

SYSTEM ANALYSIS AND DESIGN

MR. BIN

SMART WASTE MANAGEMENT SYSTEM

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Section-1

1.1 Abstract

MR. BIN aims to transform how communities connect with their garbage disposal systems. The user-centered application offers users a practical and effective platform to handle their trash disposal requirements by smoothly integrating contemporary technology and sustainability principles. The app enables users to take an active role in waste reduction and recycling initiatives with real-time bin tracking, helps users to recycle their waste by selling waste , and waste stream categorization. The user-friendly layout of the app encourages appropriate waste segregation, saves time by informing waste collector when the bin is full, and allows user to monitor their trash-related actions over time. MR. BIN motivates and helps build cleaner, greener, and more resilient communities by bridging the technological and environmental responsibility gaps.

1.2 Introduction

In many Asian countries and regions, priority was always put on the economic development and less resource was assigned in the green and environmental development especially the waste management. In addition, there was lack of awareness, ignorance, and knowledge among communities about waste issues, which had worsened the problem [1]. With growing concerns about the environmental impact of waste and the need for more efficient waste management systems, MR. BIN emerges as a beacon of innovation. Waste is not just a problem but an opportunity for positive change. MR. BIN harnesses the potential of digital technology to provide user with a seamless, user-friendly experience that not only simplifies waste disposal but also aligns with global sustainability goals. In an era where technology and sustainability intertwine, we are excited to introduce a revolutionary solution that will reshape the way you interact with your waste disposal process. MR. BIN is not just an interface; it's a powerful tool that empowers individuals, households, and businesses to take control of their waste in an environmentally conscious manner. Gone are the days of uncertainty about waste collection schedules or wondering what goes where. Our App offers a comprehensive solution that allows you to schedule waste pickups at your convenience, helping you streamline your routine and reduce unnecessary clutter. But we don't stop there; our app goes beyond the basics to offer a deep dive into waste segregation, recycling practices, ensuring that you play an active role in creating a cleaner and healthier environment.

Through this app, we aim to bridge the gap between modern living and responsible waste management. Our app combines the power of technology, community engagement, and sustainable practices to pave the way for a brighter, cleaner future.

1.3 History leading to project request

Since its independence in 1971, Bangladesh, especially its capital city Dhaka, has maintained a mostly unchanged traditional garbage management system. This technique permits waste to be dumped and burned in an open manner, disposed of in landfills, and even placed straight onto agricultural land in rural areas. Such behavior persists unchecked and is accepted after 50 years.

According to one study, "On average, 0.38 kg of waste is generated per person daily in rural areas," according to the government's first survey of its kind in the country. Thus, the daily waste generation amounts to 37,084.46 tons, 87% of which is compostable, and the remaining 13% is other waste. [2]. The main problem in waste management is segregation of the garbage and collecting it from the garbage bins.[3]Even if there is genuine intent to recycle, the facilities that are currently available are apparently insufficient, according to conversations with the general population. The various recyclable materials cannot be separated; therefore, even if they are divided at home, they all wind up in one large pile at collection. Others argued that there aren't enough incentives to recycle; instead, they emphasized how much work it takes to recycle frequently, all in vain. Some people felt the effort was not worthwhile. In comparison to other modern cities, Dhaka's waste collection and handling system is incredibly unorganized and out of date. The conventional waste collection system requires a lot of manpower and employs few cutting-edge technological innovations. Another problem is the astonishing growth in the use of electronic products (e-products) in Bangladesh over the last two decades. Bangladesh itself produces about 3 MMT of e-waste each year[4].

Therefore, I have decided to address the issue. A smart waste collection system should address the optimal number of collection nodes and their locations[5].The current rickshaw vans that collect rubbish can be converted into effective waste collection vehicles with the use of smart technology. When the bins are full, a smart sensor chip at the top of the bins can help convey data to garbage collection facilities, setting off a regular pattern for waste collection.

1.4 Identify Problem, solutions, and opportunity

Problems	Solutions
People dump garbage anywhere, creating pollution.	Now Citizens can take a picture and report any problem with the bin.
The available process is not efficient using heavy manpower.	Waste collection facilities get notified when the bins are full, and commuting gets easier.
Not enough trash cans in remote areas.	Users can place a request for a bin at the nearby address.
People can't see the live location of nearest trash cans to be more	People can get an interactive map of all the bins in the city divided by trash

environmentally responsible for waste disposal.	type and locate the nearest available empty bin.
Even if the trash is collected, they remain unsorted and unseparated for days.	Wastes will be managed accordingly to their types.

This automated system can open a wide range of opportunities in the future as we will be able to analyze the data and work on new features as well as make necessary changes if needed. Some of the opportunities are listed below:

Opportunities:

- First the system will be tested and operated in Dhaka. In future it will be operational all over the country.
- The system will be added with more features in future such as when the user is dumping the garbage, the amount of plastic beverage bottles and cans will get them a refund for returning the package back to shops ensuring recycling.
- All data will be processed and stored in a secure environment, with limited access only to authorized users.

1.5 Project goal and objectives

1.5.1 Goal:

The goal of this project is to enhance Bangladesh's trash management and collecting system. This system is smart, effective, and has both direct and indirect economic benefits from digital intervention. Citizens' lives will be made easier by this technology, which will also eliminate health risks. In the future, this system will be present throughout the nation and all trash cans will be linked to it to create a clean city.

1.5.2 Objectives:

- At first, this system will connect the trash cans of Dhaka as a model and testing period.
- After getting feedback from the users, it will add new features.
- Developing Smart Bangladesh through cleaner cities.

Section-2

2.1 Literature Review

2.1.1 Context

These sources discuss a range of waste management topics, such as technology integration, rural trash management, Internet of Things (IoT) solutions, e-waste issues, and intelligent urban garbage collection systems. They may be helpful for comprehending several parts of waste management techniques and innovations.

1. **M.L., Ali, M. Alam, and M.A.N.R. Rahaman, "RFID Based e-monitoring System for Municipal Solid Waste Management"** : This source is a paper presented at the 7th International Conference on Electrical and Computer Engineering in Dhaka, Bangladesh, in December 2012. The paper discusses an RFID-based monitoring system designed for the management of municipal solid waste. RFID technology is utilized for efficient tracking and management of waste, likely offering insights into how technology can be integrated into waste management systems.
2. **S. Saif, "Planned rural waste management on cards," The Business Standard, February 13, 2022**: This source is an article from The Business Standard, published on February 13, 2022. The article appears to discuss planned rural waste management initiatives. It might provide insights into waste management strategies and developments in rural areas.
3. **A. S. Bharadwaj, R. Rego, and A. Chowdhury, "IoT based solid waste management system: A conceptual approach with an architectural solution as a smart city application"**: This source is a paper presented at the 2016 IEEE Annual India Conference in Bangalore, India. The paper discusses an Internet of Things (IoT)-based system for solid waste management and its conceptual approach. It likely presents an architectural solution for using IoT in waste management, possibly in the context of smart cities.
4. **H. M Alamgir, "Electronic-waste is a growing public health threat for BD," The Financial Express, November 29, 2022**: This source is an article from The Financial Express, published on November 29, 2022. The article appears to discuss the growing public health threat of electronic waste (e-waste) in Bangladesh. It likely sheds light on the environmental and health issues associated with e-waste in the country.

5. **Jia-Wei Lu, Ni-Bin Chang, Li Liao, Meng-Ying Liao, "Smart and Green Urban Solid Waste Collection Systems: Advances, Challenges, and Perspectives," IEEE Systems Journal, vol.11, no.4, pp.2804-2817, 2017:** This source is an article published in the IEEE Systems Journal in 2017. The article focuses on smart and green urban solid waste collection systems, discussing advances, challenges, and perspectives in this field. It may provide valuable insights into innovative approaches for urban waste management.

2.1.2 Major Findings & Key points

Here are the major findings and key points from the studies and research papers mentioned above:

- Smart waste management systems can help to reduce the amount of waste that is sent to landfills.
- These systems can also help to improve recycling rates and reduce pollution.
- Smart waste management systems can be used to track the movement of waste and optimize waste collection routes.
- These systems can also be used to prevent illegal dumping.
- The adoption of smart waste management systems is still in its early stages, but there is a lot of potential for these systems to improve the way we manage waste.

2.1.3 References

[1] M.L., Ali, M. Alam, and M.A.N.R. Rahaman, “RFID Based e-monitoring System for Municipal Solid Waste Management,” in the 7th International Conference on Electrical and Electrical and Computer Engineering, Dhaka, Bangladesh, Dec 20-22, 2012.

[2]S. Saif, "Planned rural waste management on cards," The Business Standard, February 13, 2022. [Online]. Available: The Business Standard, <https://www.tbsnews.net/>. [Accessed June 13, 2023].

[3] A. S. Bharadwaj, R. Rego and A. Chowdhury, "IoT based solid waste management system: A conceptual approach with an architectural solution as a smart city application," *2016 IEEE Annual India Conference (INDICON)*, Bangalore, India, 2016, pp. 1-6, doi: 10.1109/INDICON.2016.7839147.

[4] H. M Alamgir, "Electronic-waste is a growing public health threat for BD," The Financial Express, November 29, 2022. [Online]. Available: The Financial Express, <https://thefinancialexpress.com.bd>. [Accessed June 13, 2023].

[5] Jia-Wei Lu, Ni-Bin Chang, Li Liao, Meng-Ying Liao, "Smart and Green Urban Solid Waste Collection Systems: Advances, Challenges, and Perspectives", *IEEE Systems Journal*, vol.11, no.4, pp.2804-2817, 2017.

Section 3:

3.1 Product Description

This project is a smart waste app which helps the user sort their waste according to category, sell waste and keep updated on the bin level. It also has the following features:

- First, the user needs to create an account in the app. They have to create an account with a phone number, password, and get the location from the GPS of the device. So, after creating the account whenever the user needs to sign in, they can sign in with their phone number and password.
- They need to turn on their GPS system to locate how many bins are available near them.
- Upon selecting a bin, they can see how full the bin is, bin for the waste type they are dumping, and the shortest route to the bin.
- They can also report any problem with the bin.
- They can also place a request for a bin at the nearby address.
- The authority can keep track of waste trucks.
- The authorities can compare the before and after results of the implementation.

That is how the entire process will be for this project.

3.2 Product Stakeholders

- ❖ Citizen
- ❖ Homeowner
- ❖ Waste Collector
- ❖ Admin

3.3 System Context diagram

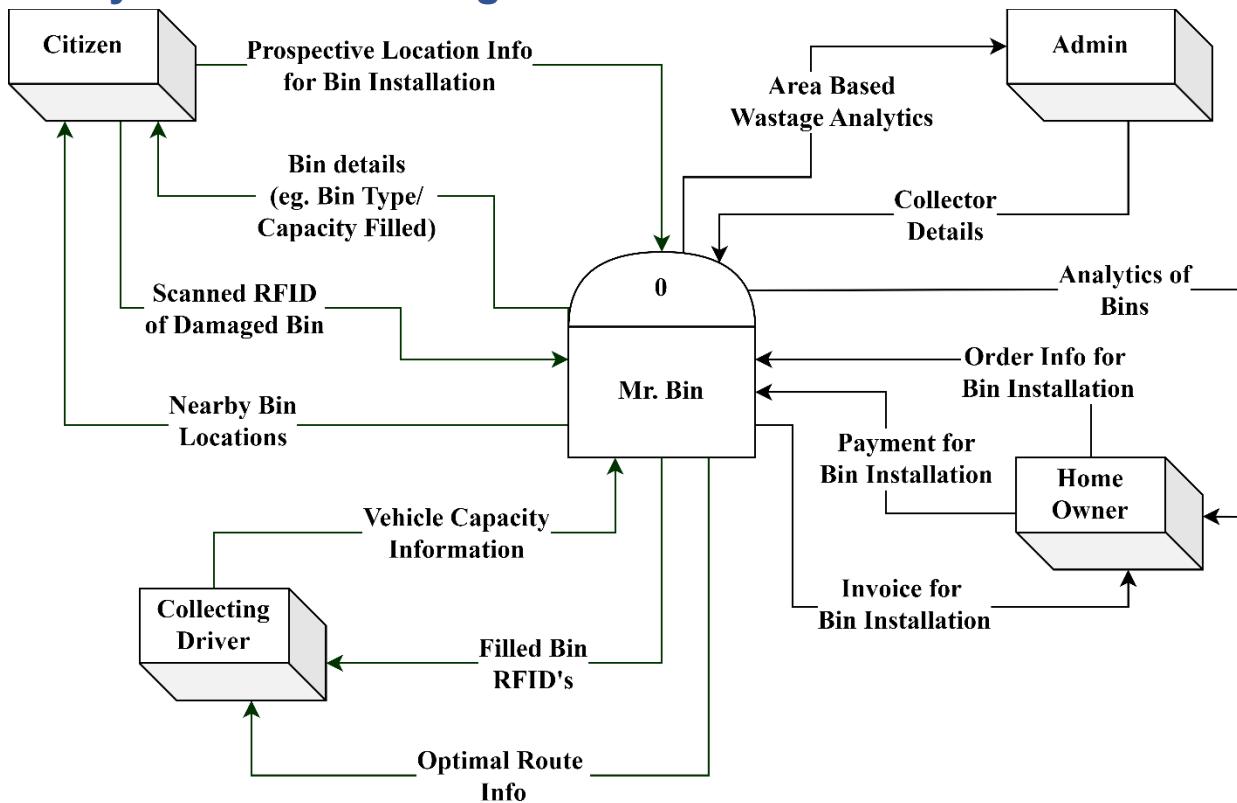


Figure 1: Context Level Dataflow Diagram

3.4 Hardware & Software detail

3.4.1 Development Environment

Hardware Components	Software Components
Processor: Intel(R) Core (TM) i7-1065G7 CPU @ 1.30GHz 1.50 GHz	Operating System: Microsoft Windows 10, Version 22H2 7
RAM: 8.00 GB (Minimum)	Development Tools: Microsoft Visual Studio Code (or any other)
Active Internet Connection	User Interface Design: HTML5, CSS3, jQuery, JavaScript, PHP (Version 8.1.16)
Ultrasonic Beam Sensor	Open-Source Server: XAMPP/ Wamp (or any other)
IoT networks – Sigfox, Lora WAN, NB-IoT and the Cat-M1 wireless network.	Database: Adminer/ MySQL/ SQLite

3.4.2 Operation Environment

3.4.2.1 Hardware Architecture

- Laptop/ PC: At least 8 GB RAM and 128 GB SSD and Intel Core i5 processors
- Smart phone: With good RAM, ROM and good processor for processing power and clock speed
- A stable and reliable Internet connection (at least 5 Mbps)

3.4.2.2 Software Architecture

- For Laptop/PC: Windows 11 v21H2 (at least Windows 10)
- For Smartphone: Android version 8.0 (Oreo) or above with Google Play Services or at least iPhone 6 or better

3.5 Rich Picture

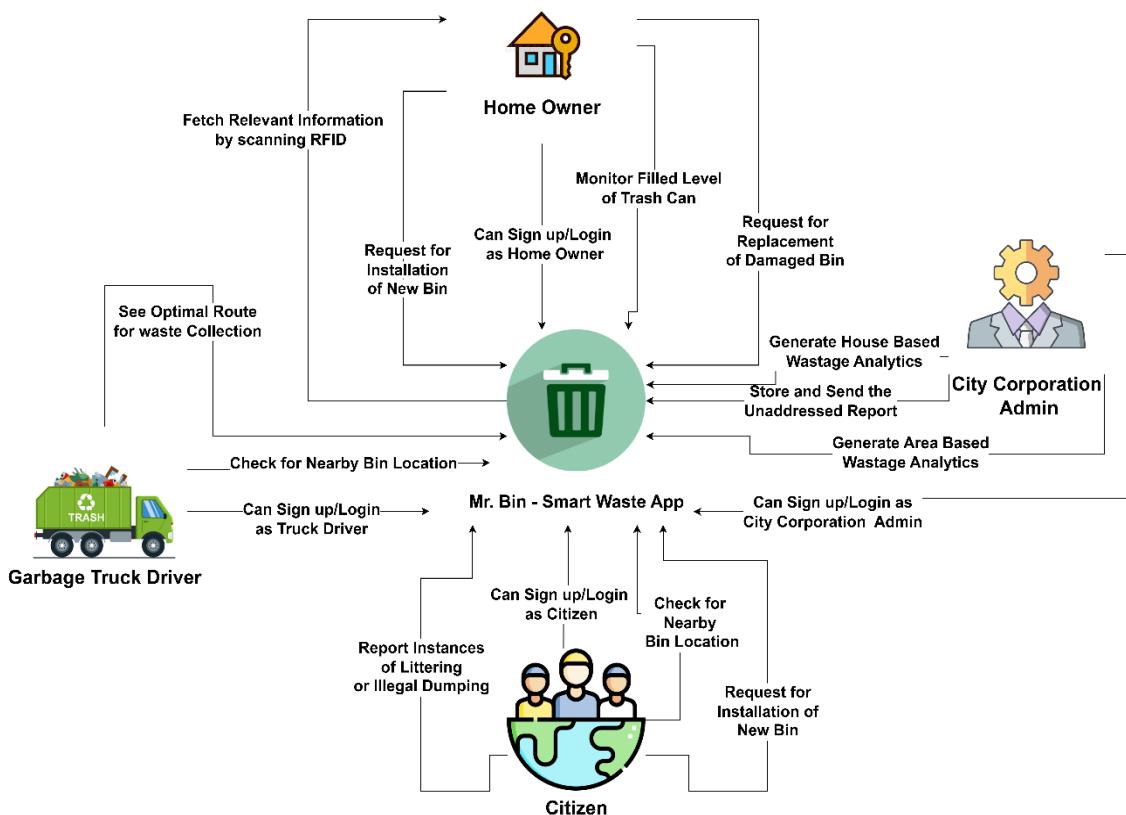


Figure 2: Rich Picture

3.6 Key Technical Features of Software

The technical features of the software are mentioned below:

- User friendly interface with easy to use and simple installation and updates.
- Secure transaction/payment method
- Data security with encryption and access control.
- Mobile apps for waste collectors and drivers to access their schedules, routes, and real-time updates.
- Monitoring and reporting on environmental impact metrics such as reduced through optimized routes, increased recycling rates, and other sustainability efforts.
- Integration with Internet of Things (IoT) devices, such as smart bins provide real-time data on fill levels, temperature, and other parameters.
- Providing real-time tracking of bins so users can waste collection vehicles and personnel to monitor their locations, activities, and progress.

Section 4

4.1 Information Gathering methods

Information collecting is a key step in the system development process. In order to establish the system scope, identify constraints, gather requirements, and develop the system design, it is crucial to understand the requirements of the system's end users. Gathering information ensures the system is scalable, dependable, and meets user requirements. Developers could wind up building a system that is neither workable nor satisfies users' needs, necessitating expensive and time-consuming redesigns. To ensure that the system is constructed within the proper cost and time restrictions while meeting the needs and expectations of the users, information gathering is thus necessary. For "Mr. BIN" project, we have used this three information gathering methods:

1. User Stories
2. Interviewing
3. Questionnaires.

4.1.1 User Stories

4.1.1.1 Story 1

During my childhood, I used to live in a densely populated area. People used to throw trash at a certain place and piles of trash gathered at one place. People walked around that space covering their face with their hands because of the bad odor of trash. Homeowners near the trash pile were helpless as there was no solution to this pile of garbage. No one agreed to throw garbage elsewhere. Trash pile was infested with Flies, rodents, and mosquitoes.

Findings:

- A user should get separate trash cans for each home and when the trash can is filled it can be collected by the nearest waste management employee at any time.
- The user must see all the available trash cans near him/her under a single platform in case the user Outside.

4.1.1.2 Story 2

Once a close relative of mine was severely sick. She was suffering from asthma. We went to visit her. She told us that her asthma problem started after she moved to this place. Huge piles of trash were burned behind her house once a week. The smoke was so terrifying that she could not breathe properly. Doctors said that burning trash or open dumping releases harmful pollutants and toxic substances into the air, leading to respiratory issues like asthma, bronchitis, and other respiratory disorders. She moved from that place after one month.

Findings:

- Trash must be sorted properly in a designated place far from the locality.
- Trash collectors can get real-time updates on trash bin fill levels, so that they can reduce unnecessary trips to trash cans.

4.1.2 Interviewing

I've made the decision to set up meetings with some of our stakeholders in order to better understand them. We started talking after I described the features of the app. There had been a mix of open-ended and closed-ended questions. I was able to better grasp their perspectives and how they perceived the difficulties they faced in maintaining records and keeping track of all the data by asking open-ended questions. The questions were arranged using the Pyramid approach. The users' identities and levels of interest in "Mr.

BIN" must be determined. In-depth discussions with select users will make it possible to pinpoint their particular demands.

4.1.2.1 Interviewee: User (Homeowner)

Questions:

1. How do you currently manage your household trash and recycling? Are there any challenges or pain points in the current system?
- Have you ever experienced missed trash pickups or irregular schedules? How did it impact your daily routine?
- How do you stay informed about changes in trash pickup schedules, recycling guidelines, or any new waste management initiatives in your community?
- Are you conscious of environmental sustainability and recycling practices? How important is it for you to contribute to waste reduction efforts?
- Do you find it easy to access information on how to properly dispose of hazardous waste items in your area?
- How would you feel about having a mobile app that provides real-time updates on the status of your neighborhood's trash pickup, including estimated arrival times?
- Would you be interested in receiving reminders or notifications about upcoming trash pickup days and any special recycling events happening in your community?
- Have you ever faced challenges in finding the nearest recycling centers or drop-off points for specific materials?
- What features would you like to see in a trash management app that would make waste disposal and recycling more convenient and efficient for you?
- How important is it for you to have a platform that educates and raises awareness about sustainable waste management practices?
- Have you encountered any difficulties in reporting issues related to trash management, such as overflowing bins or illegal dumping?
- How much time and effort are you willing to invest in using a trash management app regularly?
- Do you think a trash management app would make a positive impact on your overall waste disposal habits and environmental consciousness?

4.1.2.2 Interviewee: Garbage Truck Driver

Questions:

- How do you currently receive information about the locations and routes for trash and recycling collection?
- What are the common challenges you face in optimizing waste collection routes and schedules? How does this impact the efficiency of your work?
- Are there specific areas or neighborhoods that often experience issues like missed pickups or overflowing bins? How do you handle such situations?

- How important is real-time data on bin fill levels to help you plan and prioritize collection routes more effectively?
- Would you find value in a mobile app that provides live updates on bin fill levels and dynamically adjusts collection routes based on demand?
- How important is it for you to have a platform that allows you to report and track any issues or incidents related to waste management efficiently?
- Are there specific features you would like to see in a trash management app that would make your job easier or more efficient?
- How do you currently communicate with your team and supervisors regarding changes in collection schedules or any urgent waste management matters?
- How receptive do you think your team and colleagues would be to adopting a new trash management app as part of your daily operations?

4.1.3 Questionnaires

We have asked 104 people voluntarily to respond to some questions about trash management facilities on an online survey form that we created on Google Forms. Each person's answers will help us to assess quickly and effortlessly what the user wants. The survey allowed us to learn precise details about the issues they were experiencing. Below are the question and answers from our survey:

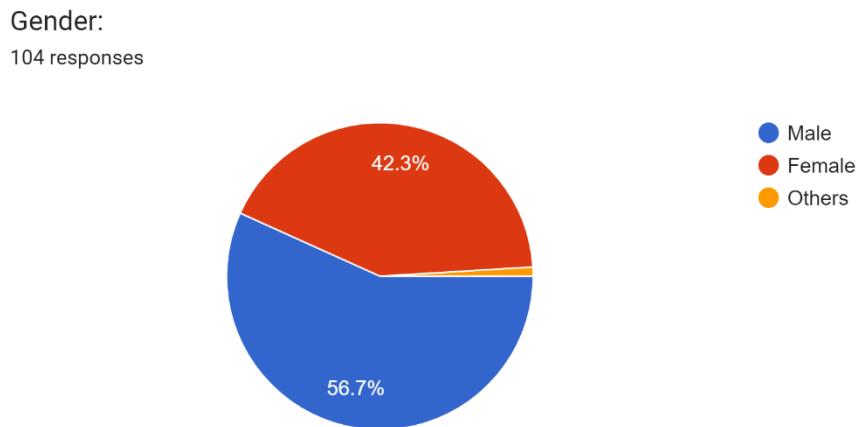


Figure 3: Gender of interviewees

Age:
104 responses

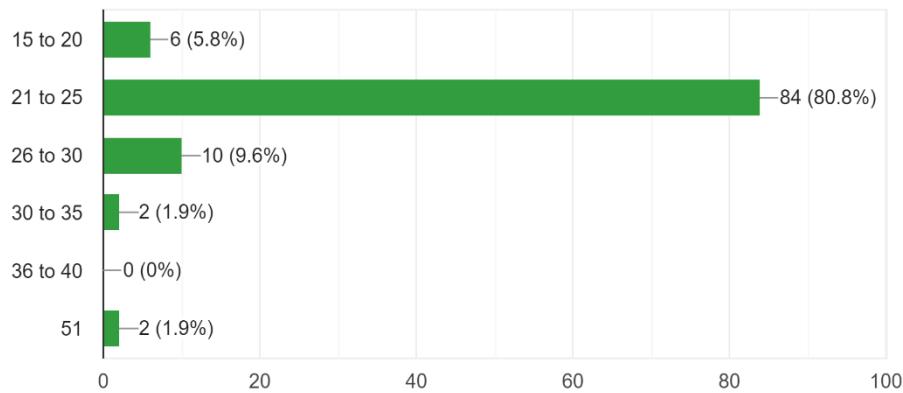


Figure 4: Age of Interviewees

What challenges do you face when it comes to recycling and proper waste disposal?
104 responses

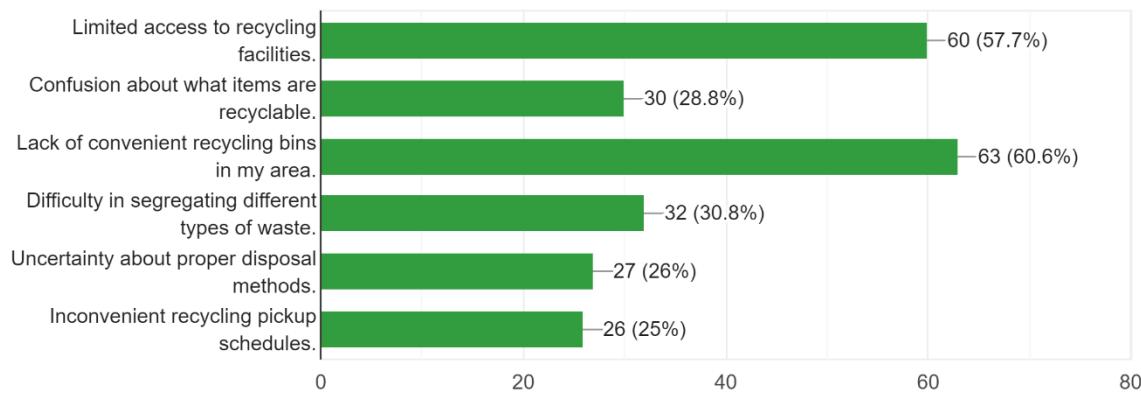


Figure 5: Challenges Faced by Users

Do you often encounter difficulties when you need to dispose trash due to the unavailability of nearby bins?

104 responses

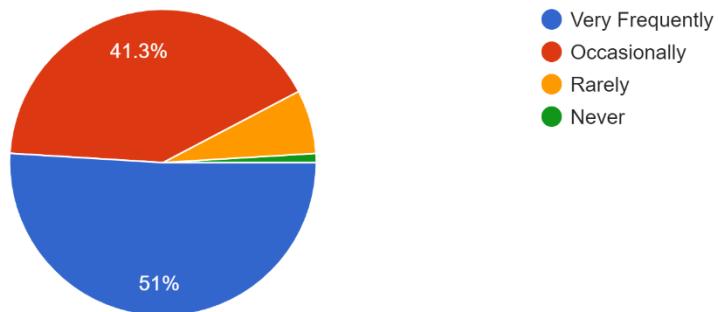


Figure 6: Difficulties Disposing Waste

How often do you currently engage in proper waste disposal practices?

104 responses

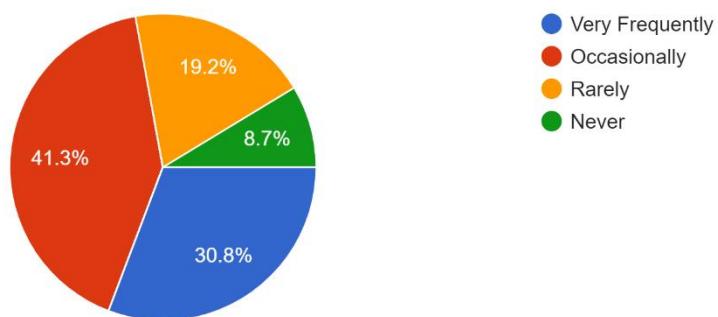


Figure 7: User Engagement in Waste Disposal

Do you think a bin locating app would be helpful to throw trash properly?
104 responses

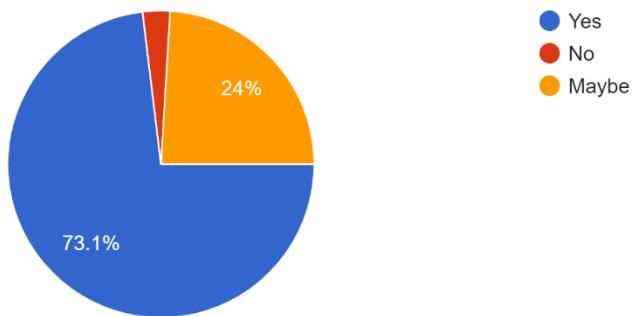


Figure 8: Opinion on Bin Locating App

Do you engage in selling recyclable materials such as paper, bottles, and cans to scrap vendors?
104 responses

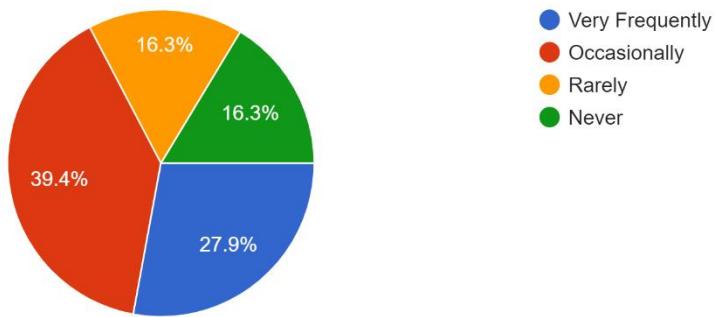


Figure 9: Opinion on Selling Recyclable Materials

Would you be interested in utilizing an app that allows you to sell recyclable goods at competitive prices?

104 responses

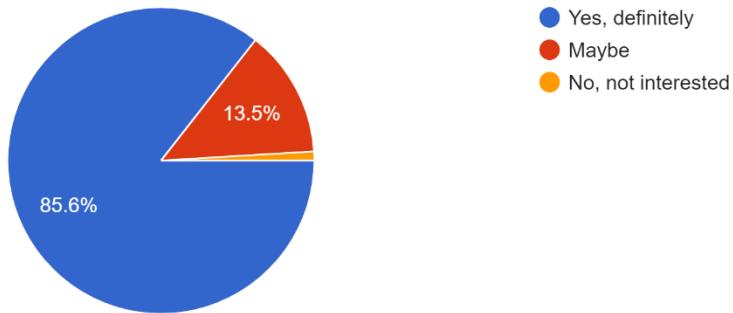


Figure 10: User Interest on using recommended App for selling recyclable goods

Would you be interested in using an app to dump your waste?

104 responses

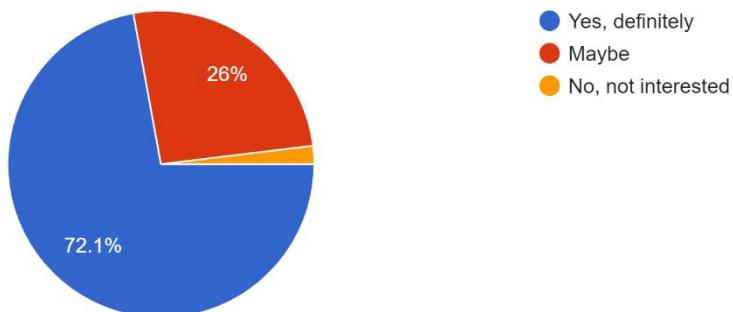


Figure 11: User Interest on Using recommended App to dump waste

Do you hold the belief that a waste management app could contribute to creating a cleaner environment in your city?

104 responses

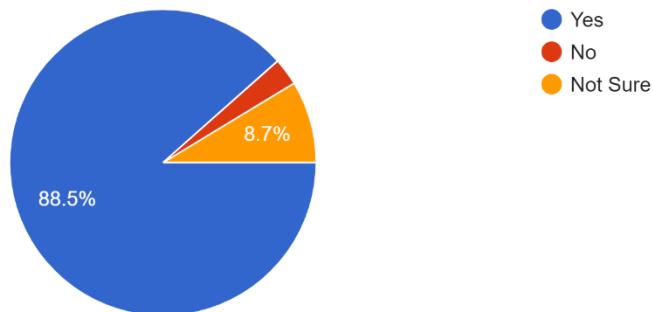


Figure 12: User belief in technology for cleaner environment

4.2 Major functionalities

The major functionalities offered by “MR. BIN” are given below:

- Allows users to locate their nearest waste disposal bins, recycling centers, and hazardous waste drop-off points.
- Allows users to create accounts where they can customize their waste management preferences, check trash bin level, and track their waste reduction progress over time.
- Truck drivers will be able to see nearest full bin and optimize route by picking the nearest full bin saving time and effort.
- Users can sell their recyclable items at competitive prices ensuring green earth.

4.3 Use Case Diagram

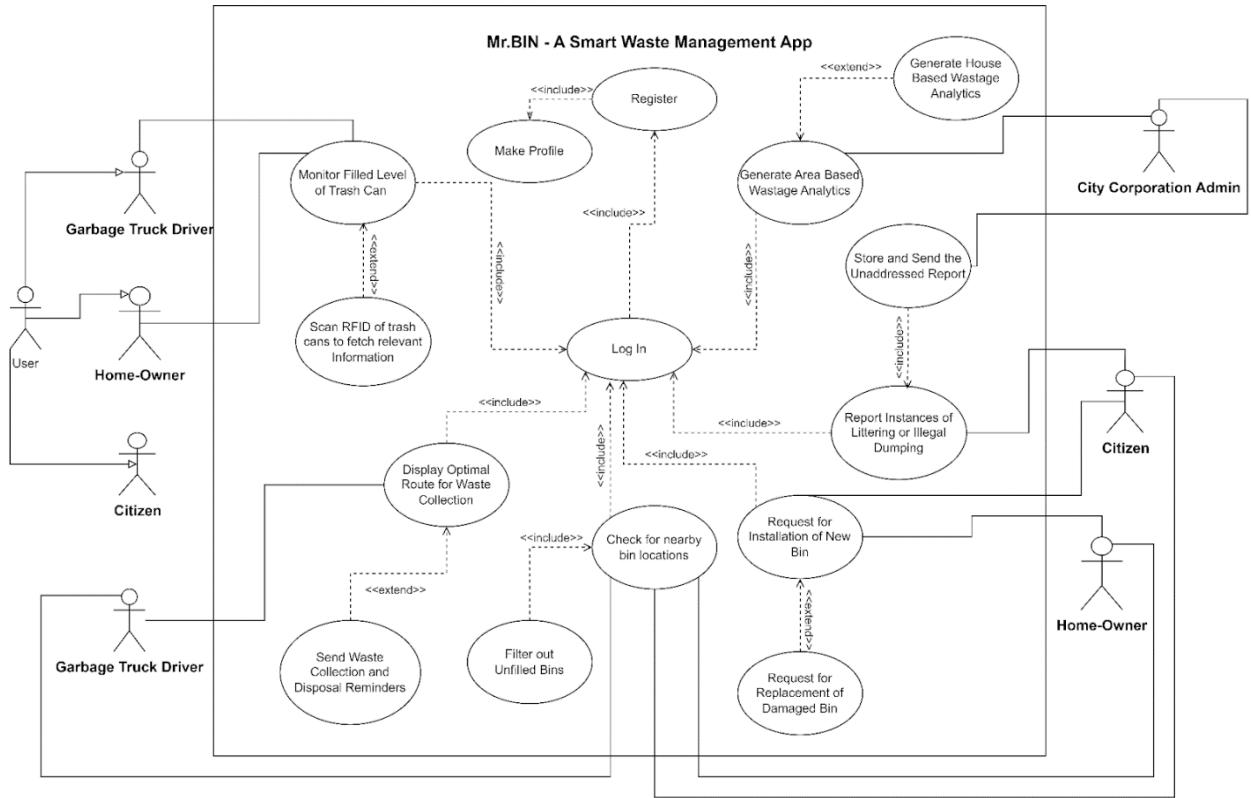


Figure 13: Use Case Diagram

4.4 Normal Scenarios

4.4.1 Case 1

Use case Name : Monitor Filled level of Trash Can MB-0001	Unique ID:
Area: User (Garbage Truck Driver) Dashboard, User (Citizen) Dashboard	
Actor(s): User (Homeowner),User(Garbage Truck Driver)	
Stakeholders: User(Home-owner), Admin	
Description: Homeowner & Waste Collector can check how much of the trash can is full.	
Triggering Event: After login with email and password user (Home-Owner) user can get real-time online access to data related to monitored bins, boxes, or containers.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:

1. Participant login using the secure Web server	1. User ID, Password
2. Click on the “Check Filled Level of trash Can” button.	2. Users must be registered in the app and logged in the account.
3. After Checking in, the user can see the percentage of bin filled.	3. Bin Output Data.
Pre-condition: Driver need to access the app	
Post-conditions: Driver must carefully input user Id and password while login.	
Assumption: Homeowners are willing to contribute to environmental sustainability without extra effort.	
Success Guarantee: Will be successful to put out trash and avoid missed collections.	
Minimum Guarantee: Can download the app and get to know about the app (how things are operating).	
Outstanding Issues: <ul style="list-style-type: none"> • What if homeowners cannot use the app properly? • What if the bin sensor somehow gets defected? 	
Priority: High	
Risk: Medium	

4.4.2 Case 2

Use case Name : Display optimal route for waste collection MB-0002	Unique ID:
Area: User (Driver) Dashboard	
Actor(s): User (Driver)	
Stakeholders: User (Citizen), User(Homeowner), City Corporation Admin	
Description: Driver can view his optimal route information for waste collection	
Triggering Event: After login with email and password, driver will be able to view the optimal route automatically while collecting waste using the system.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:
1. Participant login using the secure Web server	1. User ID, Password

2. Driver chooses the destination for collecting wastage.	2. User Input Data.
3. A page is sent to the user (driver) containing the information about the optimal route for collecting waste.	3. Output page.
Pre-condition: Drivers need to have an account on the app.	
Post-conditions: Driver will be able to see the optimal route information.	
Assumption: Drivers will go to collect waste using the system.	
Success Guarantee: Will be successful to find the optimal route.	
Minimum Guarantee: Can download the app and get to know about the app (how things are operating).	
Outstanding Issues: <ul style="list-style-type: none"> • What if there are more than one optimal route? • What if there are external activities undetected by the system while finding optimized route? 	
Priority: High	
Risk: Medium	

4.4.3 Case 3

Use Case Name : Report instances of littering or illegal dumping. Unique ID: MB-0003	
Area: User (Citizen) Dashboard	
Actor(s): User (Citizen)	
Stakeholders: User (Citizen), Garbage Truck Driver, Admin, City Corporation Admin.	
Description: A user(citizen) will be able to report littering or illegal dumping incidents.	
Triggering Event: After login with email and password user (Citizen) filters many options such as (pictures, geotag the location, submit a report etc.) and then confirms the report.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:
1. Participant login using the secure Web server	1. User ID, Password
2. Clicks on “Report littering/Illegal Dumping” button	2. Users must be registered in the app and logged in the account.

3. Filters many requirements to report littering. • Add picture • Geotag the location • Report of the littering	3. User GPS location so that it can show the exact location of littering. 3.1 User input data
4. After clicking on Confirm, a notification will be sent to the user. User gets a report submitted confirmation.	4. User confirmation for reporting the littering.
Pre-condition: User has already registered and has created a user account.	
Post-conditions: User has successfully reported illegal dumping.	
Assumption: User has a browser and a valid user ID and password.	
Success Guarantee: User has reported the incident directly to the City Corporation, promoting community involvement in maintaining cleanliness.	
Minimum Guarantee: User was able to login and could go through the reporting policies.	
Outstanding Issues: What if no measurements are taken even after reporting?	
Priority: High	
Risk: Medium	

4.4.4 Case 4

Use Case Name : Request for Installation of New Bin		Unique ID: MB-0004
Area: User (Citizen) Dashboard		
Actor(s): User (Citizen), User (Owner)		
Stakeholders: User (Citizen), Garbage Truck Driver, City Corporation.		
Description: A user(citizen) will be able to request for a bin in areas without a bin.		
Triggering Event: Citizen uses Mr. Bin website, enters userID and password, and clicks the logon button.		
Trigger Type: External		
Steps Performed (Main Path):		Information Required for Steps:
1. Participant login using the secure Web server		1. User ID, Password

2. Clicks on “Request for installation ” button	2. Users must be registered in the app and logged in the account.
3. Filters many requirements to request for a bin. <ul style="list-style-type: none">• Add picture• Geotag the location• Street No, Area Name, City Name, House no (if required).	3. User GPS location so that it can show the exact location of bin installation. 3.1 User input data
4. After clicking on Confirm, a notification will be sent to the user. User gets a successful request submitted confirmation.	4. User Input Data.
Pre-condition: User has already registered and has created a user account.	
Post-conditions: User has successfully requested for a bin.	
Assumption: User has a browser and a valid user ID and password.	
Success Guarantee: User has requested for bin directly to the city corporation, promoting community involvement in maintaining cleanliness.	
Minimum Guarantee: User was able to login and could go through the reporting policies.	
Outstanding Issues: What if no bins were installed even after requesting?	
Priority: High	
Risk: Medium	

4.4.5 Case 5

Use Case Name: Check for nearby Bin locations.	Unique ID: MB-0005
Area: User (Citizen) Dashboard	
Actor(s): User (Citizen), User (Owner), Garbage Truck Driver,	
Stakeholders: User (Citizen), Garbage Truck Driver, Admin	
Description: User (Citizen) can check nearby Bin locations.	
Triggering Event: After login with email and password, user (Citizen) will be able to check nearby bin locations by clicking on the “Nearby Bins” button.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:
1. User login using the secure Web server	1. User ID, Password

2. Clicks on “Nearby Bins” button	2. Users must be registered in the app and logged in the account.
3. A new page is sent to the user with the nearby bin locations.	3. Output page
Pre-condition: User has already registered and has created a user account.	
Post-conditions: User successfully gets nearby bin locations.	
Assumption: User has a browser and a valid user ID and password.	
Success Guarantee: Users got personalized waste collection and disposal reminders based on their location and local waste management schedule.	
Minimum Guarantee: User was able to login and could go through the notification.	
Outstanding Issues: What if user does not dump waste on time even after notification?	
Priority: High	
Risk: Medium	

4.4.6 Case 6

Use Case Name: Generate Area Based Wastage Analytics	Unique ID: MB-0006
Area: City Corporation Admin Dashboard	
Actor(s): City Corporation Admin	
Stakeholders: User (Citizen), Garbage Truck Driver, User(Homeowner)	
Description: City Corporation Admin can generate wastage analysis based on waste dumping patterns of different areas.	
Triggering Event: After login with email and password, user (admin) will be able to show reports of trash dumping timing, how many times the trash is dumped in a specific time.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:
1. User login using the secure Web server	1. User ID, Password
2. Click on the “View Area based wastage analytics” button.	2. Users must be registered in the app and logged in the account.
3. A new page is sent to the user with <ul style="list-style-type: none"> • the trash amount produced by each area monthly & yearly. • Which trash type is mostly found in the area. • Amount of toxic waste(if any). 	3. Output page

Pre-condition: User has already registered and has created a user account.
Post-conditions: User successfully gets area based wastage analytics..
Assumption: User has a browser and a valid user ID and password.
Success Guarantee: User gets a clear understanding of waste infrastructure of different areas and can identify and record all waste assets.
Minimum Guarantee: User was able to login and could go through the website.
Outstanding Issues: What if user does not get correct analytics because of wrong information?
Priority: High
Risk: Medium

4.5 Alternate Scenarios

4.5.1 Case 1

Use Case Name : Monitor Filled level of Trash Can	Unique ID: MB_ALT-0001
Area: User (Citizen) Dashboard	
Actor(s): User (Citizen)	
Stakeholders: User (Citizen), Garbage Truck Driver, Admin	
Description: Homeowner & Waste Collector can check how much of the trash can is full.	
Triggering Event: After login with email and password user (Home-Owner) user can get real-time online access to data related to monitored bins, boxes, or containers.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:
1. User login using the secure Web server	1. User ID, Password
2. Clicks on “Scan RFID” button	2. Users must be registered in the app and logged in the account.
3. A new page is sent to the user with the details information about the bin such as bin type, bin capacity etc.	3. Output page
Pre-condition: Driver need to access the app	
Post-conditions: Driver must carefully input user Id and password while login.	
Assumption: Homeowners are willing to contribute to environmental sustainability without extra effort.	

Success Guarantee: Will be successful to put out trash and avoid missed collections.
Minimum Guarantee: Can download the app and get to know about the app (how things are operating).
Outstanding Issues: What if homeowners cannot use the app properly?
Priority: High
Risk: Medium

4.5.2 Case 2

Use case Name : Display optimal route for waste collection	Unique ID: MB_ALT-0002
Area: User (Driver) Dashboard	
Actor(s): User (Driver)	
Stakeholders: User (Citizen), User(Homeowner), City Corporation Admin	
Description: Driver can view his optimal route information for waste collection	
Triggering Event: After login with email and password, the driver will be able to view the optimal route automatically while collecting waste using the system.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:
1. Participant login using the secure Web server	1. User ID, Password
2. Driver chooses the destination for collecting wastage.	2. User Input Data.
3. A page is sent to the user (driver) containing the information about the optimal route for collecting waste.	3. Output page.
4. In case, the driver does not follow the optimal route, he will get a reminder to collect the bin later in the same day.	4. Notification Message
Pre-condition: Drivers need to have an account on the app.	
Post-conditions: Driver will be able to see the optimal route information.	
Assumption: Drivers will go to collect waste using the system.	

Success Guarantee: Will be successful to find the optimal route.
Minimum Guarantee: Can download the app and get to know about the app (how things are operating).
Outstanding Issues:
<ul style="list-style-type: none"> • What if there are more than one optimal route? • What if there are external activities undetected by the system while finding an optimized route?
Priority: High
Risk: Medium

4.5.3 Case 3

Use Case Name : Report instances of littering or illegal dumping. Unique ID: MB_AILT-0003	
Area: User (Citizen) Dashboard	
Actor(s): User (Citizen)	
Stakeholders: User (Citizen), Garbage Truck Driver, Admin, City Corporation Admin.	
Description: A user(citizen) will be able to report littering or illegal dumping incidents.	
Triggering Event: After login with email and password user (Citizen) filters many options such as (pictures, geotag the location, submit a report etc.) and then confirms the report.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:
1. Participant login using the secure Web server	1. User ID, Password
2. Clicks on “Report littering/Illegal Dumping” button	2. Users must be registered in the app and logged in the account.
3. Filters many requirements to report littering. • Add picture • Geotag the location • Report of the littering	3. User GPS location so that it can show the exact location of littering. 3.1 User input data
4. After clicking on Confirm, a notification will be sent to the user. User gets a report submitted confirmation.	4. User confirmation for reporting the littering.
5. If the report is not stored then the unaddressed report will be recorded and be sent later after the authority to be sent is confirmed.	

Pre-condition: User has already registered and has created a user account.
Post-conditions: User has successfully reported illegal dumping.
Assumption: User has a browser and a valid user ID and password.
Success Guarantee: User has reported the incident directly to the City Corporation, promoting community involvement in maintaining cleanliness.
Minimum Guarantee: User was able to login and could go through the reporting policies.
Outstanding Issues: What if no measurements are taken even after reporting?
Priority: High
Risk: Medium

4.5.4 Case 4

Use Case Name : Request for Installation of New Bin	Unique ID: MB_ALT-0004
Area: User (Citizen) Dashboard	
Actor(s): User (Citizen)	
Stakeholders: User (Citizen), Garbage Truck Driver, City Corporation.	
Description: A user(citizen) will be able to request for a bin in areas without a bin.	
Triggering Event: Citizen uses Mr. Bin website, enters userID and password, and clicks the logon button.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:
1. Participant login using the secure Web server	1. User ID, Password
2. Clicks on “Request for installation ” button	2. Users must be registered in the app and logged in the account.
3. Clicks on “Request for replacement of damaged bin” button.	3. User input.
4. Filters many requirements to request for a replacement of damaged bin. • Add picture • Geotag the location • Street No, Area Name, City Name, House no (if required).	4. User GPS location so that it can show the exact location of bin installation. 4.1 User input data

5. After clicking on Confirm, a notification will be sent to the user. User gets a successful request submitted confirmation.	5. User Input Data.
Pre-condition: User has already registered and has created a user account.	
Post-conditions: User has successfully requested for a bin.	
Assumption: User has a browser and a valid user ID and password.	
Success Guarantee: User has requested for bin directly to the city corporation, promoting community involvement in maintaining cleanliness.	
Minimum Guarantee: User was able to login and could go through the reporting policies.	
Outstanding Issues: What if no bins were installed even after requesting?	
Priority: High	
Risk: Medium	

4.5.5 Case 5

Use Case Name: Check for nearby Bin locations.	Unique ID: MB_ALT-0005
Area: User (Citizen) Dashboard	
Actor(s): User (Citizen)	
Stakeholders: User (Citizen), Garbage Truck Driver, Admin	
Description: User (Citizen) can check nearby Bin locations.	
Triggering Event: After login with email and password, user (Citizen) will be able to check nearby bin locations by clicking on the “Nearby Bins” button.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:
1. User login using the secure Web server	1. User ID, Password
2. Clicks on “Nearby Bins” button	2. Users must be registered in the app and logged in the account.
3. A new page is sent to the user with the nearby bin locations.	3. Output page
4. User can filter out and see only those bins that are not filled up	4. User Input, Output page
Pre-condition: User has already registered and has created a user account.	
Post-conditions: User successfully gets nearby bin locations.	

Assumption: User has a browser and a valid user ID and password.
Success Guarantee: Users got personalized waste collection and disposal reminders based on their location and local waste management schedule.
Minimum Guarantee: User was able to login and could go through the notification.
Outstanding Issues: What if use does not dump waste on time even after notification?
Priority: High
Risk: Medium

4.5.6 Case 6

Use Case Name: Generate area based wastage analytics	Unique ID: MB_ALT-1989
Area: City Corporation Admin Dashboard	
Actor(s): City Corporation Admin	
Stakeholders: User (Citizen), Garbage Truck Driver, User(Homeowner)	
Description: City Corporation Admin can generate wastage analysis based on waste dumping patterns of different areas.	
Triggering Event: After login with email and password, user (admin) will be able to show reports of trash dumping timing, how many times the trash is dumped in a specific time.	
Trigger Type: External	
Steps Performed (Main Path):	Information Required for Steps:
1. User login using the secure Web server	1. User ID, Password
2. Click on the “View House based wastage analytics” button.	2. Users must be registered in the app and logged in the account.
3. A new page is sent to the user with <ul style="list-style-type: none"> • the trash amount produced by each house monthly & yearly. • Which trash type is mostly found in the area. • Amount of toxic waste (if any). 	3. Output page
Pre-condition: User has already registered and has created a user account.	
Post-conditions: User successfully gets area based wastage analytics.	
Assumption: User has a browser and a valid user ID and password.	
Success Guarantee: User gets a clear understanding of waste infrastructure of different areas and can identify and record all waste assets.	
Minimum Guarantee: User was able to login and could go through the website.	
Outstanding Issues: What if user does not get correct analytics because of wrong information?	

Priority: **High**

Risk: **Medium**

4.6 Functional Requirements

4.6.1 Citizen/Homeowner Functional Requirements

1. Citizen Will be able to create and log in securely to access the app's features. Citizen must Input their Name and Password to enter their dashboard.
2. Citizens will be able to report issues such as missed trash pickups, overflowing bins, or illegal dumping through the app. To report Citizen must input their complain through their designated dashboard.
3. The app will offer comprehensive guidelines on how to properly dispose of various types of waste, including hazardous materials. Educational resources, tips, and best practices for waste reduction and recycling are provided to users. Citizens can access these resources through their dashboard menu.
4. An interactive map will display the locations of trash and recycling bins, drop-off points, and recycling centers in the area. Citizens can find nearby trashcan through this app.
5. The app will display a personalized trash pickup schedule for each user based on their location and designated collection days. Users will receive timely reminders and notifications about upcoming trash pickups.
6. Users can dump waste at their time preferences. If the waste bin is full, Truck driver will get notifications and pick up the trash.
7. The app offers limited offline functionality to allow users to access essential information even in areas with poor network coverage.
8. Users Can see recyclable goods prices on their dashboard through which they will be able to sell their recyclable goods at market price.
9. The app will integrate with sensors or other data sources to provide real-time information on the fill levels of trash and recycling bins. Users can get alert when the trash is 80% full.

4.6.2 Waste Collector Functional Requirements

1. Waste Collector Will be able to create and log in securely to access the app's features. Collectors must Input their Name and Password to enter their dashboard.

2. Collectors can see the nearest full bin and collect them through optimize collection routes. This will help collectors to avoid unnecessary travel.
3. An interactive map will display the locations of trash and recycling bins, drop-off points, and recycling centers in the area. Collectors can find nearby trashcans through this app.
4. Collectors can see the price of recyclable goods when collecting recycling waste.
5. The app will integrate with sensors or other data sources to provide real-time information on the fill levels of trash and recycling bins. Waste Collectors can get alert when the trash is 80% full.

4.6.3 Admin Functional Requirements

1. Admin will be able to create and log in securely to access the app's features. Admin must Input their Name and Password to enter their dashboard.
2. Admin can generate area based waste reports based on different areas. Admin can see the amount and type of waste generated in each area.
3. Admin have access to a dashboard to track and address reported issues by the citizens efficiently.
4. Admin can update the map through regular moderation.
5. Admin can update recyclable goods price through dashboard.

4.6 Non-Functional Requirements

1. The app database will store all the data and all saved data will be safe and secure.
2. The app will be functional 24/7 so that anyone from anywhere can use this app anytime they want.
3. The app will adhere to strict data privacy and security standards to protect user information and prevent unauthorized access.
4. No cookies or unnecessary advertisements.
5. There will be two language options (Bangla, English). Users can set language as per their needs.

Section 5

5.1 Entity Relationship Diagram

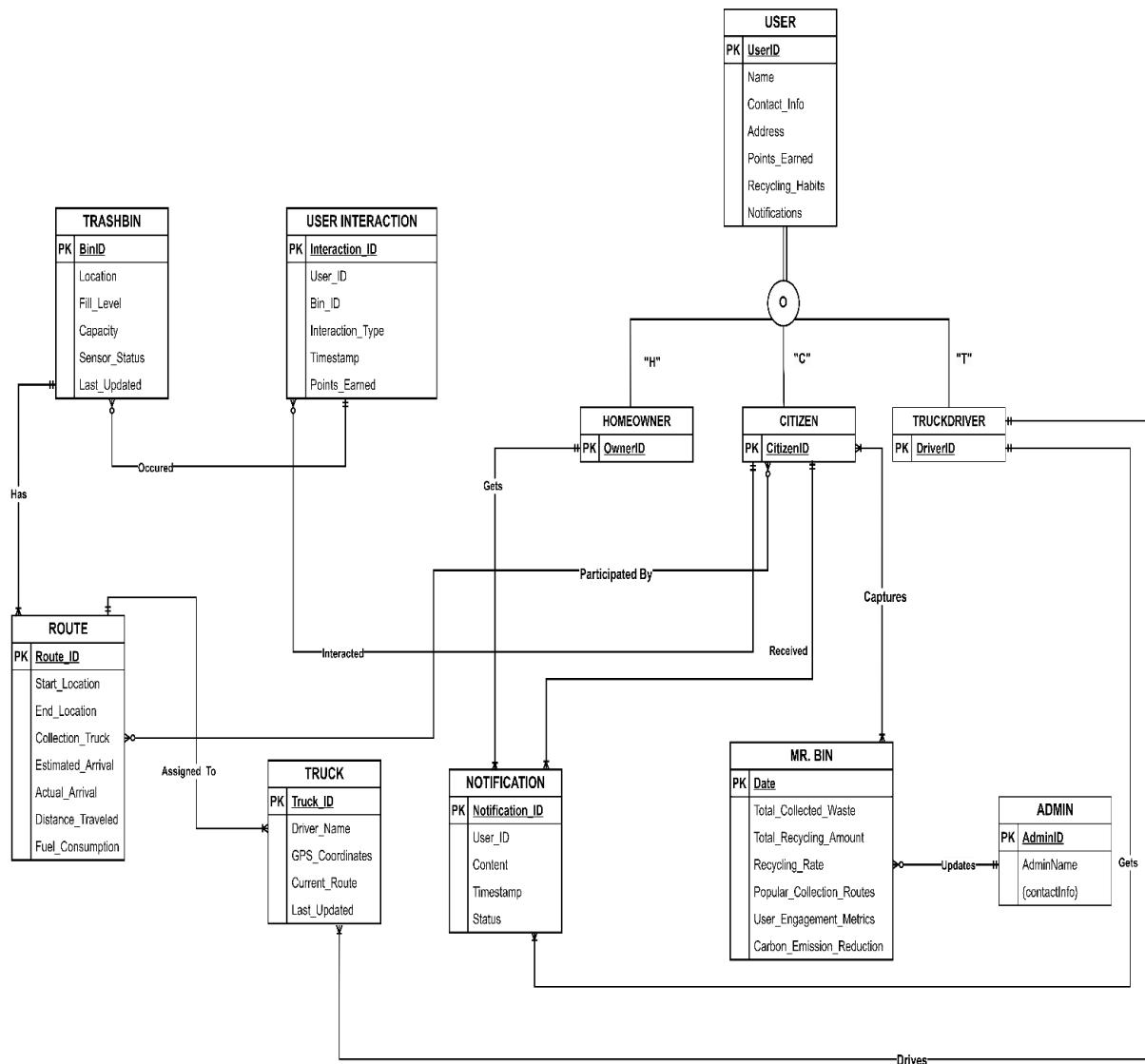


Figure 14: Entity Relationship Diagram

5.2 Logical Data Flow diagram

5.2.1 Logical DFD 0:

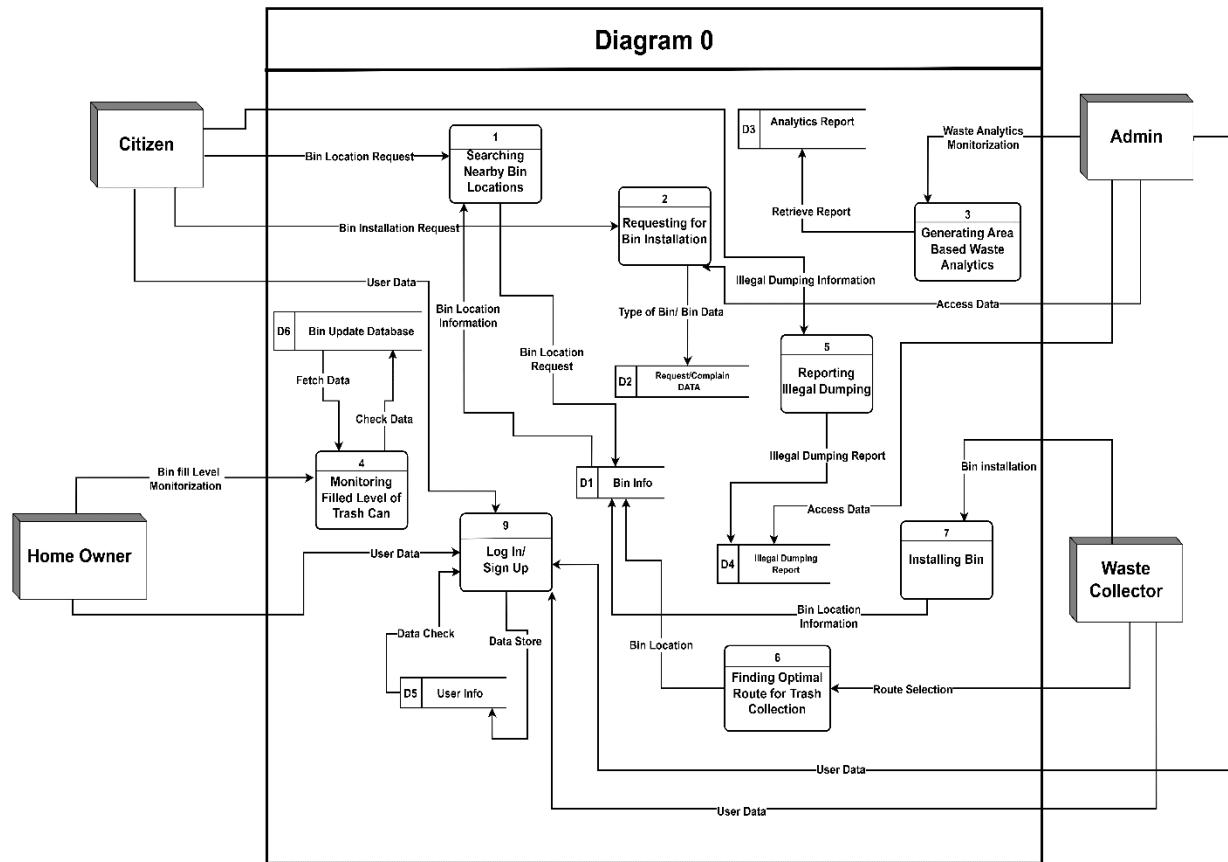


Figure 15: Logical DFD 0

5.2.1 Logical DFD 1:

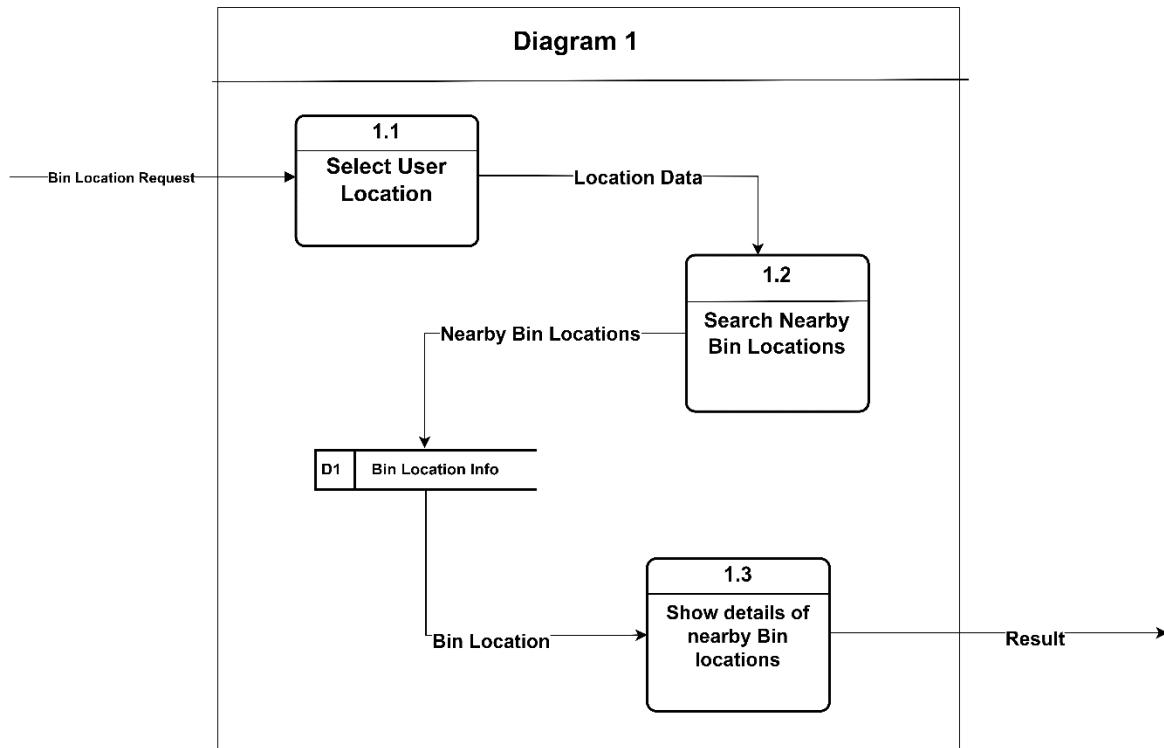


Figure 16: Logical DFD 1

5.2.2 Logical DFD 2:

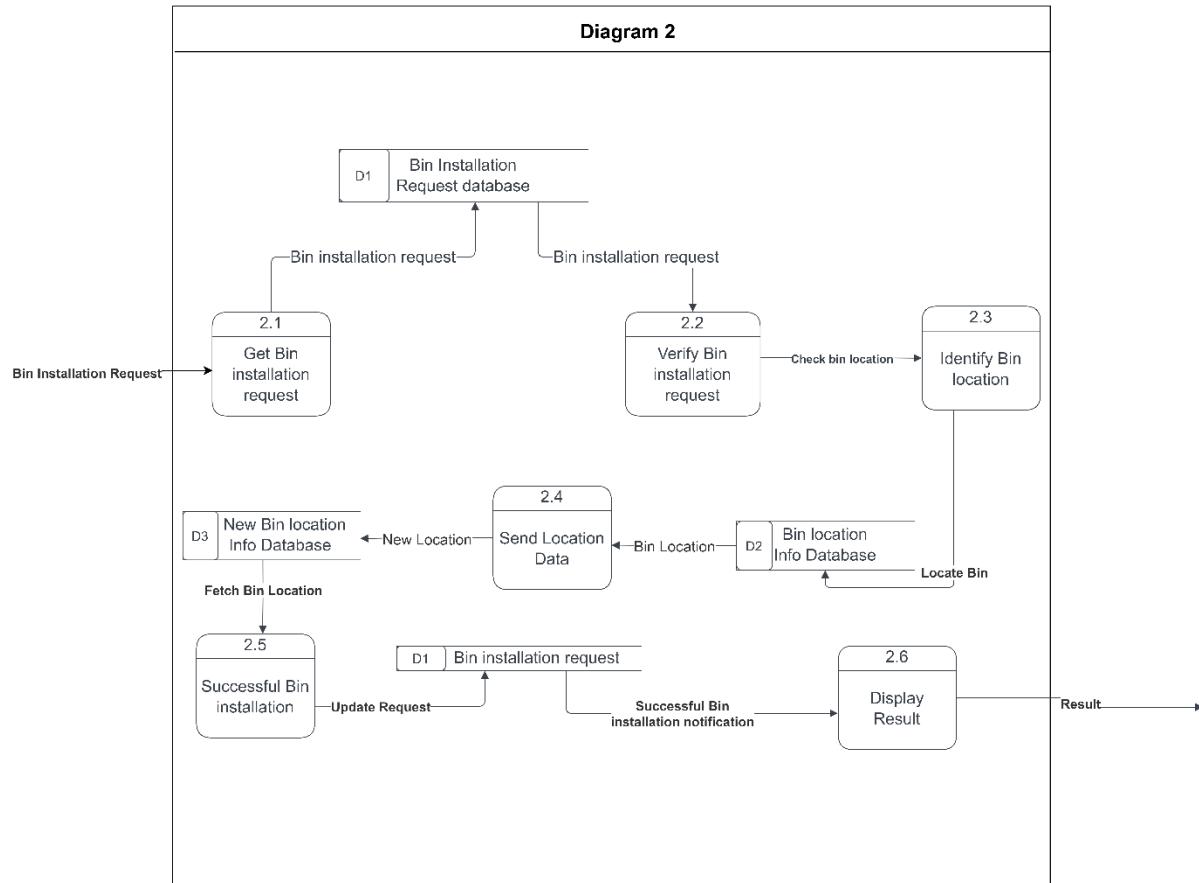


Figure 17: Logical DFD 2

5.2.4 Logical DFD 3:

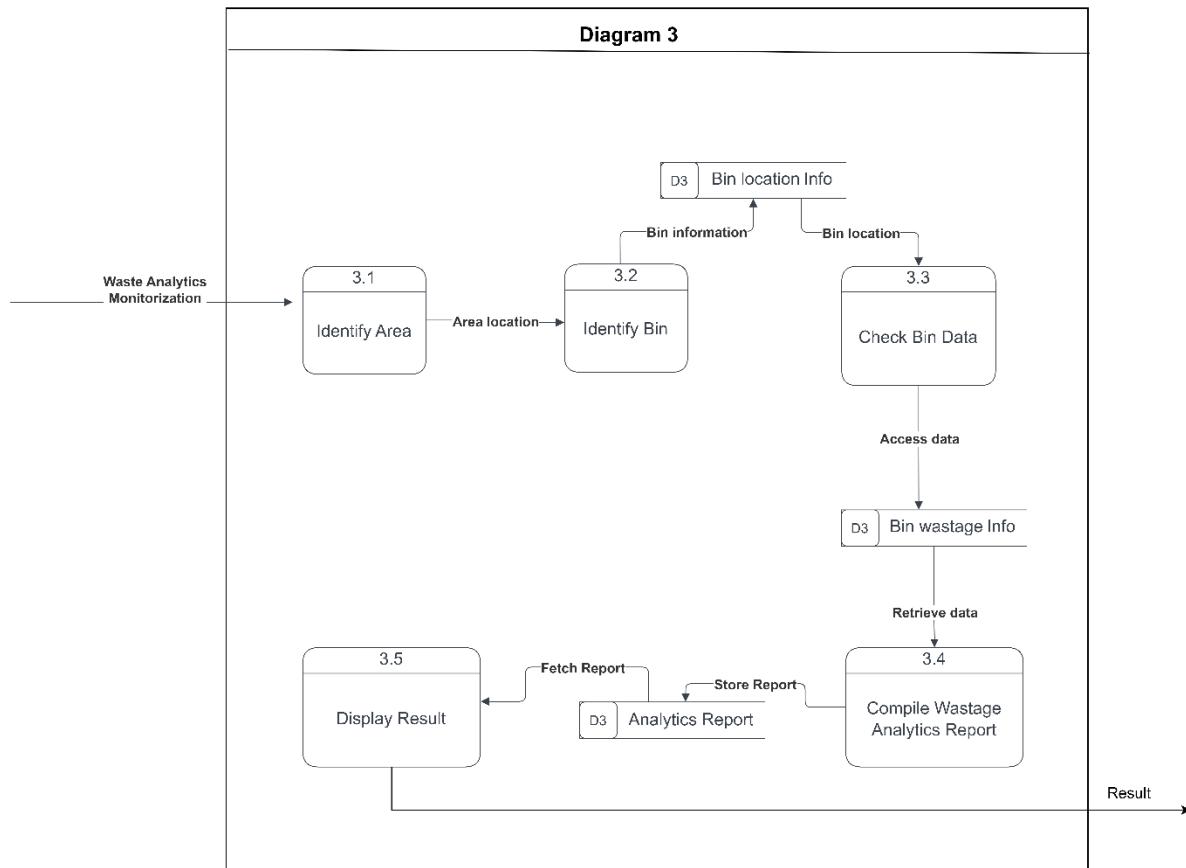


Figure 18: Logical DFD 3

5.3 Physical Data Flow diagram

5.3.1 Physical DFD 0:

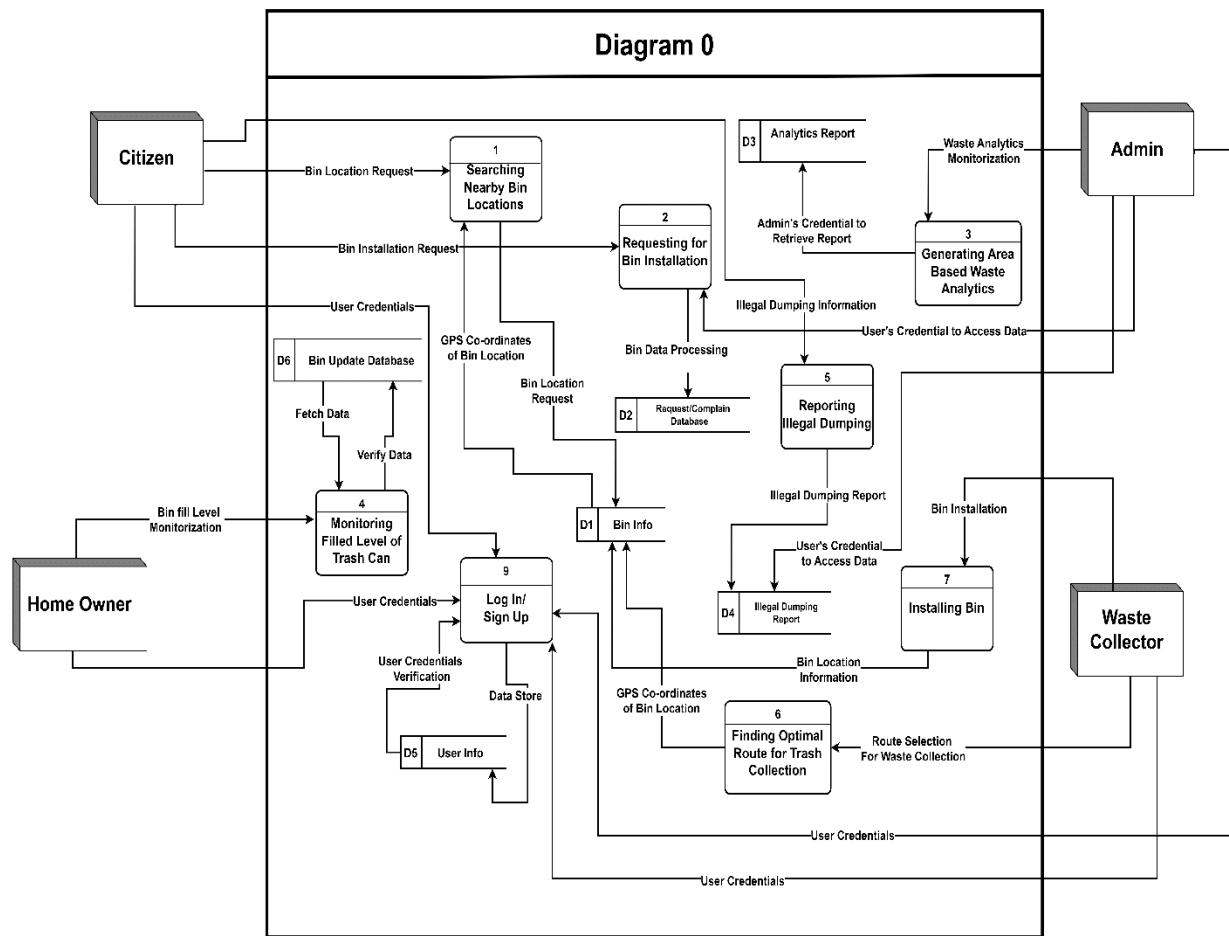


Figure 19: Physical DFD 0

5.3.2 Physical DFD 1:

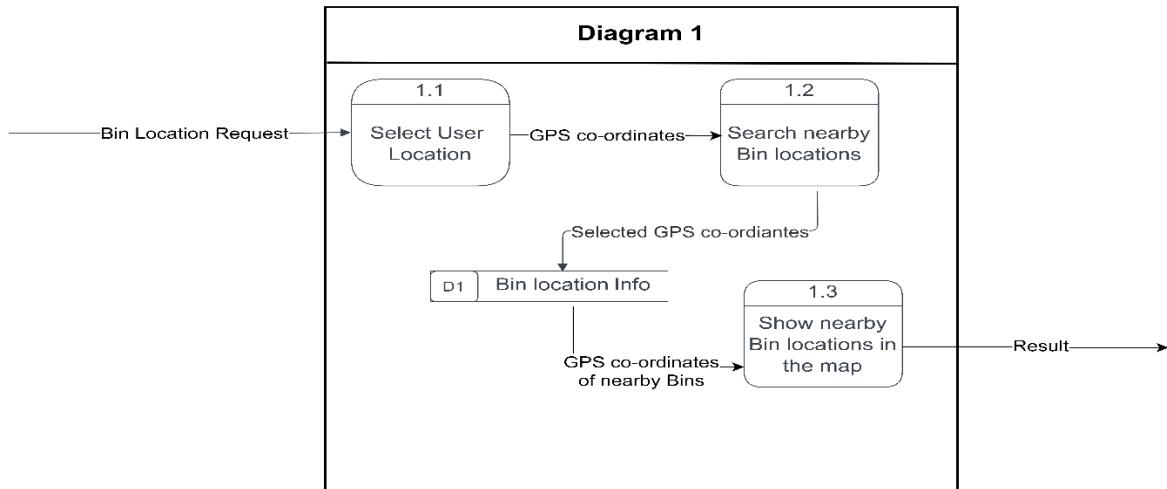


Figure 20: Physical DFD 1

5.3.3 Physical DFD 2:

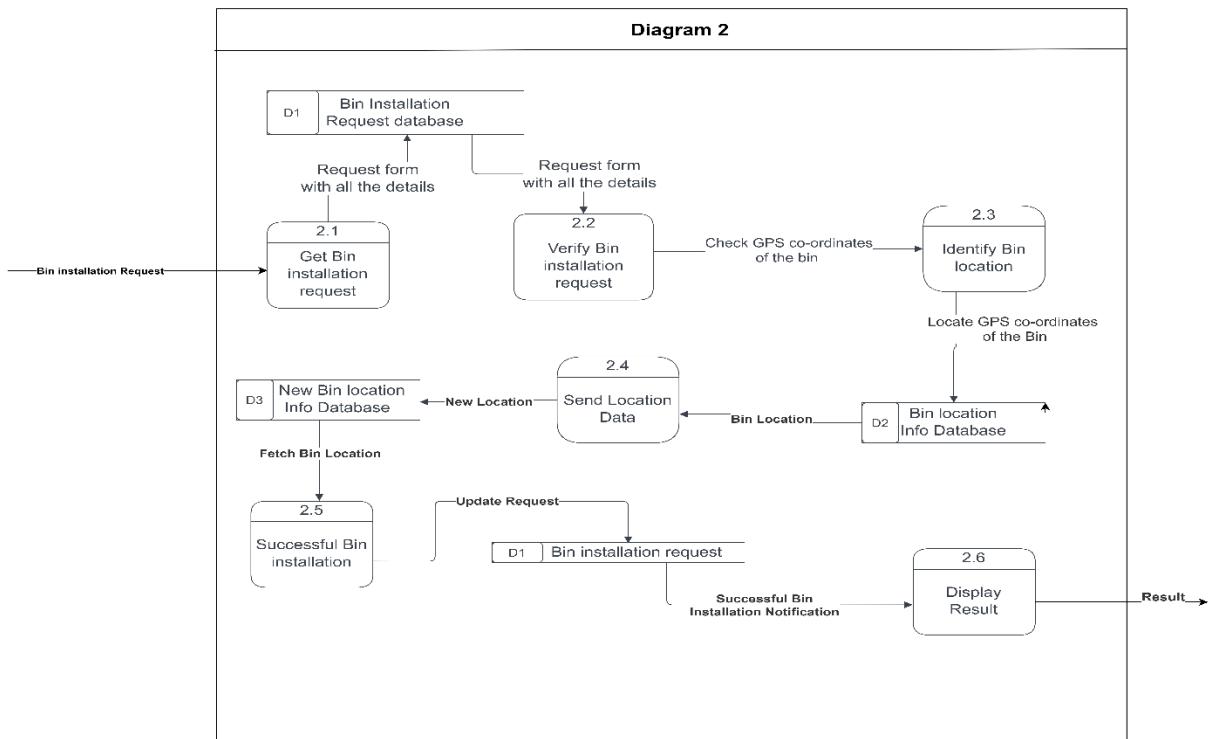


Figure 21: Physical DFD 2

5.3.4 Physical DFD 3:

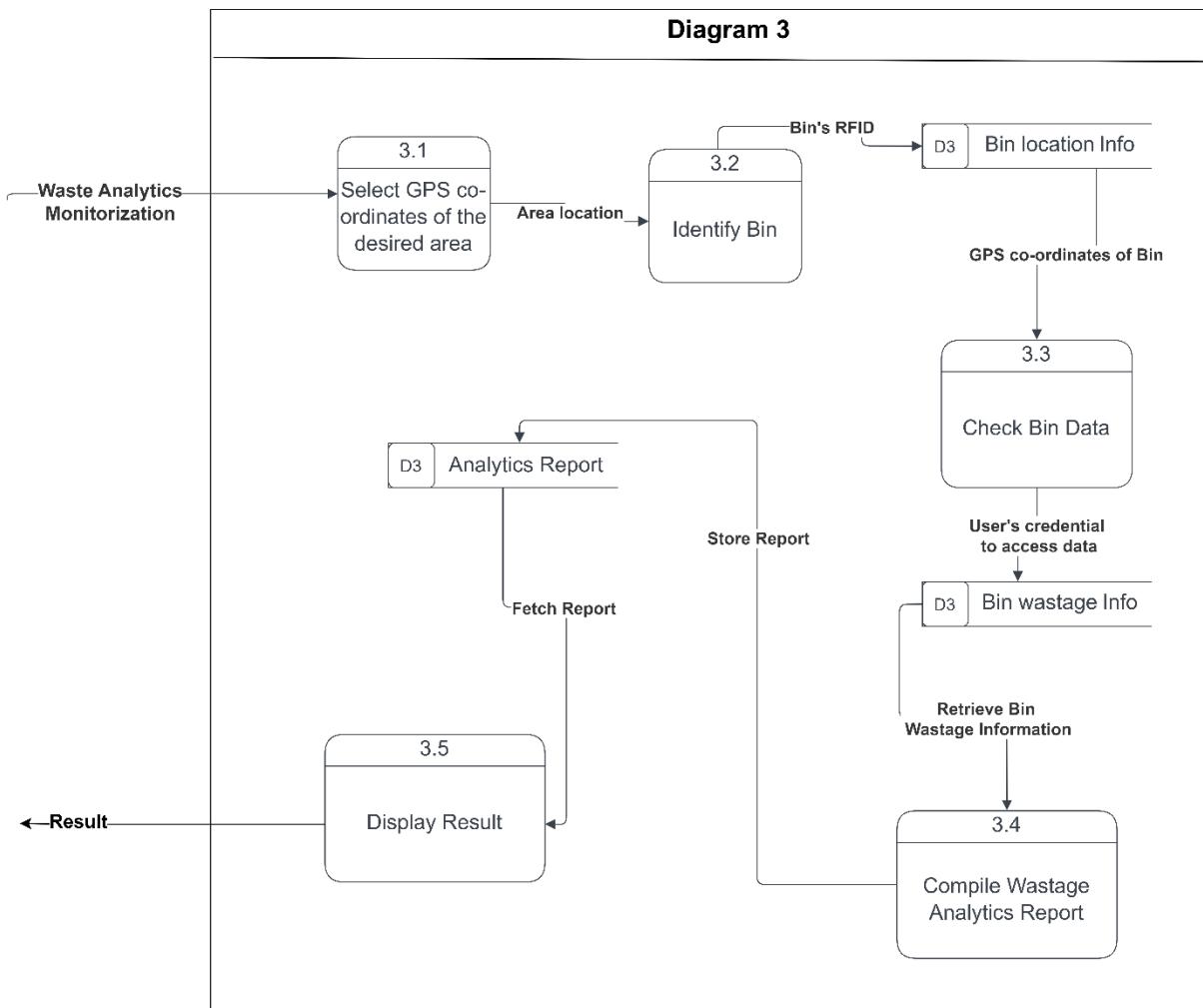


Figure 22: Physical DFD 3

5.4 Activity diagram

5.4.1 Activity Diagram for Register on Website

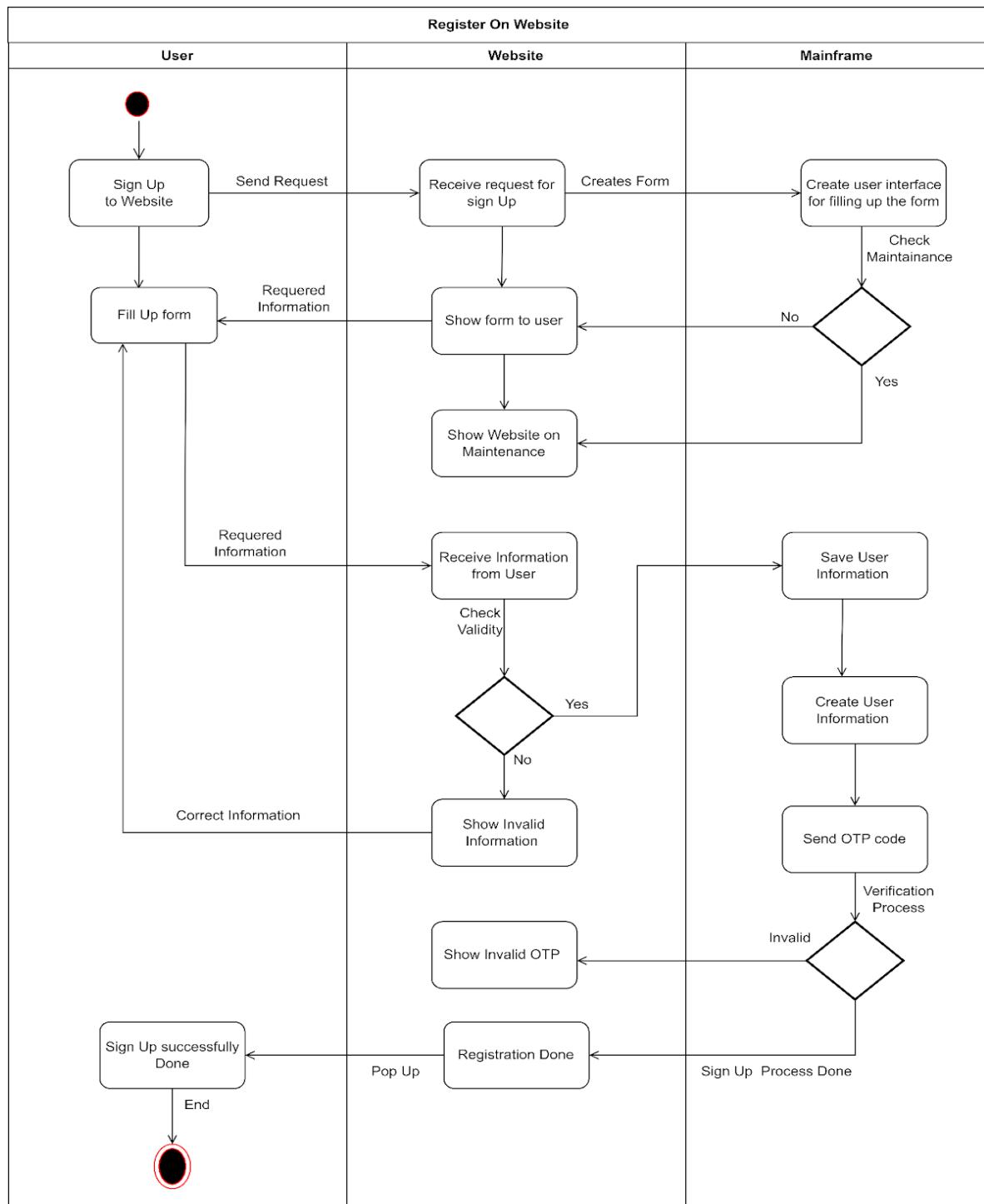


Figure 23: Activity Diagram for Registration

5.4.2 Activity Diagram for Finding Nearby Bin

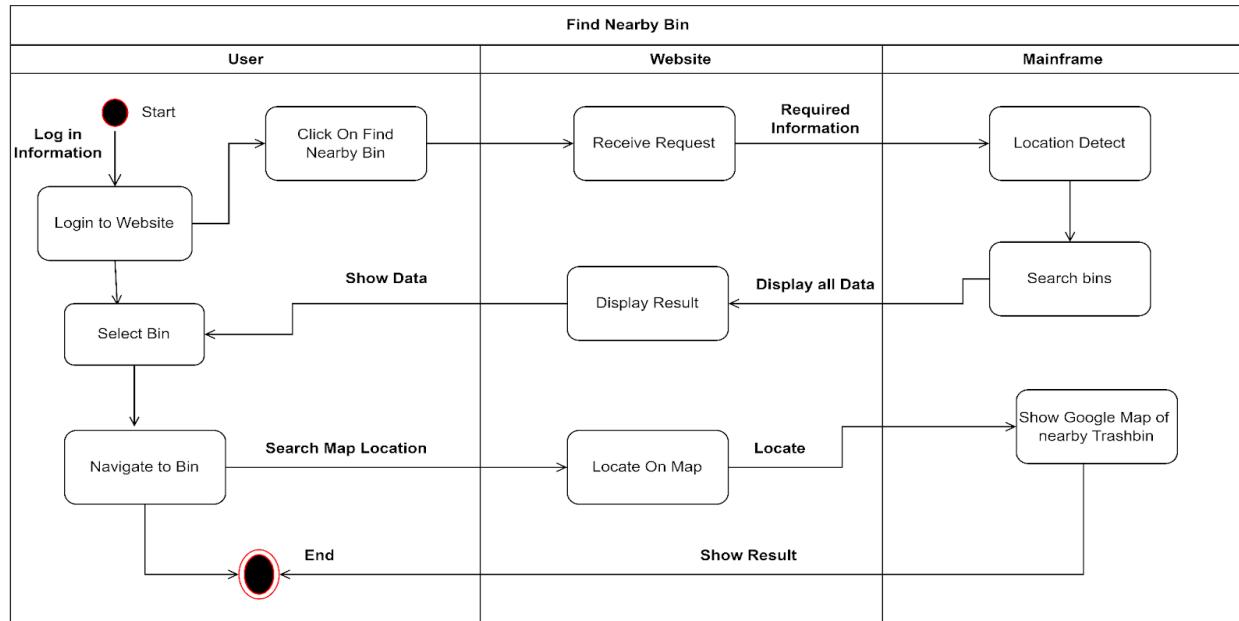


Figure 24: Activity Diagram for Finding Nearby Bin

5.4.3 Activity Diagram for Monitor Filled Level Bin

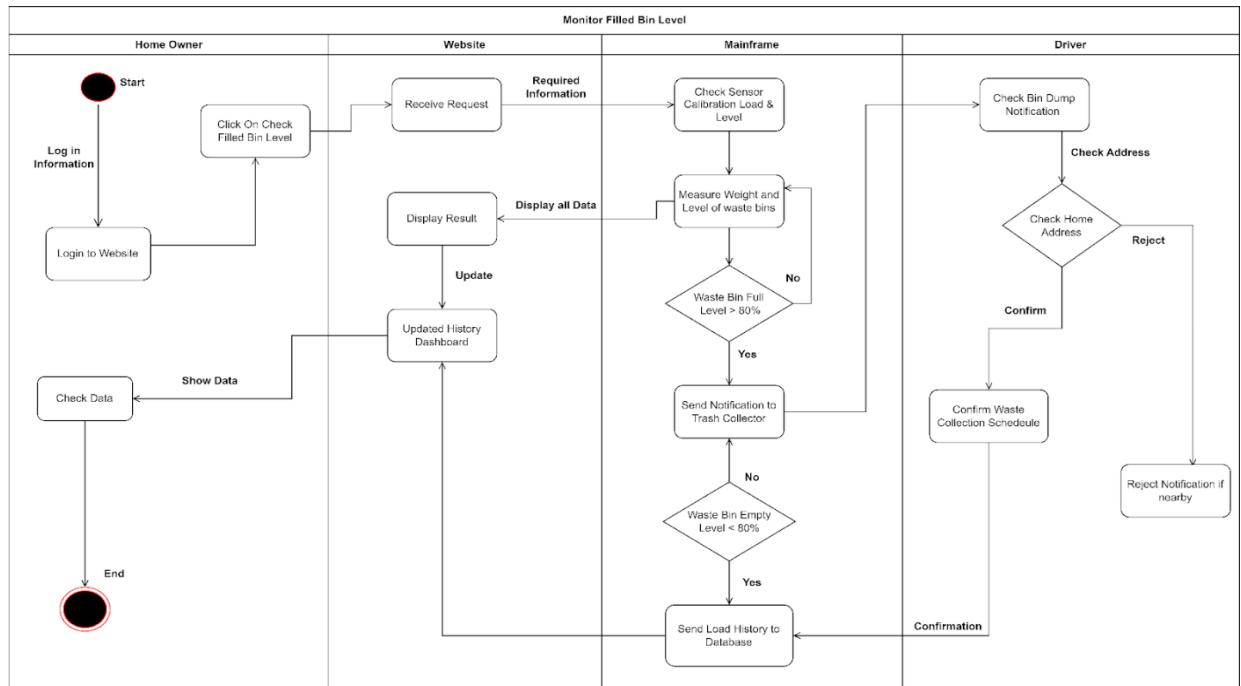


Figure 25: Activity Diagram for Monitor Filled Level Bin

5.5 Sequence diagram

5.5.1 Sequence Diagram for Find Nearby Trash Can

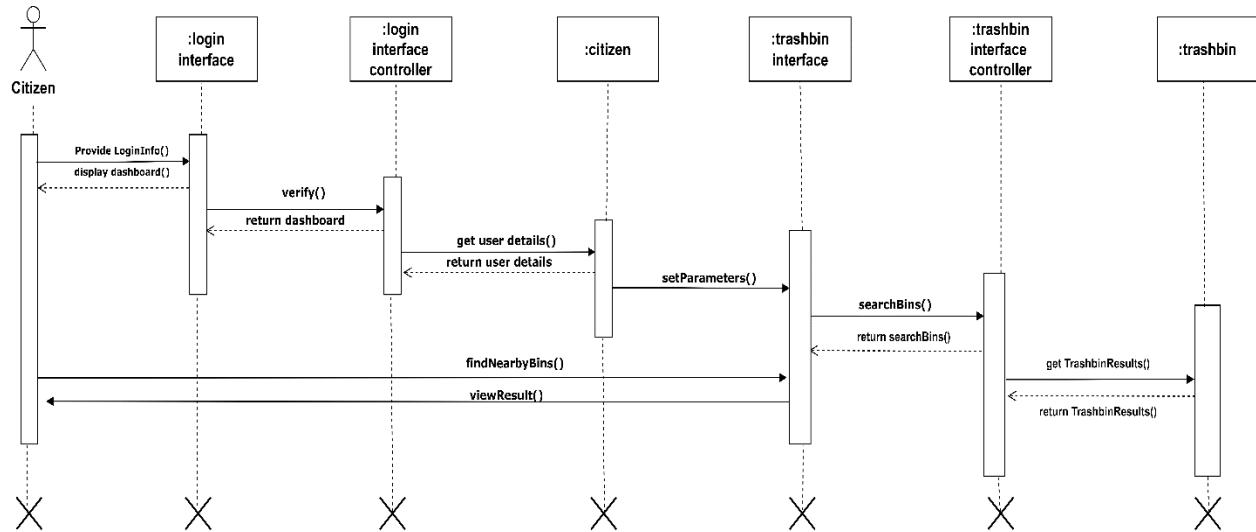


Figure 26: Sequence Diagram for Find Nearby Trash Can

5.5.2 Sequence Diagram for Registration

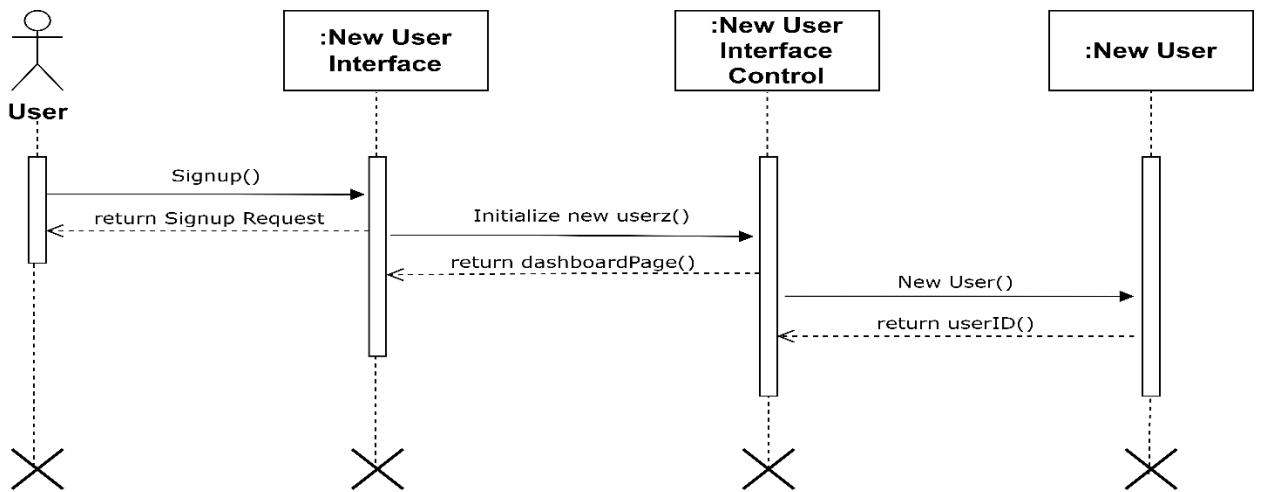


Figure 27: Sequence Diagram for Registration

5.6 Communication diagram

5.6.1 Communication Diagram for Find Nearby Trash Can

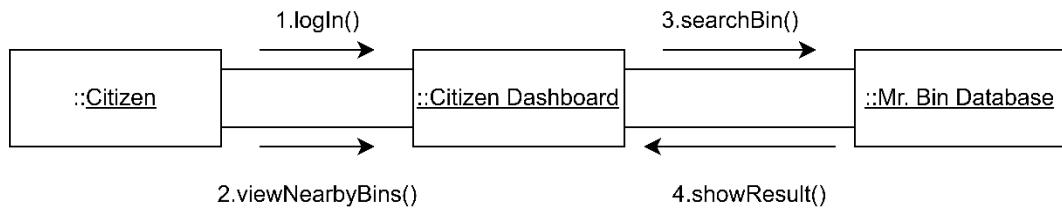


Figure 28: Communication Diagram for Find Nearby Trash Can

5.6.2 Communication Diagram of Registration

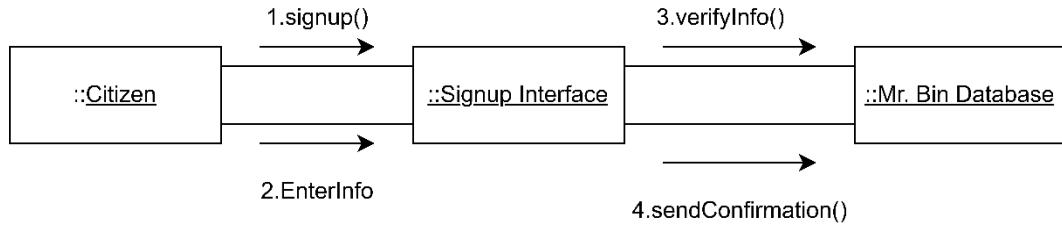


Figure 29 : Communication Diagram of Registration

5.7 Class diagram

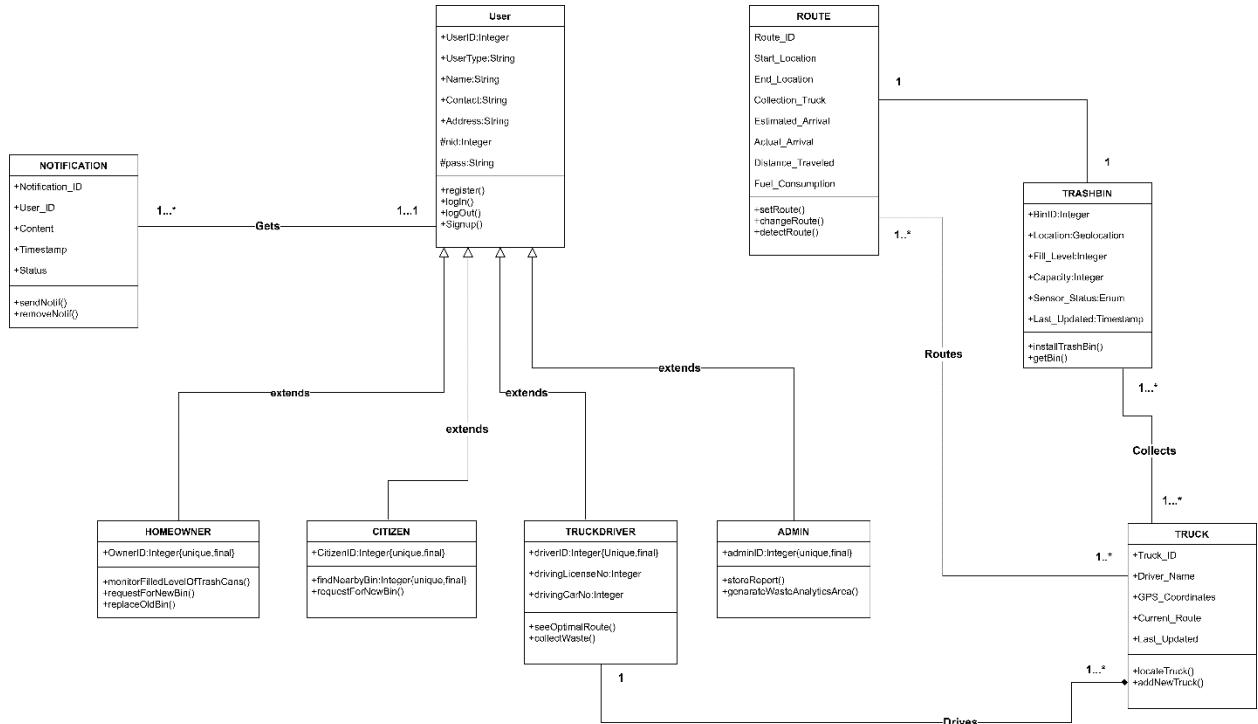


Figure 30: Class Diagram

5.8 State Chart diagram

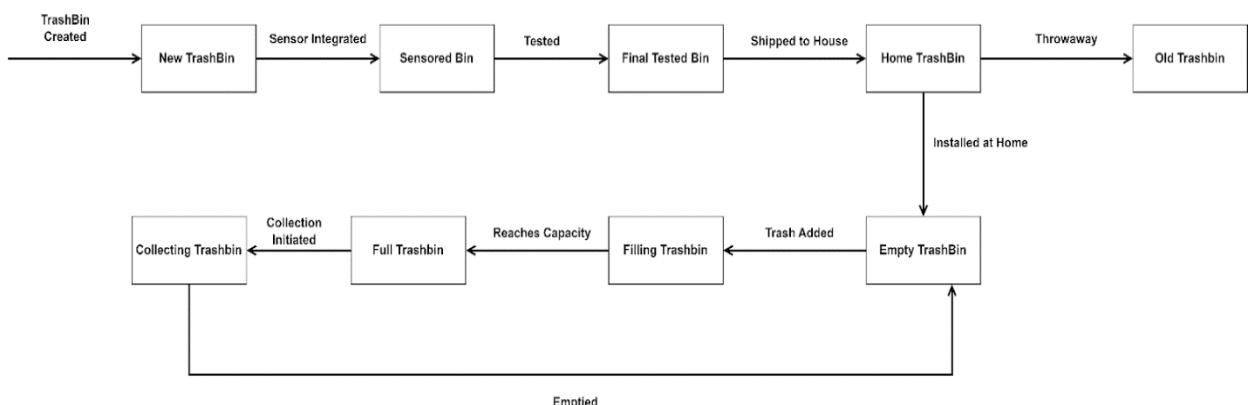


Figure 31: State Chart Diagram of Class Bin Object

5.9 CRUD Matrix

Activity	Citizen	Owner	Driver	Admin	Trash Bin	Analytical Data	Notification
Register	C	C	C	R		C	C
Login	R	R	R				C
Search Trash bin	R	R	R	R	U	R	
Report Activity	C	C	C	R		U	
Check Collection route			R	CU		U	
Request for New bin	C	C	C	RU	U	U	C
Advertising				CRUD			U
Collect Trash			C		D	U	U
Reporting and Analytics	C	C	C	CRUD		CRUD	C
See Waste Collection Route			RU	CRUD		CRUD	C

Section 6

6.1 Structure English Pseudo code for the system

6.1.1 Searching Nearby Bin Locations:

```
GET BinLocationRequest  
GET UserLocation  
  
IF UserLocation found  
    GET GPS Coordinates FROM User Location  
ENDIF  
DO WHILE there are nearby bin locations to search for  
    IF BIN Coordinates is near to GPS Coordinates  
        GET GPS Coordinates of nearby bin locations  
        MOVE GPS Coordinates to Bin Location Info data store  
    ENDIF  
ENDDO  
  
GET GPS Coordinates of nearby bins  
DO format GPS Coordinates as Map Locations  
DISPLAY Map Locations
```

6.1.2 Requesting for Bin Installation:

```
GET Bin Installation Request form  
DO GET Request Information from Bin Installation Request form  
DO format Request Information to Area, Road, and GPS Coordinate  
MOVE Request Information to Bin Installation Request Database  
  
DO WHILE Request Information there are request for Bin Installation  
    IF Area and Road data is valid  
        GET GPS Coordinate of proposd bin location  
        DO compare GPS Coordinate with data from Google Maps  
        IF GPS Coordinate is valid data  
            DO format GPS Coordinate to Bin Location  
        ENDIF  
        Update Bin Location Info Database  
        MOVE Bin Location to New Bin Location Info Database  
    ENDIF
```

Update Bin Installation Request Database
ENDDO

DO Create Succesful Bin Installation Notification
DISPLAY Succesful Bin Installation Notification

6.1.3 Generating Area Based Waste Analytics:

GET Waste Analytics Monetization Report Request

GET GPS Coordinates of the Area for which Analytics Report is desired

DO WHILE there are Bins available in the Area

 GET Bins RFID

 DO GET GPS Coordinates of Bins from Bins RFID

 GET Users Credential to Access Bin Data

 IF Credential Data is found

 GET Bin Wastage Information

 ENDIF

 DO Create Waste Analytics Monetization Report

 MOVE Waste Analytics Monetization Report to Analytics Report Data store

ENDDO

GET Waste Analytics Monetization Report from Analytics Report Data store

DISPLAY Waste Analytics Monetization Report

6.1.4 Monitoring Filled Level of Trash Can:

GET Bin Filled Level Data Request

GET Current Status of the Bin Fill Level from Bin Updates Data store

DISPLAY Current Status of the Bin Fill Level

6.1.5 Report Illegal Dumping:

GET Illegal Dumping Report from citizen

GET Location of Illegal Dumping from Illegal Dumping Report

MOVE Illegal Dumping Report to Illegal Dumping Report Data Store

DO Notify Waste Collector about the Illegal Dumping and its Location

6.1.6 Finding Optimal Route for Trash Collection:

GET Route Selection Request from Waste Collector
GET GPS Coordinates and Current Location of Waste Collector
GET GPS Coordinates of Bins nearby from Bin Info data store

DO WHILE GPS Coordinates of Bins nearby are available
 DO SORT nearby bin Coordinates from nearest to farthest from Waste Collector
ENDDO

DO Create SHORTEST PATH from Waste Collector to every nearby Bin
DISPLAY the SHORTEST PATH from Waste Collector to nearby Bins

6.1.7 Log In/Sign Up:

GET User Credentials from User

DO WHILE Credentials are available in User Info Data store
 IF Credentials is equal to User Credentials
 VERIFY User Credentials
 DO Allow User Log in to the System
 ENDIF
 ELSE IF Either Name or Password does not match
 DISPLAY Wrong User Credentials Message
 ELSE
 PROMPT User to Sign In with Valid Credentials
 GET User Input
 Create New Credentials
 Update User Info Data store
 ENDIF
ENDDO

6.2 Prototype of User Interface

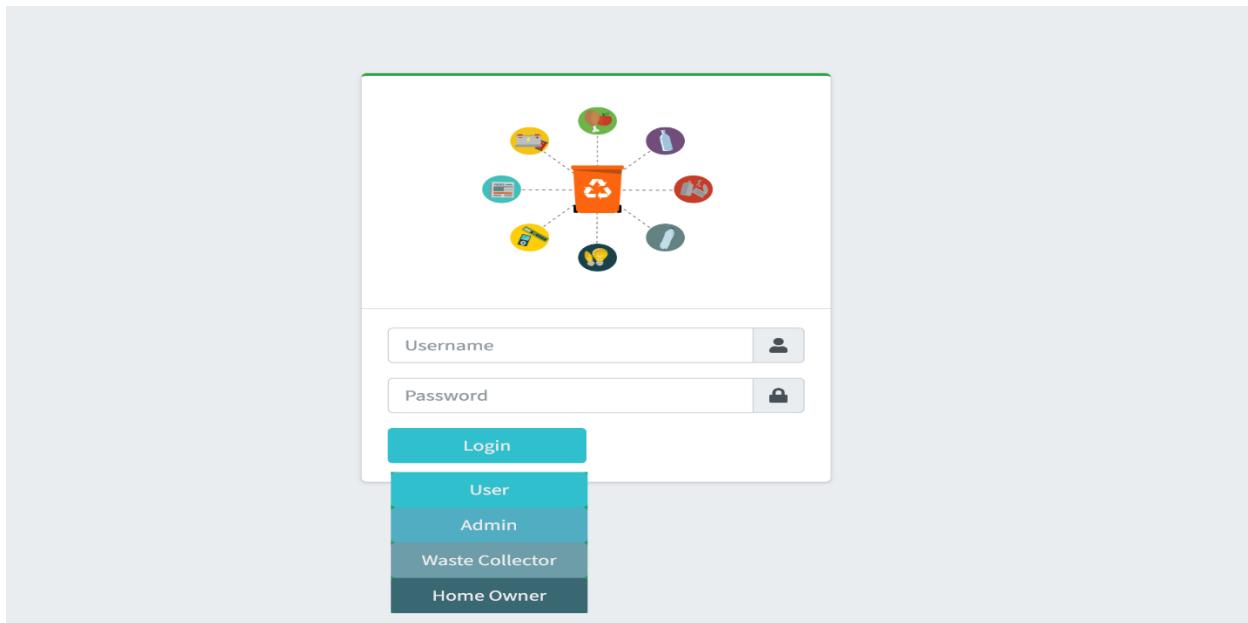


Figure 32: MR. BIN Log in Page

The image shows the Admin Waste Price Dashboard. The header features a navigation bar with a user profile icon, a search bar, and links for 'Home' and 'Collection Records'. On the left is a sidebar with icons for 'Dashboard', 'Recycling Center', and 'Collect Waste'. The main content area has a title 'Waste Price' with a 'Upload Items' button. Below is a table showing collection records. The table has columns: Garbage Type, Quantity, Total Amount, Date, Upload of scan Garbage, Status, and Action. The data is as follows:

Figure 33: Admin Waste Price Dashboard

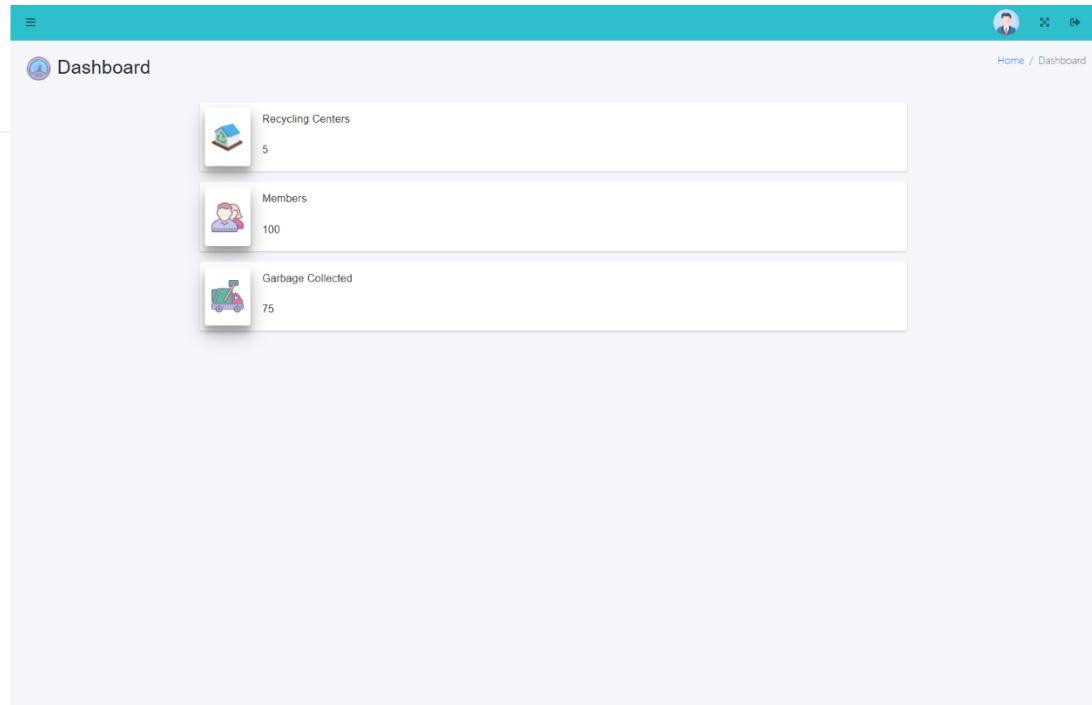


Figure 34: Admin Dashboard

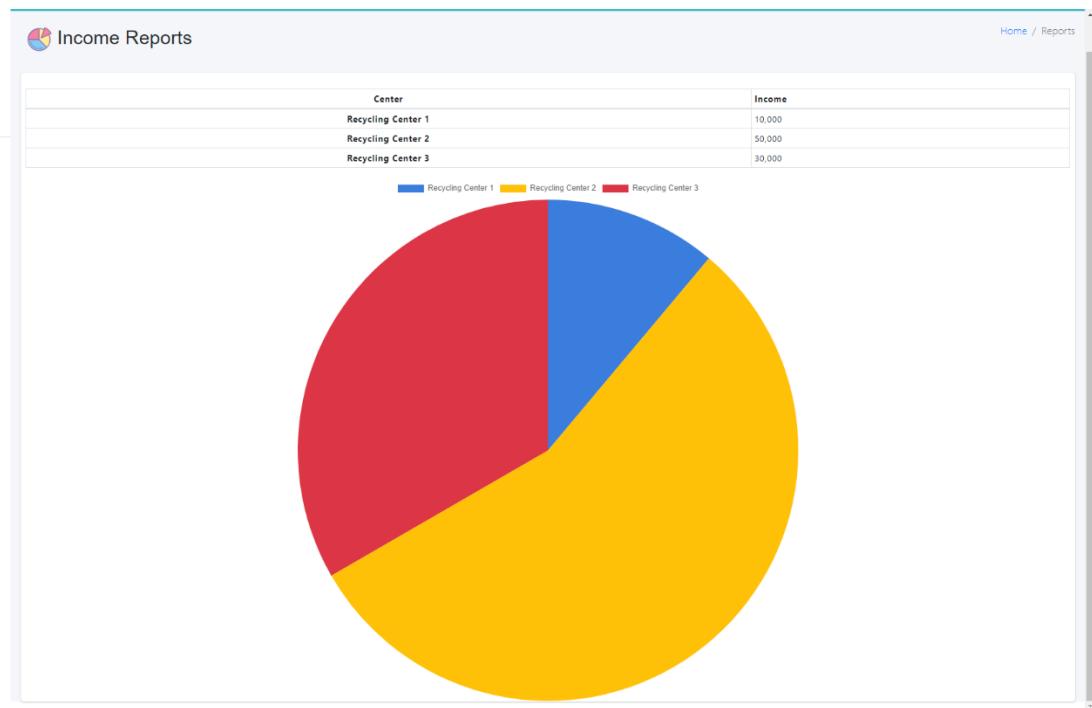


Figure 35: Admin Dashboard Income Report

The screenshot shows the Admin Dashboard for User Profile. On the left is a sidebar with icons for Dashboard, Recycling Center, Garbage Type, Members, Collection Record, and Reports. The main area is titled 'Members' and displays a table with columns: Profile, Full Name, Contact, Email, Address, Account, and Action. Two entries are listed: Ezaz Ahmed and Sourav. A modal window titled 'Member Information' is open over the table, containing fields for 'Account Status' (set to 'Active') and buttons for 'Close' and 'Save'. The top right of the page shows 'Home / Members'.

Figure 36: Admin Dashboard for User Profile

The screenshot shows the Admin Add Junkshop Page. The sidebar includes icons for Dashboard, Recycling Center, Garbage Type, Members, Collection Record, and Reports. The main area is titled 'Recycling Center' and shows a table with columns: Junkshop Name, Address, Email, and Action. Three entries are listed: BD Recycle, Gulshan 1 Dustbin, and R.K DIGITAL VANGARIWALA. A modal window titled 'Junkshop Information' is open, containing fields for 'Junkshop Name', 'Address', 'Contact', and 'Email', along with 'Cancel' and 'Save' buttons. The top right of the page shows 'Home / Recycling Center'.

Figure 37: Admin Add Junkshop Page

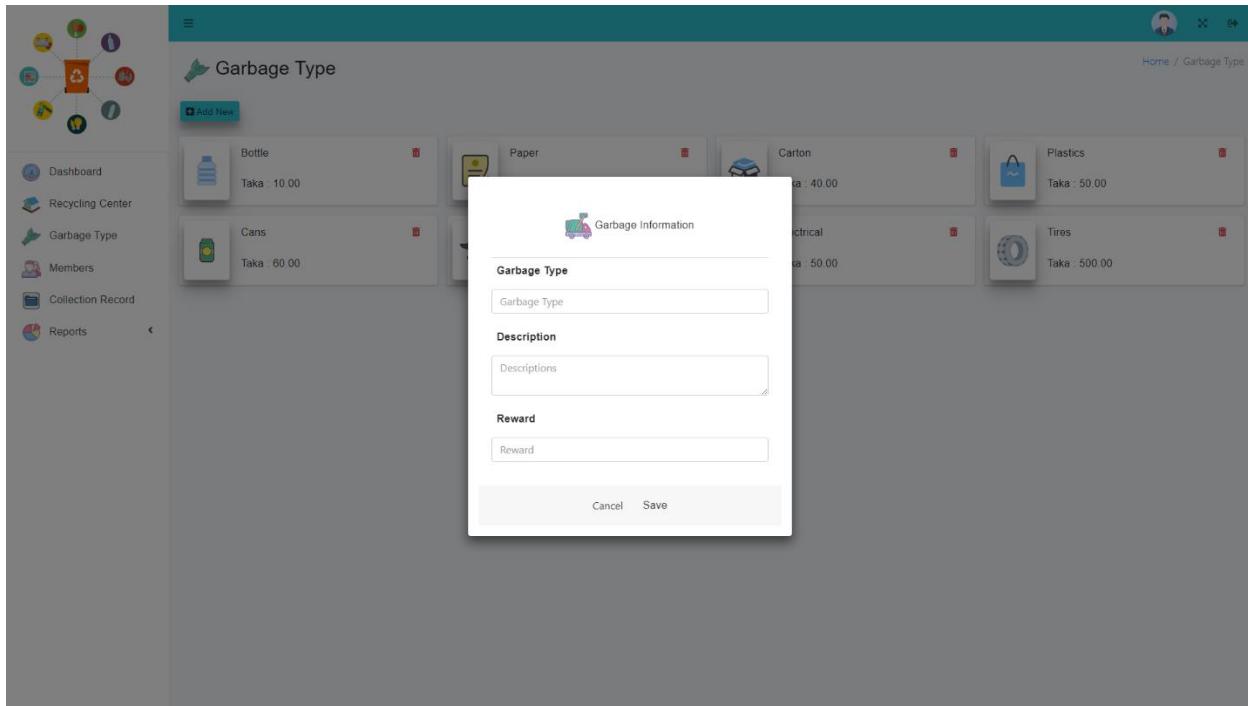


Figure 38: Admin Add Garbage Type

Recycling Center					
Add New					
Show 10 entries Search: <input type="text"/>					
Junkshop Name	Address	Contact	Email	Action	
BD Recycle	Pakuriya, Khantek, Behind Tara Moshjid, Sector 14, Uttara	01998765456	Mosh@gmail.com	View Edit Delete	
Gulshan-1 Dustbin	H#15, R#15, Block#A, Nishat Nagar	01998765456	gulshan@gmail.com	View Edit Delete	
R.K DIGITAL VANGARIWALA	1229 Kha Para Road	01998765456	RK@gmail.com	View Edit Delete	

Figure 39: Admin Add Recycling Center Page

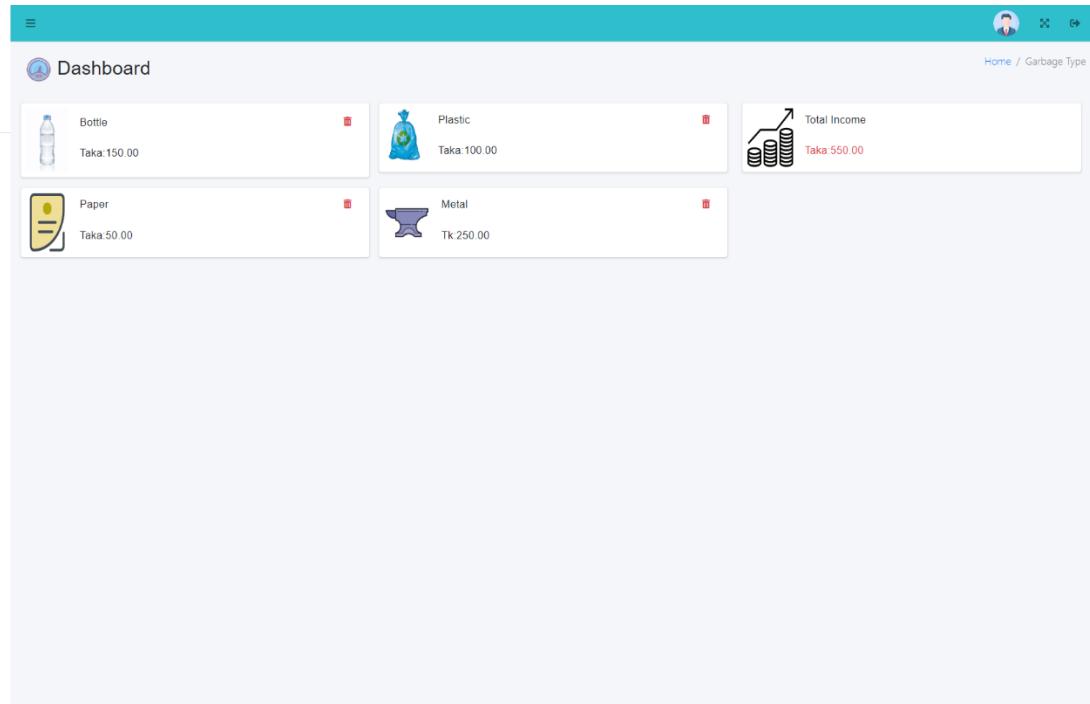


Figure 40: User Dashboard Product Price



Figure 41: Admin Garbage Type Report

The screenshot shows a user interface for managing waste collection. On the left, there's a sidebar with icons for Dashboard, Recycling Center, and Collect Waste. The main area has a title 'Collect Waste' with a trash icon. It displays a table of 5 entries:

House	Address	Contact	Email	Bin Level	Action
Afsar Monjil	Block A, 20 Road No. 22	01812345789	Af@gmail.com	<div style="width: 80%;">80%</div>	<button>View location</button>
Ahmed Villa	Begum Rokeya Ave, Dhaka 1216	01711-024119	Ahmed@gmail.com	<div style="width: 75%;">75%</div>	<button>View location</button>
Bissash Builders	House No 69, Block Z, Road No 25	01812345444	Bissash@gmail.com	<div style="width: 90%;">90%</div>	<button>View location</button>
Rose mansion	House No, Block k, 25 Road No. 20	01812345876	Ro@gmail.com	<div style="width: 60%;">60%</div>	<button>View location</button>
Wazed Noor Garden	House # 4, 90 Rd 90, Dhaka, Bangladesh	01715661234	W@gmail.com	<div style="width: 50%;">50%</div>	<button>View location</button>

At the bottom, it says 'Showing 1 to 5 of 5 entries' and has navigation buttons for 'Previous', '1', and 'Next'.

Figure 42: User Bin Full Level

The screenshot shows a user interface for managing collection records. On the left, there's a sidebar with icons for Dashboard, Recycling Center, and Collection Record. The main area has a title 'Collection Records' with a camera icon. It displays a table of 4 entries:

Garbage Type	Quantity	Total Amount	Date	Upload of scan Garbage	Status	Action
Bottle	12	24.00	08-15-2023		accepted	<button>Update</button> <button>Delete</button>
Electrical Waste	10	100.00	08-15-2023		accepted	<button>Update</button> <button>Delete</button>
Medical waste	5	250.00	08-15-2023		accepted	<button>Update</button> <button>Delete</button>
Metal	10	50.00	08-15-2023		rejected	<button>Update</button> <button>Delete</button>

Figure 43: User Collection Record Dashboard

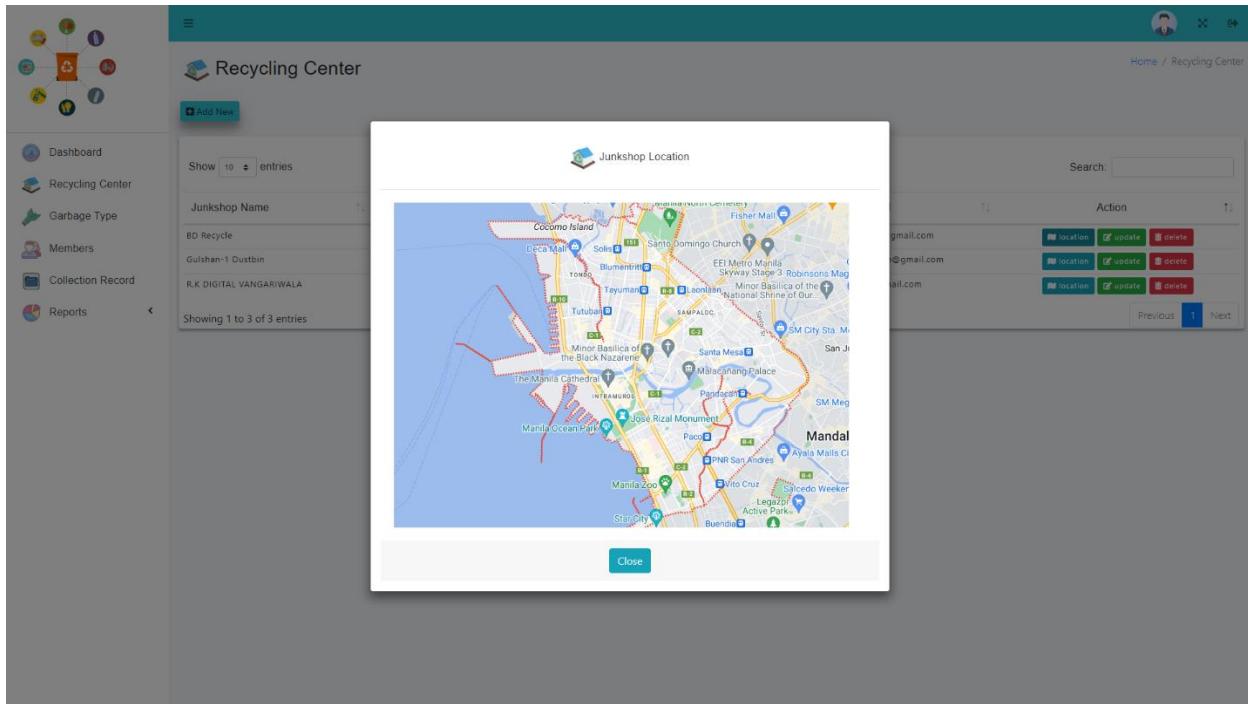


Figure 44: User Nearby Bin Location

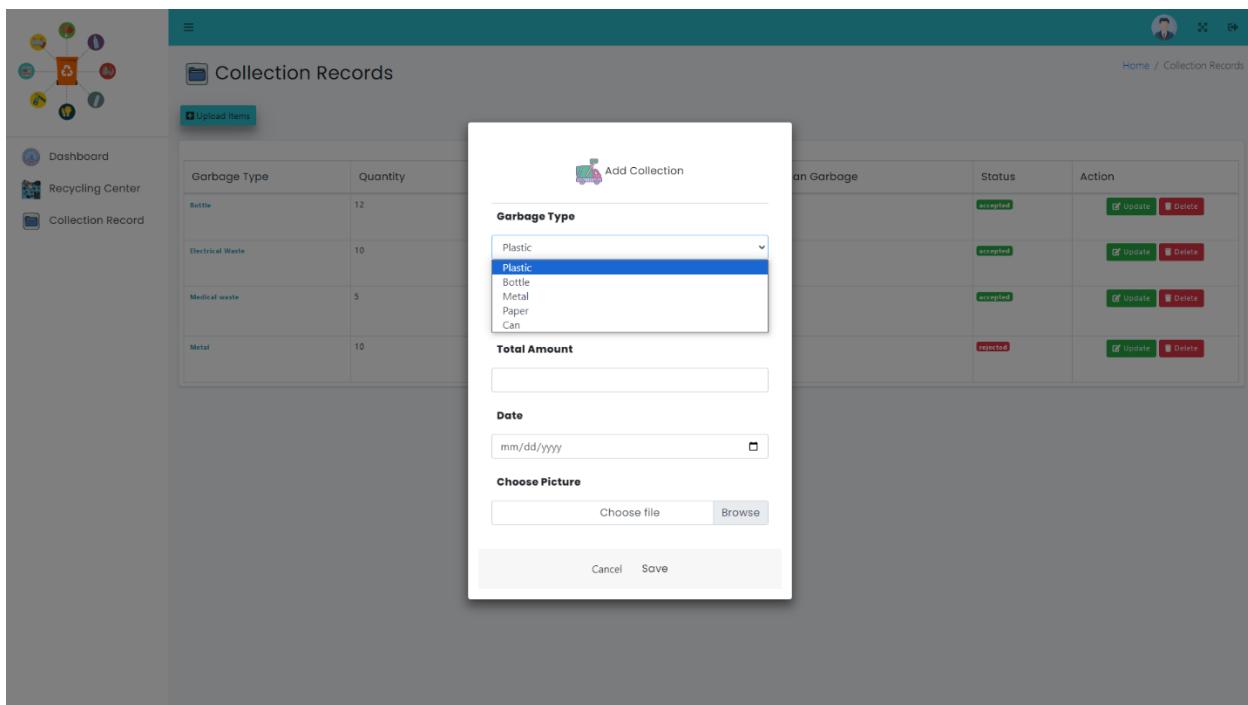


Figure 45: User Recyclable goods Amount Input Page