

KONGUNADU COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

**HX 8001-PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY
AND ENTREPRENEURSHIP**

**SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN
CITIES USING IOT**

NALAIYA THIRAN PROJECT REPORT 2022

Submitted by,

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TEAM ID :PNT2022TMID13627

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1. INTRODUCTION

1.1 PROJECT OVERVIEW:

The term "Internet of Things" refers to items that are connected to the internet and occasionally allow users to operate these gadgets remotely. The Internet of Things (IoT) is a theory in which remote items connect to one another automatically across wired and wireless networks. To offer users cutting-edge intelligent services, IoT objects share information and communicate with one another. The IoT has piqued significant academic interest as a result of recent developments in mobile devices outfitted with various sensors and communication modules, as well as communication network technologies like Wi-Fi and LTE. Waste management has grown to be a big problem in academics, industry, and government as important IoT application domains as a result of the features and benefits of IoT services.

1.2. PURPOSE :

The term "Internet of Things" (IoT) refers to the existing global network of internet-connected gadgets that is constantly growing. Through real-time monitoring and administration of city processes, IoT is essential to improving smart city applications. Solid waste management is one of the main issues with smart city applications because it affects both the environment and society's health. The goal of solid waste management is to limit the amount of solid waste disposed of on land by recovering materials and energy from solid trash as shown. By 2050, it is anticipated that worldwide waste will reach 3.40 billion tonnes, more than tripling population increase during that time.

2. LITERATURE SURVEY

An inevitable consequence of development and industrial progress is generation of waste. Therefore, efficient waste management is a matter of international concern and countries have setup robust regulatory waste management regimes for balancing the objectives of development and environment sustainability. In India, the national

environment policy, 2006 while suggesting measures for collection of wastes and safe disposal of residues [7].

The metro cities and major economic hubs generate the maximum volume of waste, but a survey of 20 smaller cities selected to be developed as smart cities show that most are struggling to manage waste. So, there should be an improvement in the waste management techniques.

2.1 EXISTING PROBLEM :

| TITLE | AUTHOR & YEAR | JOURNAL NAME | REMARKS |
|---|----------------------------------|-------------------------|---|
| Smart Waste Management System Using IOT | S.A.Mahajan & 2017 | | This project shows how the smart waste management system using IOT can be implemented. This proposed system assures the collection of garbage level reaches its maximum level. Thus, dustbins will be cleared as and when filled, giving way to cleaner city. |
| Smart Waste Management System Using IOT | Tejashree Kadus & 2020 | | Improper disposal and improper maintenance of domestic waste create issues in public health and environment pollution thus this paper attempts to provide practical solution towards managing the waste collaborating using IOT. |

4

| | | | |
|--|-----------------------------------|--|---|
| Garbage Managing System Using IOT | Asha and Balamurugan & 2019 | | This model creates awareness about how hygiene of our surrounding garbage cans is important. It also helps in segregating dry and wet waste & also helps in checking the toxicity level of the waste further simplifying the municipality work of collecting garbage. |
| Automation of Smart Waste Management Using IOT | Madhuri Mohare & 2019 | | Here using a one variable voltage source & set -250v as a threshold value By varying voltage below threshold value we got output on virtual terminal that is dustbin is not full. |

5

| | | | |
|--|--------------------------------------|--|---|
| IOT Adoption barriers of smart cities waste management | Manu Sharma & 2020 | | Waste management of smart cities is considered to be the most important issue in developing countries over the past decades. A review of existing literature revealed fifteen IOT of smart cities waste management. |
| IOT Technologies Based Smart Waste Collection | Brucu Oralhan and Yavuz Yigit & 2016 | | Our presented smart waste management system can be improved by using some other knowledge such as a garbage container area population, using future garbage container fill level estimation. |

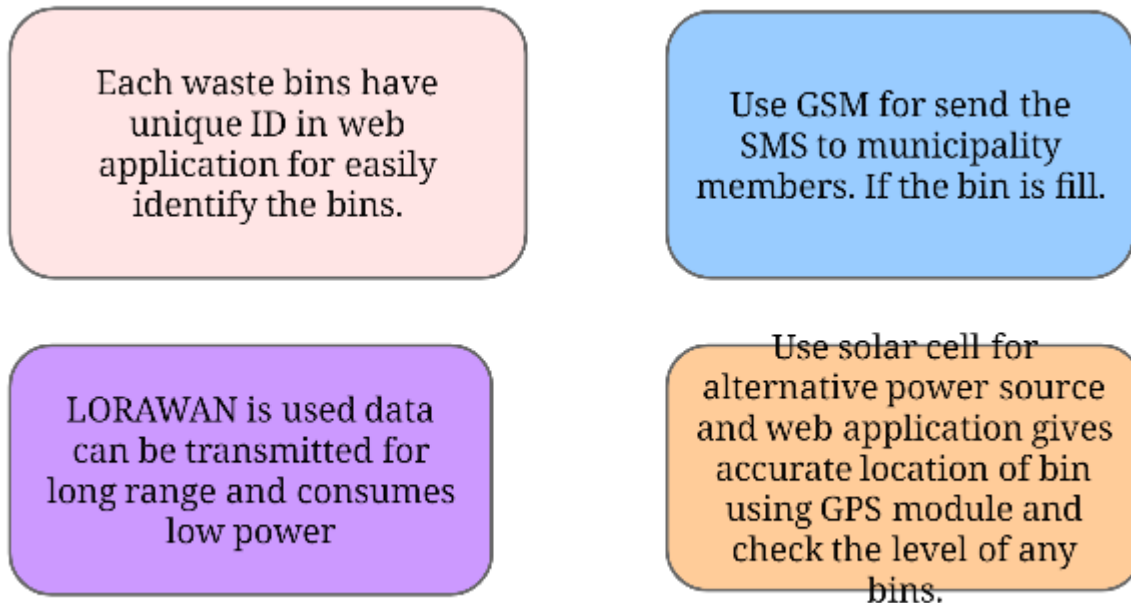
6

2.2 REFERENCES :

1. Tarandeep Singh , Rita Mahajan , Deepak Bagai, “Smart Waste Management using Wireless Sensor Network”, in IJRCCE Volume 4 , Issue 6 , June 2016.
2. Narayan Sharma, “Smart Bin Implemented for Smart City”, International Journal of Scientific & Engineering Research, Volume 6, Issue 9, September-2015
3. Issac, R;Akshai,M. “An effective solid waste management system for Thiruvalla Municipality in Android OS” IEEE Conference Publications , 2013.
- 4.Longhi,S ; Marzioni,D ; Alidori, E ; Di Buo,G.; Pris,M. ; Grisostomi, M. ; Pirro,M. “Solid Waste Management Architecture Using Wireless Sensor Network Technology”, New Technology, Mobility and Security (NTMS), 2012 5th International Conference.
- 5.MANGESH, N., SWAPNIL, K., AVINASH, P. & AVINASH,G. 2017. Iot Based Waste Management for Smart City. International Journal of Advance Research, Ideas and Innovations in Technology, 3, 247-250.
- 6.BANDAL, A., MANKAR, R., NATE, P., POWAR, R. & S.A.J ADHAV, P. 2017.
7. Smart Wi-Fi Dustbin System. International Journal of Advance Engineering and Research Development, 4, 336-339.

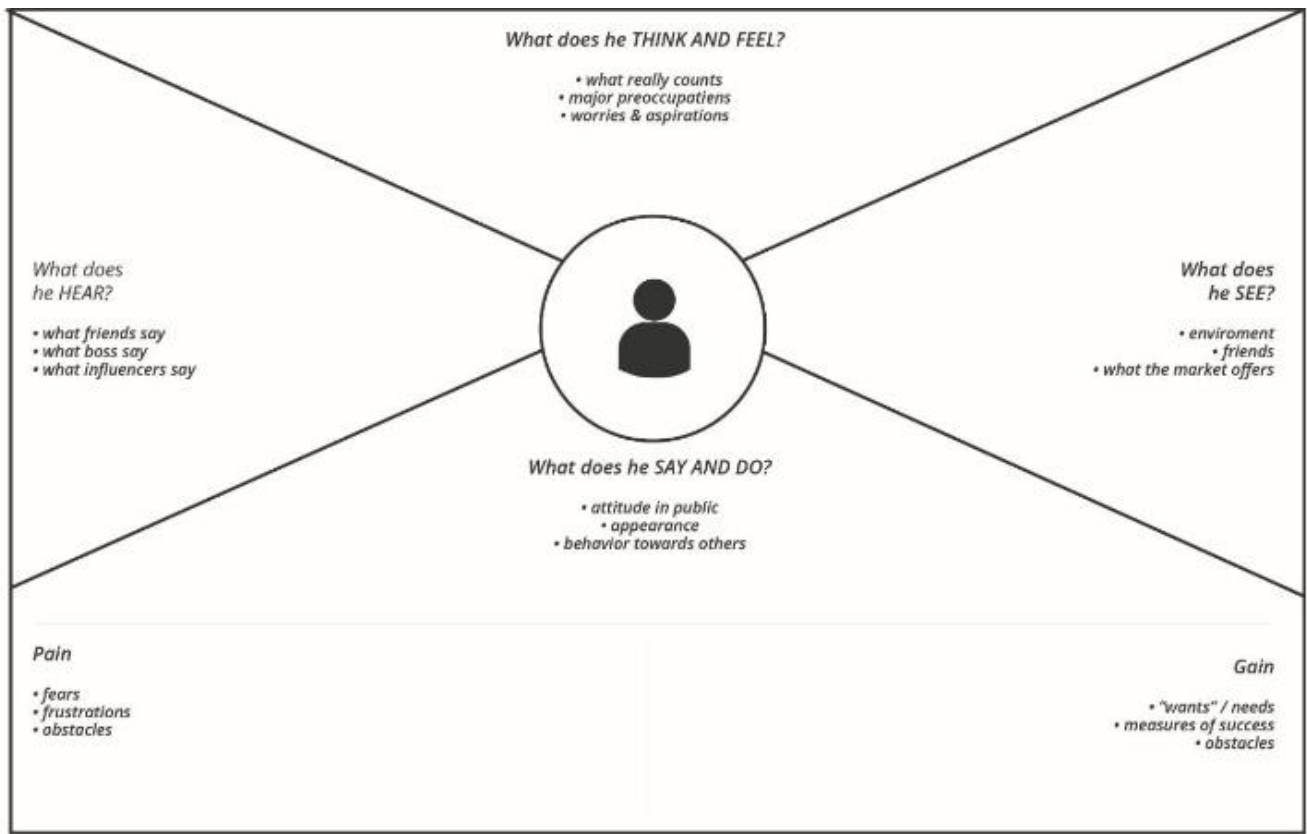
7. BOROZDUKHIN, A., DOLININA, O. & PECHENKIN, V. App roach to the garbage collection in the “Smart Clean City” project. Information Science and Technology (CiSt), 2016 4th IEEE International Colloquium on, 2016. IEEE, 918-922.

2.2 PROBLEM STATEMENT DEFINITION :



3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas :



3.2 Ideation & Brainstorming

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare
1 hour to discuss
3-8 people recommended

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

TEAM ID: PNT2022TMD13627

- Team gathering: Define who should participate in the session and send an invite. Share relevant information or provide access.
- Set the goal: Think about the problem you'll be focusing on solving in the brainstorming session.
- Learn how to use the facilitation tools: Use the Facilitation Supporters to run a happy and productive session.
- Open session

Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

How might we (your problem statement)?

Key rules of sticky notes

To run an smooth and productive session:

- Stay on topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

Activate Wi
Go to Settings 1

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

SARAVANASUDHAN.S

The proposed system would be able to automate the solid waste monitoring process and management of the overall collection process using IOT (Internet of Things).

Placing Ultrasonic sensor to detect level of bins

Enable GPS function to locate bins easier

Waste generation analysis to understand cities usages

TAMIL INIAN.R

Load cell on bottom of bins

Place Arduion board at left side of bins

Visual fill status indicators on top of bins

using by GSM in bins achieve wireless communication with bins and managing center

MOHAMEDUMAR.N

when bins fill alert message to the authorized person

solar panels for power supply for IOT devices

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

20 minutes

Smart garbage maintenance server

Transparency and sustainable solution than normal garbage bins

Optimized trash collection route

Collect only degradable and non-degradable wastes

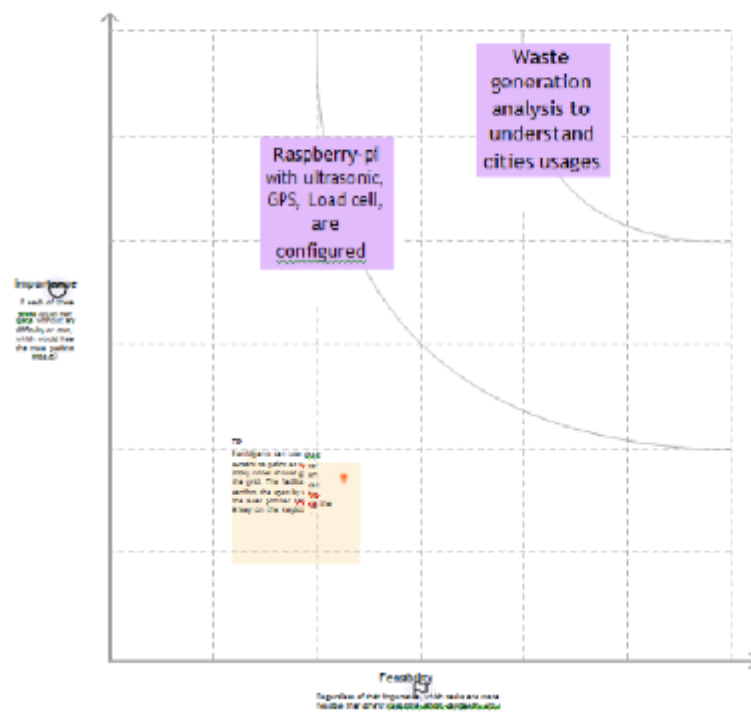
IOT alert authorized person when bins going to fill

Activate Wi
Go to Settings 1

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

10 minutes



After you collaborate

You can export the mural as an image or PDF to share with members of your company who might find it helpful.

Quick editors

- Share the mural**
Share a new link to the mural with stakeholders to keep them in the loop about the outcomes of the session.
- Export the mural**
Export a copy of the mural as a PDF or PNG to attach to emails, include in slides, or save on your drive.

Keep moving forward

Strategy blueprint

Define the components of a new idea or initiative.



Open the template

Customer experience journey map
Understand customer needs, motivations, and behaviors for an experience.



Open the template

Strategy, challenges, opportunities to focus

Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.



Open the template

Get a template feedback



3.3 Proposed Solution:

| S.No. | Parameter | Description |
|-------|--|--|
| 1. | Problem Statement (Problem to be solved) | Rapid increase in volume and types of hazardous waste as a result of continuous economic growth, urbanization and industrialization is becoming a burgeoning problem for waste management agencies to ensure an effective and sustainable management of waste. |
| 2. | Idea / Solution description | Smart waste management is characterized by the usage of technology in order to be more efficient when it comes to managing waste. This makes it possible to plan more efficient routes for the trash collectors who empty the bins, but also lowers the chance of any bin being full for over a week! |
| 3. | Novelty / Uniqueness | The smart cities concept highlights the use of Information and Communication Technology (ICT) to increase the quality and build more efficient technological solutions in different urban network services of a city life. One of the most famous models used to make a smart city is Internet Of Things (IOT) |
| 4. | Social Impact / Customer Satisfaction | Poor waste management contributes to climate change and air pollution, and directly affects many ecosystems and species. |

| | | |
|----|--------------------------------|--|
| | | <p>Landfills, considered the last resort in the waste hierarchy, release methane, a very powerful greenhouse gas linked to climate change. Methane is formed by microorganisms present in landfills from biodegradable waste, such as food, paper and garden waste. Depending on the way they are built, landfills might also contaminate soil and water.</p> <p>After waste is collected, it is transported and treated. The transport process releases carbon dioxide — the most prevalent greenhouse gas — and air pollutants, including particulate matter, into the atmosphere.</p> |
| 5. | Business Model (Revenue Model) | Waste Management generates revenue through the provision of various waste management and disposal services and recycling solutions to residential, commercial, industrial, and municipal clients. The Company derives its revenue in the form of various fees associated with its service offerings. |
| 6. | Scalability of the Solution | <p>Waste management is important as it saves the environment from the toxic effects of inorganic and biodegradable element present in waste.</p> <p>Mismanagement of waste can cause water contamination, soil erosion and air contamination. Waste can be recycled if collected and managed efficiently.</p> |

3.4 Problem Solution fit



| Problem Statement (PS) | I am | I'm trying to | But | Because | Which makes me feel |
|------------------------|------------------------|------------------------|--------------------------------|---|---------------------------------|
| PS-1 | Need clean environment | Garbage level checking | In cities it's not easy | The wastage monitoring machine is not working | The customer becomes very happy |
| PS-2 | Monitoring | Analyse the pollution | It leads to high level wastage | It's a summer season | They are disappointed |

4. REQUIREMENT ANALYSIS

4.1 Functional requirement:

| FR No. | Functional Requirement (Epic) | Sub Requirement (Story / Sub-Task) |
|--------|--|--|
| FR-1 | Smart sensors | Smart Sensors are designed for monitoring fill level in smart trash bins and containers using ultrasonic technology. Sensors transfer data very simple via all currently available IoT networks and/or GPRS. Sensors monitor all types of waste in bins and containers of different sizes. They are robust, water and shock-resistant. Fire alarm, tilt recognition and other features are included. |
| FR-2 | Smart Waste Management Software System | The powerful cloud-based waste management software system enables the customer to configure, monitor and manage daily operations of a waste management company. In addition, to live data from Waste monitoring, the tool can also hold complex bin database, plan the optimal collection routes, predict filling cycles, and manage reports from employees and citizens |
| FR-3 | Citizen app | Citizens app provides access to data from Smart Sensors to citizens. The mobile app informs about the location and fill level of monitored bins and enables you to find the nearest available bin for disposal of garbage or report an issue. Logged users can access even more information about the bins, request a pickup or maintenance. Available for free on Android and iOS. |
| FR-4 | Adjust bin distribution | Ensure the most optimal distribution of bins. Identify areas with either dense or sparse bin distribution. Make sure all trash types are represented within a stand. Based on the historical data, you can adjust bin capacity or location where necessary. |
| FR-5 | Eliminate inefficient picks | Eliminate the collection of half-empty bins. The sensors recognize picks. By using real-time data on fill-levels and pick recognition, we can show you how full the bins you collect are. The report shows how full the bin was when picked. You immediately see any inefficient picks below 80% full. |

4.2 Non functional requirements:

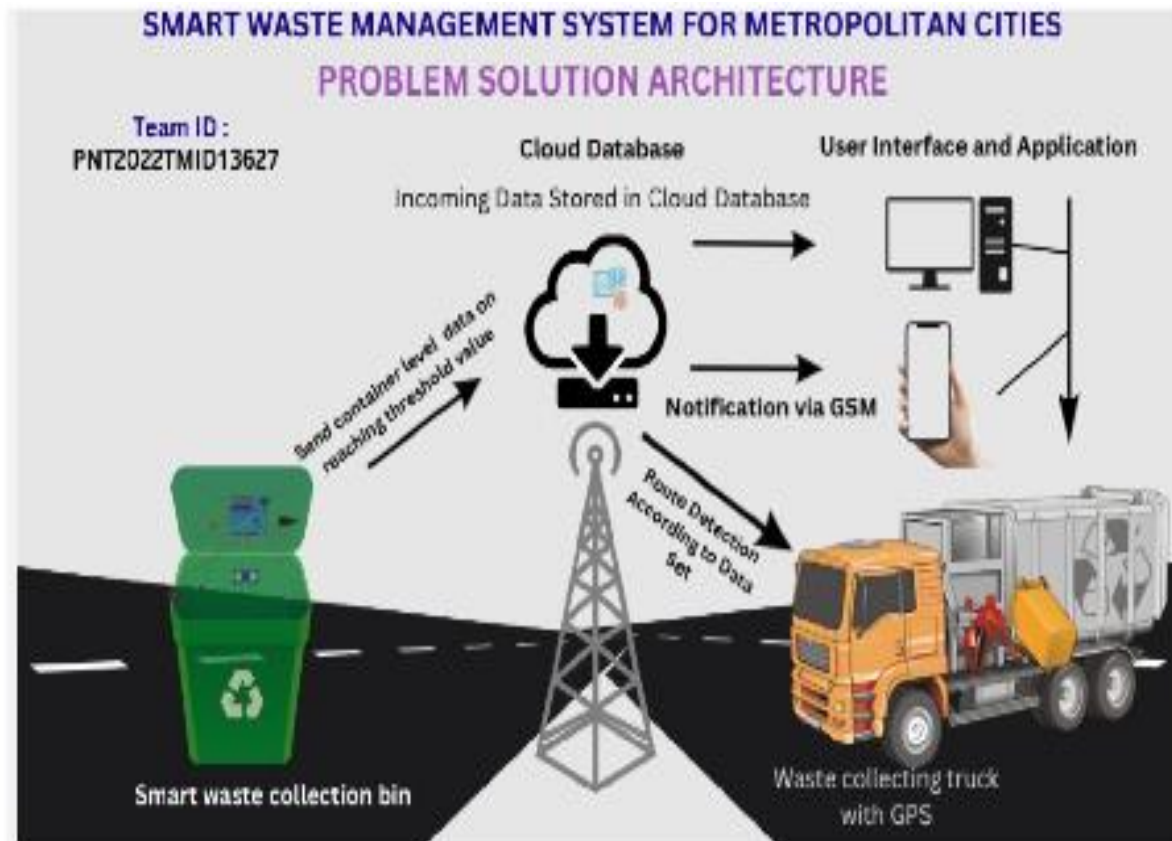
Non-functional Requirements:

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

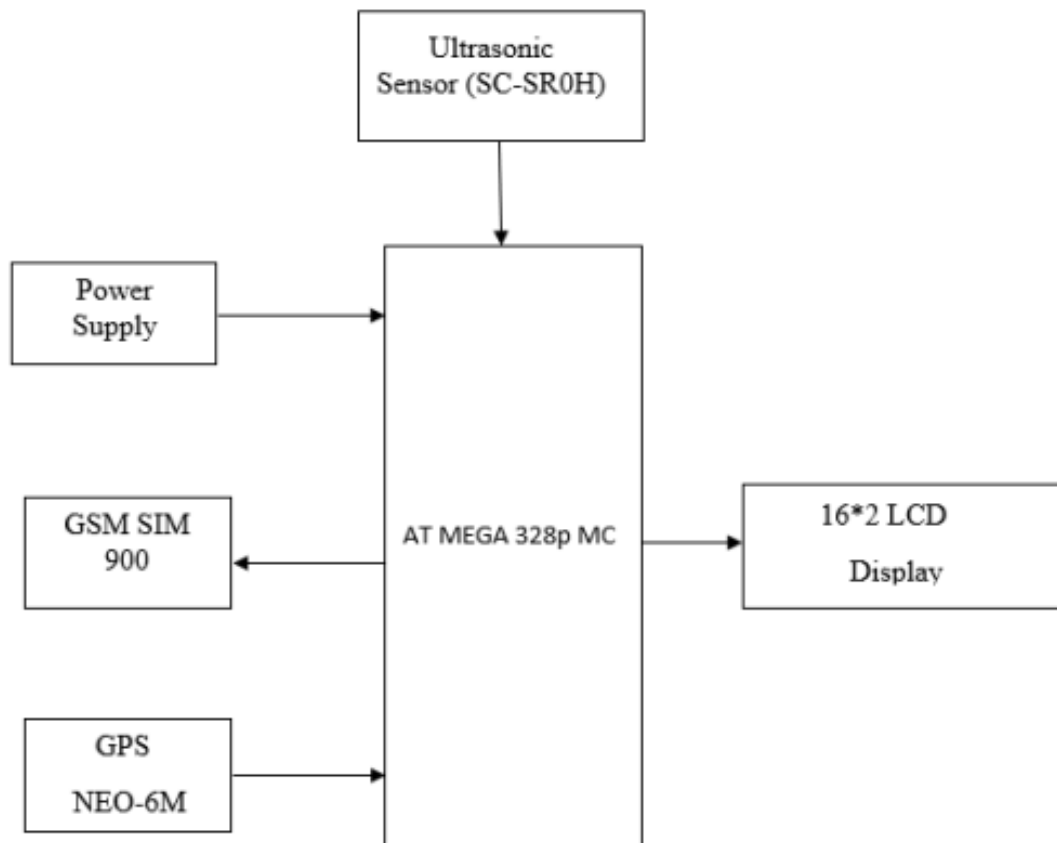
| FR No. | Non-Functional Requirement | Description |
|--------|----------------------------|--|
| NFR-1 | Usability | IoT device verifies that usability is a special and important perspective to analyse user requirements, which can further improve the design quality. In the design process with user experience as the core, the analysis of users' product usability can indeed help designers better understand users' potential needs in waste management, behaviour and experience. |
| NFR-2 | Security | Use a reusable bottles Use reusable grocery bags Purchase wisely and recycle Avoid single use food and drink containers. |
| NFR-3 | Reliability | Smart waste management is also about creating better working conditions for waste collectors and drivers. Instead of driving the same collection routes and servicing empty bins, waste collectors will spend their time more efficiently, taking care of bins that need servicing. |
| NFR-4 | Performance | The Smart Sensors use ultrasound technology to measure the fill levels (along with other data) in bins several times a day. Using a variety of IoT networks (NB-IoT,GPRS), the sensors send the data to Smart Waste Management Software System, a powerful cloud-based platform, for data- driven daily operations, available also as a waste management app. Customers are hence provided data-driven decision making, and optimization of waste collection routes, frequencies, and vehicle loads resulting in route reduction by at least 30%. |
| NFR-5 | Availability | By developing & deploying resilient hardware and beautiful software we empower cities, businesses, and countries to manage waste smarter. |

5. PROJECT DESIGN

5.1 Data Flow Diagram:



5.2 Solution & Technical Architecture:



5.3: User Stories



6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

| TITLE | DESCRIPTION | DATE |
|---|---|-------------------|
| Literature Survey & Information Gathering | Literature survey on the selected project & gathering information by referring the technical papers, research publications etc. | 30 SEPTEMBER 2022 |
| Prepare Empathy Map | Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements | 30 SEPTEMBER 2022 |
| Ideation | List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance. | 30 SEPTEMBER 2022 |
| Proposed Solution | Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc. | 20 OCTOBER 2022 |
| Problem Solution Fit | Prepare problem-solution fit document. | 20 OCTOBER 2022 |
| Solution Architecture | Prepare solution architecture document. | 20 OCTOBER 2022 |
| Customer Journey | Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit). | 20 OCTOBER 2022 |

| | | |
|--|---|-----------------|
| Functional Requirement | Prepare the functional and non-functional requirement document. | 20 OCTOBER 2022 |
| Data Flow Diagrams | Draw the data flow diagrams and submit for review. | 20 OCTOBER 2022 |
| Technology Architecture | Prepare the technology architecture diagram. | 20 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. | IN PROGRESS.. |

6.2 Sprint Delivery Schedule

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

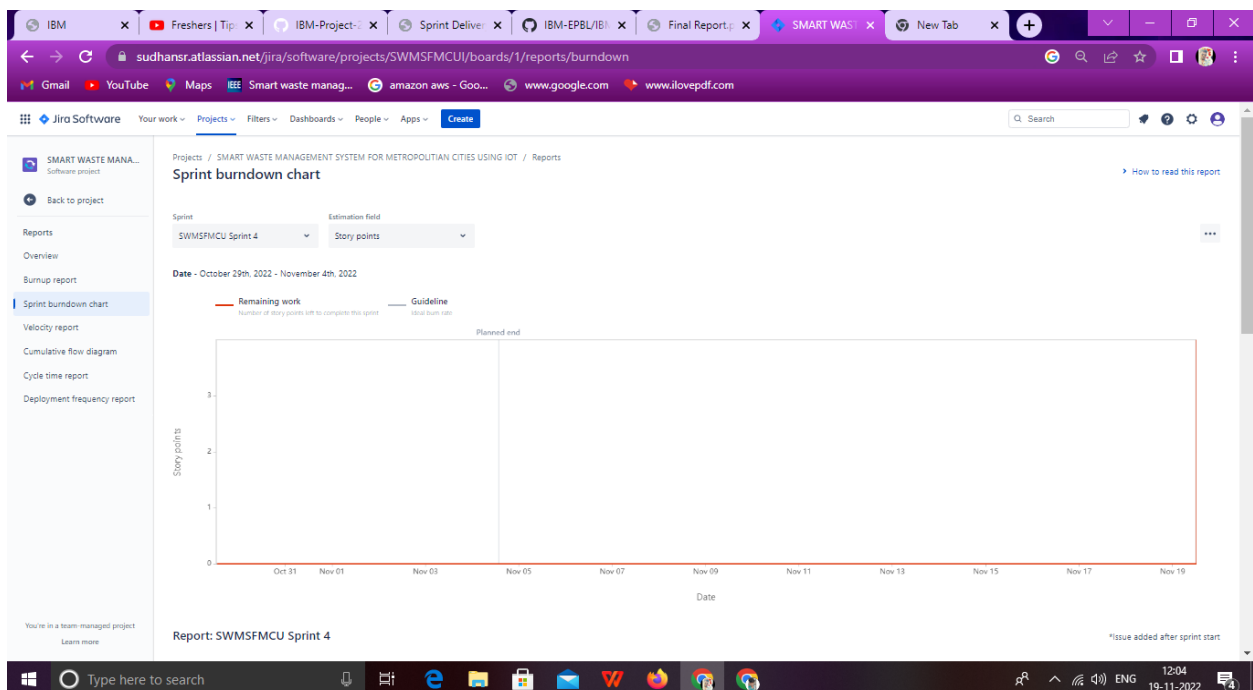
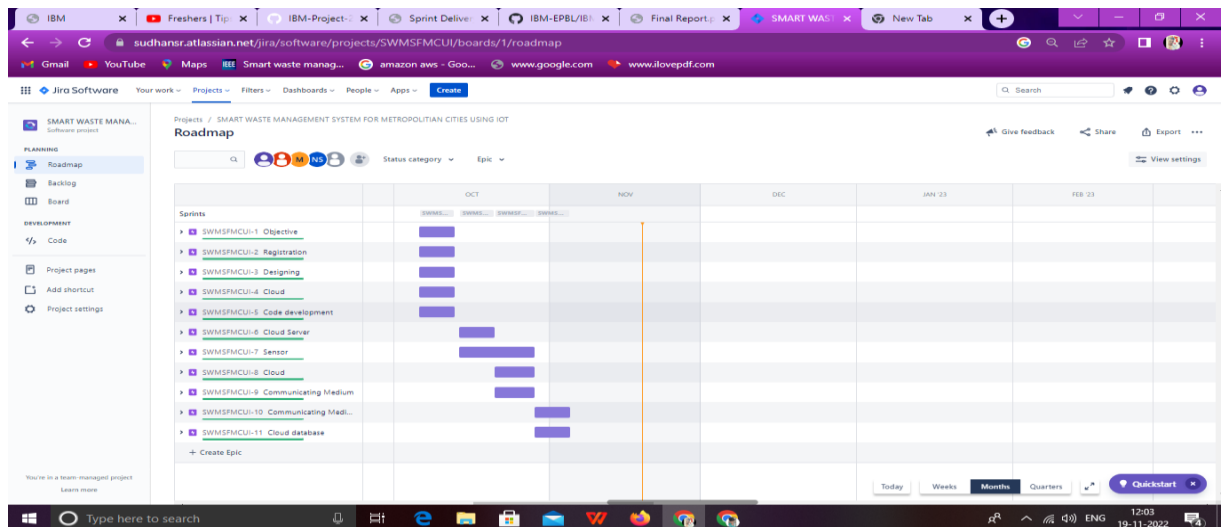
| Sprint | Functional Requirement (Epic) | User Story Number | User Story / Task | Story Points | Priority | Team Members |
|----------|-------------------------------|-------------------|--|--------------|----------|-------------------|
| Sprint-1 | Objective | USN-1 | The smart bin system will alert the nearby garbage collectors when the bin overflows. | 6 | High | SARAVANA SUDHAN.S |
| Sprint-1 | Registration | USN-2 | The user(garbage collectors) can register for the application using the respective credentials provided to them. | 4 | Medium | SARAVANA SUDHAN.S |
| Sprint-1 | Designing | USN-3 | Designing a circuit with sensors and arduino interface | 6 | High | SARAVANA SUDHAN.S |
| Sprint-1 | Cloud | USN-4 | As an administrator, register in IBM cloud | 4 | Medium | SARAVANA SUDHAN.S |
| Sprint-2 | Code development | USN-5 | Develop a code to send a message when the bin overflows using ultrasonic sensor | 10 | High | NAVEEN S |

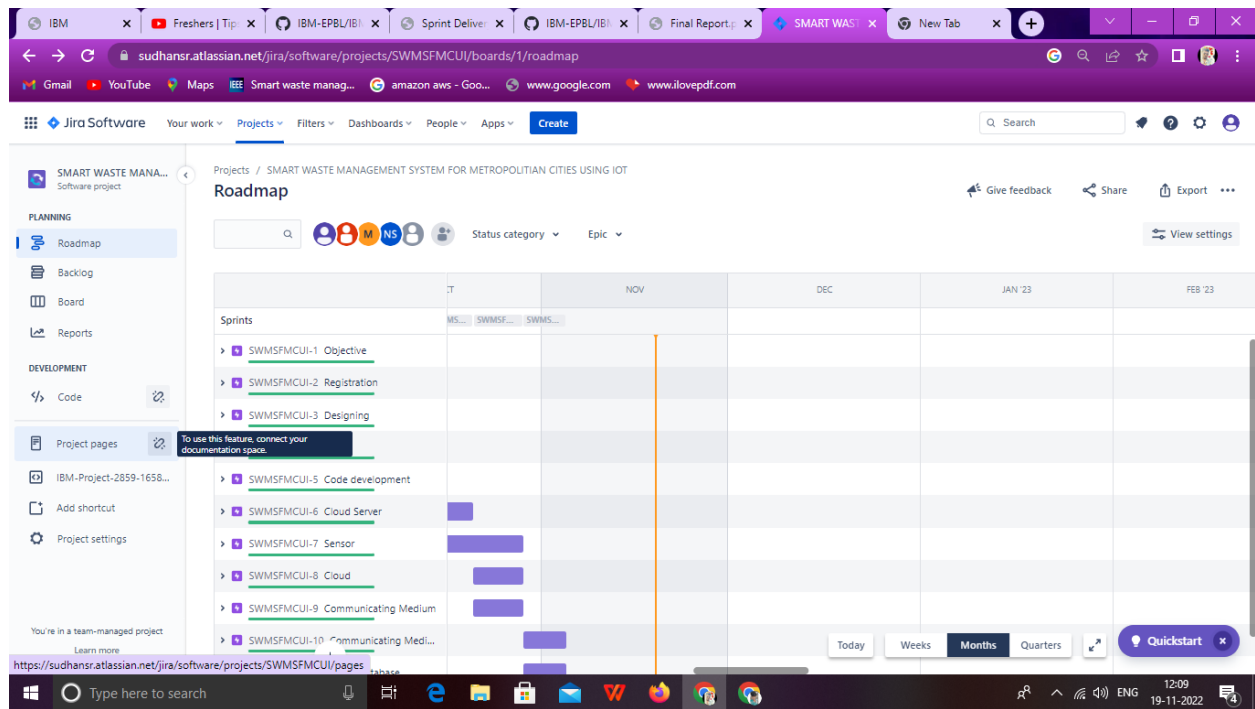
| Sprint | Functional Requirement (Epic) | User Story Number | User Story / Task | Story Points | Priority | Team Members |
|-----------|-------------------------------|-------------------|--|--------------|----------|----------------|
| Sprint-2 | Cloud Server | USN-6 | Cloud web server is created which connects the bin and the authority who is responsible for the disposal of waste from its bin | 10 | High | NAVEEN S |
| Sprint-3 | Sensor | USN-7 | Detect the level of garbage using sensor and store it in the server for specific interval of time. | 10 | High | TAMILINIAN. R |
| Sprint-3 | Cloud | USN-8 | Authority should allocate which garbage collector should collect the waste at particular area | 10 | High | TAMILINIAN. R |
| Sprint-4 | Communicating Medium | USN - 9 | Garbage collector receives the message from the authority and goes to collect the garbage | 10 | High | MOHAMEDU MAR.N |
| Sprint-4 | Communicating Medium | USN-10 | Once the garbage is collected the particular person should intimate the completion of the task | 5 | Medium | MOHAMEDU MAR.N |
| Sprint -4 | Cloud database | USN-11 | Update the database after task completion | 5 | Medium | MOHAMEDU MAR.N |

Project Tracker, Velocity & Burndown Chart: (4 Marks)

| Sprint | Total Story Points | Duration | Sprint Start Date | Sprint End Date (Planned) | Story Points Completed (as on Planned End Date) | Sprint Release Date (Actual) |
|----------|--------------------|----------|-------------------|---------------------------|---|------------------------------|
| Sprint-1 | 20 | 6 Days | 24 Oct 2022 | 29 Oct 2022 | 20 | 30 Oct 2022 |
| Sprint-2 | 20 | 6 Days | 31 Oct 2022 | 05 Nov 2022 | 20 | 05 Nov 2022 |
| Sprint-3 | 20 | 6 Days | 07 Nov 2022 | 12 Nov 2022 | 20 | 12 Nov 2022 |
| Sprint-4 | 20 | 6 Days | 14 Nov 2022 | 19 Nov 2022 | 20 | 19 Nov 2022 |

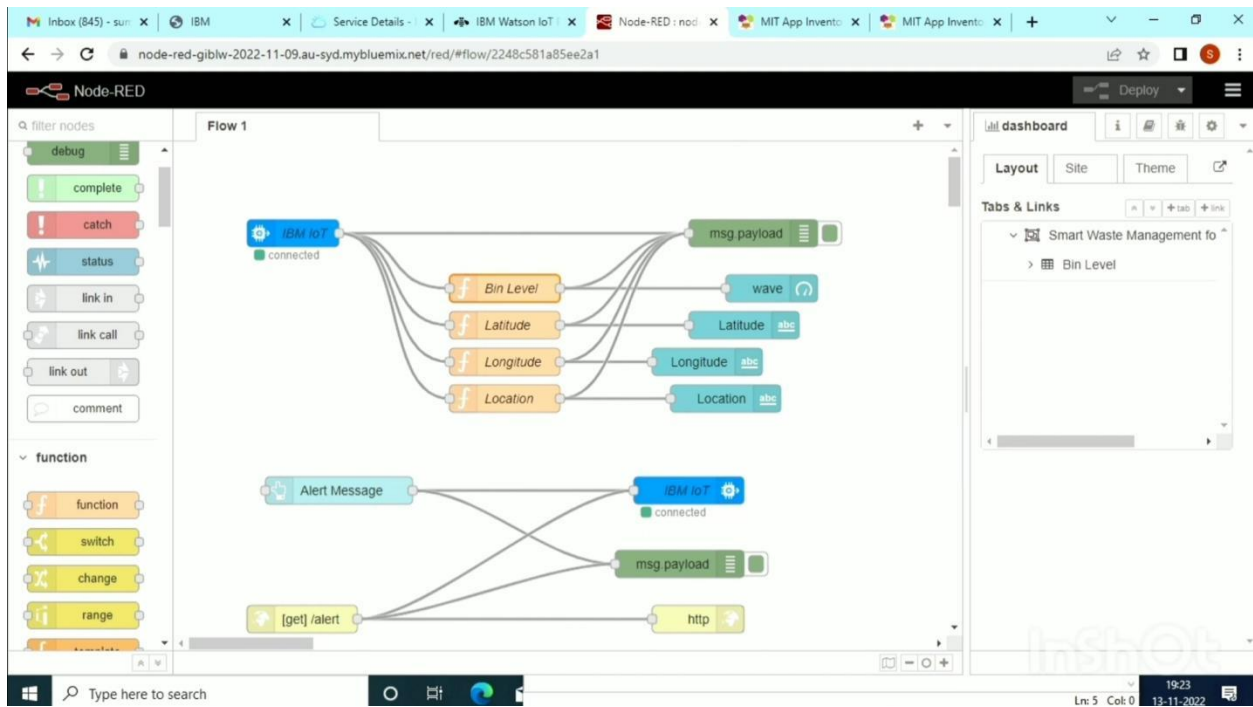
6.3 Reports from JIRA



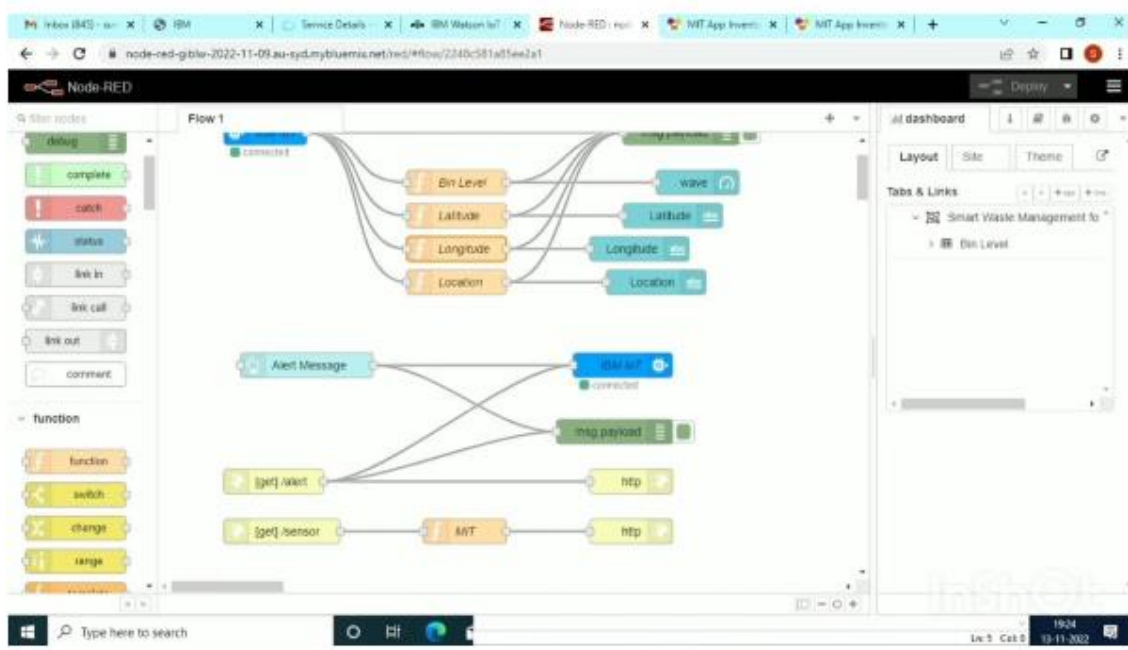


7.CODING & SOLUTIONING

7.1 Feature 1



7.2)Figure 2



7.3 Database Schema



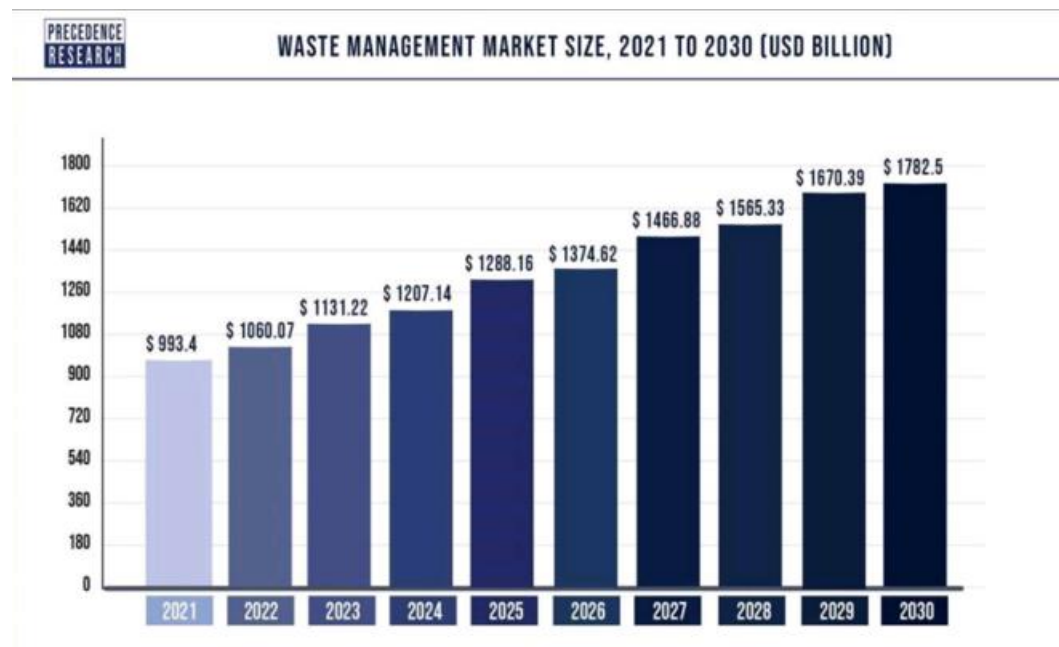
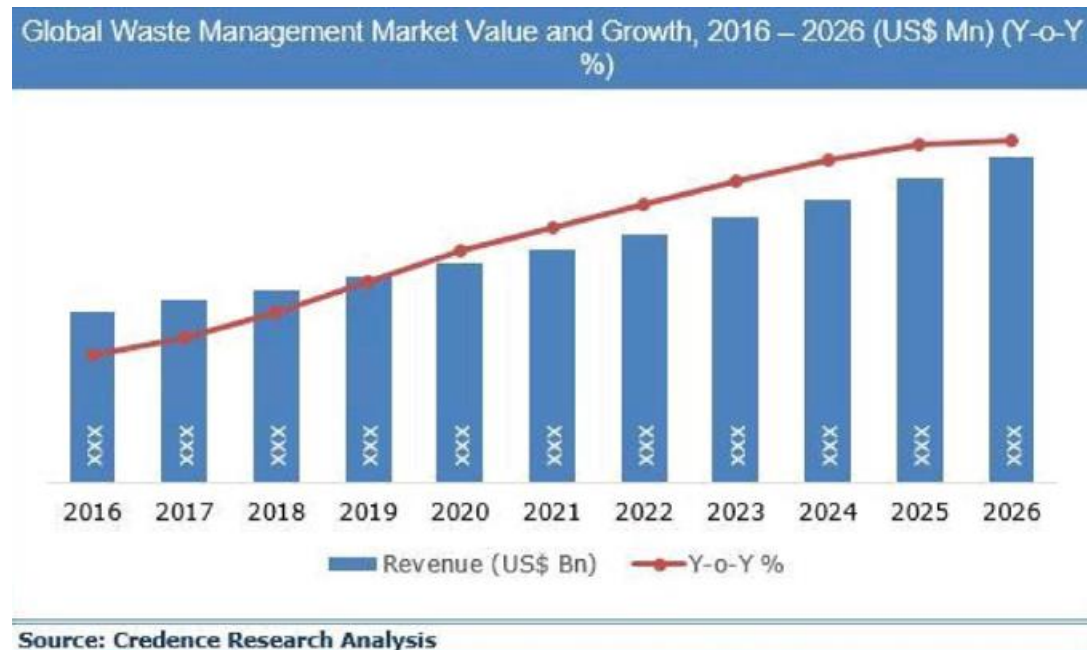
8.TESTING

8.1 Test Cases

| TESTCASE ID | TESTCASE | TEST SCENARIO | TEST STEPS | INPUTS | EXPECTED OUTPUT | ACTUAL OUTPUT | TEST RESULT | TEST COMMENTS | BUG ID | TESTED BY |
|-------------|-------------------------|---|--|------------------------|---|--|-------------|---------------|--------|-----------------|
| 1 | IBM WATSON IOT PLATFORM | To check whether the IBM Watson is get connected | login to IBM Watson IoT platform | id , password | it should get login to the Watson page | it has been logged in to the login page | PASS | GOOD | | KIRUBA M |
| | | | check whether it has the separate organization id | new id | it should show the organization id | separate organization id has been shown | PASS | GOOD | | KIRUBA M |
| | | | check whether team mates are get connected | team mates id | it should show all the team members name / id | it is showing all the team members | PASS | GOOD | | KIRUBA M |
| | | | check whether separate device name , id , authentication token generated | device name , type | new device should be created | new device has been created | PASS | GOOD | | KIRUBA M |
| | | | to check whether it is showing output | device code and inputs | it should show device gets connected and should show the output | its showing that device gets connected and output are verified | PASS | GOOD | | KIRUBA M |
| 2 | Python Compiler | to check the connection is established in Cloud | To check whether the pH value is shown or not | pH reading | it need to show the pH value sometimes may random | it show the pH value for the input | PASS | GOOD | | MADHUSHREE S |
| | | | to check whether the Temperature and humidity are shown | Temperature & humidity | it should show temperature & humidity | it show the temperature & humidity value for input | PASS | GOOD | | MADHUSHREE S |
| 3 | NODE-RED | to check whether node-red is connected and shows the output | login in to node-red | id , password | it should get login to the node-red page | its get entered into the login page | PASS | GOOD | | MADHUSHREE S |
| | | | check whether all the necessities are imported and connected | nodes | it should not show any error on nodes | it is not showing any errors | PASS | GOOD | | MADHUSHREE S |
| | | | check whether all the nodes are connected | node connection | blocks should get connected | blocks has been connected | PASS | GOOD | | MADHUSHREE S |
| | | | check whether the output are shown in node-red | output found or not | output should be obtained | output has been obtained | PASS | GOOD | | MADHUSHREE S |
| 4 | MIT App Inventor | check whether the outputs are shown in | check whether the login is created | id,password | Get into the MIT app inventor | MIT App inventor is getting | PASS | GOOD | | DHANYA R |
| | | | check whether new project is created in MIT | Project created | the new project is created | the new project is created | PASS | GOOD | | DHANYA R |
| | | | check whether the designer page is ready to use | create app | it should be created | it is created successfully | PASS | GOOD | | DHANYA R |
| | | | check whether the block page is created | create block | block should be created | it is created successfully | PASS | GOOD | | DHANYA R |
| | | | check whether the block run successfully without error | run block | it should get input from cloud | it has been connected and provide output | PASS | GOOD | | DHANYA R |
| 5 | QR CODE | check whether qr code is generated | check whether the code shows any error | code | it should not show any error | it is not showing any errors | PASS | GOOD | | DHANYA R |
| | | | check whether the MIT provide QR code | QR Code | QR code has been generated | QR code is generated | PASS | GOOD | | DHANYA R |
| | | | check whether the MIT app is installed in mobile | install in mobile | user should install mobile app | app is installed successfully | PASS | GOOD | | DHANYA R |
| | | | check whether the QR code get connected | app link | mobile gets connected | mobile has been connected | PASS | GOOD | | DHANYA R |
| | | | check whether the screen is found in mobile | screen found | screen should be generated | screen has been generated | PASS | GOOD | | DHANYA R |
| 6 | TESTING | check entire process | check whether Watson is connected | watson | iot Watson should produce its output | iot Watson has produced its output | PASS | GOOD | | DEVADHARSHINI B |
| | | | check whether node-red is connected | node-red | node-red should produce its output | node-red has been producing its output | PASS | GOOD | | DEVADHARSHINI B |
| | | | check whether Python is connected | python | python should get connected | python has been connected | PASS | GOOD | | DEVADHARSHINI B |
| | | | check whether details are shown | MIT App | details in MIT should be shown | details in MIT should be shown | PASS | GOOD | | DEVADHARSHINI B |

9.RESULTS

9.1 Performance Metrics



10. ADVANTAGES & DISADVANTAGES:

ADVANTAGES:

- Less time and fuel consumption as the trucks go only to the filled containers.
- Decreased noise, traffic flow and air pollution as a result of less trucks on the roads.
- Our smart operating system enable two way communication between the dustbin deployed in the city and service operator. Therefore the focus is only on collection of route based fill level of the containers.
- The sensors installed in the containers provide real time information on the fill level.
- This information helps determine when and where to prioritise collection.
- In this way both service providers and citizens benefit from an optimized system which results in major cost savings and less urban pollution.
- Reduces the infrastructure (trucks, containers), operating (fuel) and maintenance costs of the service by upto 30%.
- Applying this technology to the city optimises management, resources and costs, and makes it a “SMART CITY”.
- Historical information on collections helps adapt the deployment of containers to the actual needs of the city, therefore reducing the number of containers that clutter up the road and increasing public parking spaces.

DISADVANTAGES:

- System requires a greater number of waste bins for separated waste collection as population in the city.
- This results in high initial cost due to expensive smart dustbins compare to other methods.
- Sensor node use in the dustbin have limited memory size.

11. CONCLUSION:

The genesis, characteristics, collection, and transportation of have all been reviewed in an honest and thorough manner. The suggested system would be able to handle and monitor the entire collecting process for solid waste. This method would enable timely solid trash collection while also overcoming all of its drawbacks, including the need for a short route, minimal fuel use, a clean, green environment, and a vehicle that is readily available. The technologies that are incorporated into the proposed system are sufficient to guarantee that it is perfect for managing and monitoring the solid waste collection procedure in a green environment.

12)FUTURE SCOPE:

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

- Change the user authentication and atomic lock systems for bins to better safeguard them from theft and damage.
- Having case studies or data analytics on the type and times waste is collected on different days or seasons, making bin filling predictable and removing the reliance on electronic components, and fixing the coordinates would make the idea successful and aid in the achievement of collaborative waste management efforts, thus fulfilling the idea of Swachh Bharath.

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

13) APPENDIX:

13.1)SOURCE CODE:

```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random
#Provide your IBM Watson Device Credentials
organization = "vi4esk"
deviceType = "sudhan"
deviceId = "12345"
authMethod = "token"
authToken = "12345678"
# Initialize GPIO
def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status=="alarmon":
        print ("DUST BIN IS FULL")
    else:
        print ("Alarm is off")

#print(cmd)

try:
    deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method":
                    authMethod, "auth-token": authToken}
    deviceCli = ibmiotf.device.Client(deviceOptions)
    #.....
except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()
# Connect and send a datapoint "hello" with value "world" into the cloud as an event of
type"greeting" 10 times
deviceCli.connect()
while True:
    #Get Sensor Data from DHT11

    latitude=random.randint(0,100)
```

```

logditude=random.randint(0,100)

data = { 'latitude' : latitude, 'logditude': logditude }
#print data
def myOnPublishCallback():
    print ("Published latitude = %s C" % latitude, "logditude = %s %" % logditude, "to IBM
Watson")
    success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
on_publish=myOnPublishCallback)
    if not success:
        print("Not connected to IoT")
        time.sleep(10)

deviceCli.commandCallback = myCommandCallback
# Disconnect the device and application from the cloud
deviceCli.disconnect()

```

13.2) GITHUB LINK:

<https://github.com/IBM-EPBL/IBM-Project-2859-1658484622>

13.3) PROJECT LINK:

<https://youtu.be/8dRePqZ1meE>