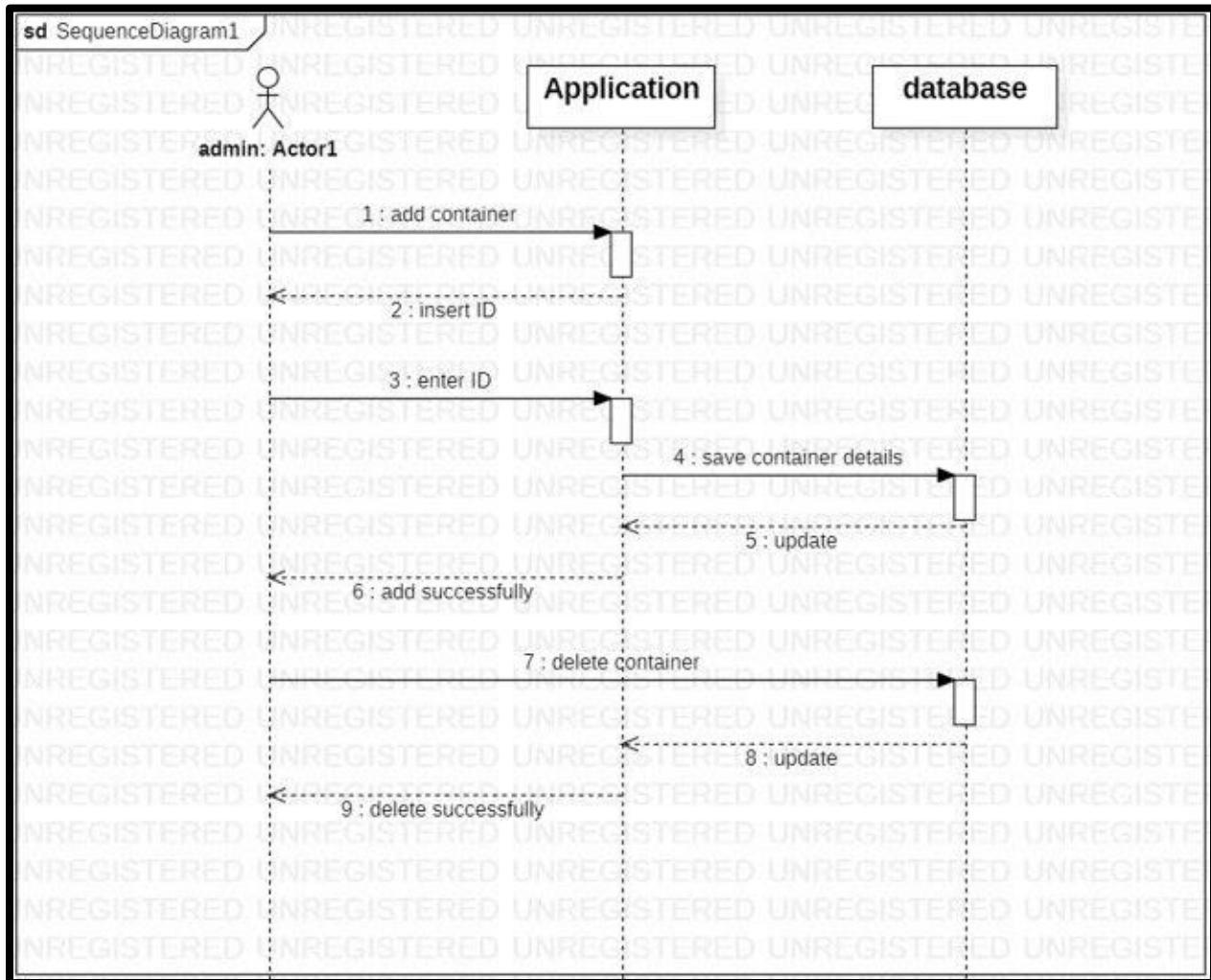
Here the administrator can check if each section in the container contains the same type or not



**Figure 9 Sequence for tracking truck**

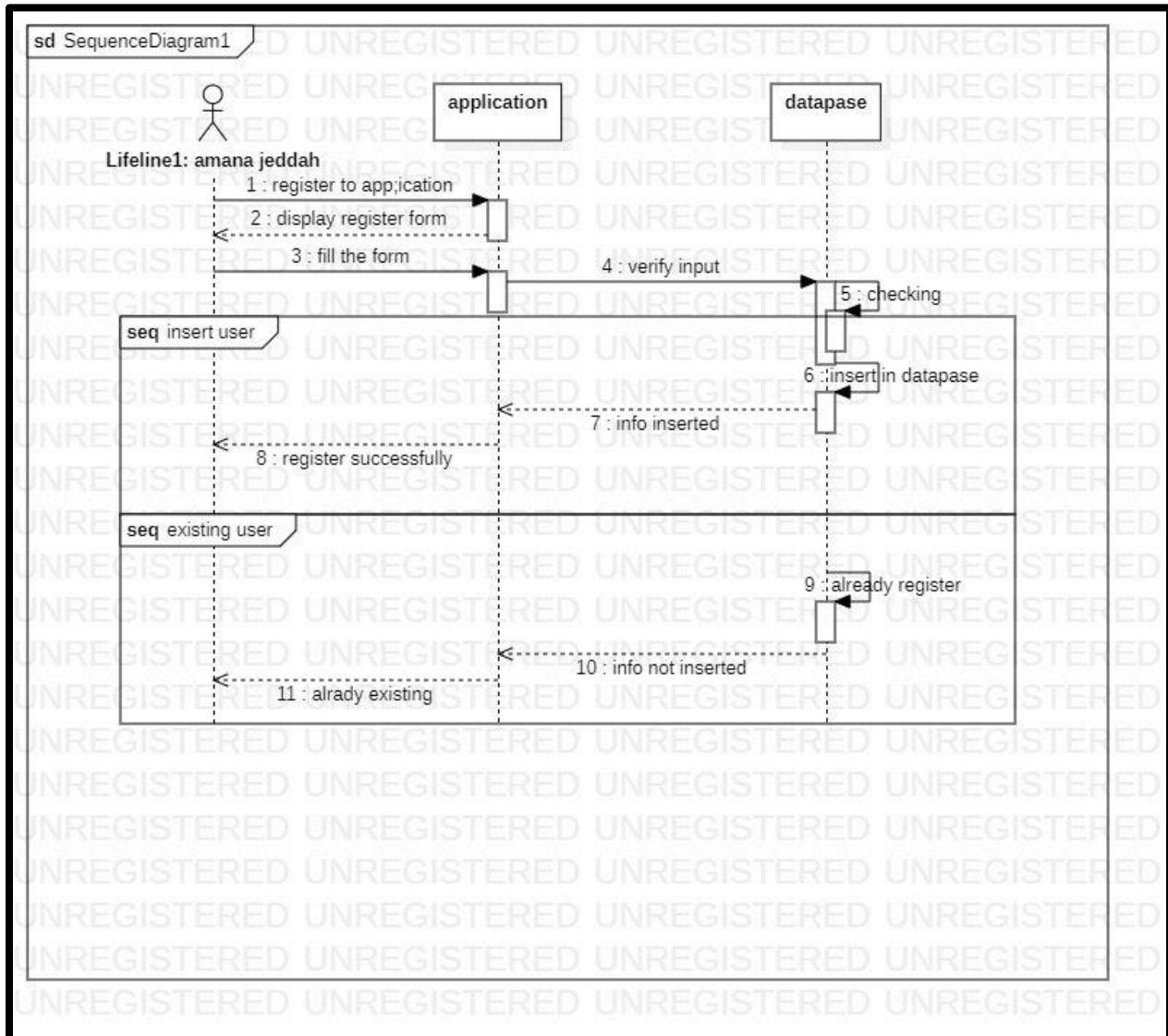
Here the administrator will choose the truck tracking option of any truck direct on map





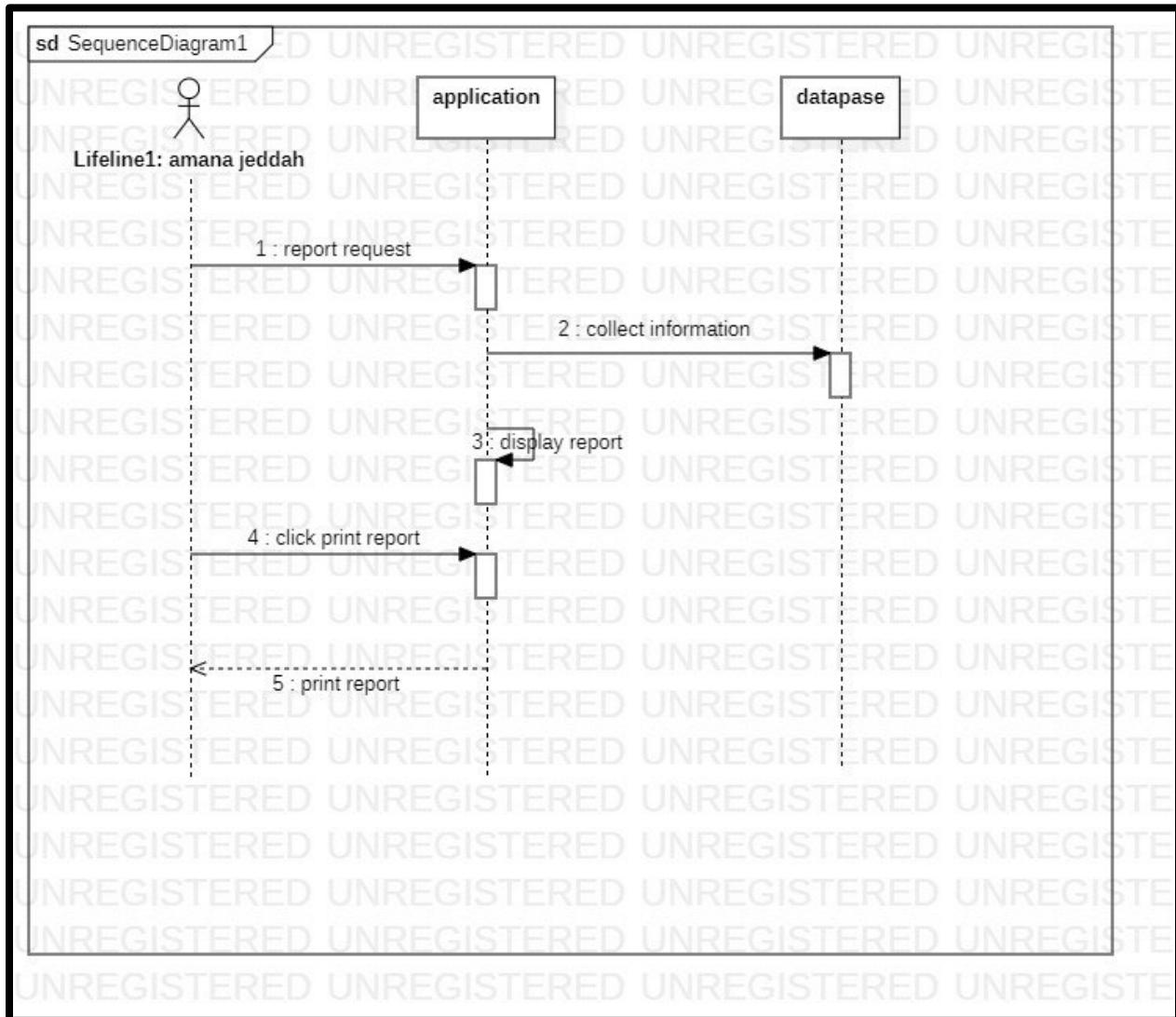
**Figure 10 Sequence for Edit**

Here the administrator can add or delete a container



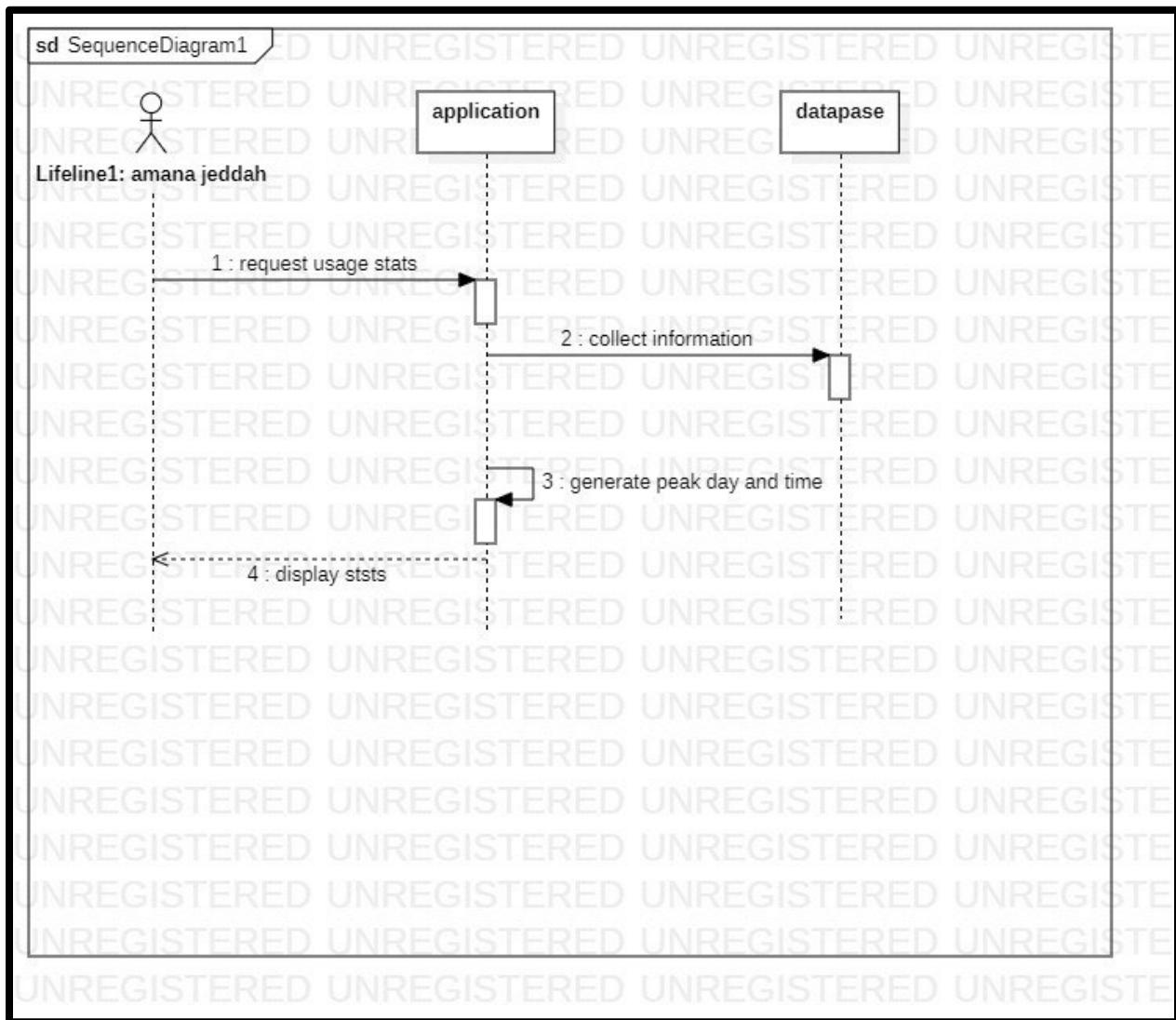
**Figure 11 Sequence for Register**

In this Sequence, amana creates the accounts for the employees, where he adds the employee's data and creates the account for him, and when the employee is already registered, he gets a statement that he already exists



**Figure 12 Sequence For Report**

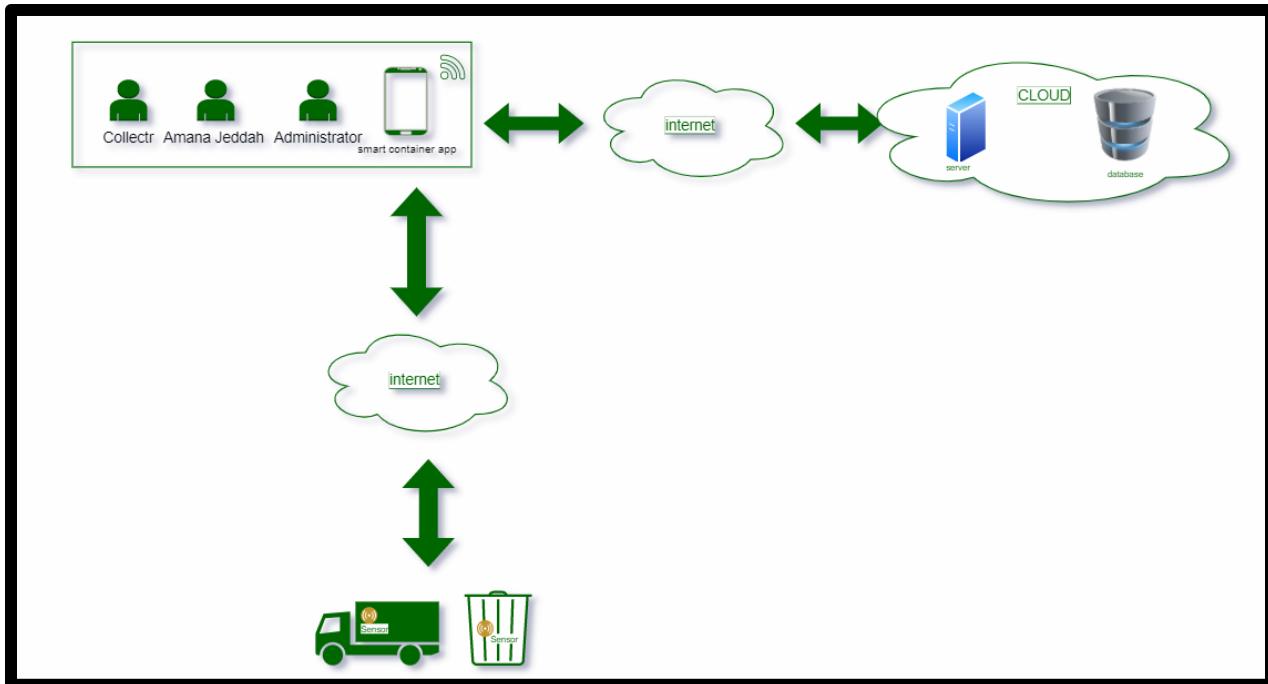
In this sequence, amana requests the report that contains all the stats



**Figure 13 Sequence for peak time**

In this sequence, amana calculates the peak time from the container information

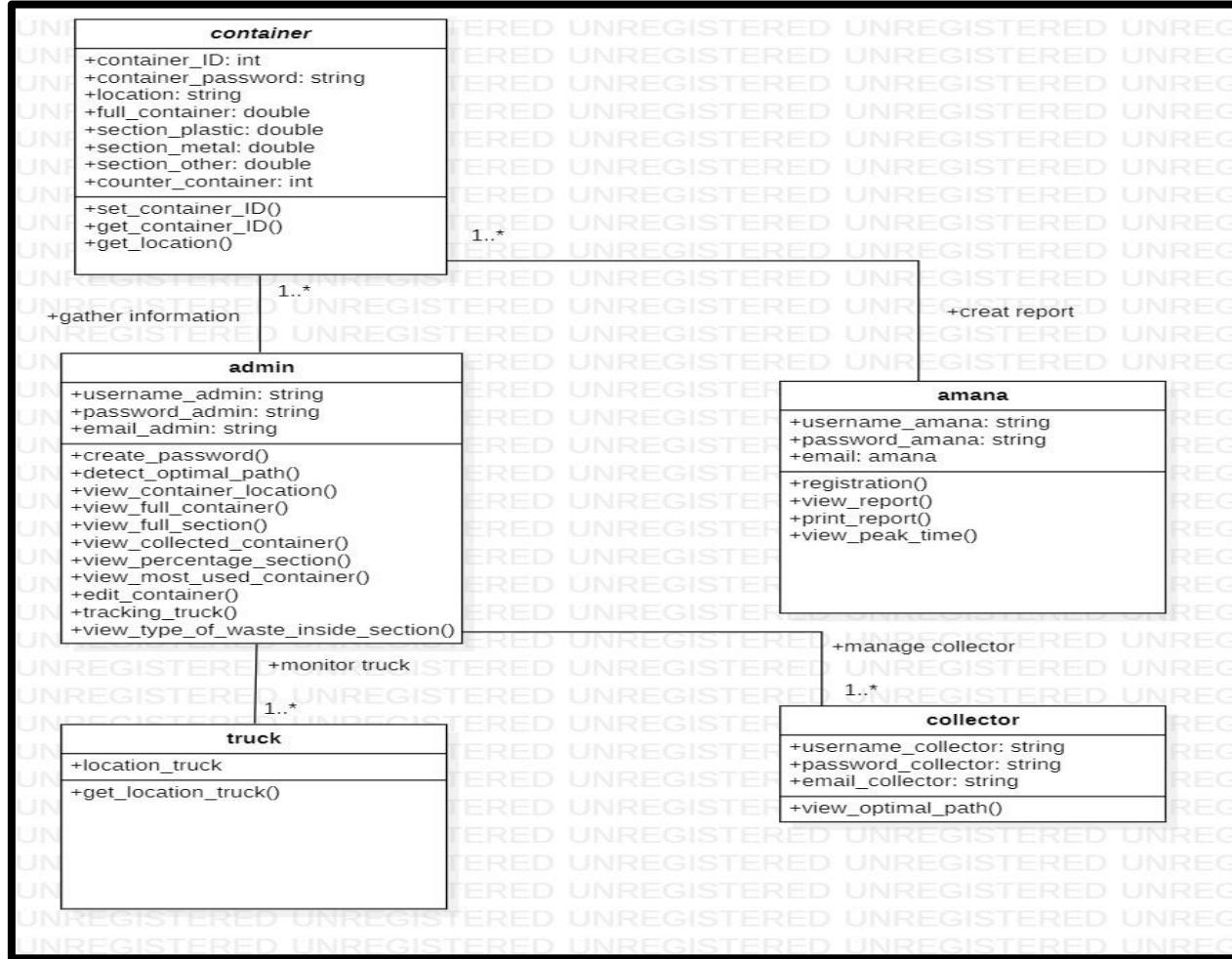
### 3.6 System architecture



**Figure 14 System architecture**

Here the container and truck information will be sent to the application and their data will be stored in the database and then users will be able to see it and perform the functions

### 3.7 Class diagram



**Figure 15 Class diagram**

We have made classes for all interfaces in the application

we have 3 main users The admin, Amana, and the collector

Home page Class of admin have these classes (View location -Create password-Edit-truck tracking-information's about Container-Choose optimal path)

Amana Jeddah Class have (view peak time- view report-registration) Classes

Collector Class can have access to Choose the optimal path class and log in class

Container class is to get the information's about Container

### 3.8 Methodology

In our project we will use the Incremental Model

In incremental model the whole requirement is divided into various builds.

Multiple development cycles take place here, making the life cycle a “multi-waterfall” cycle. Cycles are divided up into smaller, more easily managed modules.

Because it can :

1. Generates working software quickly and early during the software life cycle.
2. This model is more flexible less costly to change scope and requirements.
3. It is easier to test and debug during a smaller iteration.
4. In this model, user can respond to each built.
5. Lowers initial delivery cost.
6. Easier to manage risk because risky pieces are identified and handled during it'd iteration.

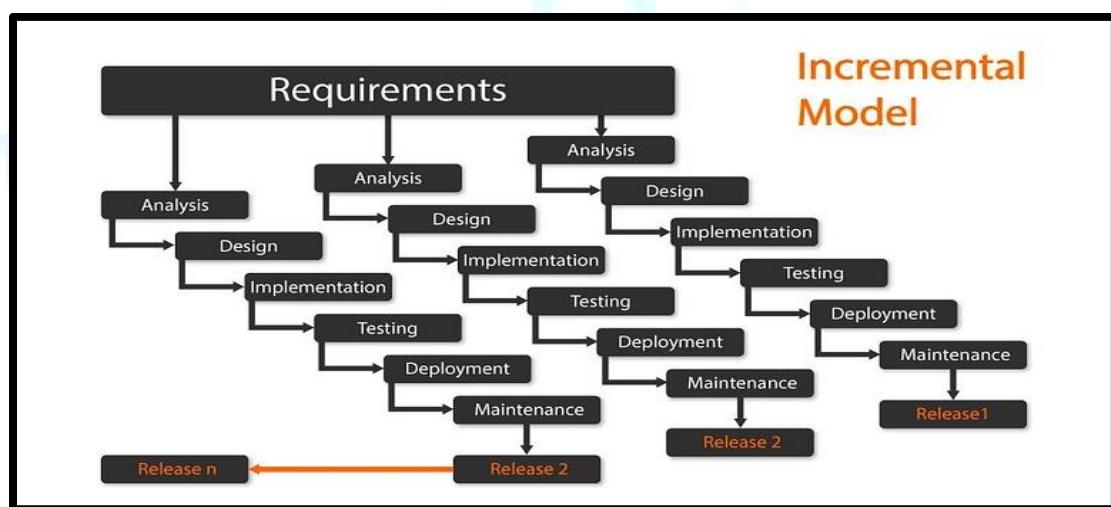
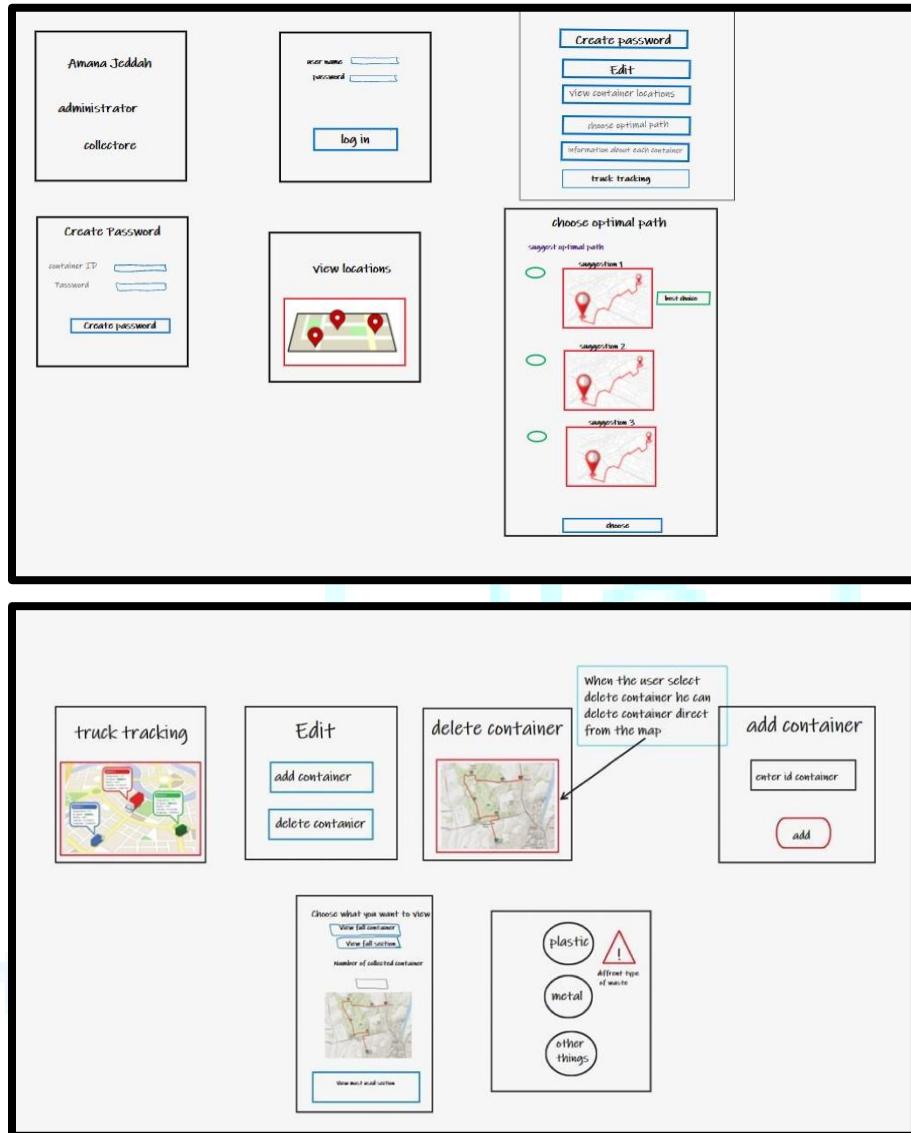


Figure 16 incremental model



## Chapter IV: Design

## 4.1 Prototype design(low fidelity)



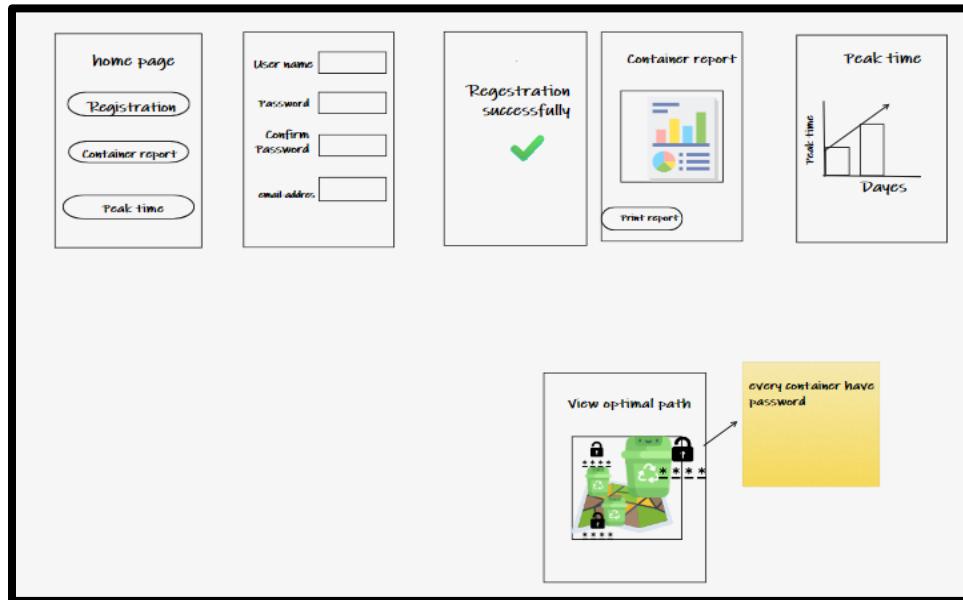


Figure 17 low fidelity



## 4.2 Prototype design

**First page:**

the user chooses who he is

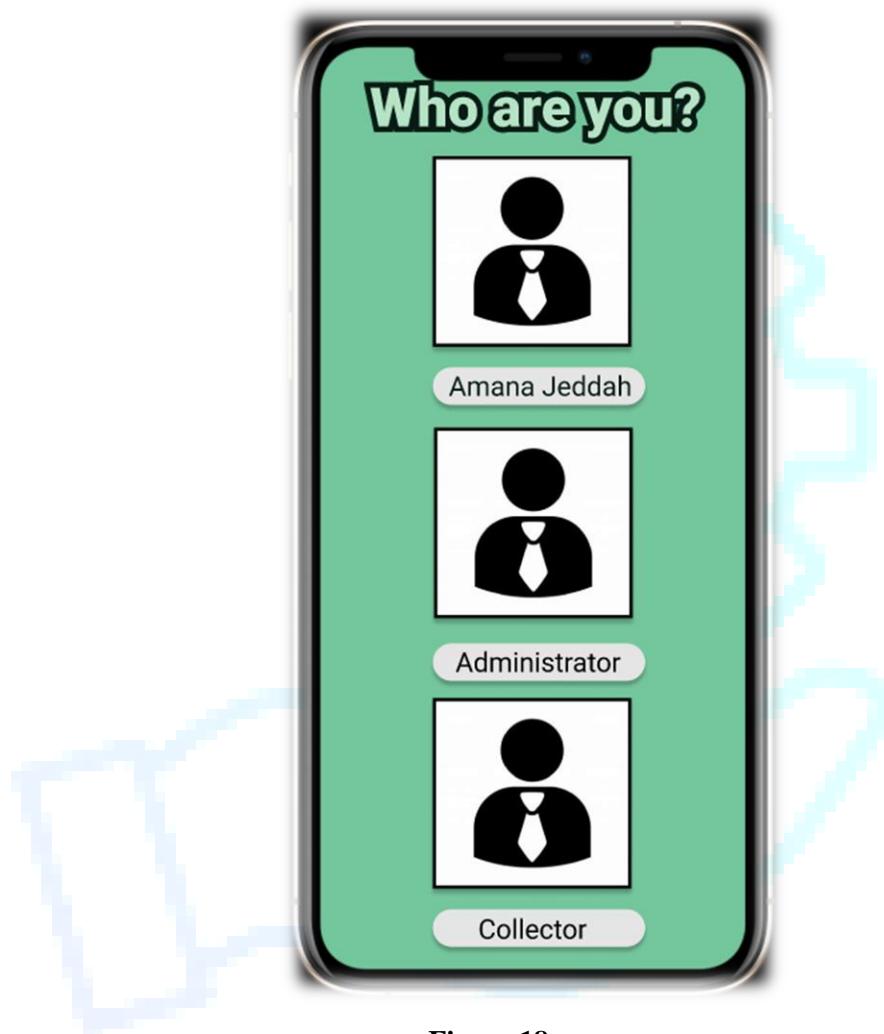


Figure 18 user page



### login page:

The user (Amana Jeddah – Administrator – collector ) only can login to the system

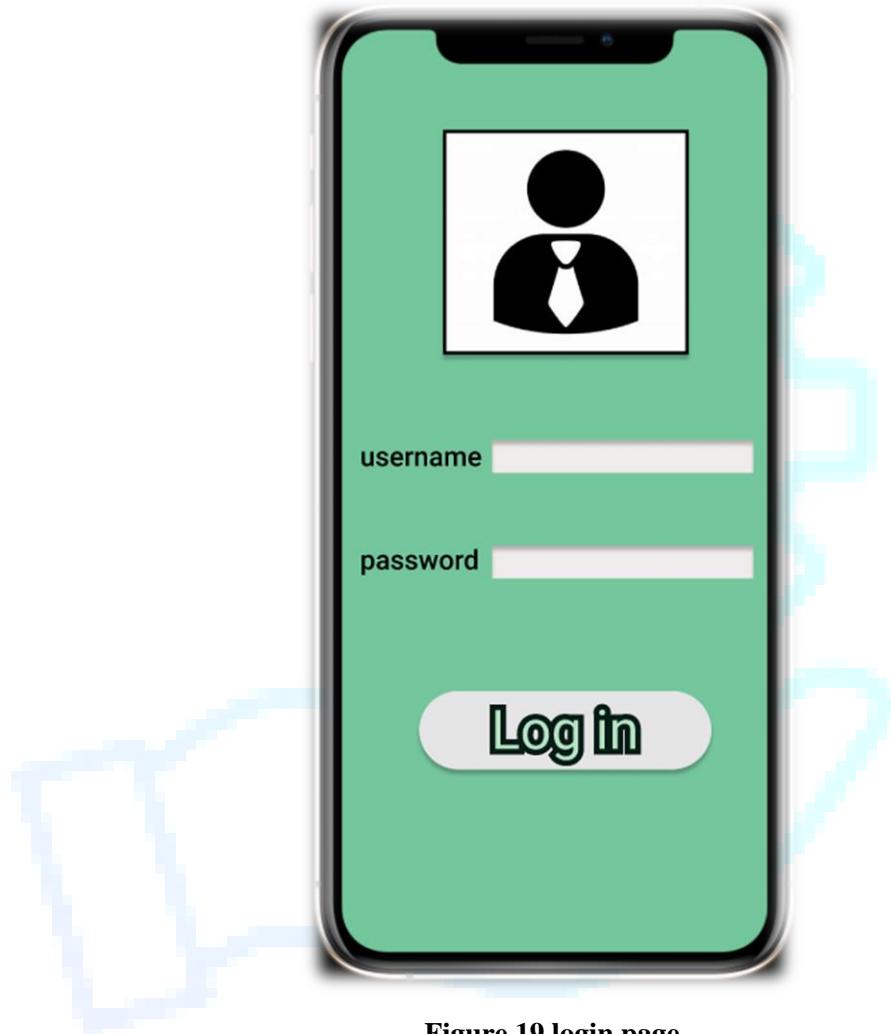


Figure 19 login page



## Home page:

This is the Start point of the major function in our application.

Home page for the administrator :

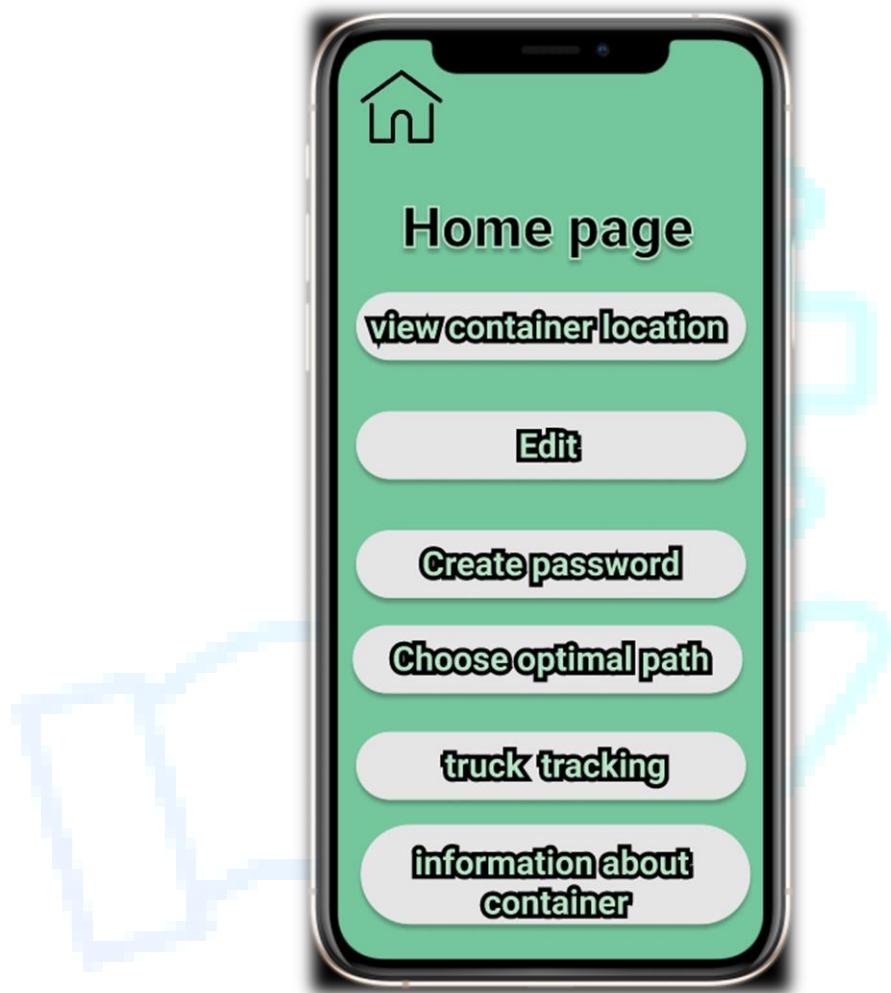
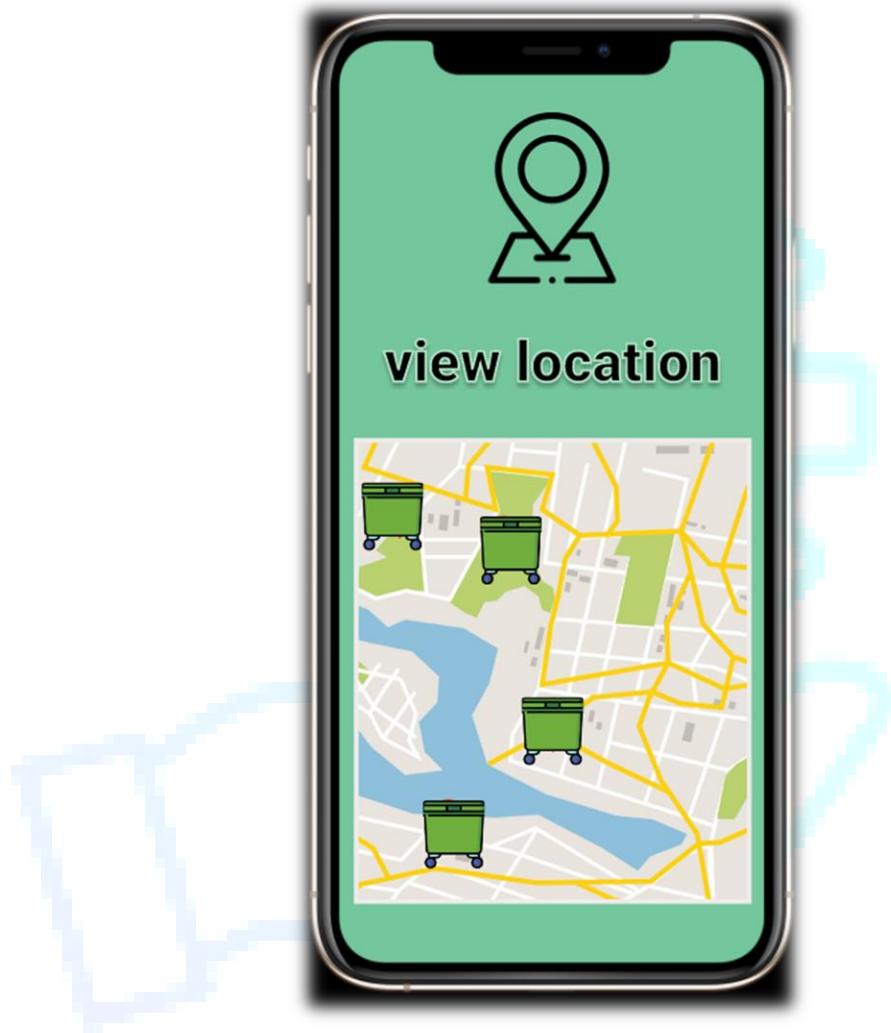


Figure 20 home page



**View location page :**

**The administrator can view the location each container**



**Figure 21 View location page**



### Edit page :

The administrator can edit container in the system



Figure 22 Edit page



### Add container:

The administrator can add more container.

When he adds the container, the following page will appear



Figure 23 add container page

### Delete container:

The administrator can delete container directly through the map

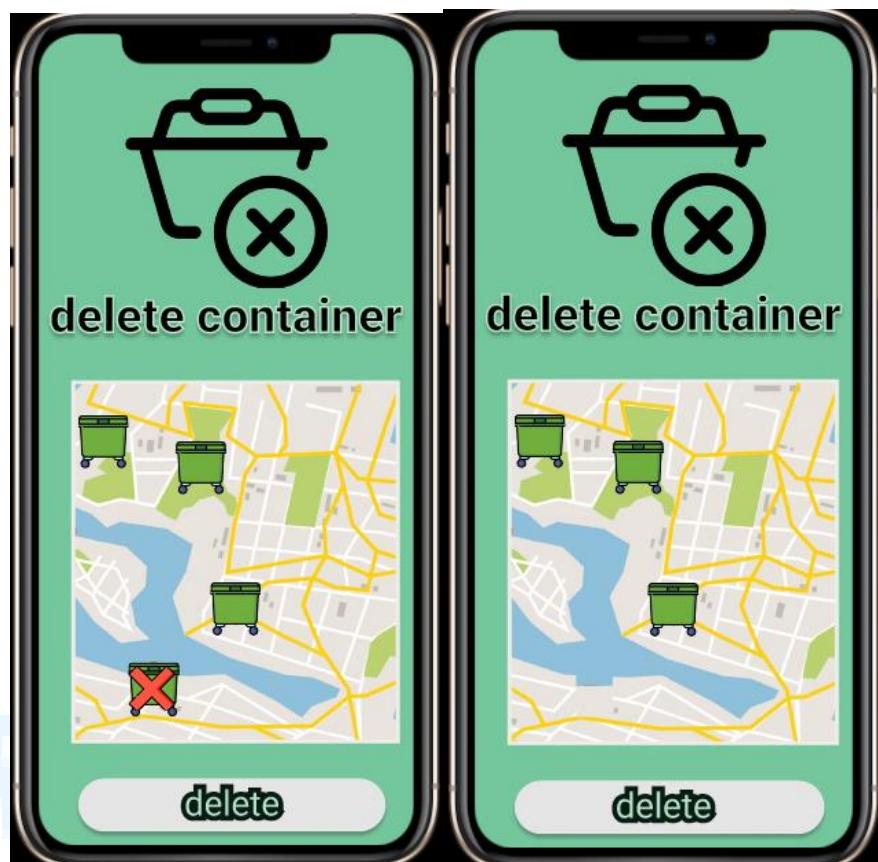


Figure 24 delete container page



### Create password page :

here the administrator can create a password for each container



Figure 25 Create password page

### Choose optimal path page :

Here, the system will display more than one optimal path, and the best path will be indicated as “best choice,” and the administrator determines the path that suits him.

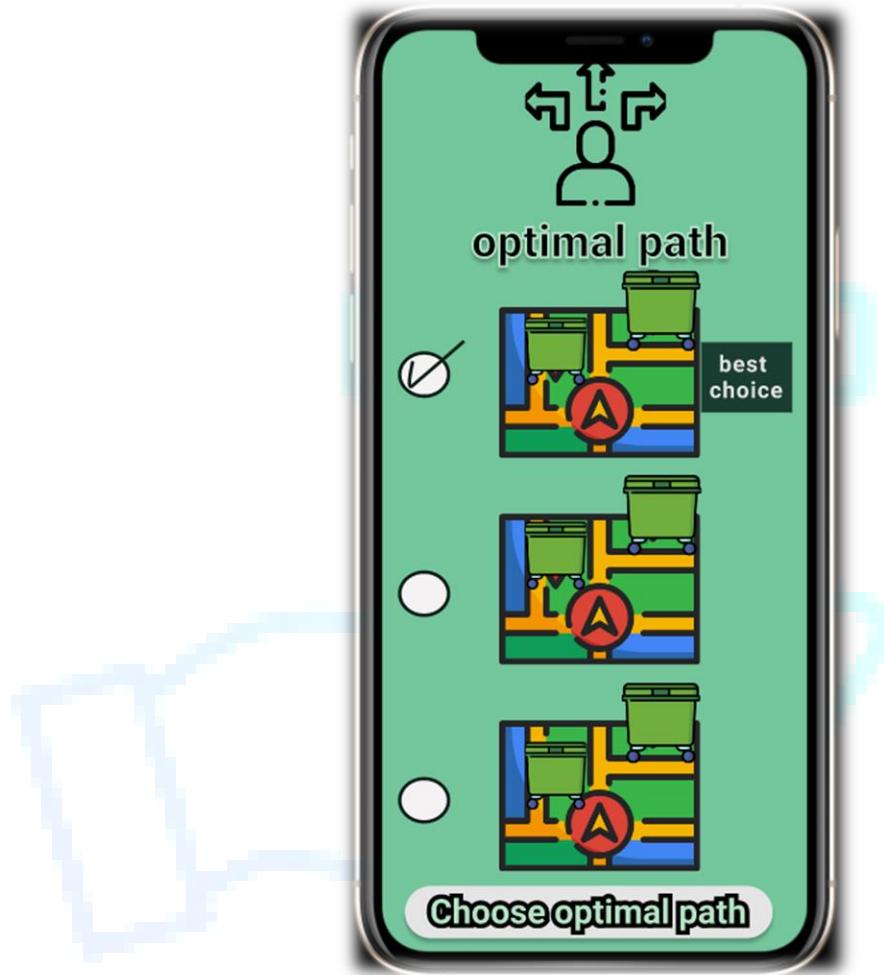


Figure 26 Choose optimal path page

## Truck tracking:

Administrator can tracking truck location on the map

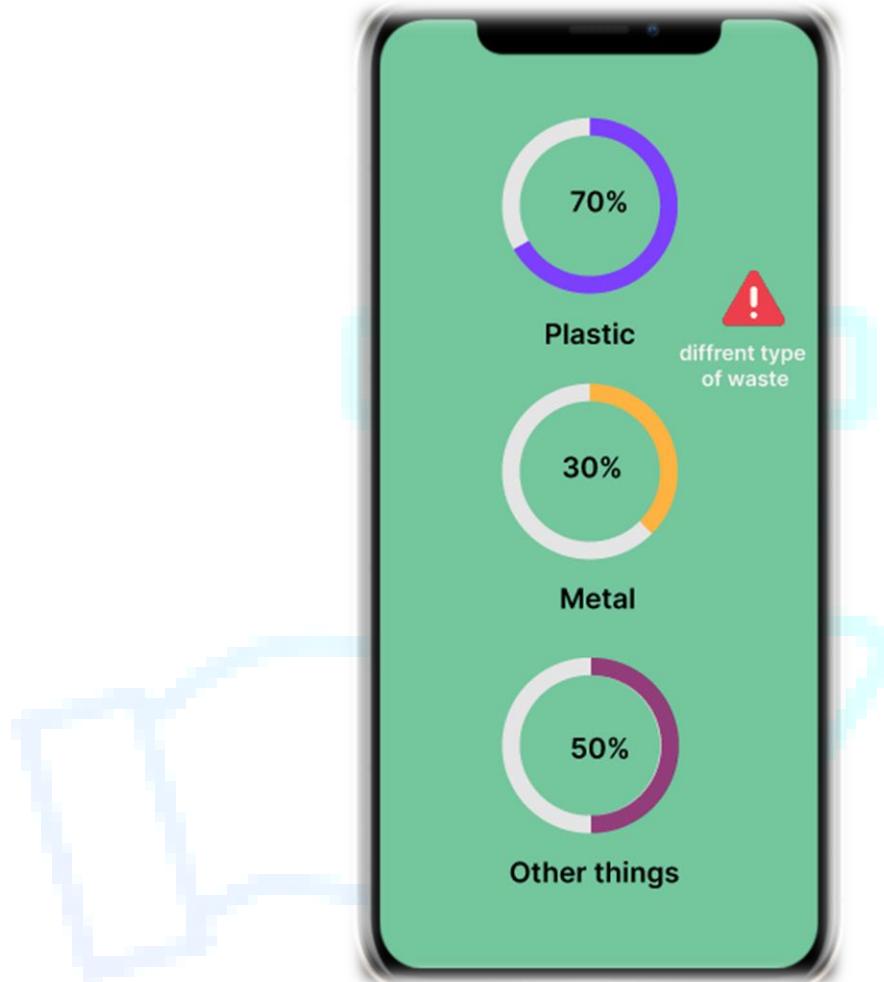


Figure 27 Truck tacking

### **View type of waste inside section:**

The administrator must be able to view if the waste inside the section has the same type or not.

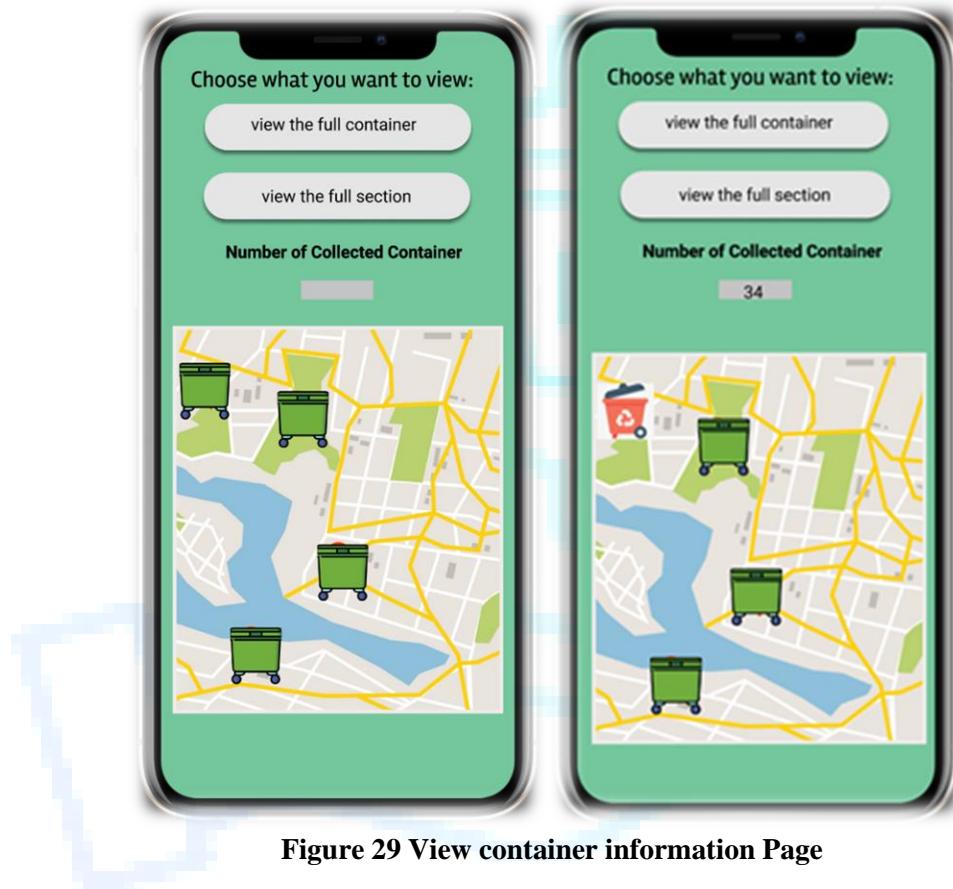
A warning sign will appear if there are different types within any section



**Figure 28 View type of waste inside section page**

### **View container information Page :**

**view full container will display the full containers in a different color on the map and the number of collected containers will display**



**Figure 29 View container information Page**



### Full section page:

View full section will display how full is each section in the container

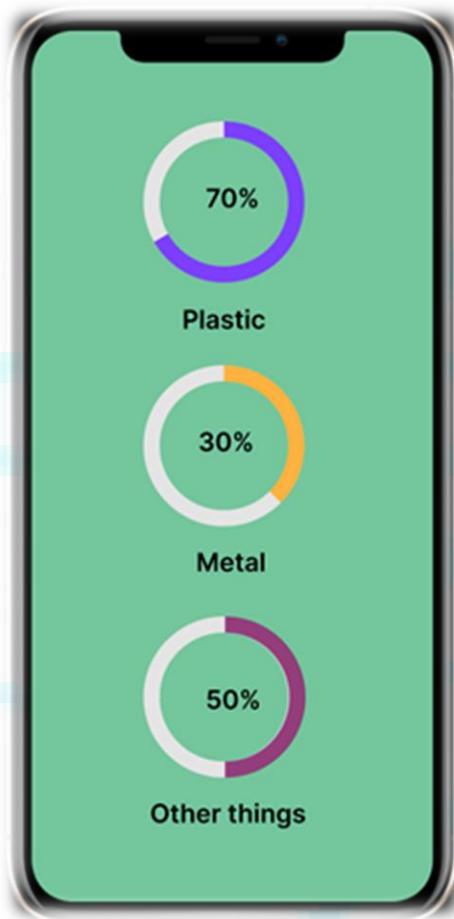


Figure 30 View container information Page



### Home page:

The home page contains the amana functions that you perform

Home page for amana jeddah :

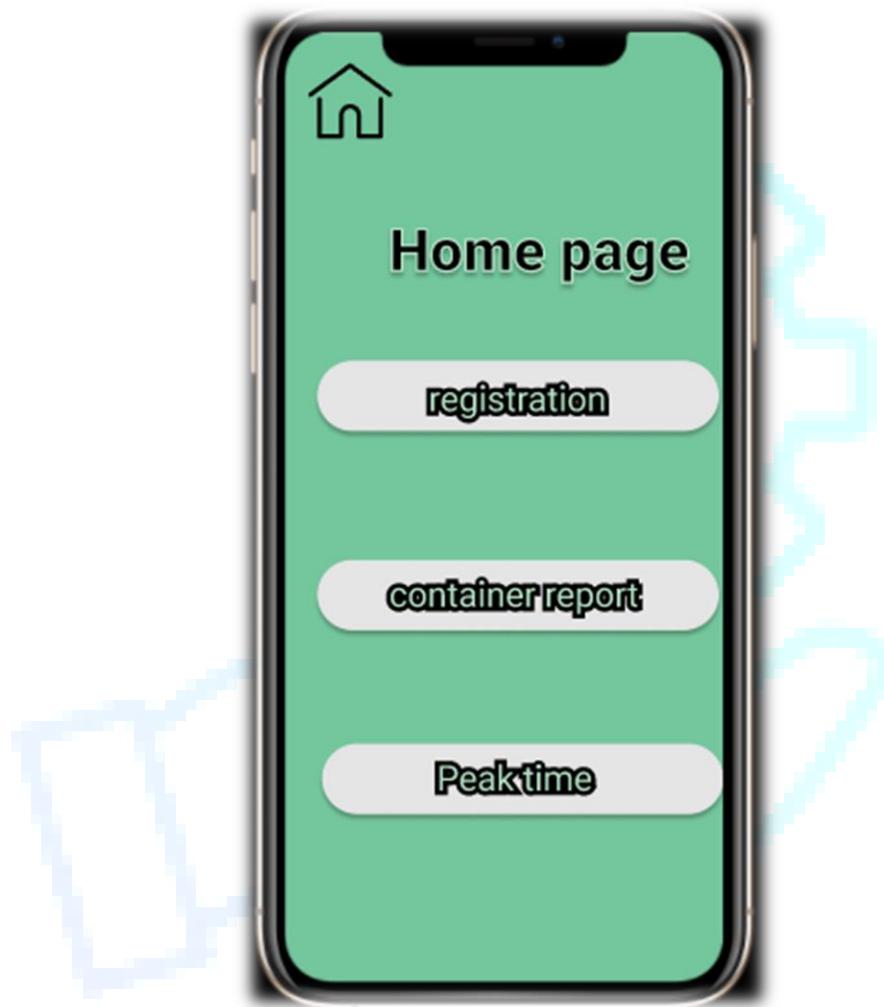


Figure 31 home page amana



### registration page:

The amana jeddah creates accounts for employees by filling out this form

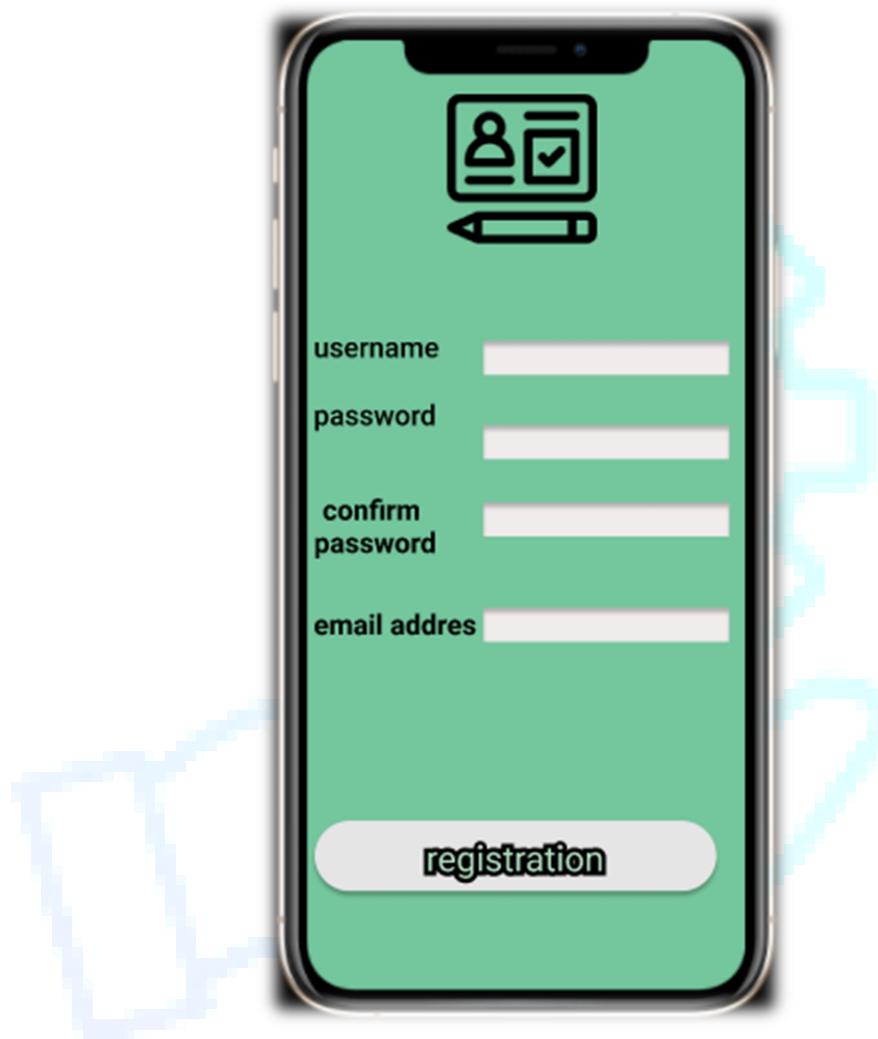


Figure 32 Registration page



### Registration success page:

This page appears when the account has been successfully created

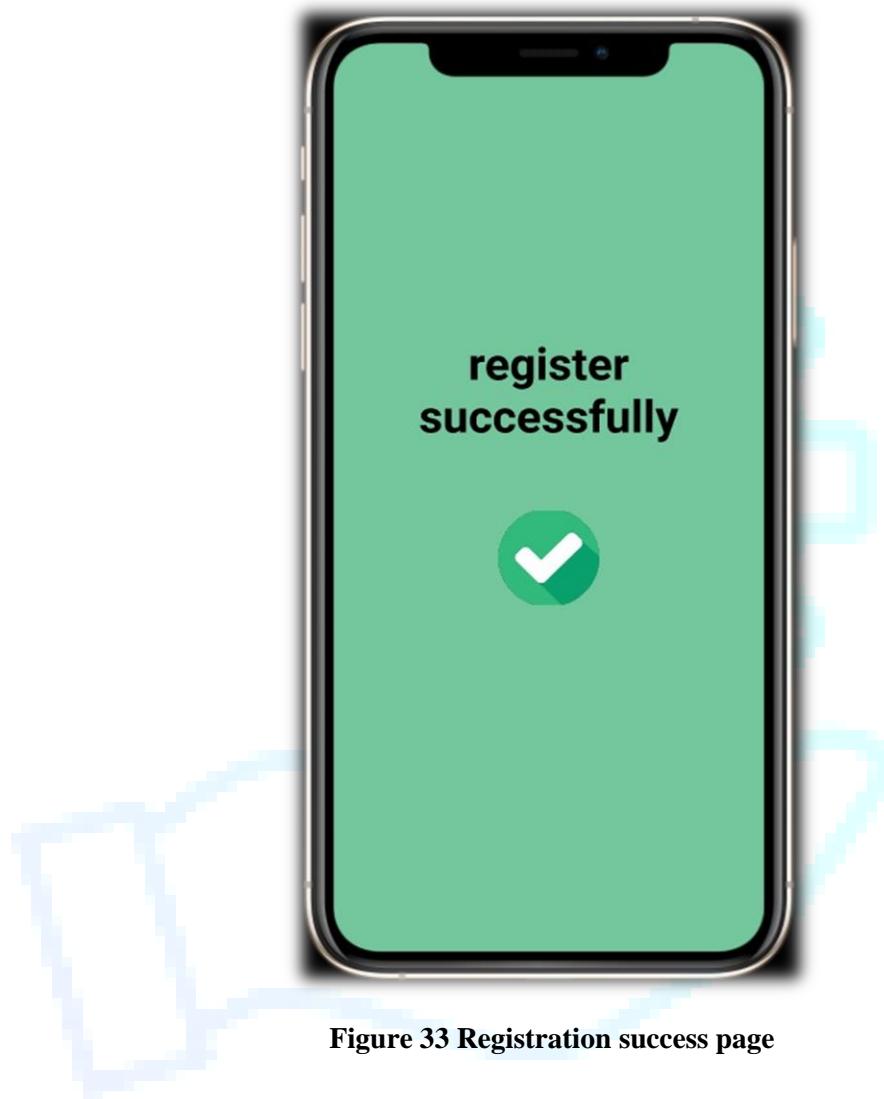


Figure 33 Registration success page

### report page:

When the amana clicks on the container report, this page appears that contains the container information, where the amana can view or print it

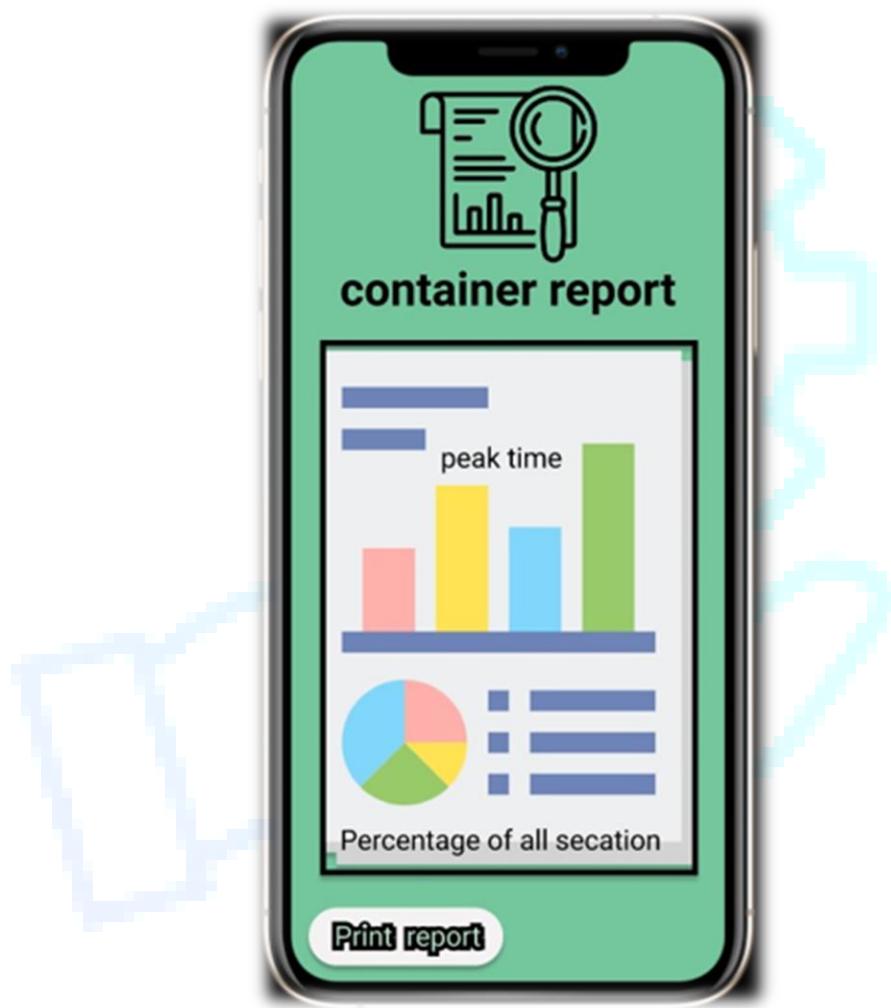


Figure 34 report page

### Peak time page:

When the amana click the peak time, a graph is displayed showing the peak time with days



Figure 35 Peak time page

### optimal path page:

When the collector logs in, a map will appear containing the ideal route to take and the secret numbers for each container.



Figure 36 View optimal path page



## Chapter V: Implementation



## 5.1. Introduction

most of the plans and processes become a reality in this chapter, The implementation phase represents the work done to meet the requirements of the scope of work and fulfill the charter. During the implementation phase, the project team accomplished the work defined in the plan.

## 5.2. Software Programming Language and Tools

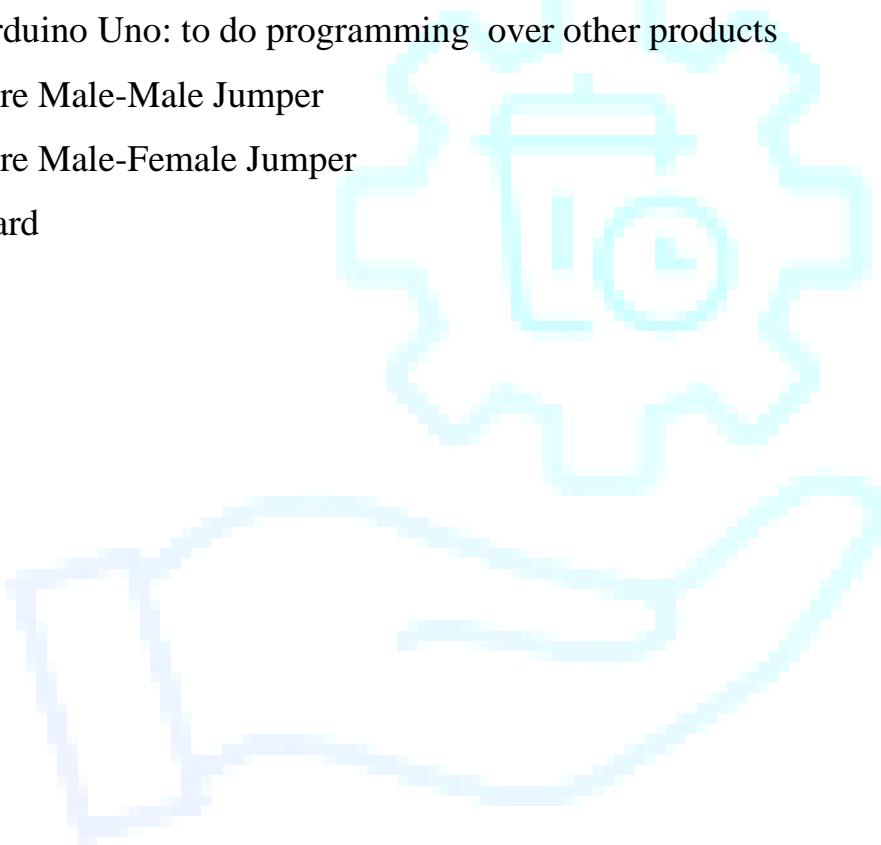
This section represents the software and programming languages that we used throughout the implementation chapter of our smart container application:

1. Android Studio: Android Studio is the official Integrated Development Environment (IDE) for Android app development [11] and we used the Java language to develop our application
2. firebase: Firebase is an app development platform that helps you build and grow apps and games users love. Backed by Google and trusted by millions of businesses around the world [12]. we used firebase to connect hardware information to the application.
- 3.arduino : is an open-source electronics platform based on easy-to-use hardware and software. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do it you can use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. [13]

### 5.3. Hardware Tools

This section represents the hardware that we used throughout the implementation chapter of our smart container application:

- 1- NEO-6M GPS: to detect the location
- 2- inductive sensor: to detect metal
- 3- ultrasonic: to detect the level of trash
- 4- ESP8266 NodeMCU: to connect with firebase
- 5- Arduino Uno: to do programming over other products
- 6-Wire Male-Male Jumper
- 7-Wire Male-Female Jumper
- 8-board





## 5.4 Application Implementation

In this part, we will describe the interfaces of our application smart container

### 5.4.1. Login page:

it shows the login code, that verifies the authorization by correct email and password

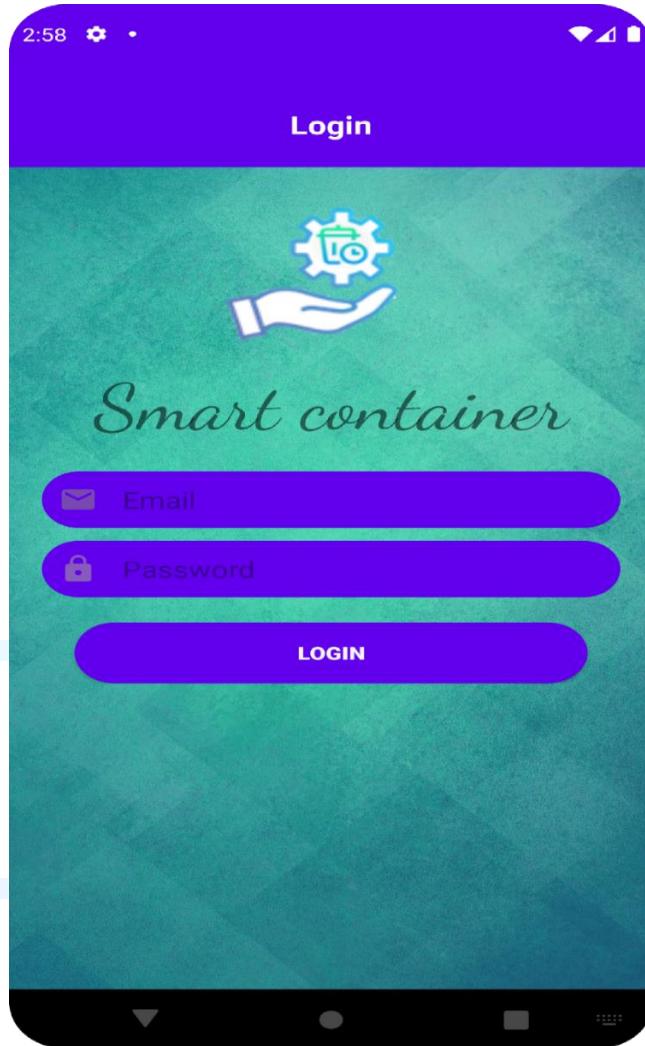


Figure 37 Login page



#### 5.4.2 Choose optimal path page:

the administrator to choose the optimal path for the container collector through the containers that have been filled

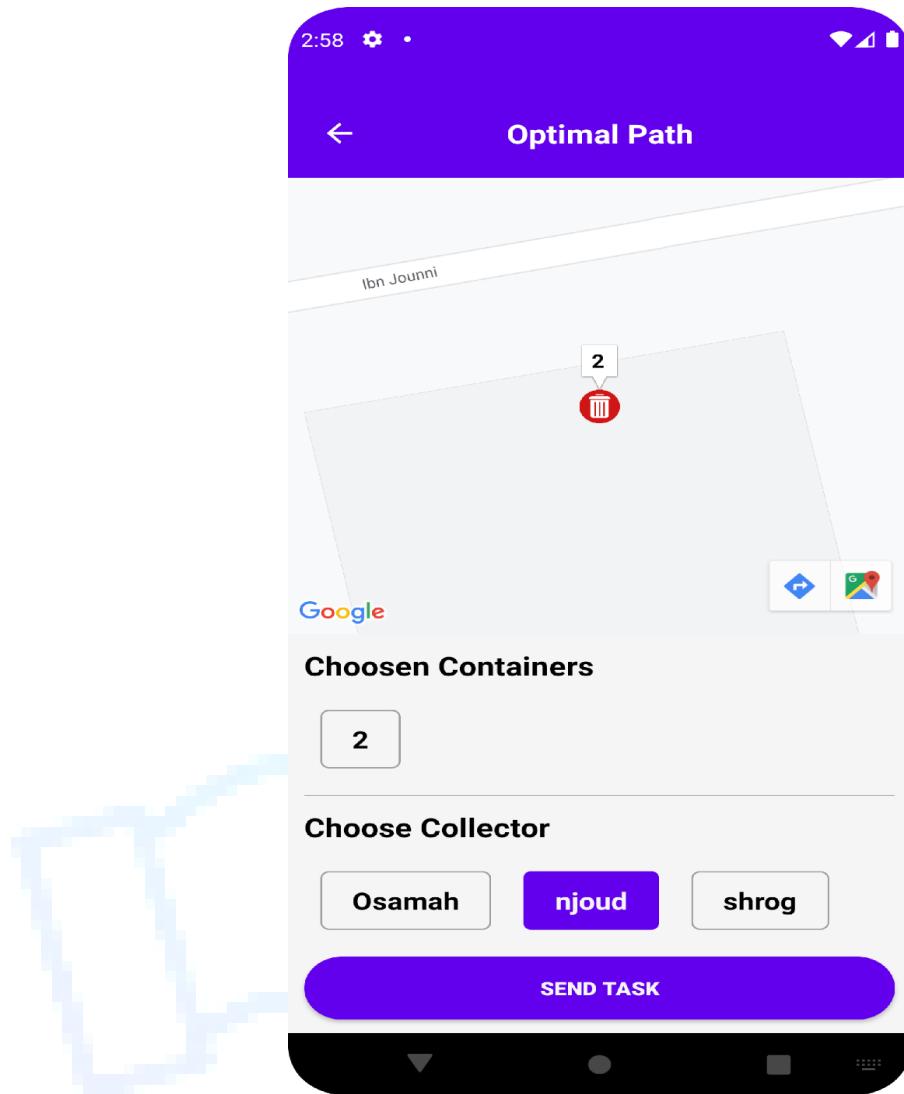


Figure 38 Choose optimal path page

#### 5.4.3 modify container page:

it shows adding a container in the place specified by the administrator and activating it or deactivating

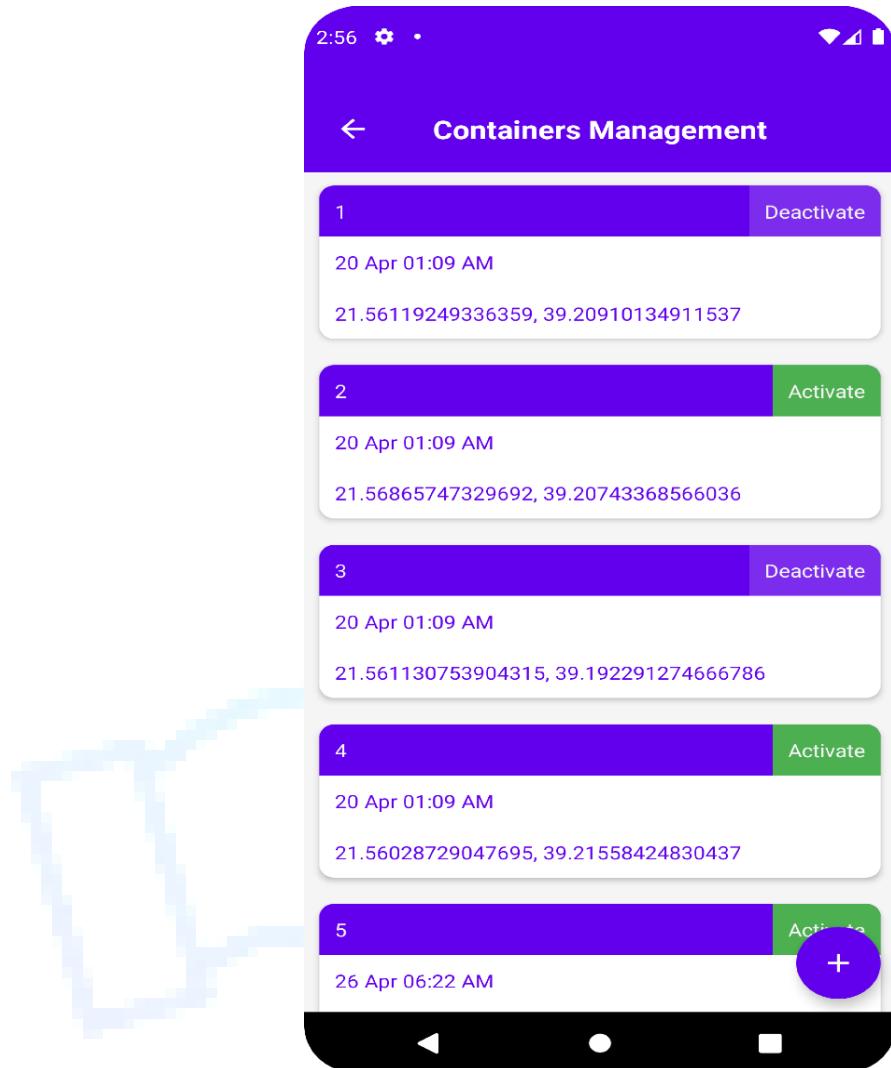


Figure 39 modify containers page

#### 5.4.4 container report page:

it shows the container information, how much it is filled, what is the most full section and the peak time

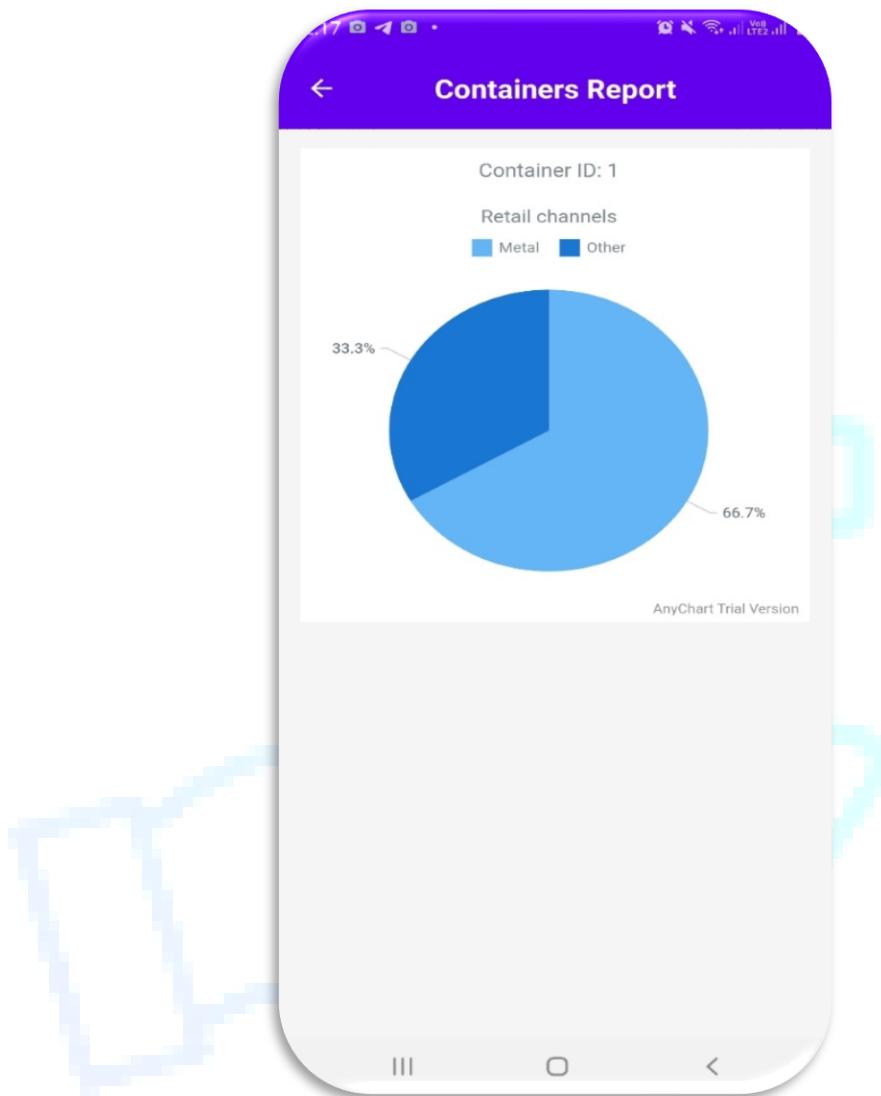


Figure 40 container report page



#### 5.4.5 task collectors page:

It shows the tasks sent from the administrator to the containers collectors, which contains the optimum path for collecting the filled containers.

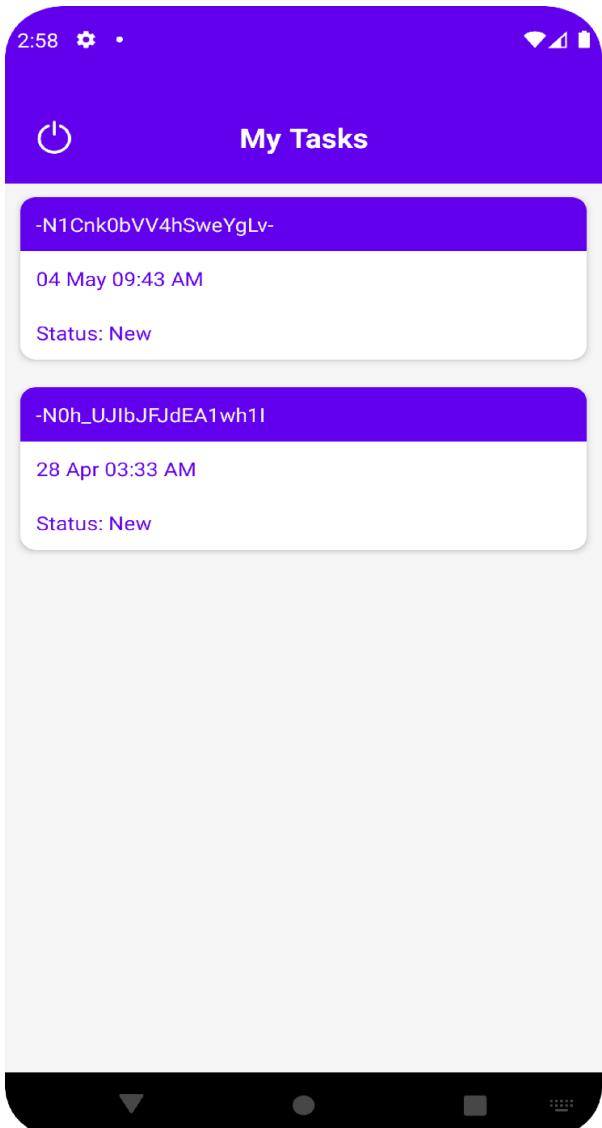


Figure 41 task collectors page

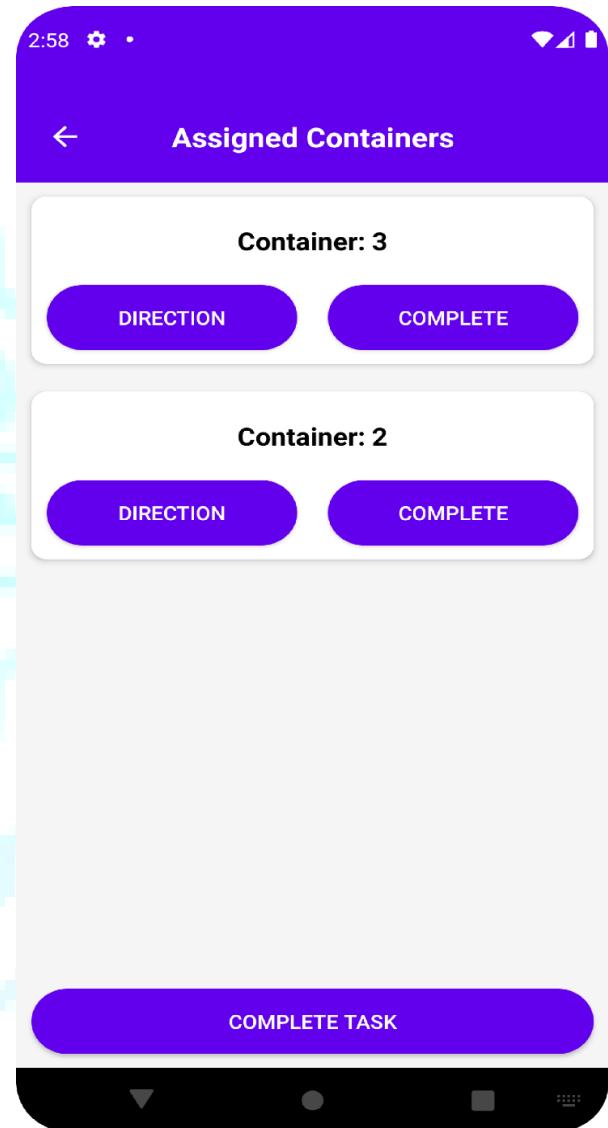
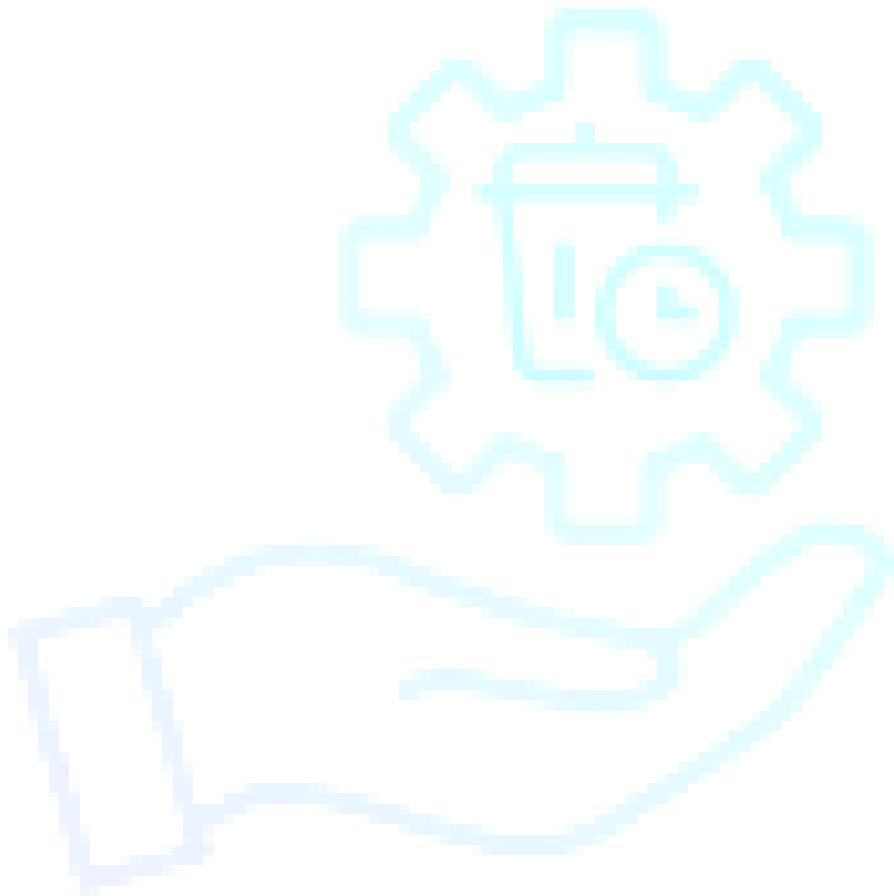


Figure 42 task collectors page

## 5.5. Conclusion

In this chapter, we discussed the main steps of the implementation phase that including software programming. The next chapter will present our testing plan and results for our system.





## Chapter VI: System testing

## 6.1 introduction

Testing is the process of evaluating a software product to see whether the current software product meets the required conditions. Our goal is to ensure that the Smart Container application performs all functions as required and ensures that the software is free from errors that can be identified early and resolved before the software is delivered. Testing helps ensure that properly tested software has a high level of reliability, security, and high performance, resulting in time and cost savings.

The tests we did include:

- Unit Testing
- Integration Testing
- System Testing
- Compatibility Testing
- Usability Testing

## 6.2 Unit Testing

is a type of software testing that performs tests of individual components in a program to verify that each unit of program code is working as expected

No.	Functions	Test steps	Test Data	Expected	Actual	Pass/Fail
				Result	Result	
1	Log in	1-Insert Email and password 2-Click “Log in”	Email: admin@gmail.com Password: 123123	Log-in successfully	Log-in successfully	Pass
2	Choose the optimal path	1-Select choose the optimal path choice 2-Chooose containers from the map 3-Choose collector 4-Press Send Task button		Task created successfully	Task created successfully	Pass
3	Modify Container	1-Select Modify Container 2-Press Add button 3-Select Activate		Activate successfully	Activate successfully	Pass
4	Container Report	1-Log in to Amanah account 2-Select Container Report	Email: Amanah@gmail.co m Password: 123123	Show the information of the Report	Show the information of the Report	Pass
5	Collector's tasks	1-Login to collector account 2-Select Task 3- Choose Direction	Email: "collectorname"@g mail.com Password: 123123	Complete successfully	Complete successfully	Pass

Table 24 Unit Testing



### 6.3 Integration Testing

The stage in software testing in which individual software modules are combined and tested as one integrated unit. Integration testing is performed to assess the compliance of a system or component with specific functional requirements.

Test Case ID	Test scenarios	Result
1	The administrator must first log in to the application so that he can control all the services available	Pass
2	Administrator can display full containers on the map and set priority to collect containers and send them to the collector, then will show the collector the optimal path to collect the containers	Pass
3	The collector must log in to the application to show the list of tasks that contain the containers that he must collect in order and then display the location of each container when the task is completed will choose the option "Complete"	Pass
4	in the container Report, All activities are recorded from determining the time of filling the container to the time of its collection, and statistics are displayed for the peak times of the containers	Pass

Table 25 Integration Testing

## 6.4 System Testing

It is a test performed on an integrated system to assess the compliance of the system with its specified requirements. The system test takes, as its input, all the integrated components that have passed the integration test

Test scenario		Result Status
login for admin path	→ admin Dashboard → choose optimal	pass
login for admin	→ admin Dashboard → truck tracking	pass
login for admin	→ admin Dashboard → container location	pass
login for admin Deactivate or Activate	→ admin Dashboard → modify container	pass
Login for amana Information of Registration	→ amana Dashboard → Registration	pass
Login for amana	→ amana Dashboard → container report	pass
Login for amana	→ amana Dashboard → peak time	pass
Login for collector	→ collector Dashboard → Task of collector	pass

Table 26 System Testing

## 6.5 Compatibility Testing

Device Model	Device Type	Android Version	Memory Space	Pass/Fail
Samsung	Galaxy S20+ 5G	12	128	pass
Samsung	Galaxy A31	10	128	pass
Samsung	Galaxy S10	12	128	pass

Table 27 Compatibility Testing



## 6.6 Usability Testing

The goal or purpose of testing is to ensure that the system performs each required function correctly. We will test if the system is easy to use by the target users and that it completes the required tasks which leads to ensuring that the system is free from bugs and errors.

Measure	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinion
<b>Learnability:</b> How easy is it for users to accomplish basic tasks the first time they encounter the design?					
<b>Efficiency:</b> Once users have learned the design, how quickly can they perform tasks?					
<b>Memorability:</b> When users return to the design after a period of not using it, how easily can they reestablish proficiency?					
<b>Errors:</b> How many errors do users make, how severe are these errors, and how easily can they recover from the errors?					
<b>Satisfaction:</b> How pleasant is it to use the design?					

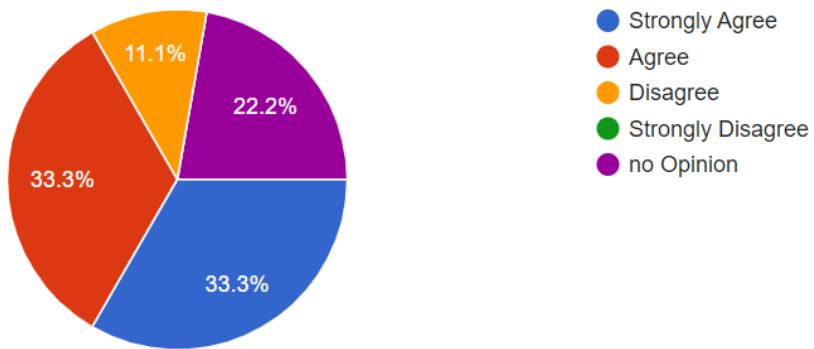
Table 28 Usability Testing

## The results of the System Usability Testing



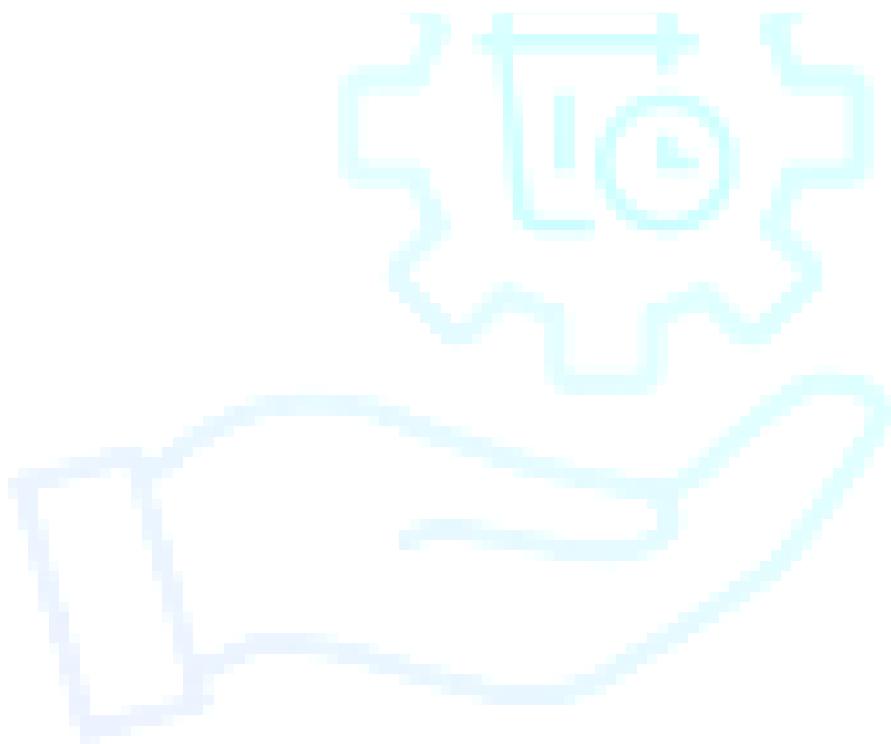
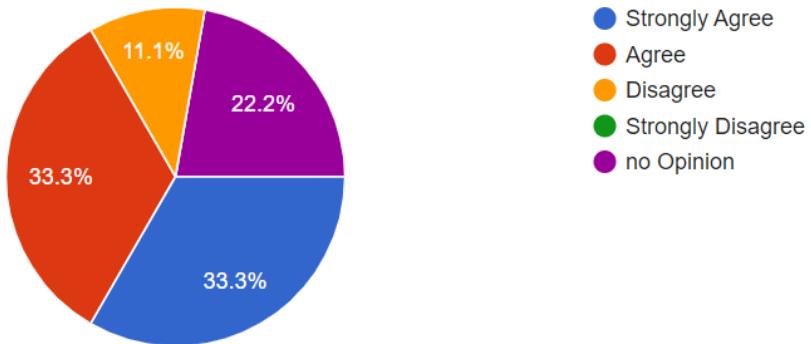
Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design

ردود 9



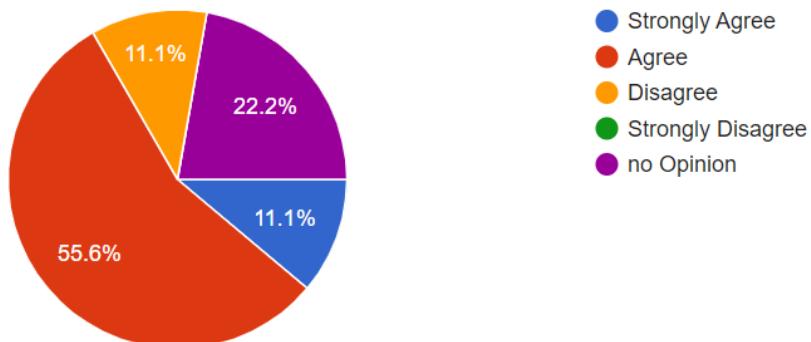
?Efficiency: Once users have learned the de- sign, how quickly can they perform tasks

ردود 9



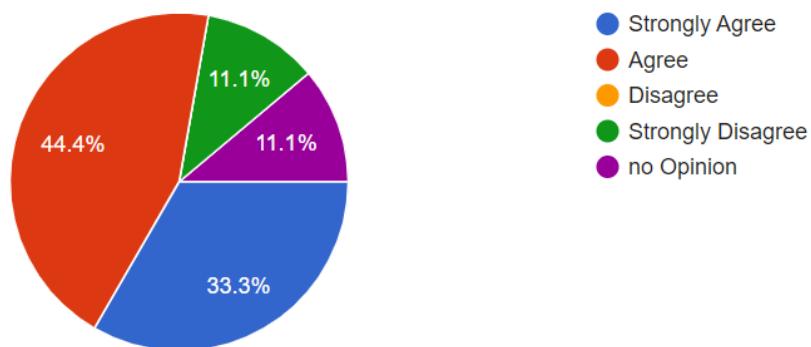
Memorability: When users return to the de- sign after a period of not using it, how easily  
 ?can they reestablish proficiency

ردود 9



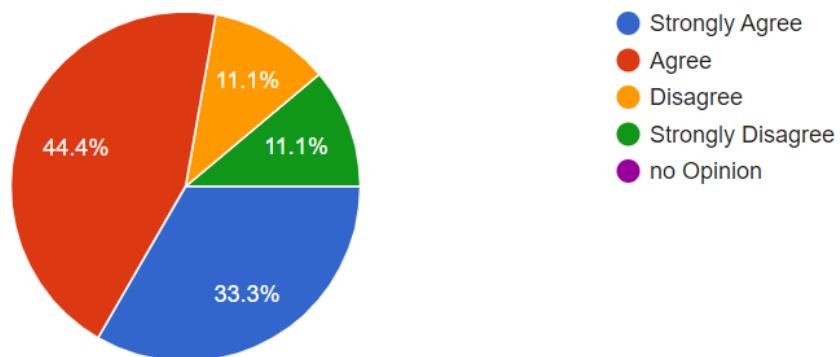
Errors: How many errors do users make, how severe are these errors, and how easily can  
 ?they recover from the errors

ردود 9



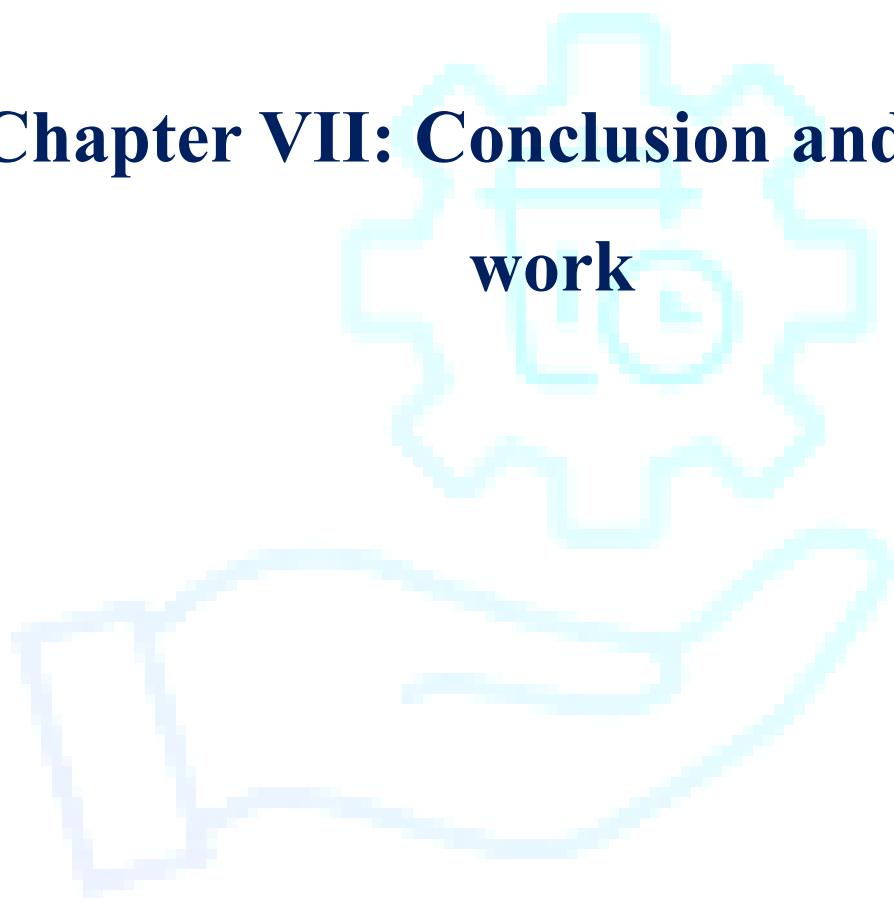
?Satisfaction: How pleasant is it to use the design

ردود 9





## Chapter VII: Conclusion and future work





## 7.1 Introduction

Our smart container application covers a very important area which is the cleanliness of the environment in the Kingdom of Saudi Arabia. In fact, the Kingdom of Saudi Arabia is a country rich in concern for the environment and its preservation, but the problem is that there is no smart container with beautiful technology in all parts of the Kingdom that makes it easier for them and the community to take care of the environment.

The Kingdom of Saudi Arabia is also witnessing an increase in population growth and an increase in the number of new cities, which has led to an increase in waste. Waste management has become a major challenge with a population of nearly 34 million people. Therefore, we cannot manage waste traditionally and manually because it leads to a waste of time, effort and money, and it is not compatible with the vision of the Kingdom of Saudi Arabia 2030 and its progress! So smart waste management will overcome the waste of time, money and effort and will be in line with the Kingdom's vision, so we present to you the smart container, which in turn will work on waste management in a smart way! The smart waste management system can be implemented in all smart places and cities in the Kingdom of Saudi Arabia, and the collection of containers will be high, and the places will be clean, tidy and free of unpleasant odors with minimal effort, time and money. Also, there is no application like our application in the Kingdom which provides a smart container divided from the inside and can immediately open them to pack, and recyclers can easily recycle any part of them.

Therefore, we designed in our project an application that cares about the cleanliness of the environment in the Kingdom of Saudi Arabia because it is rich in technical details of the cleanliness of the environment. This project will facilitate the discovery of the places that need the most containers in Saudi Arabia as well as the discovery of the most used materials.

This chapter highlights the difficulties we encountered during the project analysis, design, implementation and testing phases, and what is the future of the project's work objectives in order to enhance the cognitive testing system.



## 7.2 The problems encountered during our project:

During this project, we encountered some difficulties. We found it difficult to learn how to create a mobile app ourselves and to find tutorials to improve self-learning. Also, we encountered some code problems, well when we build our system pages. We also had trouble calling some APIs from google servers and linking them to APIs. We also encountered difficulties with the hardware and programming the sensors and the container. Our project has become more and more complex over time due to the huge number of functions that are included in it, Especially since our application contains a software section and a hardware section. Therefore, the short time did not support us.

## 7.3 Future work

There are many areas that could be improved and added more functionality. Like:

- The system can be implemented as a smart phone application for other phone systems.
- The system can be implemented in the future as a web application
- The system can be enriched with more functions such as increasing container partitions.
- The system can be expanded to include another component, which is recycling.
- The system can be downloaded on google play



## 7.4 Conclusion

Therefore, we cannot manage waste traditionally and manually because it leads to a waste of time, effort and money, and it is not compatible with the vision of the Kingdom of Saudi Arabia 2030 and its progress. Thus, smart waste management will overcome the waste of time, money and effort and will be in line with the Kingdom's vision. For that, we conceive and develop a smart container which in turn will work on waste management in a smart way. The smart waste management system can be implemented in all smart places and cities in the Kingdom of Saudi Arabia. The collection of containers will be high, and the places will be clean, tidy and free of unpleasant odors with minimal effort, time and money. Also, there is no application like our application in the Kingdom which provide a smart container divided from the inside and can immediately open them to pack, and recyclers can easily recycle any part of them. Therefore, we designed in our project an application that cares about the cleanliness of the environment in the Kingdom of Saudi Arabia because it is rich in technical details of the environment cleanliness. This project will facilitate the discovery of the places that need the most containers in Saudi Arabia as well as the discovery of the most used materials. This chapter highlights the difficulties we encountered during the project analysis, design, implementation and testing phases, and what is the future of the project's work objectives in order to enhance the cognitive testing system



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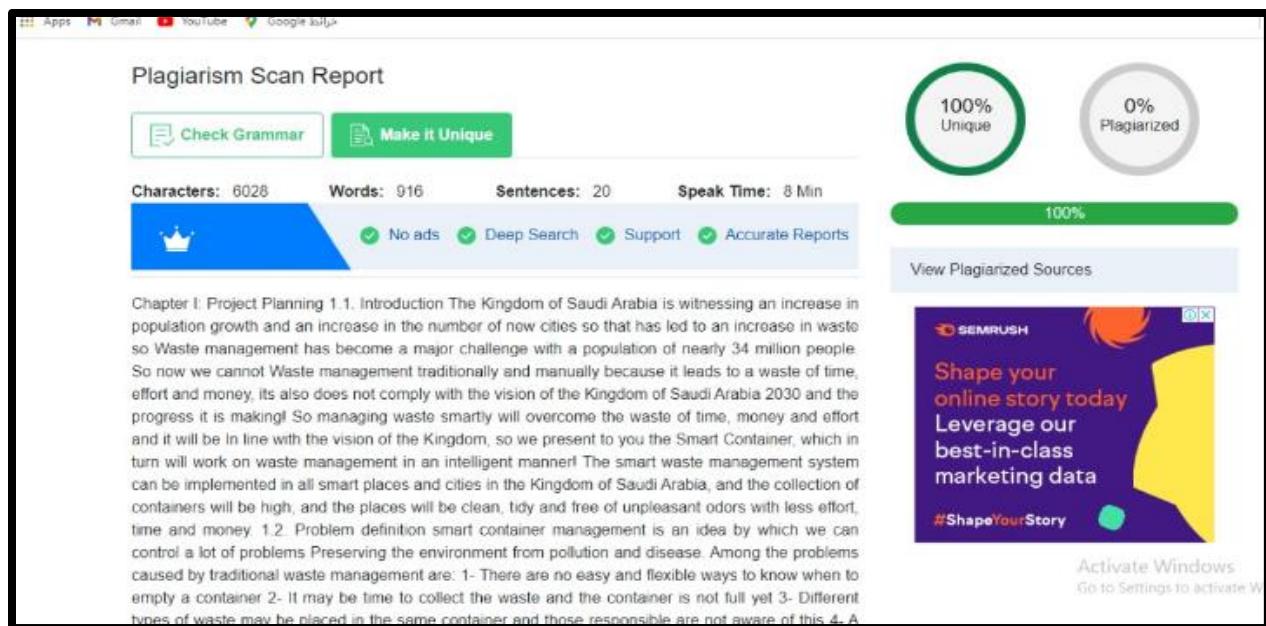


Figure 43 Plagiarism for chapter 1

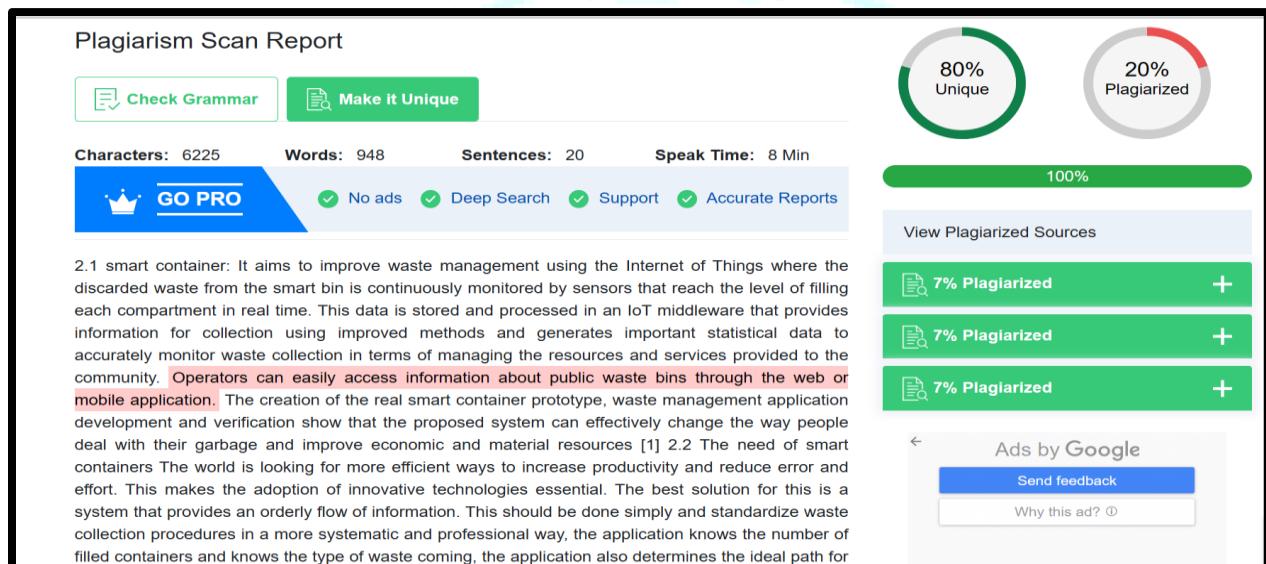


Figure 44 Plagiarism for chapter 2



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Chapter III: Analysis 3.1 Interview 3.1.1 Interview Questions 1. What is the current waste collection process? 2. Is the waste collection process easy to manage? 3. Is there a tracking of waste collection trucks? 4. Is the waste emptied periodically or is there a specific time? 5. Are the types of waste separated? 6. Does the waste collection process take a lot of time? 3.1.2 Primary data collected: These questions were answered by the Janitorial Projects Department Manager Q1-The city is divided into a certain number of projects and operational plans are established for that Q2-The problem is not the collection, but the different times of throwing garbage and some wrong behavior Q3-All equipment is monitored with tracking devices Q4-Containers are unloaded in the internal streets once a day and in the main streets twice a day Q5-There are specific waste sorting plants Q6-Yes, in some of the narrow neighborhoods due to overcrowding and the difficulty of entering equipment during crowding and the density of the population in it 3.1.3 What we found after the interview: Our application is similar to the operations of Amana Jeddah in the presence of tracking devices and the division of the city into several projects, but our application provides many other features such as 1-Waste is collected when

**Figure 45 Plagiarism Chapter 3**

