PROJECT REPORT

Team ID	**PNT2022TMID28057**
Project Name	**Smart waste management systemfor metropolitan cities**

INTRODUCTION

1.1 Project Overview

Our waste generation is constantly growing to form a global garbage crisis. Even though we indulge in creating a more sustainable and greener, we still fail to handle our waste generation and management. Combining technology support with a vision of social, economic and environmental sustainability is the best way out of this problem. It is done in the following manner. The smart bin system undergoes a thorough system check and battery level monitoring in order to function efficiently. If the battery level is found to be low, it has to be recharged immediately, else it can proceed to the next step. The threshold level of the bin is indicated my multiple sensors attached to bin. If the garbage exceeds the level, then an alter messageis sent to the garbage collectors as well as to the municipality or area administration. The area in which garbage is found to overflow is

allocated to respective garbage collectors inthe form of messages through GSM system. Once the waste bin is emptied, an informationupdate is sent to the municipality and server updated. This is how the waste from bins can be efficiently handled and managed using technology which in turn keeps the environment clean and healthy.

1.2 Purpose

We amalgamate technology along with waste management in order to effectively create a safe and a hygienic environment. Smart waste management is about usingtechnology and data to create a more efficient waste industry. Based on IoT (Internet of Things) technology, smart waste management aims to optimize resource allocation, reduce running costs, and increase the sustainability of waste services. This makes it possible to plan more efficient routes for the trash collectors who empty the bins, but towers the chance of any bin being full for over a week. A good level of coordination exists between the garbage collectors and the information supplied via technology. This makes them well aware of the existing garbage level and instigate them whenever the bins teach the threshold

level. They are sent with alert messages so that they can collect the garbage on time without listening the surrounding area. The fill patterns of specific containers can be identified by historical data and managed accordingly in the long term.In addition to hardware solutions, mobile applications are used to overcome the challenges in the regular waste management system, such as keeping track of the drives while they are operating on the field. Thus, smart waste management provides us with the most optimal way.

2 LITERATURE SURVEY

2.1 Existing Problem

Waste management has become an alarming challenge in local towns and cities across the word. Often the local area bins are overflowing and the municipalities are notaware of it. This affects the residents of that particular area in numerous ways starting from bad odour to unhygienic and unsafe surroundings. Poor waste management - ranging from non-existing collection systems to ineffective disposal - causes air pollution, water and soil contamination. Open and unsanitary areas contribute to contamination of drinking water and can cause infection and transmit diseases. Toxic components such as Persistent Organic Pollutants (POPs) pose particularly significant risks to human health and the environment as they accumulate through the food chain. Animals eating contaminated plants have higher doses of contaminants than if they were directly exposed. Precipitation or surface water seeping through waste will absorb hazardous components from landfills, agricultural areas, feedlots, etc. and carry them into surface and groundwater. Contaminated groundwater also poses a great health risk, as it is often used for drinking, bathing and recreation, as well as in

agricultural and industrial activities. Landfills and waste transfer stations can attract various pests (insects, rodents, gulls, etc.) that look for food from waste. These pests can spread diseases through viruses and bacteria (i.e., salmonella and e-coli), which are a risk to human health.

2.2 References

PAPER 1:

AUTHOR NAME: Keerthana

betel.

PUBLICATION YEAR: 2017

DESCRIPTION:

Designed an internet of bins for trash management in India. When the garbage level reaches its peak, the smart TRASH management system, which uses sensor, microcontroller, and other modules, guarantees that thetrash cans are properly emptied. If the waste quantity exceeds one of the two thresholds established for the bins, an alarm message is delivered to the vehicle that picks up the garbage. People may continue to put garbage bags in the bins until they exceed the threshold limit thanks to the technology. IoT empty the bin, it waits for the van to acknowledge it, and if it doesn't, it sends the message again until it approaches the threshold limit, at which point the bin is locked. When the bin gets locked it displays the message "Overloaded". Then the dustbin will be monitored for a specific time and when not cleared within a certain time limit, then a message will be sent to the higher authority who can take appropriate action.

PAPER 2:

TITTLE: IoT based Smart garbage collection system

Author NAME: Rahul Kumar Borah, Sahana Shetty, Rahul Patidar, Anisha Ranawaka and Kiante Jain

PUBLICATION YEAR: 2018

DESCRIPTION:

To create an effective and dynamic waste management system, the smart trash container is crucial. One of the most significant challenges for municipal organisations across the world is managing waste from its inception to transfer. Due to the daily growth in garbage, dustbins placed across finished urban areas and placed in open areas are overflowing, creating unsanitary circumstances for the residents. To maintain a crucial barrier from such a situation, we have proposed a remote strong waste management prototype for smart urban groups. This prototype enables common associations to remotely monitor the status of trash cans, complete web server, and profitably maintain urban areas clean by increasing the cost and time required for it.

PAPER 3:

AUTHOR NAME: Fechlin F oleate, Yong Sheng Low and Wai LeongYew

PUBLICATION YEAR: 2015

DESCRIPTION:

A three-tier design is proposed for the smart bin system. Each Smart bin is equipped with an ultrasonic sensor that detects bin fullness andrecords readings and sensor statuses. The gateway nod, which is a pair ofevery sensor cluster, receives the sensor leading and transmits it. To thebackend server, it transmits the data. The back-end server's analytics module examines the information that the bin subsystem has gathered. The analytics module examines fullness leadings, compares against present criteria, and creates events when a threshold is exceeded. The workstation receives data from the bin sub-system, and a graphical user interface displays useful data to users.

2.3 Problem Statement Definition

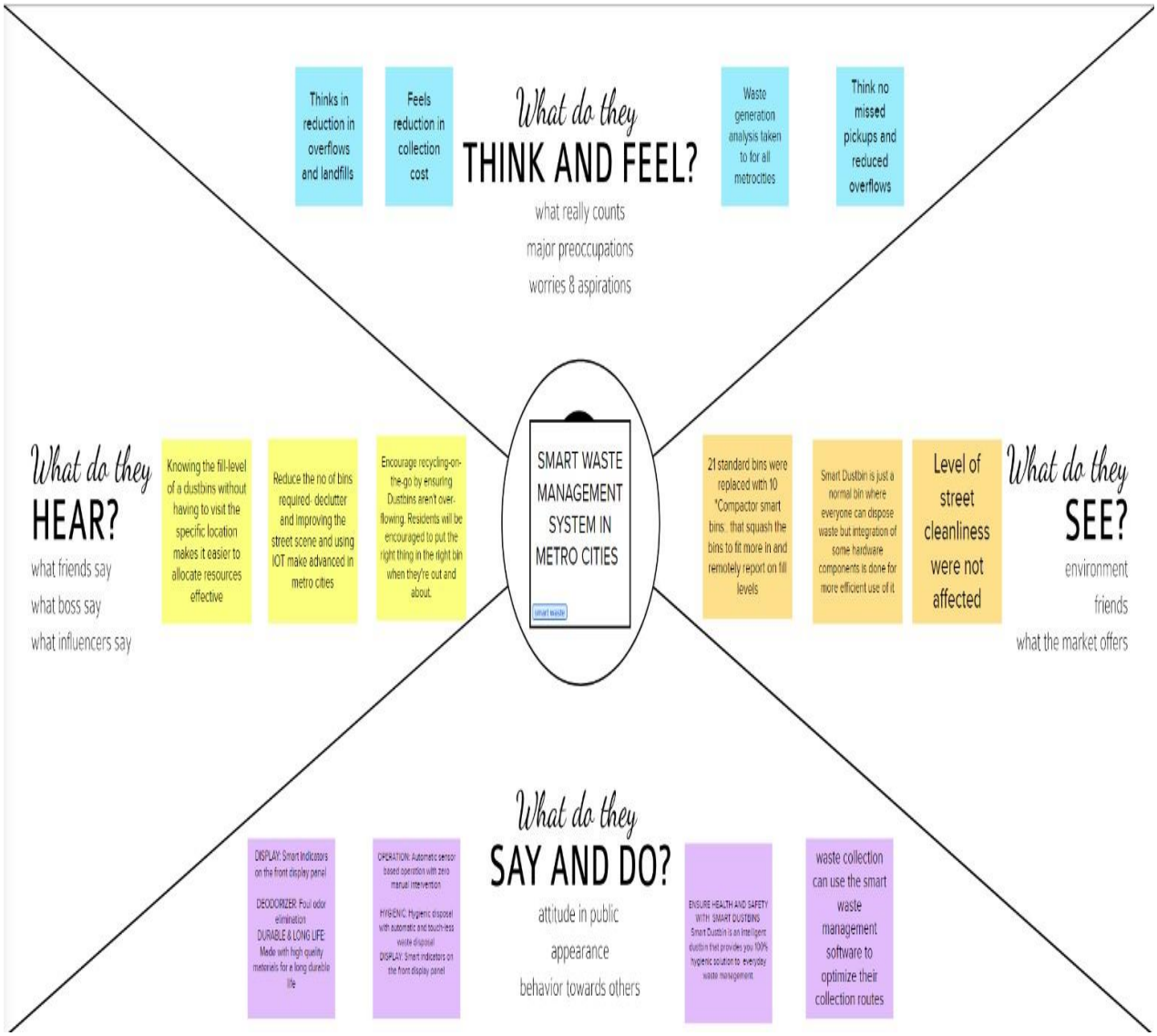
Problem Statement (PS)	**I am (Customer)**	**I'm trying to**	**But**	**Because**	**Which makesme feel**

PS-1	Municipal corporation authority	Get notified when the trash cans are full and be made aware of where the fullcans are located.	Don't have the facilitiesat the moment	There is no tool availableto determinethe level of bins.	Frustrated
PS-2	Individual working for a private Limited corporation	Get id of the example of asurplus of waste	The Trash cans are always filled	I occupy a metropolitan where there is a city is invariably crowd.	Worried

Solid

3 IDEATION & PROPOSED SOLUTION

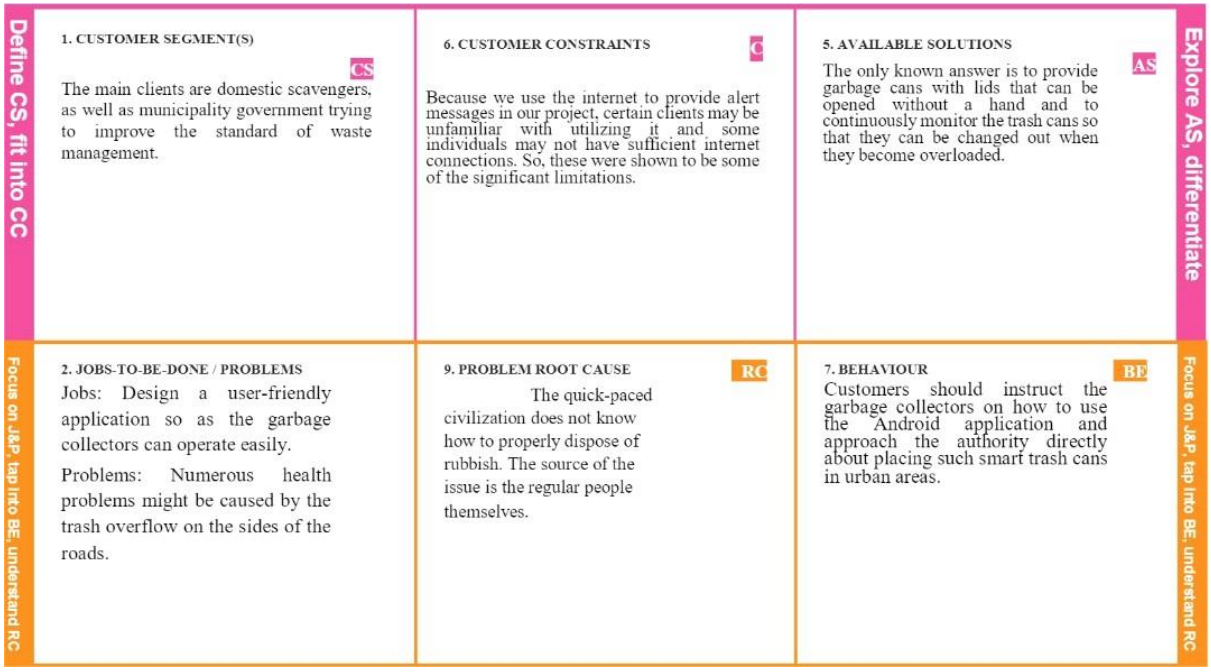
3.1 Empathy Map Canvas

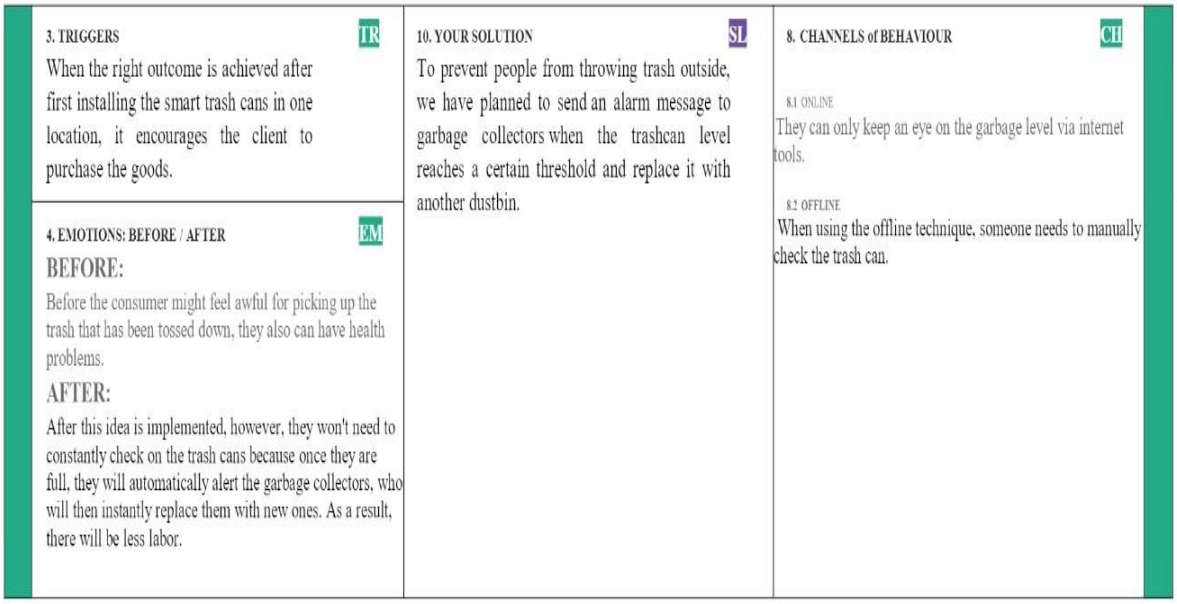


3.2 Proposed Solution

S.NO	Parameter	Description
1.	Problem Statement (Problem to besolved)	• The manual monitoring of wastes in trash cans is a labours operation that require additional time, money, and human labours • Unsafe trash disposal is generating problems for people. • Bad odour all around the place from uncollected trash or rubbish.
2.	Idea / Solution description	• This **Pro**cedure uses a cloudconnection and non-bio degradable wastes and an ultrasonic sensor to determine the level of a rubbish container • By developing an app, the company of a certain neighbourhood inside alarge metropolis will be able tocheck the trash cans to see if they are full or not.
3.	Novelty / Uniqueness	• In contrast to the traditional ways for collecting trash cans, this strategy instructs us to utilize the transportation only when necessary. • Keeping an eye on the trash Canarsie and less labour-intensive for humans.
4.	Social Impact / Customer Satisfaction	• People can experience aclean atmosphere. • Reduces the amount of labour required from humans for waste disposal. • For a municipal corporation to monitor the cleanliness of differentareas of the city, this proposal will be quite helpful.
5.	Business Model (Revenue Model)	• By cutting back on unneeded transportation costs to pointless locations, this lowers a significant amount offuel costs for city businesses. • This initiative intends to **assist municipal Corporation**. • Provide a sanitary atmosphere.

3.3 Problem Solution fit





4 REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional Requirements of the proposed solution.

ÏR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Real time bin monitoring.	The Dashboard shows statistics on the amount of fill in bins as it is being tracked by smart sensors. The application also forecasts when the bin will fill up based on past data in addition to the percentageof fill level, which is one of the features that even thefinest waste management software lacks. As picks are also Recognized by the sensors, you can determine when the bin was last emptied. You can get id of the over flowing bins and cease collecting half-empty ones using real-time data and forecasts.
FR-2	Eliminate inefficient picks.	Get id of the collection of half-empty trash cans. Picks are recognized by sensors. We can demonstrate to you how full the bins you collect areusing r eal-time data on fill-levels and pick recognition.
FR-3	Plan waste collection route.	Route planning for rubbish pickup is semi- automated using the tool. You are prepared to act and arrange for garbage collection based on the levels of bin fill that are now present and forecasts of approaching capacity. To find any discrepancies,compared the planned and actual paths.
FR-4	Adjust bin distribution.	Ensure the best possible bin distribution. Determine which regions have a dense or sparsedistribution of bins. Ensure that each form of waste has a representative stand. You can make any required adjustments to bin position or capacity based on past data.
FR-5	Expensive bins.	We assist you in locating containers that increase collection prices. The tool determines a collection cost rating for each bin. **T** he tool takes local average depo-bin discharge into account. The tool determines the distance from depo-bin dischargeand rates bins (1–10).
FR-6	Detailed bin inventoíy.	On the map, you can see every monitored bin andstand, and you can use Google Street View at any time to visit them. On the map, bins or standsappear as green, orange, or red circles. The Dashboard displays information about each bin, including its capacity, trash kind, most recent measurement, GPS position, and pick-up schedule.

4.2 Non-functional requirement

Following are the non-functional requirements of the proposed solution.

SR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Usability is a unique and significant perspective toexamine user needs, which may further enhance thedesign quality, according to IoT devices Analysing how well people interact with a product may help designers better understand customers' prospective demands for waste management, behaviour, and experience in the design process when user experiences is at the Centre.
NFR-2	**Security**	Utilize recyclable bottles. Utilizer usableshopping bags. Spend responsibly and recycle Eat and drink in limited-use containers.
NFR-3	**Reliability**	Creating improved working conditions for garbage collectors and drivers is another aspect of smart waste management. Waste collectors will use their time more effectively by attending to bins that require service rather than travelling the same collection routes and servicing empty bins.
NFR-4	**Performance**	The Smart Sensors assess the fill levels in bins (along with other data) numerous times each day using ultrasonic technology. The sensors feed data to Senone's Smart Waste Management Software System, a robust cloud-based platform with data- driven daily operations and a waste management app, using a variety of IoT networks (NB-IoT, GPRS). As a consequence, customers receive data-driven decision-making services, and garbage collection routes, frequency, and truck loads are optimized, resulting in at least a 30% decrease in route length.
NFR-5	**Availability**	By creating and implementing robust hardware and gorgeous software, we enable cities, companies,andnations to manage garbage more intelligently.
NFR-6	**Scalability**	Using smart trash bins allows us to scale up and monitor the rubbish more efficiently while also reducing the number of bins needed in towns and cities.

5 Project PLANNING & SCHEDULING

5.1 Sprint Planning &Estimation

PROJECT PLANNING

Milestone and Activities List

Date	21 Oct 2022

Team ID	**PNT2022TMID28057**
Project Name	Smart Waste Management System For Metropolitan Cities

Tittle	Description	Detail
Literature Survey & Information Gathering	Literature survey on the selected project & gathering information by referring the, technical papers, research publication etc.	28 SEPTEMBER 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem Statements.	24 SEPTEMBER 2022
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	25 SEPTEMBER 2022
Proposed Solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	23 SEPTEMBER 2022
Problem Solution Fit	Prepare problem - solution fit Document.	30 SEPTEMBER 2022
Solution Architecture	Prepare solution architecture Document.	28 SEPTEMBER 2022

Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).	20 OCTOBER 2022
Functional Requirements	Prepare the functional requirement	08 OCTOBER 2022

	document.	
Data Flow Diagrams	Draw the data flow diagrams and submit for review.	09 OCTOBER 2022
Technology Architecture	Prepare the technology architecture diagram.	10 OCTOBER 2022
Prepare Milestone & Activity List	Prepare the milestones & activity list of the project.	22 OCTOBER 2022
Project Development - Delivery of Sprint-1, 2, 3 & 4	Develop & submit the developed code by testing it.	19 NOVEMBER 2022

5.2 Sprint Delivery Schedule

Week-1 22-27 Aug 2022

Preparation Phase

Pre requisites, Registrations, Environment Set-up, etc.)

Week 2-4

29Aug-17rd Sept 2022

Ideation Phase

Literature Survey, Empathize, Defining Problem Statement, Ideation

Week 5-6

19Sept-01oct 2022

Project Design Phase-I

Week 7-8

03oct-15oct 2022

Proposed Solution, Problem Solution Fit, Solution Architecture

Week -9

17oct-22oct 2022

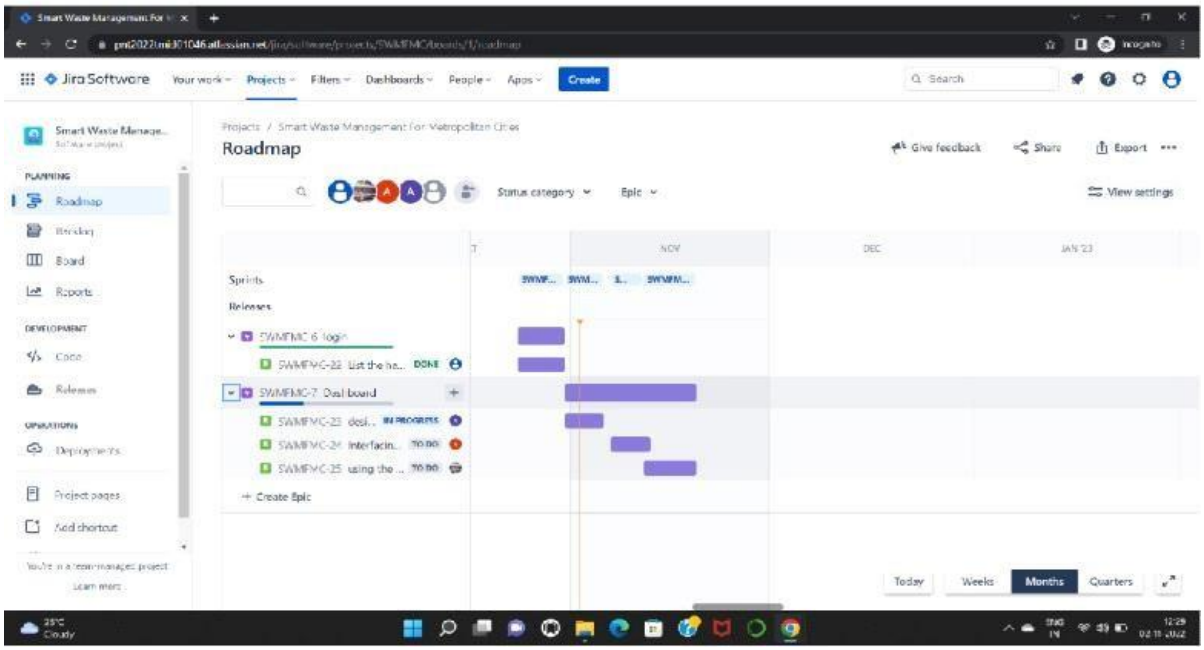
Project Design Phase-II

Requirement Analysis, Customer Journey, Data Flow Diagrams, Technology Architecture.

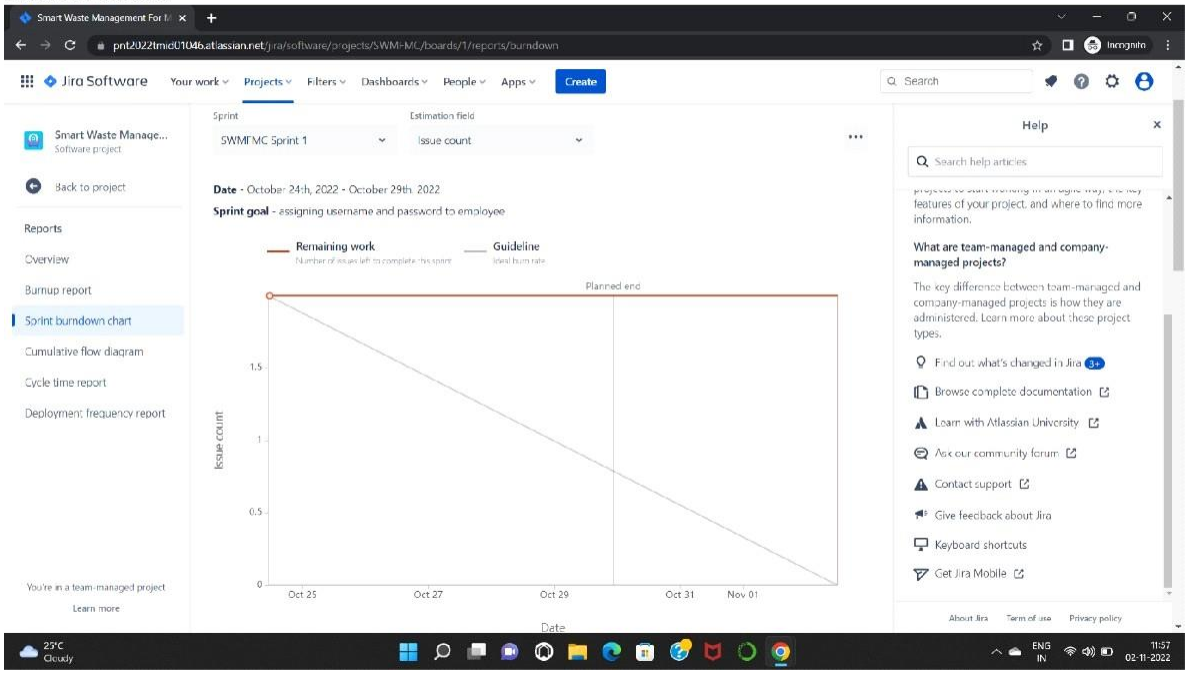
5.3 Report from JIRA

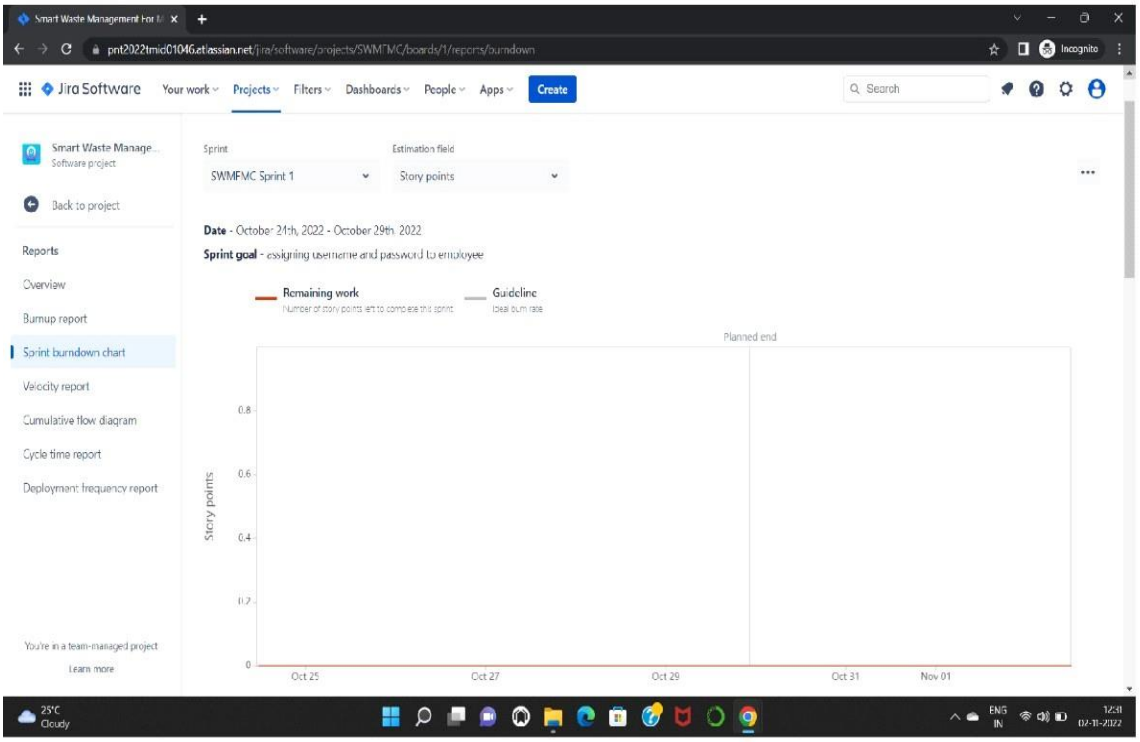
Jira Software Screenshots:

ROADMAP



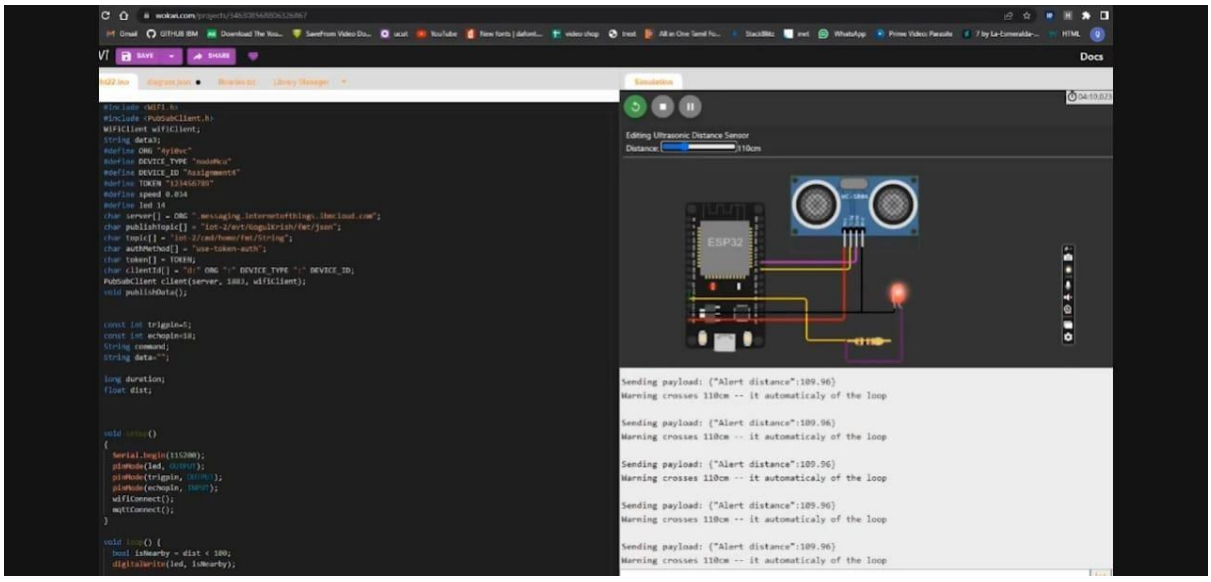
BURNOUT CHART:





6 CODING & SOLUTIONING

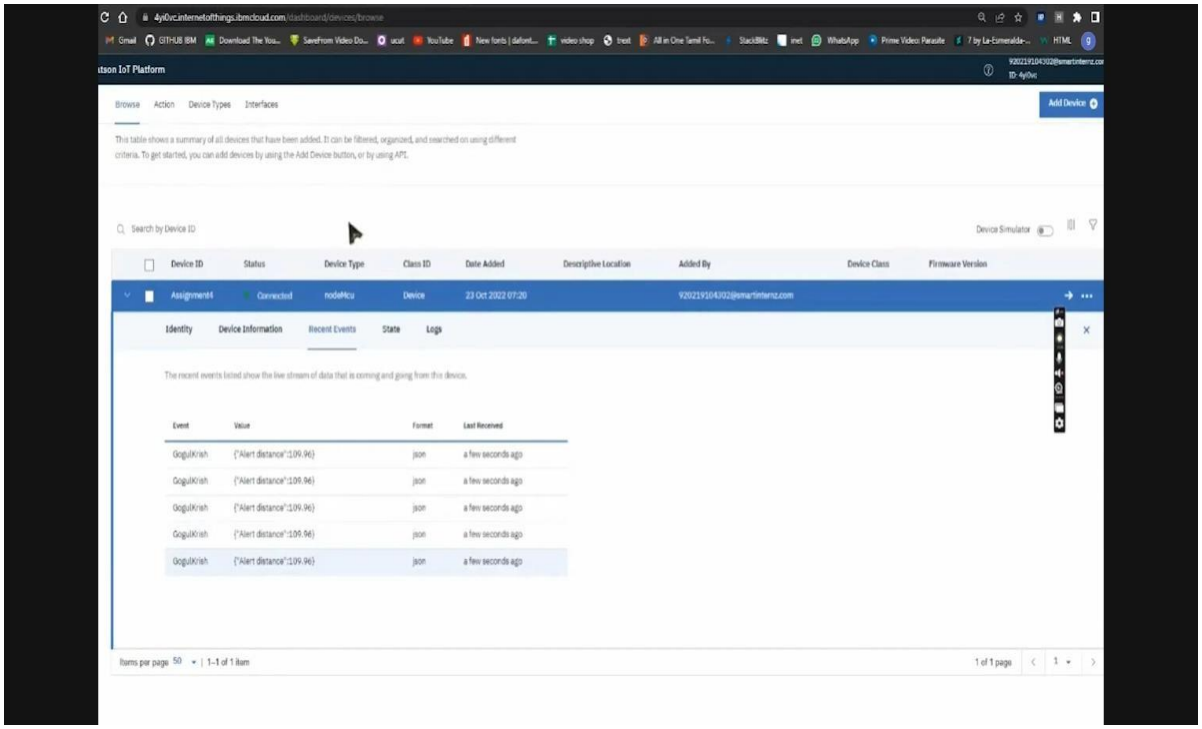
6.1 Feature 1



6.2 Feature 2

With ultrasonic sensor nodemcu with a constant of a to allot admin when it crosses 100 cm right and real-time CM values are also shown in IBM cloud and node
Pick up this was appointed to points3 points 16 over 100 cm each source normal in alert message on crossover 102 change show warning Vijay up to 110 CM 16 also cross 110 CM it hit the circuit will temporarily V to please state and the output is possible to IBM cloud and nodemcu interface is also my show in screen right now adjustable to transform this It's between hundred rate normal distance once it crosses hundred it will show some warning Right you got the screenPlay 16411 you can travel on cm It will certainly of the said to temporarily and the City the Ultrasonic waves below below the trouble on said it will again on and so the warning message toThanks for thanks for the time chairs

6.3 Database Schema



6.1.1 Project DESIGN

- **Data Flow Diagrams**

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows withina system. A neat and clear DFD can depict the light amount of the system requirement graphically.

It shows how data enters and leaves the system, what changes the information, and where data is stored.

A smaít waste management platform uses analytics to translate the data gather in your

bins into actionable insights to help you improve your waste services.

You can receive data on metric such as:

- The first test conducted is the situation where the garbage bin is empty or its garbage levels very low
- Then, the bin is filled with more garbage until its level has surpassed the first threshold

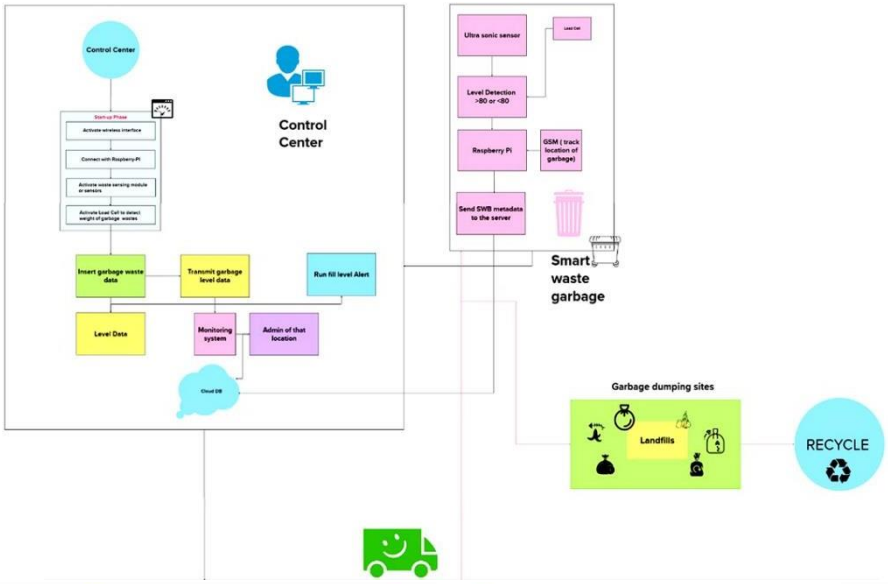
value, which is set to 80% then the first warning SMS is being sent, as depicted

- The first notification SMS sent by the system, once the waste reaches the level of 85% full
- The second notification SMS sent by the system, indicating that bin is at least 95% full and

the garbage needs to be collected immediately

- Locations prone to overflow
- The number of bins needed to avoid overflowing waste
- The number of collection services that could be saved
- The amount of fuel that could be saved
- The Driving distance that could be save.

6.1.2 Dataflow Diagram



Smart waste management system

Team ID : PNT2022TMID39665

STEP 1

Problem Solving Cards

-Basic question

#Problem Statement

1. *What's most valuable to the customer?*
2. *What are we the best at?*
3. *Where are we looking to improve?*

STEP 2

Framing Statements

Smart waste management system framing

How can we use our Optimization skills to increase the customer's value of Saving Time in order to improve the waste management?

The greatest problem regarding waste management in developing countries begins at the very starting point of the process. Due to lack of proper systems for disposal and collections, wastes and garbage's end up in the roads and surrounding. According to a report from Google research, the amount of waste generation in 2010 was around 20,000 tons per day, and it is estimated that by 2025 the amount will be no less than around 47000 tons per day. With the existing methods of collecting and disposal it is near impossible to manage such amount of waste in the future as around 30% of waste end up on the roads and public places due to ineffective disposing and collecting methods. Not only that, there is even no systematic methodology for the collected garbage for treating and recycling thus most of them end up in land filling and river water, making the environment unhealthier. The prime impediment of implementing smart waste management system based on IoT in a developing country is the social and economic infrastructure of the country itself. The initial stage of this system comprises of proper disposal and collection, which is the biggest challenge. In addition, to motivate and influence people to follow proper waste disposal methods is also important.

STEP 3

Ideas

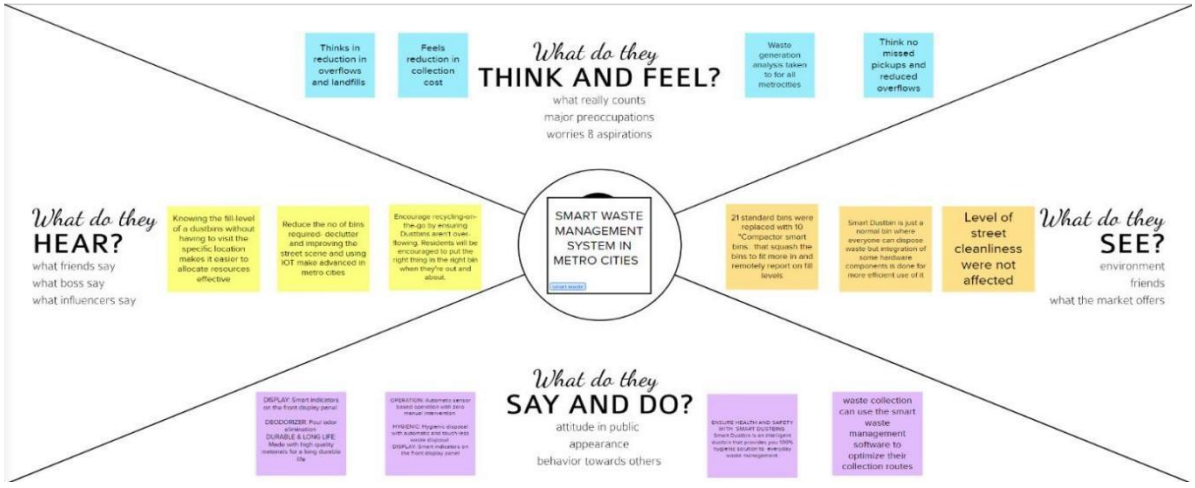
Problem Solution

Example ideas:

AI-based smart waste bin, designed for public places, enabling them to Monitor and Manage

Reduce the number of bins required & DE-cluttering and improving the street scene

Previously there were numerous initiatives on waste management and educating people to dispose waste properly, and as they failed to achieve significant results, we have figured out the scopes that could be develop. To solve this problem, we have designed a process that ensures proper disposal and efficient waste collection. The procedures we designed involves creative initiative that will inspire people to dump in designated area or bins, and innovative method by using Decreasing Time algorithm or DTA for monitoring garbage generation and collection of the garbage's.



7 Testing

7.1 Test Cases

Unit Testing

Unit testing involves the testing of each unit or an individual component of the software application. It is the first level of functional testing. The aim behind unit testing is to validate unit components with its performance.

A unit is a single testable part of a software system and tested during the development phase of the application software.

The purpose of unit testing is to test the correctness of isolated code. A unit component is an individual function or code of the application. White box testing approach used for unit testing and usually done by the developers.

Whenever the application is ready and given to the Test engineer, he/she will start checking every component of the module or module of the application independently or one by one, and this process is known as **Unit testing** or **components testing**.

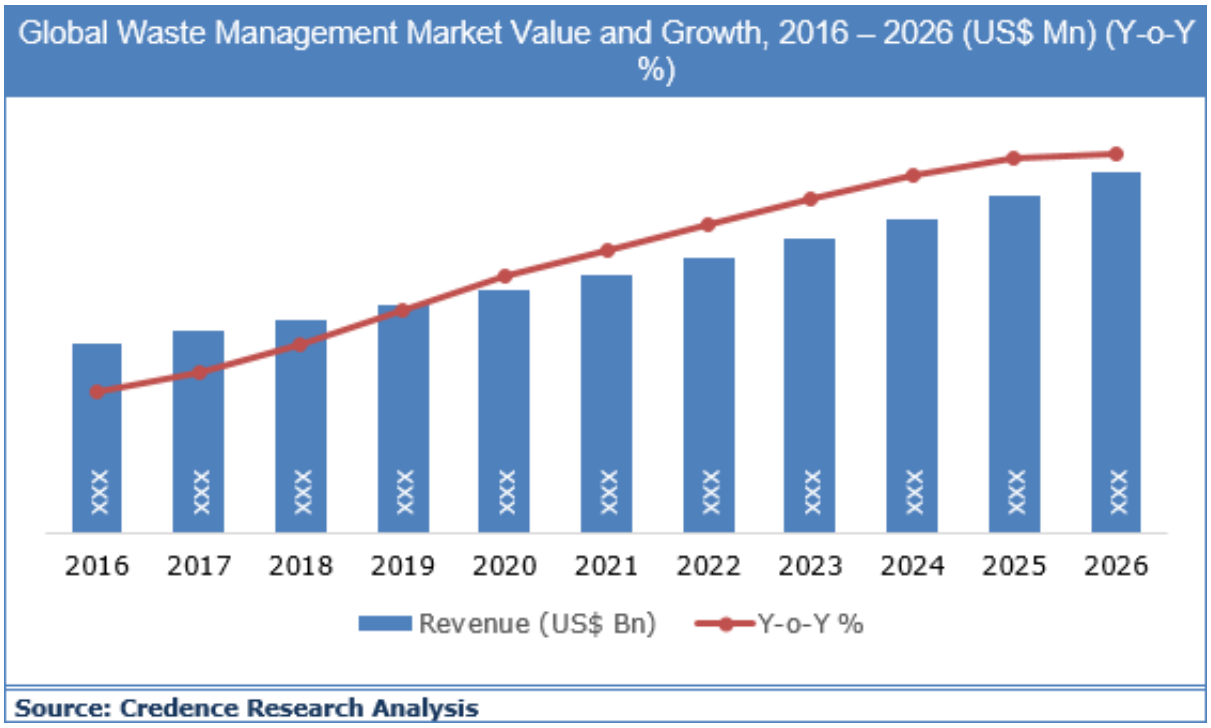
7.2 User Acceptance Testing

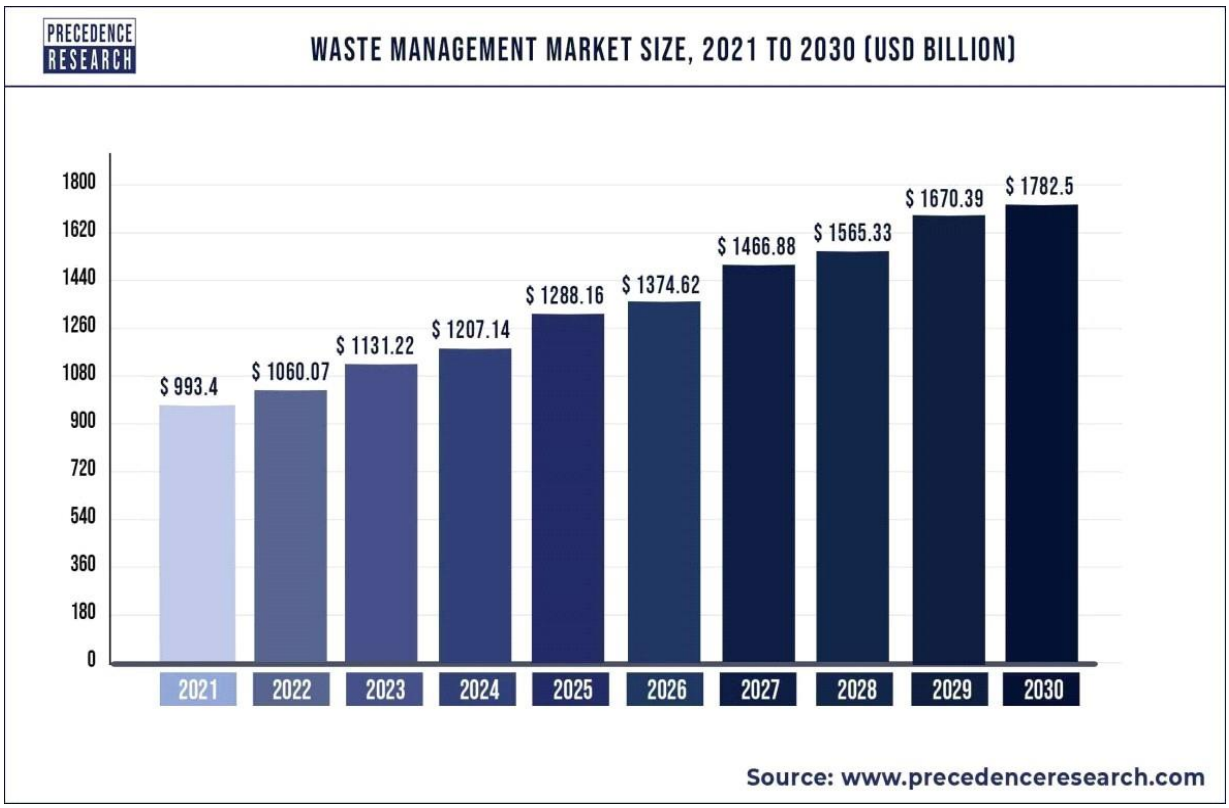
Table-1: Components & Technologies:

S.no	Component	Description	technology
1.	User Interface	Mobile Application	HTML, CSS, JavaScript.
2.	Application Logic	Logic for a process in the application	Java
3.	Database	Data Type, Configurations etc.	MySQL
4.	Cloud Database	Database Service on Cloud	IBM Cloud
5.	File Storage	File storage requirements	Local Filesystem and IBM cloud
6.	Infrastructure (Server / Cloud)	Application Deployment on Cloud Local Server Configuration	Local and Cloud Foundry

8 Results

8.1 Performance Metrics





9 ADVANTAGES & DISADVANTAGES

- **ADVANTAGES**
    - Reduction in Collection Cost
    - No Missed Pickups
    - Reduced Overflows
    - Waste Generation Analysis
    - CO2 Emission Reduction

DISADVANTAGES

- System requires a greater number of waste bins for separate waste collection as per population in the city.
- This results into high initial cost due to expensive smart dustbins compare to other methods.
- Sensor nodes used in the dustbins have limited memory size.

10 CONCLUTION

A Smart Waste Management system that is more effective than the one in use now is achievable by using sensors to monitor the filling of bins. Our conception of a "smart waste management system" focuses on monitoring waste management, offering intelligent technology for waste systems, eliminating human intervention, minimizing human time and effort, and producing a healthy and trash-free environment. The suggested approach can be implemented in smart cities where residents have busy schedules that provide little time for garbage management. If

desired, the bins might be put into place in a metropolis where a sizable container would be able to hold enough solid trash for a single unit. The police might be high.

11 FUTURE SCOPE

There are several future works and improvements for the proposed system, includingthe following:

- Change the system of user authentication and atomic lock of bins, which would aid inprotecting the bin from damage or theft.

- The concept of green points would encourage the involvement of residents or end users, making the idea successful and aiding in the achievement of collaborative waste management efforts, thus fulfilling the idea of Swachh Bharath.

- Having case study or data analytics on the type and times waste is collected on differentdays or seasons, making bin filling predictable and removing the reliance on electronic components, and fixing the coordinates.

- Improving the Server's and Android's graphical interfaces

12 APPENDIX

SOURCE CODE

```
<!DOCTYPE html>
<html>

<head>
  <link rel="stylesheet"
href="https://cdn.jsdelivr.net/npm/bootstrap@4.3.1/dist/css/bootstrap.min.css" integrity="sha384-ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T" crossorigin="anonymous">
    <meta charset="utf-8">
    <meta name="viewport" content="width=device-width">
    <title>Garbage Management System</title>
    <link rel="icon" type="image/x-icon"
href="/Images/DUMPSTER.png">
    <link href="style.css" rel="stylesheet" type="text/css" />
    <script
src="https://www.gstatic.com/firebasejs/8.10.1/firebase-app.js"></script>
    <script
src="https://www.gstatic.com/firebasejs/8.10.1/firebase-database.js"></script>
```

```
    <script>
        var firebaseConfig =
        {
            apiKey: "AIzaSyB9ysbnaWc3IyeCioh-
aJQT_UCMd5CBFeU",
            authDomain: "fir-test-923b4.firebaseapp.com",
            databaseURL: "https://fir-test-923b4-default-
rtdb.firebaseio.com",
            projectId: "fir-test-923b4",
            storageBucket: "fir-test-923b4.appspot.com",
            messagingSenderId: "943542145393",
            appId:
"1:943542145393:web:9b5ec7593e6a3cbd7966d0",
            measurementId: "G-BN7JNX1Q7B"
        };
        firebase.initializeApp(firebaseConfig)
    </script>
    <script defer src="database.js"></script>
</head>

<body style="background-color:#1F1B24;">
    <script src="map.js"></script>
```

```
            <div id="map_container">
                <h1 id="live_location_heading" >LIVE
LOCATION</h1>
                <div id="map"></div>
                <div id="alert_msg">ALERT MESSAGE!</div>
  </div>
    </div>
<center><a href="https://goo.gl/maps/G9XET5mzSw1ynHQ18"
 type="button" class="btn btn-dark">DUMPSTER</a></center>

    <script

    src="https://maps.googleapis.com/maps/api/js?key=AIzaSyB
BLyWj-
3FWtCbCXGW3ysEiI2fDfrv2v0Q&callback=myMap"></script></div>
</body>
</html>
```

Database code:

```
const cap_status = document.getElementById('cap_status');
const alert_msg = document.getElementById('alert_msg');

var ref = firebase.database().ref();
```

```
ref.on("value", function(snapshot)
 {
   snapshot.forEach(function (childSnapshot) {
      var value = childSnapshot.val();

                const alert_msg_val = value.alert;
                const cap_status_val = value.distance_status;



                alert_msg.innerHTML= `${alert_msg_val}`;
   });
 }, function (error) {
   console.log("Error: " + error.code);
 });
```

GIT-HUB LINK : https://github.com/IBM-EPBL/IBM-Project-27894-1660098021