Location Based Garbage Management System with IOT for Smart City

Project ID: 17-100

Software Requirement Specification

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Declaration

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2nd of May 2017

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1. Introduction

1.1 Purpose

The purpose of this Software Requirement Specification (SRS) document is to clearly describe the details of android application and route calculation algorithm which is one of main component of Location Based Garbage Management System with IOT for Smart City. This document gives to priority to explain the route calculation algorithm and workforce user application. It will provide how to behavior with this component with other component in the system. In this document try to give a clear idea of this particular component of the system with its related functions. Also, this SRS document describes in detail about research components that are involved in the project. It will provide dependencies assumption made for implementation and technologies which is related to this project.

1.2 Scope

In this project which is Location Based Garbage Management System with IOT for Smart City include several major components. This document will mainly focus on main two components that are route calculation algorithm and workforce user application among that components. In this project authors decide to develop android application separately for end user and workforce user and finally merge these application as a one android application. End user application will be explained other SRS document and Workforce application will explained in this document. In workforce application provide three main features for cleaners. That features are provide infrastructure to collect garbage and manage their activities.

Authors hope to develop best route calculation to collect garbage efficient manner. This best route will be navigated through google API using GPS or network based in android application. To develop route calculation algorithm will be used recent data and past data.

Using past data this algorithm will be predicted future garbage filled level in every bin in the city.

All these user location information is maintained in a database. And system admin uses the admin-portal in order to manage the whole system and to keep information the details accurate.

1.3 Definitions, acronyms, and abbreviations

Table 1.3.1 Definitions, acronyms, and abbreviations

Term	Definition
End User	The person who actually uses a particular android application to dispose garbage. (Citizen)
Workforce User	The person who actually uses a particular android application to collect garbage. (Cleaners)
Admin/Administrator	System administrator who is given specific permission for managing and controlling the system
GPS	Global Positioning System
API	application programming interfaces
IoT	Internet of Things
Author	Person submitting an article to be reviewed.
Bin	Garbage bin

1.4 Overview

The remainder of this document includes four chapters. In first chapter provide above part that are included introduction about this project with purpose of project and its scope.

The second chapter provide overall description of the project. It will consist more details about workforce application that are product perspective, product function, user characteristics and constraints.

The third chapter provide specific requirement of mobile application. In this chapter describe external interface requirements, performance requirements, design constraints and other requirements.

The final chapter provide supporting or background information to help the readers of SRS document.

The workforce mobile application is mainly focus on,

- Connects cleaning staff with their main system.
- Provide facilities to communicate with administrators or managers.
- Provide infrastructure to job related activities.

2. Overall description

Those days garbage is very important factor cleaning and healthy environment. When it can't manage properly, it will affect to citizens and environment in the city. Therefore, public and private sector intend to find solution to manage garbage. Mainly municipal council provide infrastructure to dispose and collect garbage.as a solution they put garbage bins in the city to dispose garbage for citizens. But cleaning staff can't manage that garbage bins properly. therefore, it will cause for filled up garbage bins and citizen will dispose garbage bad manner.

The Location Based garbage management System with IOT for Smart City project will provide better solution for citizens and cleaning staff.in this project includes automated garbage bins with wireless sensor network, web services and android applications. The android application divide two main part that are workforce application and end user application. Author provide details about system requirement specification of workforce application which is main component of above high level system architecture (figure 2.1).

Main objective of workforce application is to provide more effective and efficient services to cleaning staff. By using mobile application's features, it provides mobility services to manage their activity. Through this android application cleaning staff can interact with real time data and can determine best route to collect garbage in the city without wasting their time and power.

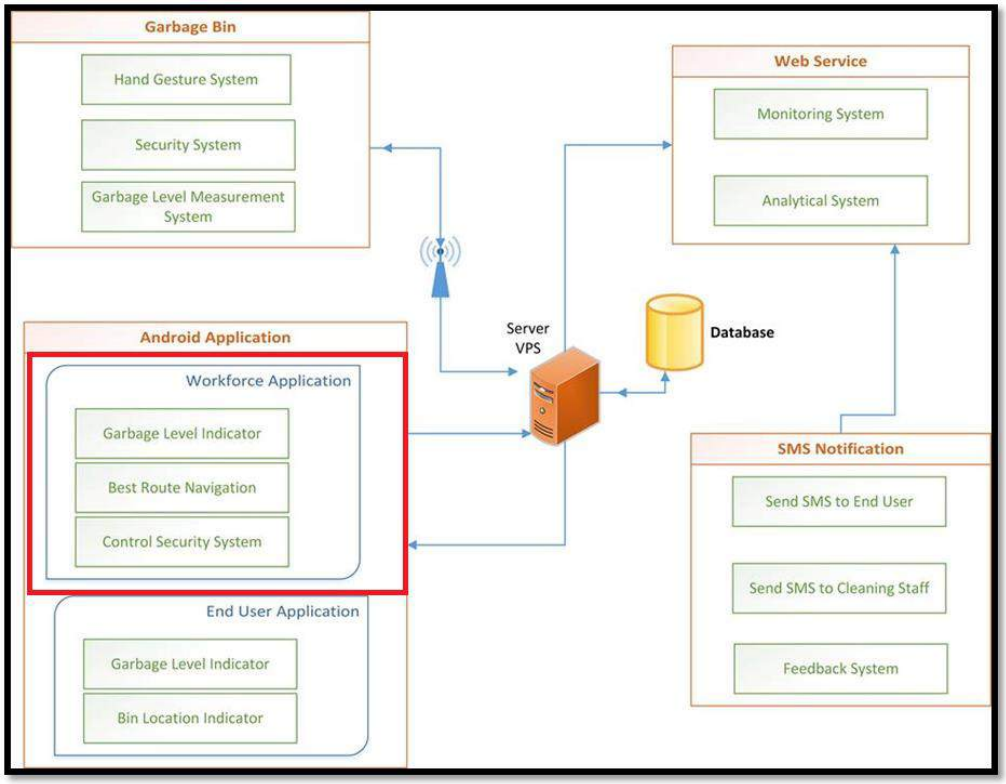

Figure 2.1 High level system architecture

The workforce android application includes three main features.

1.Best route

2. Real time bin level and bin location

3. Disabling/re-enabling the security system

- Best route

When a certain bin reaches 80% fill level the cleaner receives the best route calculated to the 80% filled bin from the base station. This route is calculated taking into consideration some other bins that will be filled in a certain period of time in the future. These extra bins will be added as waypoints into the route. This route calculation mechanism is further explained later.

- Real time bin level and bin location

The map shows all the bins that are placed throughout the city. The cleaner can access each bin to get all the specific information about the bin like real time level, history of fill levels, etc.

- Disabling/re-enabling the security system

The bin has a security system that is enabled when its placed in the city. Using this feature cleaner can avoid unwanted data passing into the database. because of while cleaner clan garbage bins it will happen move sensors and pass wrong data into database. When a cleaner has to clean a bin, the security system has to be disabled in order to do so. This function enables the cleaner to disable the security system at the start and re- enable it when the cleaning is finished.

Route Calculation

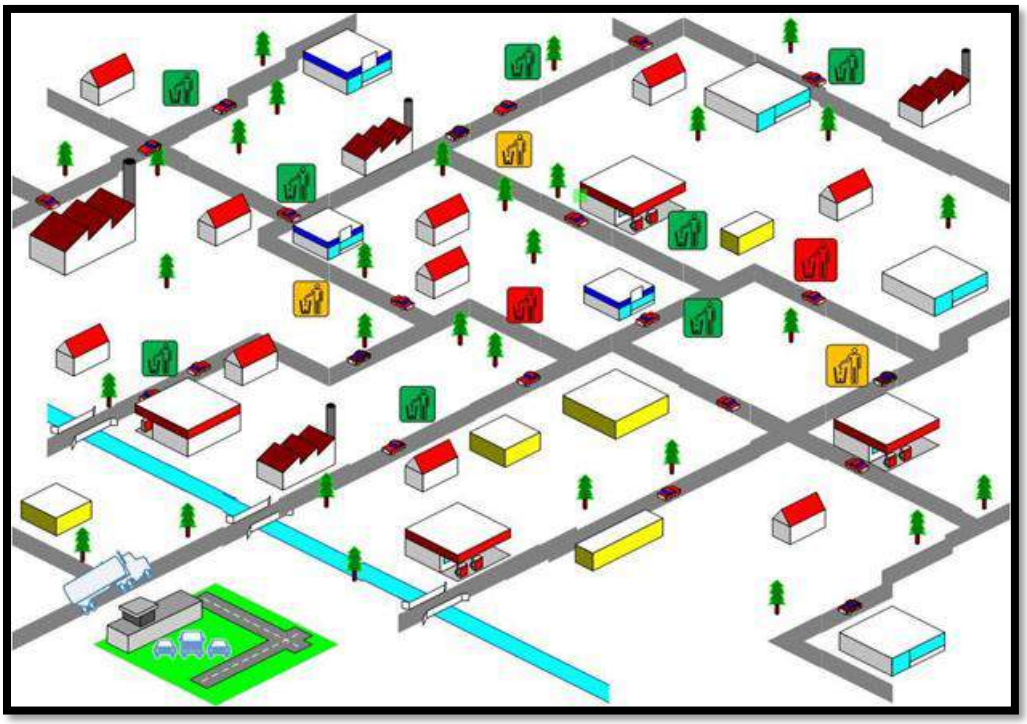

Figure 2.2 : Sample Distribution of Bins

The figure 2.2 indicates a normal map of a city. Bins have been placed on usual locations. The available bins are colored green, bins that are going to be over a certain percentage in yellow, bins that are over 80% capacity in red.

The priority for calculating the route is given to the red bins. The yellow bins are added as waypoints. When a bin reaches 80% capacity the system checks which of the nearest bins are going to be filled in the future on a given period of time. These bins are marked in yellow based on our algorithm.

The algorithm: Basically, the algorithm predicts which of the bins that are nearest to the 80% capacity bin is going to be filled at an exact time of day. This is done by using the newton forward interpolation formula.

An algorithm is developed for each bin which describes how the bins are going to be filled. Our database is constantly updated by new capacity values. This data is taken as the past data to predict future fill levels.

After predicting the bins using the above algorithm, the identified bins are marked as waypoint on the route that is being calculated. Then use google maps to calculate the route using the base station, 80% filled bin and the waypoints. Google maps use Dijkstra's algorithm to calculate the shortest path. The path calculated is demonstrated on Figure 2.3.

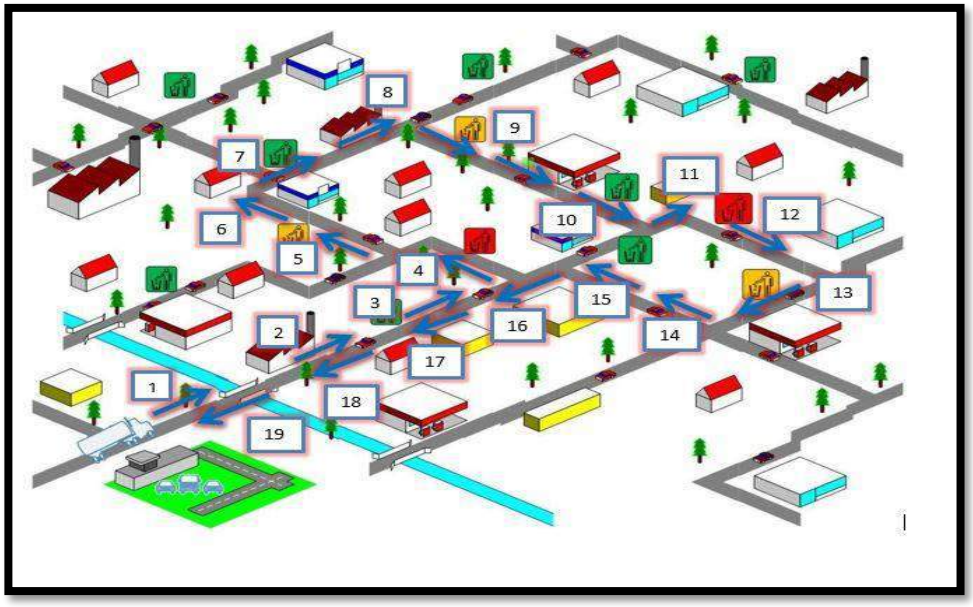

Figure 2.3 : Calculated Shortest Path

With these features workforce application develops using new technique and tools. The author hope to use GPS or network based tracking system to provide current location and provide best route. This android application can use latest devises and operation system.

2.1 Product perspective

Few research papers have implemented garbage management system with different key features. This project introduces an Implementation of Automated Management System for a Optimized Waste Collection System.

A Public Automotive Sensing Platform for Smart Cities (2016) [5] introduces Cruisers, an automotive sensing platform for smart cities. The technology consists of a collection of sensor nodes installed into the same number of garbage collecting trucks, one proxy server and one data server. Java program is developed to control the sensor nodes. An iOS application is also developed to demonstrate the sensing process and the covered area. In this research paper not provide better route to collect garbage in the city for garbage collecting trucks.

IOT Based Smart Garbage alert system using Arduino UNO (2016) [6] proposes a smart alert system for garbage clearance by giving an alert signal to the municipal web server for instant cleaning of dustbin with proper verification based on level of garbage filling. An Android application is developed and linked to a web server to send the alerts and remote monitor worker progress. The notifications are sent to the Android application using Wi-Fi module.

Cloud Computing Based Smart Garbage Monitoring System (2016) [7] is proposed with a network of dustbins which integrates the idea of IoT with Wireless Sensor Networks. They provide windows app which is coded by C#. It consists of two modes, User and Admin. The admin can add new devices, monitor fill levels and get reports about failures. The user can only view all the bins that has been deployed in the area by entering the area code that has been set up by the admin. They are using Bing Maps API to show the geographical location of the bin. The Admin can also get the shortest path comprising of all the filled bins and can redirect garbage vans.

These research paper provide various feature for garbage management. But these papers not provide better solution to collect garbage in the smart cities. Therefore, the garbage cleaner

or garbage collecting truck will put more effort to collect garbage in the very large cities. The author provides more efficient solution using workforce mobile application and route calculation algorithm.

2.1.1 System interfaces

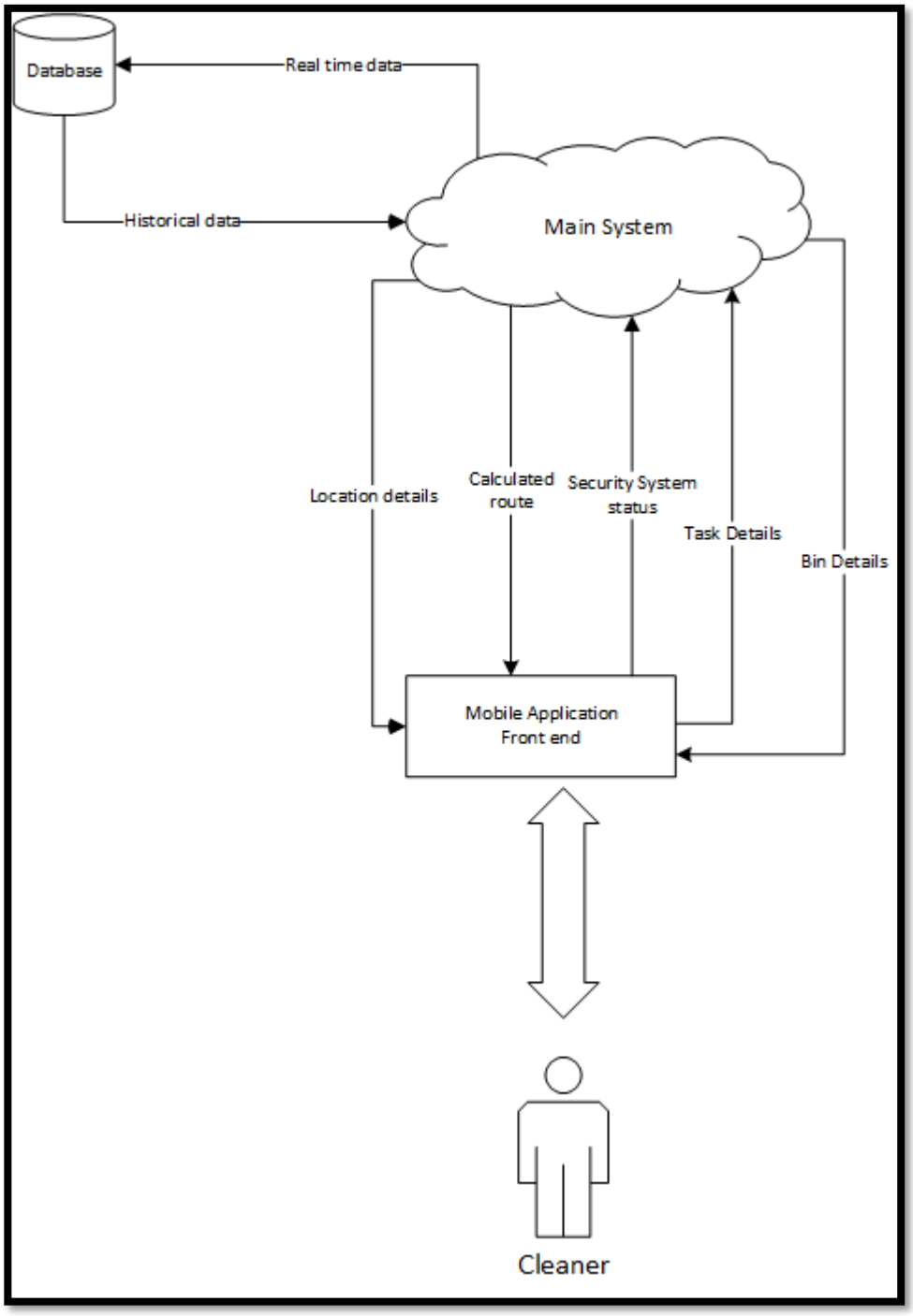

Figure 2.1.1.1 System interface diagram

Author is going to design few system interfaces to gather the data and manipulate and provide system endpoints to distribute the transformed data for route calculation processor and keep service management. We have two data sources. One is live data which coming from garbage bins. Other data source is data which we previously gather from our bins. Those data will be store in MySQL database. Those data will be added to route calculation algorithm and calculate best route for working staff.

2.1.2 User interfaces

The workforce mobile application includes several user interfaces for interact with mobile user and system. It has simple and reliable interfaces to use mobile application easily.

Firstly, user should login into the system. Login interface is figure 2.1.2.1 and it has two buttons and two user input text box. This login interface is same to workface user and end user. Account recovery option and register option are not needed to workforce user. Because of system administrator will provide username and password for cleaning staff.

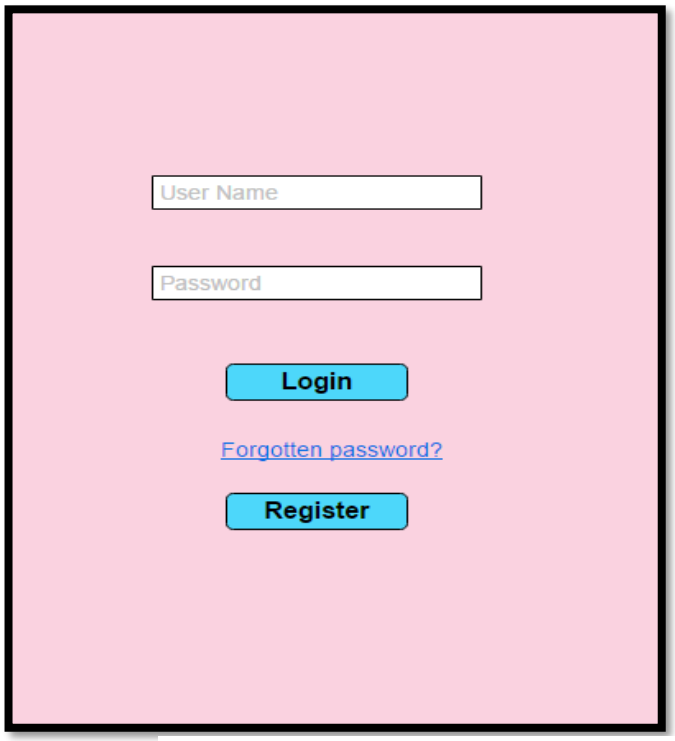

Figure 2.1.2.1 Login Interface

After successfully login into mobile application, user will move to control panel (figure 2.1.2.2) which is include main operations. The control panel has four buttons which is helpful for clean garbage bin, edit user profile and view bin details.

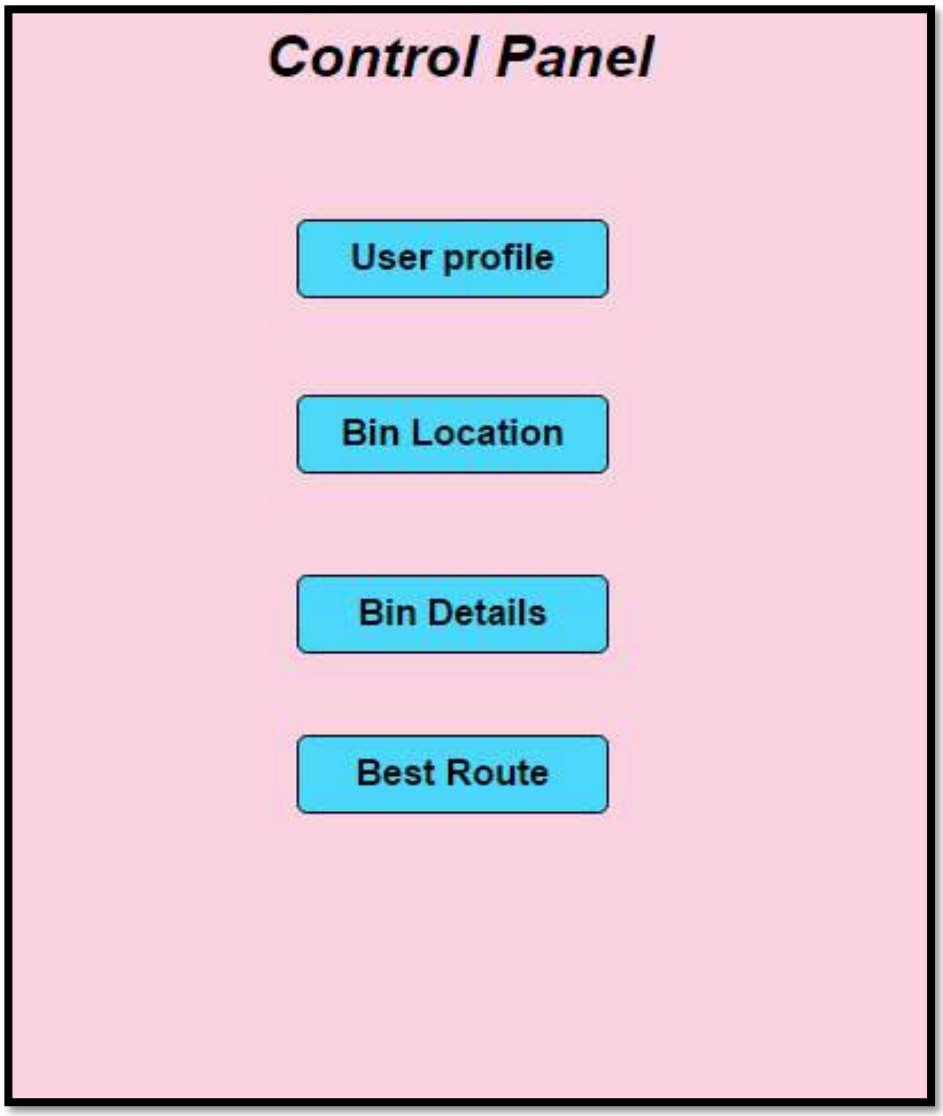

Figure 2.1.2.2 Control Panel Interface

After clicking user profile button, user move into user profile interface (figure 2.1.2.3) and current user details will be showed when this interface is loaded. Using this interface user can edit password and update user information.

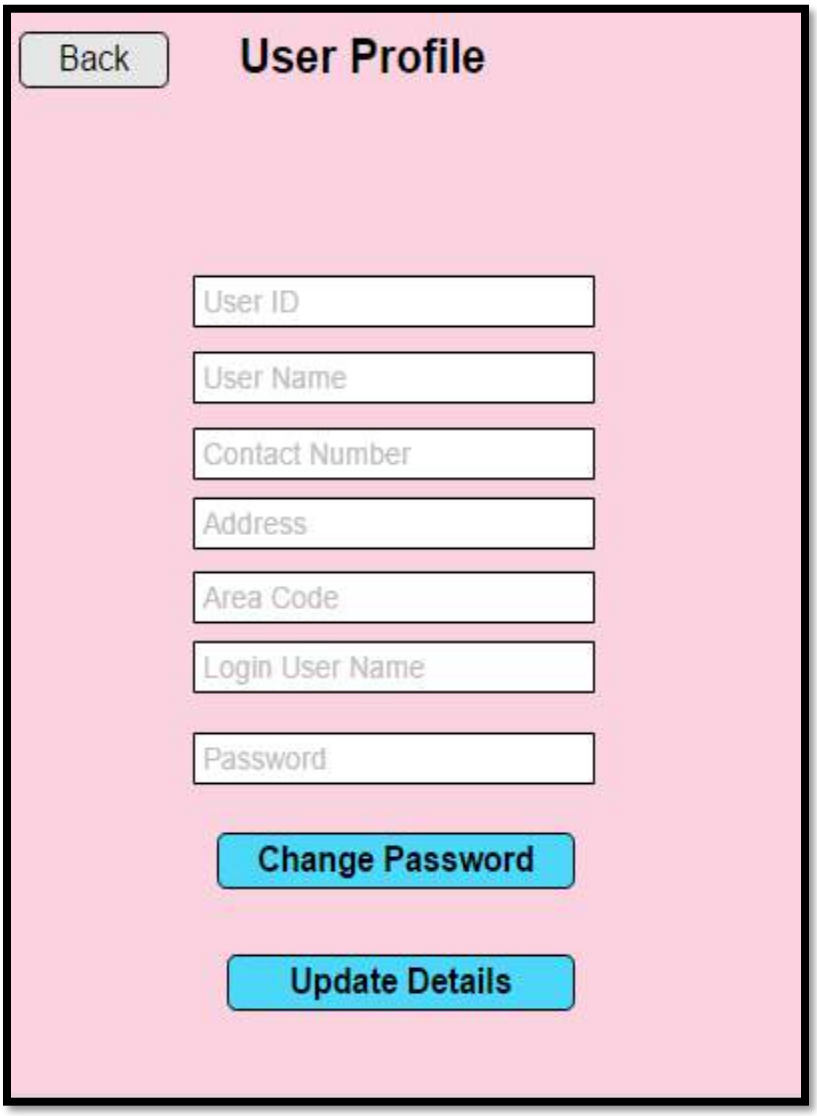

Figure 2.1.2.3 User Profile Interface

When clicking bin location buttons in control panel interface (figure 2.1.2.2), user can see location of all bins in the smart city through bin location interface (figure 2.1.2.4).

Figure 2.1.2.4 Bin Location Interface

To see more details of garbage bin, user should move to bin details interface (figure 2.1.2.5). This interface provides bin ID, bin area, real time filled level of bin etc. User can get bin details by providing keyword into the search function. Using Cleaning History buttons, cleaner can see cleaning history of relevant bin. And using change status button, user can disable or enable security system.

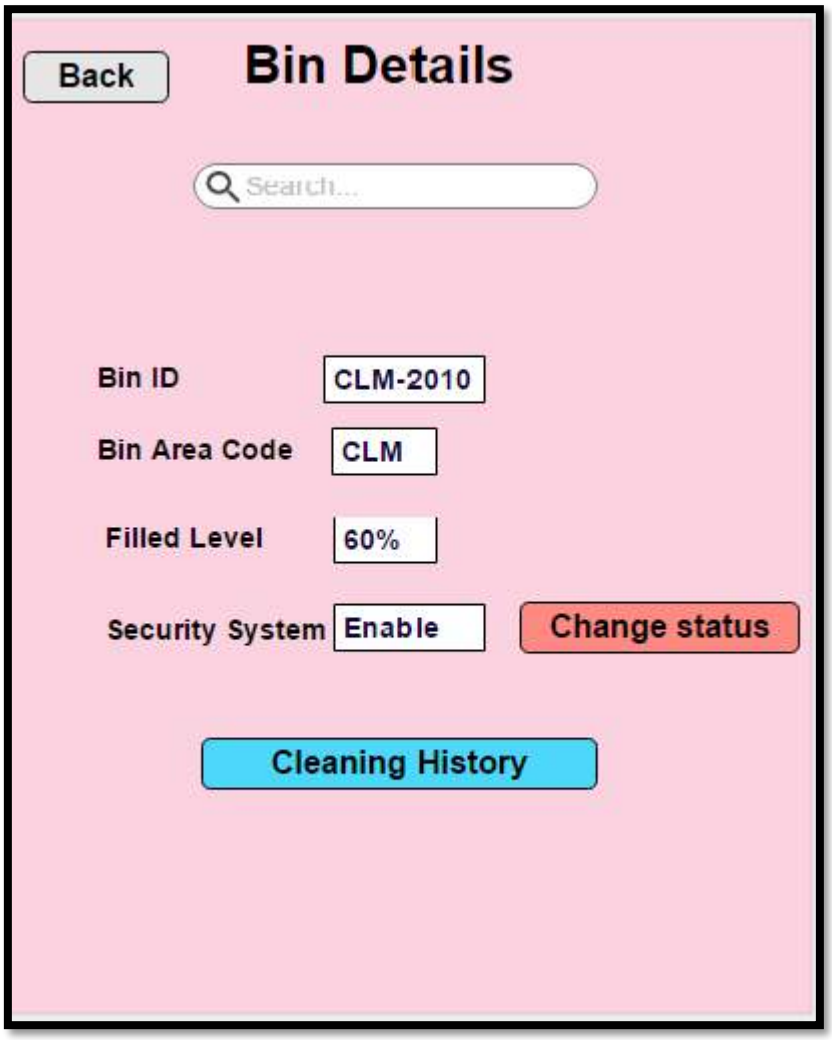

Figure 2.1.2.5 Bin Details Interface

The best route interface (figure 2.1.2.6) provides more suitable route for collect garbage to cleaner. This route will be built by route calculation algorithm from server.

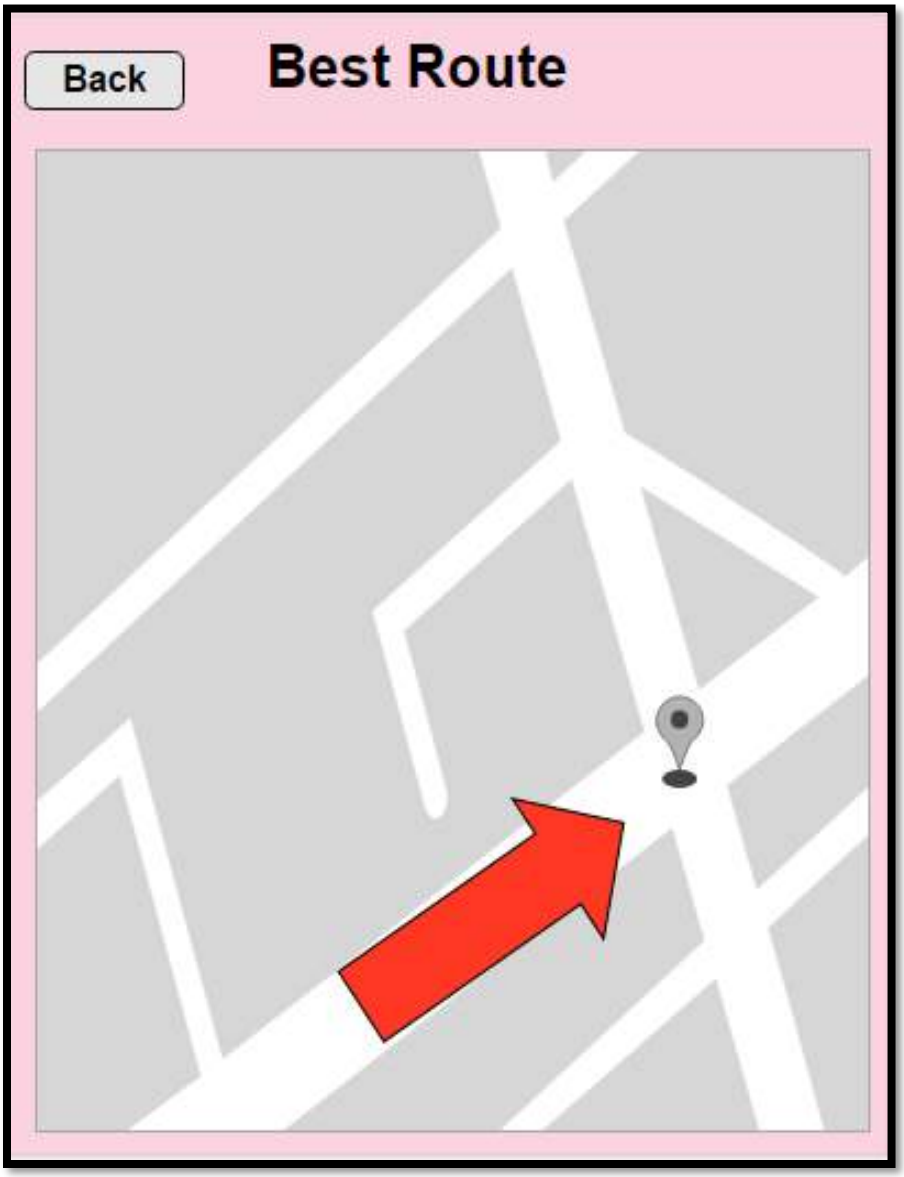

Figure 2.1.2.6 Best Route Interface

The admin control panel interface (Figure 2.1.2.7) provide user management button, Bin management button, bin location button and task management button. Using these buttons, the admin can perform add, delete and update system details.

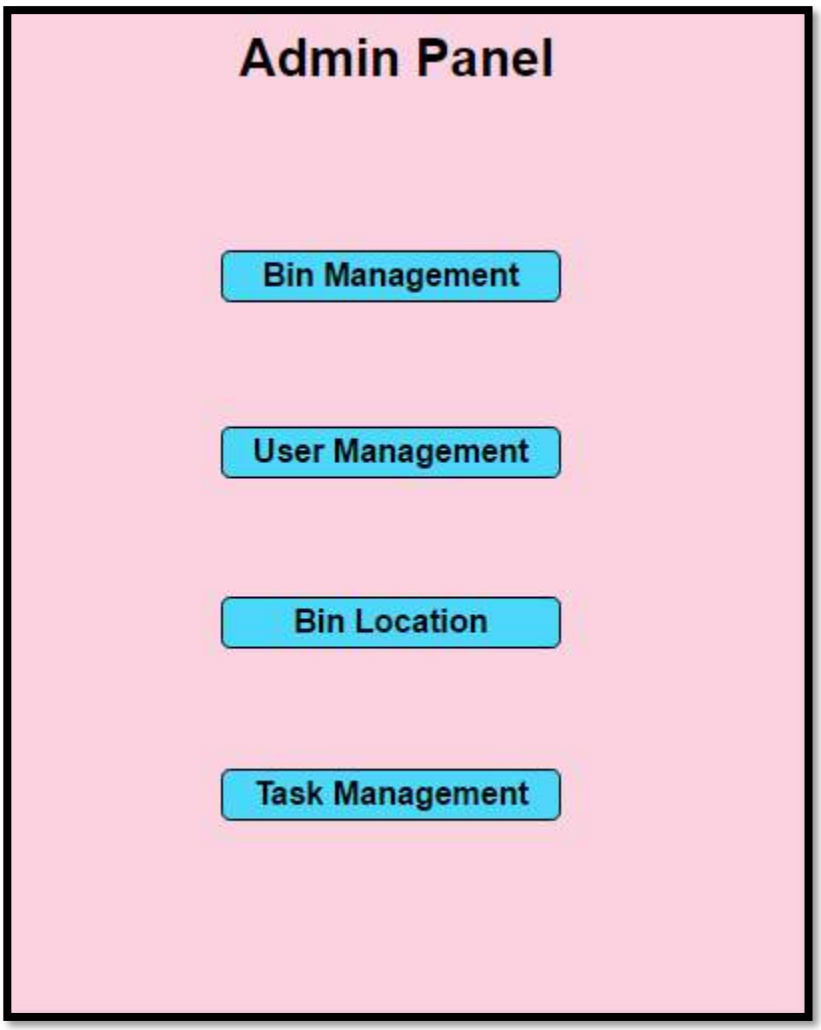

Figure 2.1.2.7 Admin Panel Interface

The User Management Interface (Figure 2.1.2.8) can add, delete and update user details.

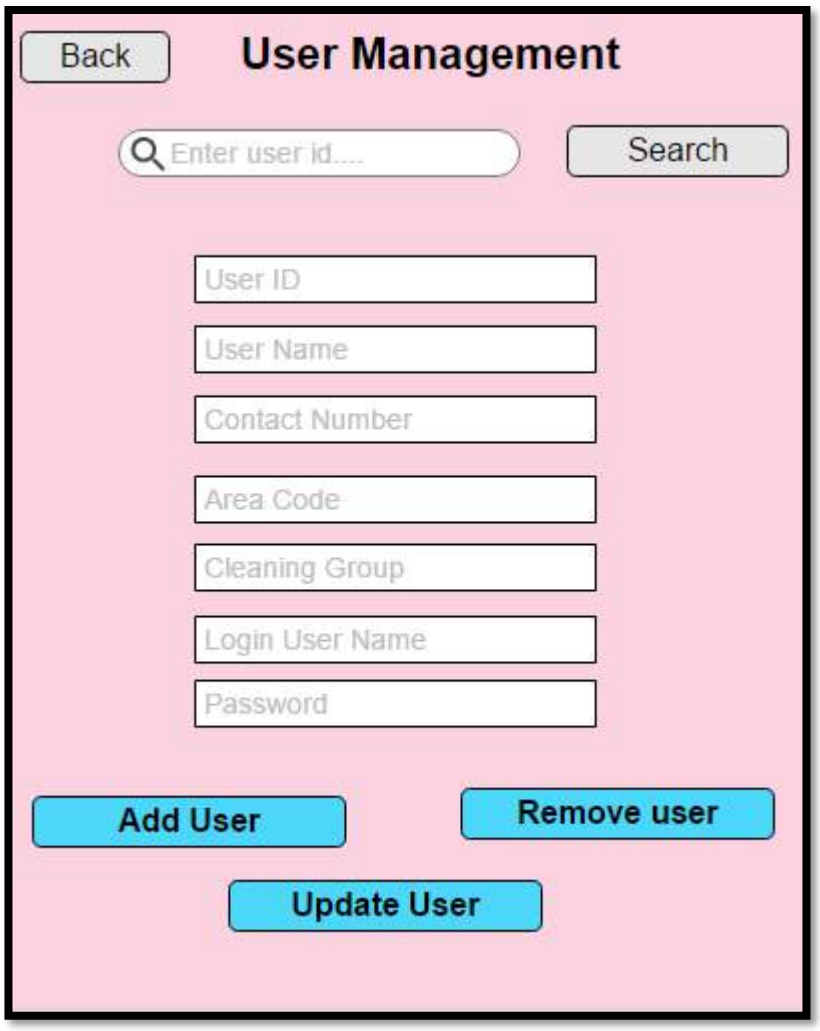

Figure 2.1.2.8 User Management Interface

The User Management Interface (Figure 2.1.2.8) can add, delete and update bin details.

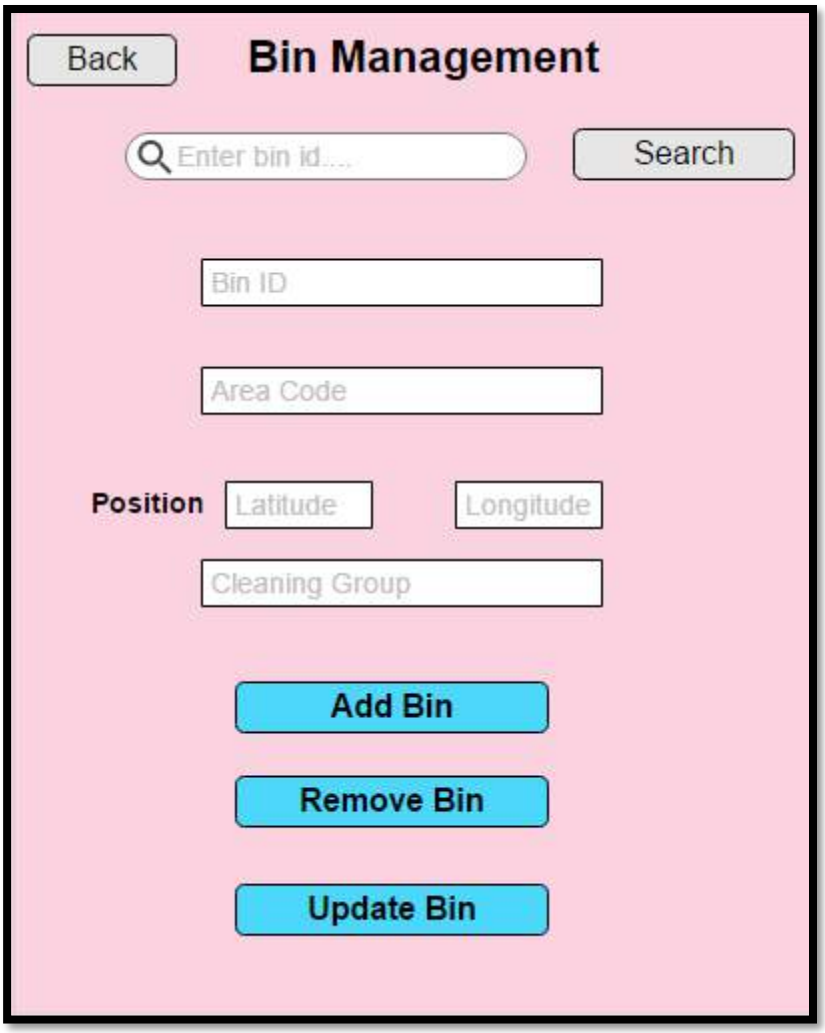

Figure 2.1.2.9 Bin Management Interface

2.1.3 Hardware interfaces

Author will develop mobile application that can be operated minimum hardware requirement with more feature. To run workforce android application will be needed minimum android KitKat 4.4.4 (API level 19) operating system or higher version. Therefore, run this application should be include following requirements in mobile device that are minimum 512 MB RAM (2GB recommended) and 1 GHz or higher processor. To connect Wi-Fi, mobile devices should support IEEE 802.11 b/g/n.

2.1.4 Software interfaces

Mobile application is connected with MySQL database to store and retrieve data. Therefore, the system must use MySQL Server as its database component and author use LAMP server that are include MySQL database.

2.1.5 Communication interfaces

We are developing this project for smart city. We are assuming Wi-Fi is available in smart city. Wi-Fi is communication media to pass data in between trash can and our system. Internet is required to control mobile application. Therefore, mobile application will be used Wi-Fi or mobile network to access to internet.

2.1.6 Memory constraints

The workforce application will be needed internal or external memory space in mobile device to download and install application. Also, it will be needed some memory space for cache data and other data.

2.1.7 Operations

The Location Based Garbage Management System with IOT for Smart City has several user group and workforce application will be used by cleaning staff. Recent time lot of people have

basic knowledge of handling smart phone and it will be useful to introduce this mobile application to cleaning staff. After implementing system, by doing lectures tutorials cleaning staff can be guide through our system. Firstly, cleaning member should login into the system using username and password that are given by system admin. After successfully login user can edit password and user profile if its needed. And simply users can use android application by getting their services what they need like getting bin details, bin location and identify the best route that is allocated area to clean. Also, workforce user can see bins cleaning history and apply request for job related activity.

2.1.8 Site adaptation requirements

Users can simply download and install android application and enable GPS and connect to internet. After that they can login with system using given username & password.

2.2 Product functions

The workforce mobile application use case diagram is demonstrated by figure 2.2.1.

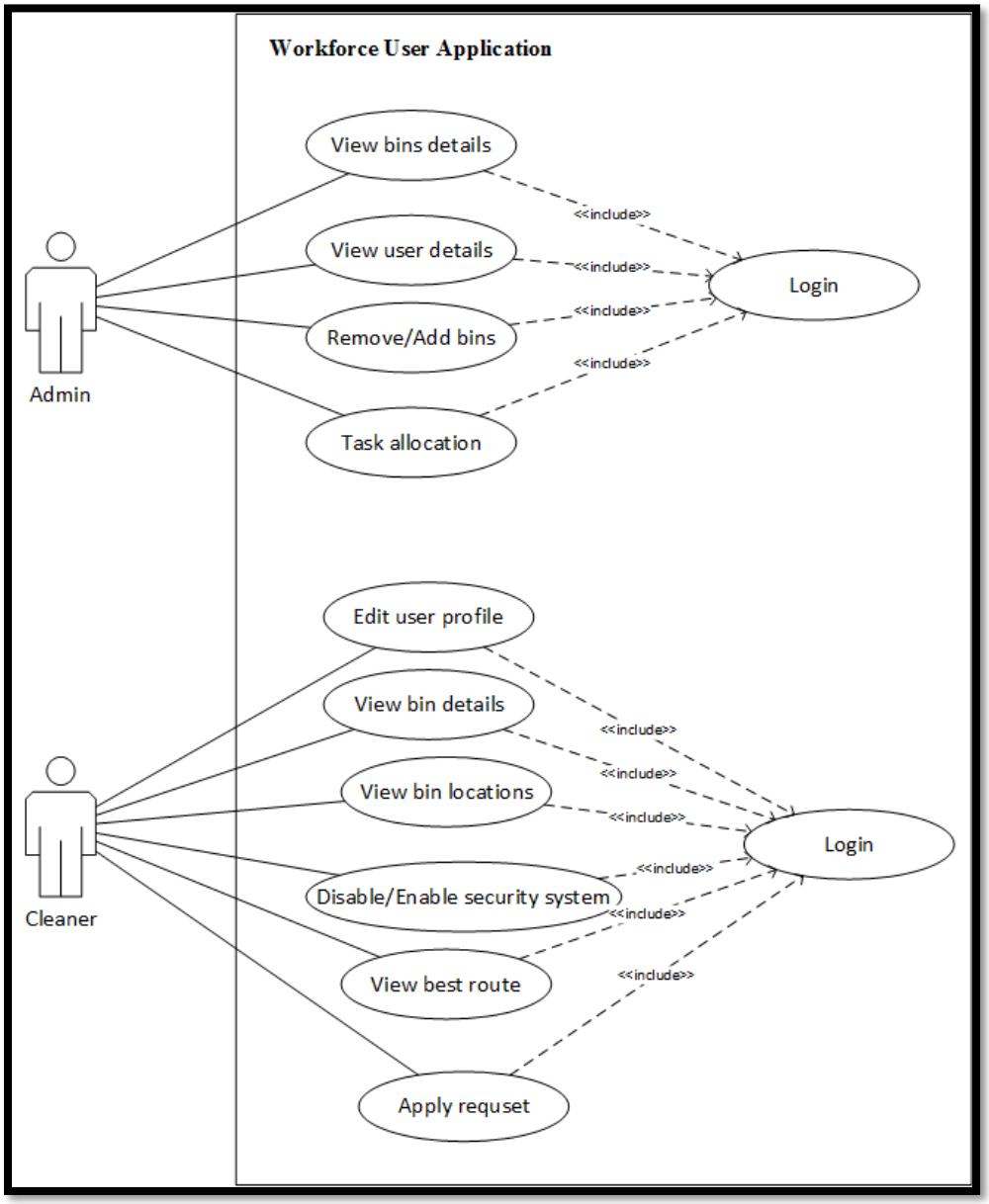

Figure 2.2.1 Use case Diagram

Table 2.2.1 Login

Use case	Login
Description	User should be able to login into the system by providing username & password.
Pre-condition	Application must install in user's smart phone and connect to internet
Actors	Admin, Cleaner
Main Flow Events	1. Open application 2. Fill the text box by providing username & password.

Table 2.2.2 View map details/View bin location

Use case	View map detail/ View bin location
Description	User should be able to view all available bins within his area and bin details.
Pre-condition	Login to android application
Actors	Cleaner
Main Flow Events	1. login to system 2. Request available bin within area by clicking bin detail button or bin location buttons.

Table 2.2.3 Disabling/Enabling security system

Use case	Disabling/Enabling security system
Description	User can change security system status.
Pre-condition	Login to android application.
Actors	Cleaner
Main Flow Events	1. Login to android application 2. Go to the bin details interface 3. Search needed bin & select it 4. Click change status button

Table 2.2.3 View best route

Use case	View best route
Description	User can see suitable path for collect garbage
Pre-condition	Login to android application
Actors	Cleaner
Main Flow Events	1. login to android application 2. Go to the best route interface

Table 2.2.4 Apply request

Use case	Apply request
Description	User can apply request to change area, change working time etc.
Pre-condition	Login to android application
Actors	Cleaner
Main Flow Events	1. login to android application 2. Go to the user profile and click apply request button.

Table 2.2.5 Edit user profile

Use case	Edit user profile
Description	User can update user details and change password.
Pre-condition	Login to android application
Actors	Cleaner
Main Flow Events	1. Login to android application 2. Go to the user profile and click change password button or update profile button.

Table 2.2.6 View user details

Use case name	View user detail
Description	Admin must able to view all users and there details
Pre-condition	Login to android application
Primary user	Admin
Main flow of events	1. Login to system 2. View detail

Table 2.2.7 Add or remove bins

Use case name	Add or remove bins
Description	Admin can add new bins to map as well as admin can remove bins from map
Pre-condition	Admin must login to system
Primary user	admin
Main flow of events	1. Admin login to system 2. Go to User management activity 3. Click the bin that need to change and do necessary changes

Table 2.2.8 Task allocation

Use case name	Task allocation
Description	Admin can allocate special task to cleaning staff
Pre-condition	Admin must be login to system
Primary user	Admin
Main flow of events	1. Login to system 2. View cleaning staff details 3. Select certain users 4. Allocate task

2.3 User characteristics

There are several types of users who are interact with the system.

Users of the workforce mobile application

1. System administrators
2. Cleaning Staff

The system administrators also only interact with back-end system. There they will manage the information regarding the services as well as the overall system. The system administrator can view bin & user information and add or delete information through mobile application. Also, administrator can manage user task related activities.

The cleaning staff also only interact with front-end system. The cleaning staff can view bin details and their allocated task which is collect garbage using best route feature in application. They can't add or delete bin information and user's information.

2.4 Constraints

The application is developed for mobile phones and for proper navigation the phone should have sensors such as gyroscope, accelerometer and compass the phone should be a “Smart Phone”. The application is operating system dependent and should be running only on Android (Minimum Android 4.4.4 KitKat) powered Smart Phones.

2.5 Assumptions and dependencies

One assumption about the product is that the GPS components in all Android smartphones work in the similar manner. Another assumption about the product is that it will always be used on mobile phones that have enough performance. The smart phones should enable GPS. Smart city must have Wi-Fi enable all the time. Another main assumption is database server up and running 100%.

2.6 Apportioning of requirements

This section describes the order of the fulfillment of the requirements of the system.

1. Using GPS mobile can detect its exact location.
2. Bin must send fill level data all the time.
3. Using Wi-Fi or mobile network can connect with main server.

3. Specific requirements

This segment includes all the functional and quality requirements of the mobile application.

3.1 External interface Requirements

3.1.1 User interfaces

To accomplish two-way communication between user and the service provider a feedback interface is introduced. Therefore, this visual effect can engage the attention and it will improve user satisfaction as well.

Table 3.1.1.1 Detailed UI Info-Login

Screen name	Login
Description of screen	Initial screen the user is presented with
Inputs, outputs of screen	Username, password, Login button, password reset link, Register button
Limitations, permissions	The user cannot go past the login page unless he/she successfully logs in with the given username and password combination
Relationship to other screens	Assuming the correct details are entered, the Control Panel is pushed to the user.
Supported screen sizes	Responsive screen. Supports a range of devices from mobile screens up to high resolutions. The screen will automatically adapt to the screen size

Table 3.1.1.2 Detailed UI Info-Control Panel

Screen name	Control Panel
Description of screen	Control panel contains all function that is needed to cleaner.
Inputs, outputs of screen	Bin location button, Bin details button, User Profile button, Best Route button, Apply request button
Limitations, permissions	-
Relationship to other screens	When click any button in control panel, user move to relevant activity.
Supported screen sizes	Responsive screen. Supports a range of devices from mobile screens up to high resolutions. The screen will automatically adapt to the screen size

Table 3.1.1.3 Detailed UI Info-Bin Details

Screen name	Bin Details
Description of screen	Provide all details relevant bin in the city.

Inputs, outputs of screen	Bin ID, Change Status button, cleaning history button, back button
Limitations, permissions	User can't edit bin details. But can change security status
Relationship to other screens	Clicking back button, user can move control panel
Supported screen sizes	Responsive screen. Supports a range of devices from mobile screens up to high resolutions. The screen will automatically adapt to the screen size

Table 3.1.1.4 Detailed UI Info-Bin Location

Screen name	Bin Location
Description of screen	Provide bin location in the city using map
Inputs, outputs of screen	Bin ID, back button
Limitations, permissions	-
Relationship to other screens	Clicking back button, user can move control panel
Supported screen sizes	Responsive screen. Supports a range of devices from mobile screens up to high resolutions. The screen will automatically adapt to the screen size

Table 3.1.1.5 Detailed UI Info-Best Route

Screen name	Best Route
Description of screen	Provide best route for cleaners to collect garbage using map.
Inputs, outputs of screen	Back button
Limitations, permissions	User can’t edit route.
Relationship to other screens	Clicking back button, user can move control panel
Supported screen sizes	Responsive screen. Supports a range of devices from mobile screens up to high resolutions. The screen will automatically adapt to the screen size

Table 3.1.1.1 Detailed UI Info-User Profile

Screen name	User Profile
Description of screen	User can update user details and change password.
Inputs, outputs of screen	User ID, User name, Address, Area code, Contact, Login user name, password, change password button, update details button

Limitations, permissions	User can't edit Area code, User ID
Relationship to other screens	Clicking back button, user can move control panel
Supported screen sizes	Responsive screen. Supports a range of devices from mobile screens up to high resolutions. The screen will automatically adapt to the screen size

3.1.2 Hardware interfaces

Since the application must run on the mobile, all the hardware shall require to connect internet hardware interface for the system. As for e.g. Access points, Wi-Fi. The GPS module is managed by the GPS application inside the mobile device.

3.1.3 Software interfaces

For this system, there are few external interfaces.

1. MYSQL for database access
2. Android studio for android development
3. Lamp server for hosting purpose

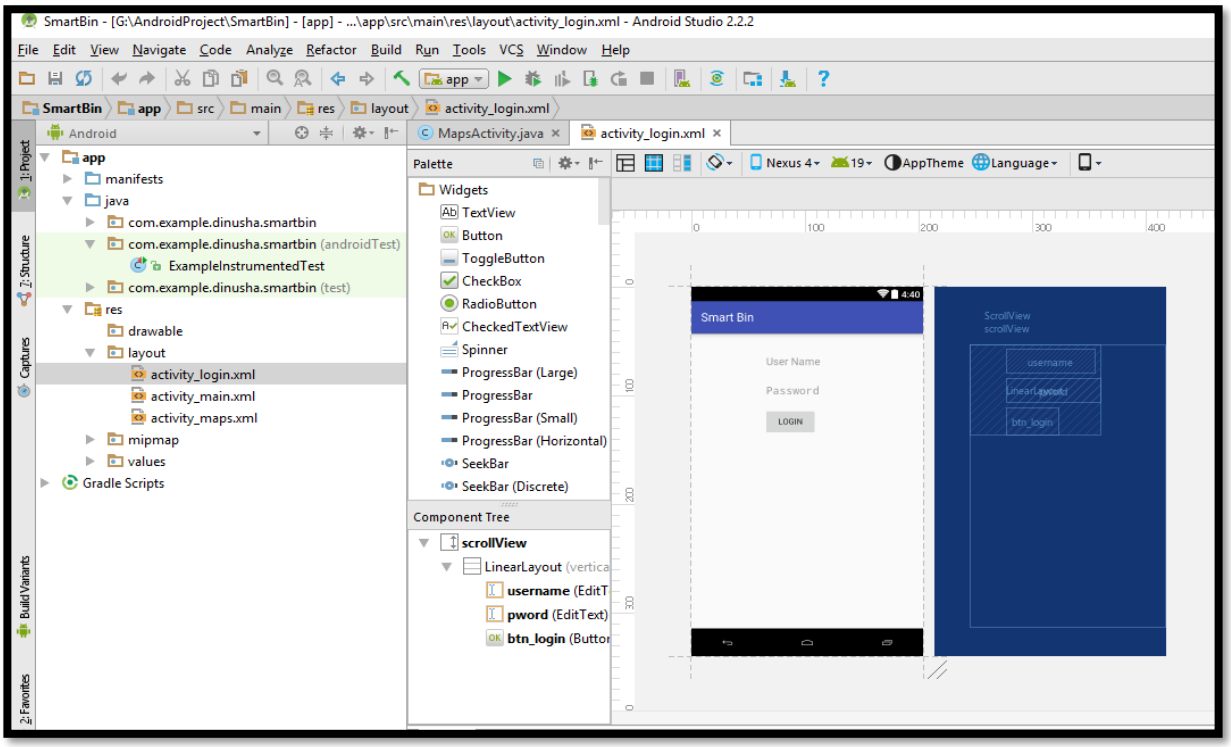

Figure 3.1.3.1 Android studio

Figure 3.1.3.2 phpMyAdmin

3.1.4 Communication interfaces

The main Communication interfaces used in android application are GPS and Wi-Fi.

To find the mobile app customer's current location App needs to turn on location services.

Most smart phones have GPS receiver to identify the exact location of the user. Internet connection should be there for thus, there should be a communication interface between the system and the router.

3.2 Class / Objects

The figure 3.2.1 is demonstrated mobile application class diagram.

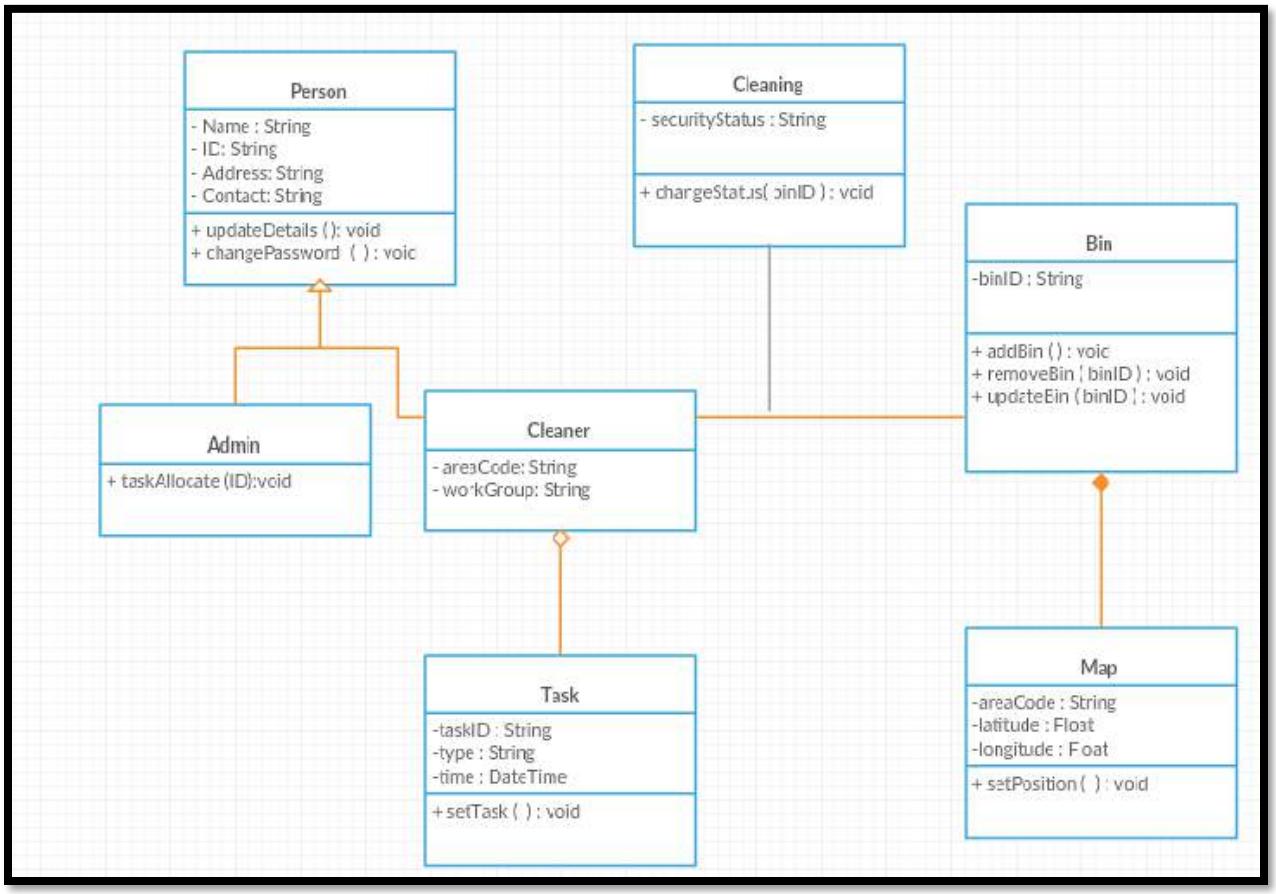

Figure 3.2.1.1 Class Diagram

3.3 Performance Requirements

To run workforce android application will be needed minimum android KitKat 4.4.4 (API level 19) operating system or higher version. Therefore, run this application should be include following requirements in mobile device that are minimum 512 MB RAM (2GB recommended) and 1 GHz or higher processor. To connect Wi-Fi, mobile devices should support IEEE 802.11 b/g/n. Also, mobile devices should have GPS feature.

3.4 Design constraints

All the GUIs should be implemented in according to UX design principles to give a good user experience to the users.

Object oriented concepts should be used in the whole implementation of the system.

Proper naming conventions are followed when naming objects in database and when coding the system. This is done to increase readability and understandability. Using proper naming conventions will make the code syntactically correct as well as make the purpose clear to the developer.

3.5 Software system attributes

3.5.1 Reliability

Reliability is an ability of android application to perform its intended functions and operations in a system's environment, without experiencing failure (system crash). Therefore, the uptime from the server-side boasts an impressive 99%. However, this is very much limited by the electricity as well as internet service provider’s side in the country and the system’s uptime in the end depends on the local conditions.

3.5.2 Availability

The system could be accessed whenever in in need. App must be available do download any time. Also, the availability of user data will be done by the database server, and backups will be taken every 24 hours to ensure the data is safe in the event of a crash.

3.5.3 Security

Location Based Garbage Management System with IOT for Smart City will not require any sensitive data of the users, but general security should be maintained in the system such as authentication

3.5.4 Maintainability

Updates must be available for the user time to time. There are no maintainability requirements from the user's side but management will handle the necessary updates when required.

4. Supporting information

4.1 References

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