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

NALAIYA THIRAN PROJECT REPORT 2022

Submitted by

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Team ID: PNT2022TMID13383

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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. Therefore, it's essential to have a good waste management system to stop the spread of some fatal diseases. Monitoring the condition of the smart bins and making decisions based on that information. Municipal entities then collect up this rubbish and put it in landfills and disposal sites. However, some rubbish is not collected owing to a lack of resources or inadequate groundwork, posing a major health risk to the neighbourhood. Cleaning at the appropriate intervals could solve this issue. However, manually monitoring the status of the bin is a very challenging task. In the city or on the

campus, there are several trash cans. The Smart trash cans in our system are linked to the internet to obtain real-time.

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
- Global trash is predicted to exceed 3.40 billion tonnes by 2050, more than double the rate of population growth during that time.
- By recovering materials and energy from solid waste, as shown, solid waste management aims to limit the amount of waste that is dumped on land.

2. LITERATURE SURVEY

Waste production is a natural result of growth and industrial advancement. Because of this, effective waste management is a global priority, and nations have established strong regulatory waste management regimes to balance the goals of development and environmental sustainability. The national environment policy for India from 2006 suggested steps for waste collection and secure disposal of residues.

The largest amount of waste is produced in metro areas and significant economic centres, but a review of 20 smaller cities chosen for development as smart cities reveals that the majority are having difficulty managing waste. Therefore, waste management methods ought to be improved.

2.1 EXISTING PROBLEM :

Literature Survey

TITLE	AUTHOR & YEAR	JOURNAL NAME	REMARKS
Smart Waste Management System Using IOT	S.A.Mahajan & 2017	Tejashree Kadus	This project shows how the smart waste management system using IOT cam 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	Pawankumar Nirmal	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	Kartikee Kulkarn	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	Bharadwaj B	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	M Kumudha	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	Gowri Chandra N	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, Is sue 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. Smart Wi-Fi Dustbin System. International Journal of Advance Engineering and Research Development, 4, 33 6-339.

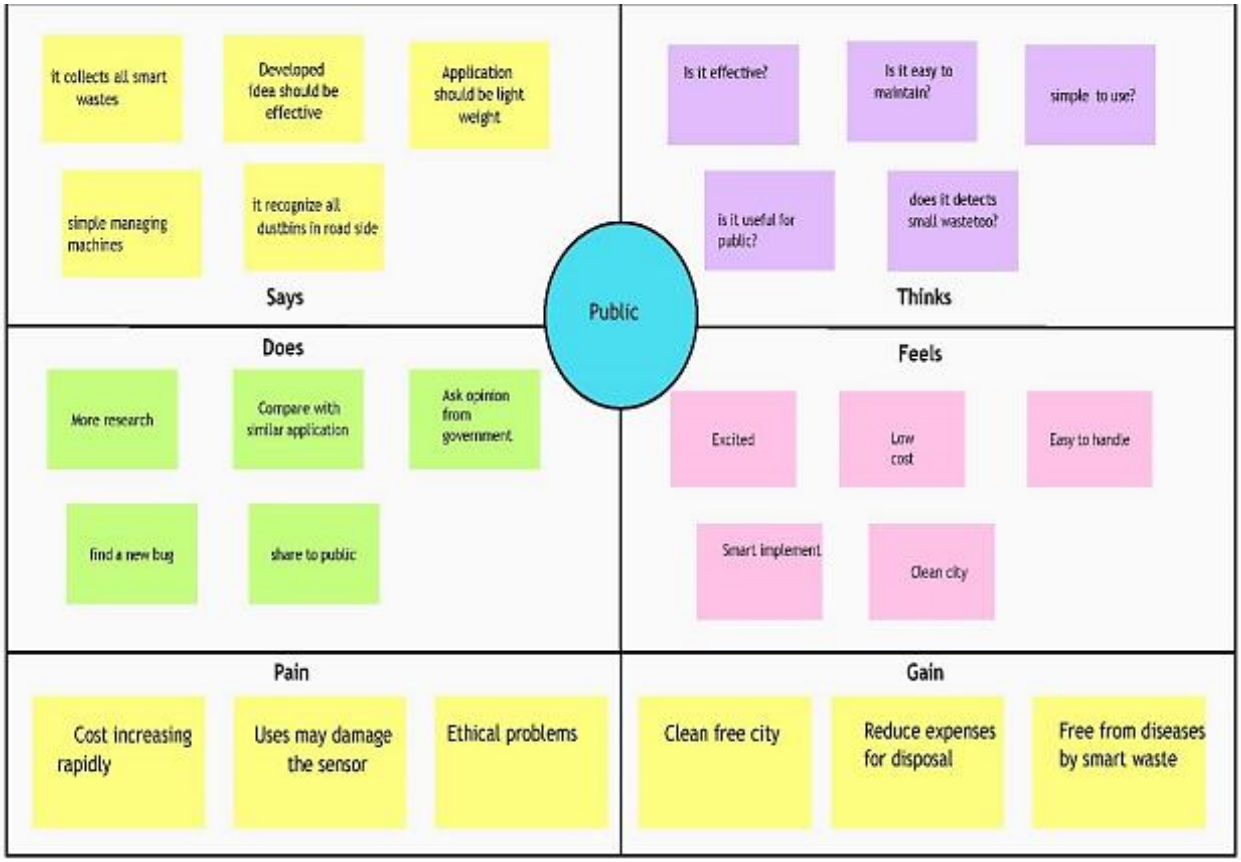
7. BOROZDUKHIN, A., DOLININA, O. & PECHENKIN, V. App roach to the garbage collection in the “Smart Clean City” project. Information Science and Technology (CiSt), 2016 4th IEEE International Colloquium on, 2016. IEEE, 918-922.

2.2 PROBLEM STATEMENT DEFINITION :

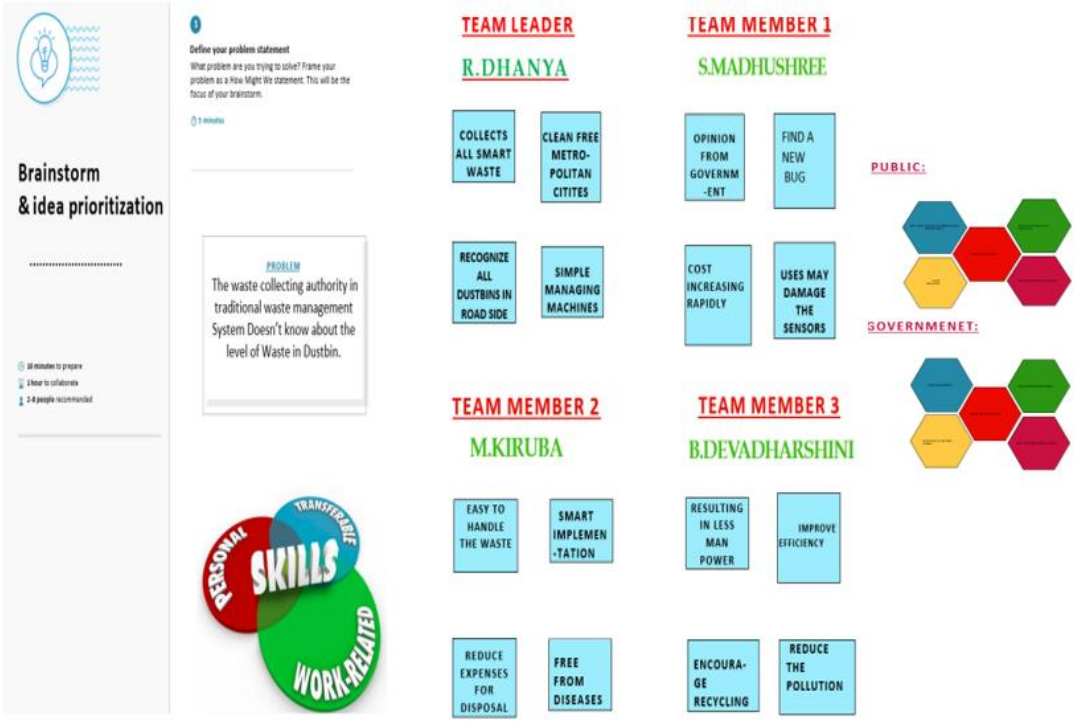
Due to lack of proper systems for disposal and collections, wastes and garbage's end up in the roads and surrounding.	The waste collecting authority in traditional waste management system doesn't know about the level of garbage in dustbin in roadsides.	Few waste treatment options are available to manage waste and so they are more expensive than landfill costs.
When waste gets overflowed as well as spelled out from the dustbin leading to unhygienic condition in cities.	Sometimes due to unclean wastes, bad smell arise cause toxic and unhygienic gases are produced which is way to support to the air pollution and harmful diseases which are easily spreadable.	Despite smart waste management plan and other policies is a still a big problem.
Design a smart waste collection system that allows citizens to segregate the various types of smart waste they want to dispose and the municipal authorities to efficiently collect the same.	Growing pressure on outdated waste management infrastructure, with declining levels of capital investment and maintenance.	Smart waste causes pollution in any form interferes with our food chain, health, amenities etc,.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas :



3.2 Ideation & Brainstorming



3.3 Proposed Solution:

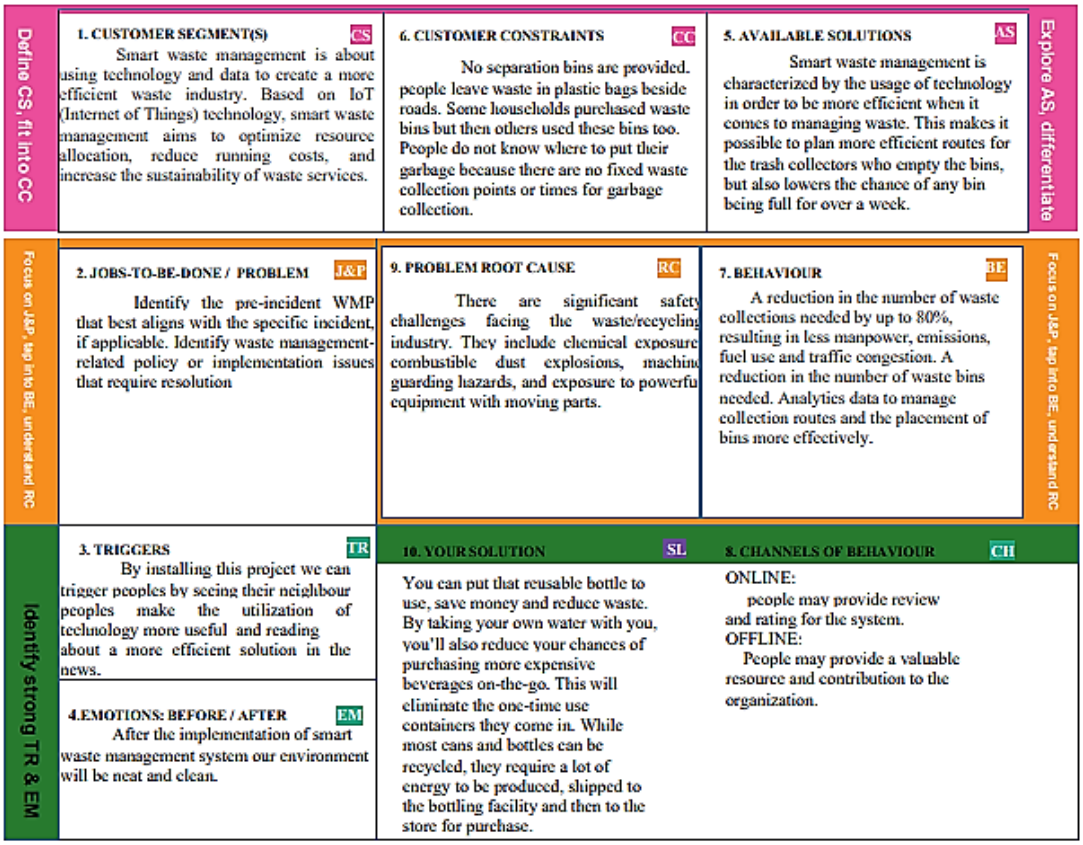
Proposed Solution Template:

Project team shall fill the following information in proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	The major problems affecting smart waste management are unscientific treatment, improper collection of waste, and ethical problems. Therefore we need to prevent waste management.
2.	Idea / Solution description	It can be prevented by creating an interactive dashboard by IOT. By doing this we can predict the upcoming events.
3.	Novelty / Uniqueness	It can give correct and accurate information.
4.	Social Impact / Customer Satisfaction	In the point of social impact, it has a great interactive dashboard for predicting the wastages.
5.	Business Model (Revenue Model)	It has a huge revenue when it comes to the market.
6.	Scalability of the Solution	It has easy manipulation of data.

3.4 Problem Solution fit

Smart Waste Management System For Metropolitan Cities | Project Design Phase-I - Solution Fit Template | Team ID: PNT2022TMID13383



4. REQUIREMENT ANALYSIS

4.1 Functional requirement:

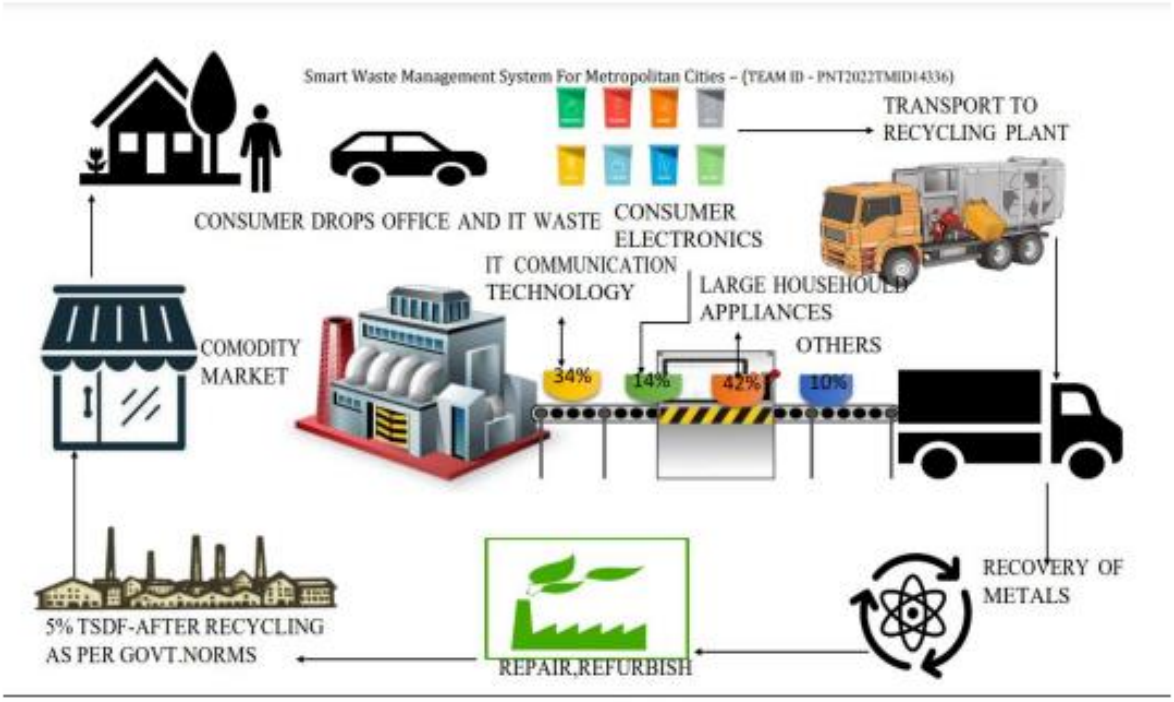
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Detailed bin inventory.	All monitored bins and stands can be seen on the map, and you can visit them at any time via the Street View feature from Google. Bins or stands are visible on the map as green, orange or red circles. You can see bin details in the Dashboard – capacity, waste type, last measurement, GPS location and collection schedule or pick recognition.
FR-2	Real time bin monitoring.	The Dashboard displays real-time data on fill-levels of bins monitored by smart sensors. In addition to the % of fill-level, based on the historical data, the tool predicts when the bin will become full, one of the functionalities that are not included even in the best waste management software.. Sensors recognize picks as well; so you can check when the bin was last collected. With real-time data and predictions, you can eliminate the overflowing bins and stop collecting half-empty ones.
FR-3	Expensive bins.	We help you identify bins that drive up your collection costs. The tool calculates a rating for each bin in terms of collection costs. The tool considers the average distance depo-bin-discharge in the area. The tool assigns bin a rating (1-10) and calculates distance from depo-bin discharge.
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 unefficient 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.

4.1 Non-Functional requirement:

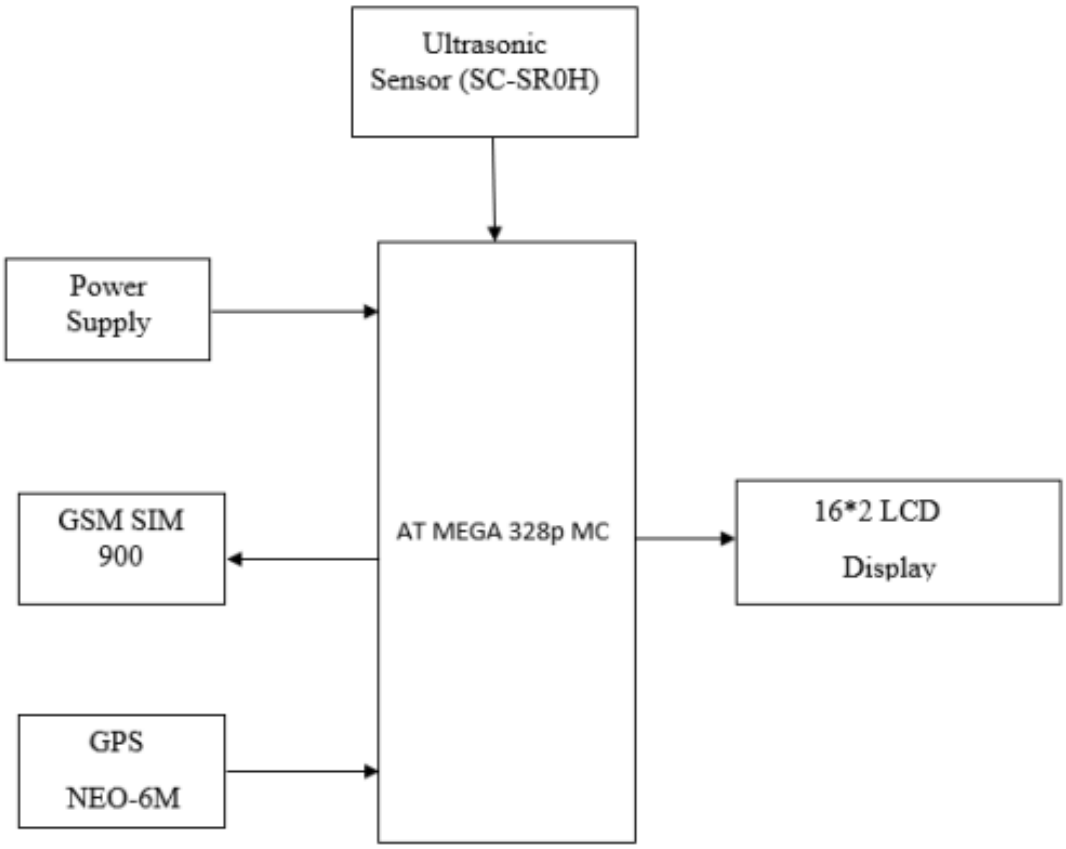
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	IoT device verifies that usability is a special and important perspective to analyse user requirements, which can further improve the design quality. In the design process with user experience as the core, the analysis of users' product usability 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

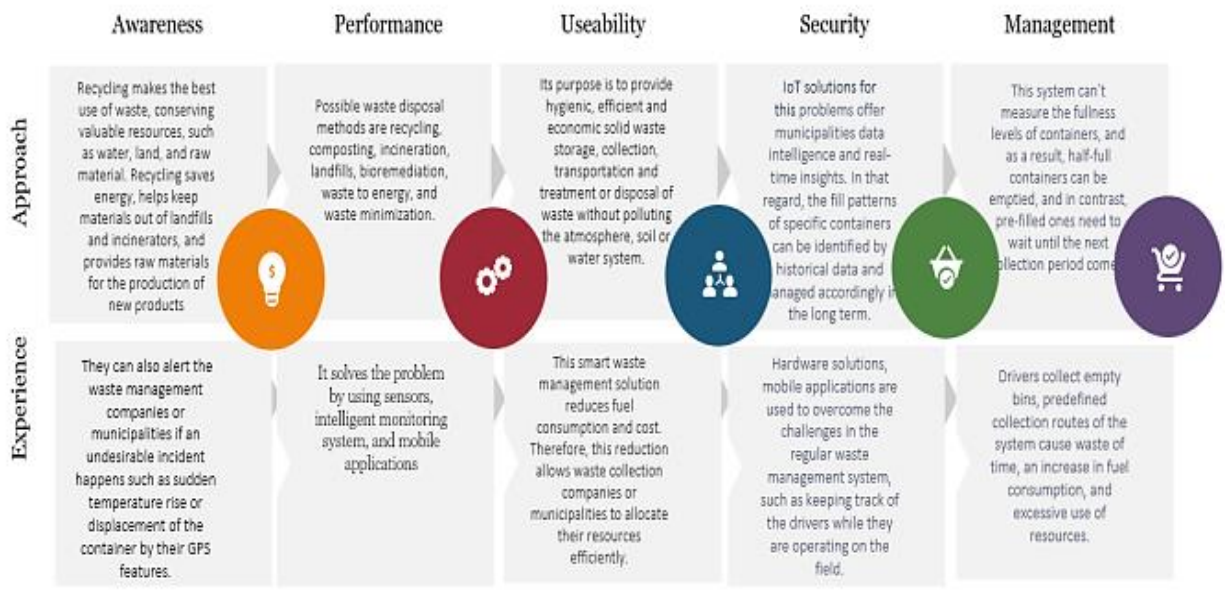
5.1 Data Flow Diagram:



5.2 Solution & Technical Architecture:



5.2: User Stories



6. PROJECT PLANNING & SCHEDULING

6.1Sprint 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.	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

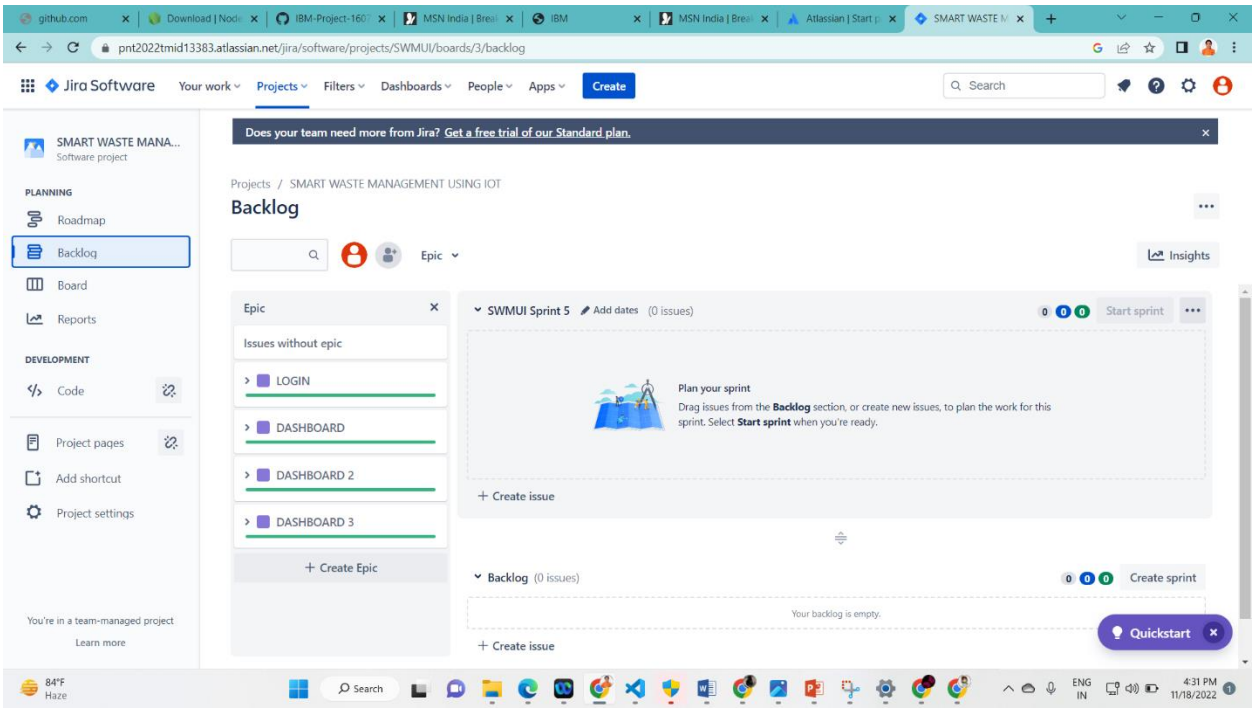
Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).	20 OCTOBER 2022
Functional Requirement	Prepare the functional requirement document.	8 OCTOBER 2022
Data Flow Diagrams	Draw the data flow diagrams and submit for review.	9 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.	IN PROGRESS..

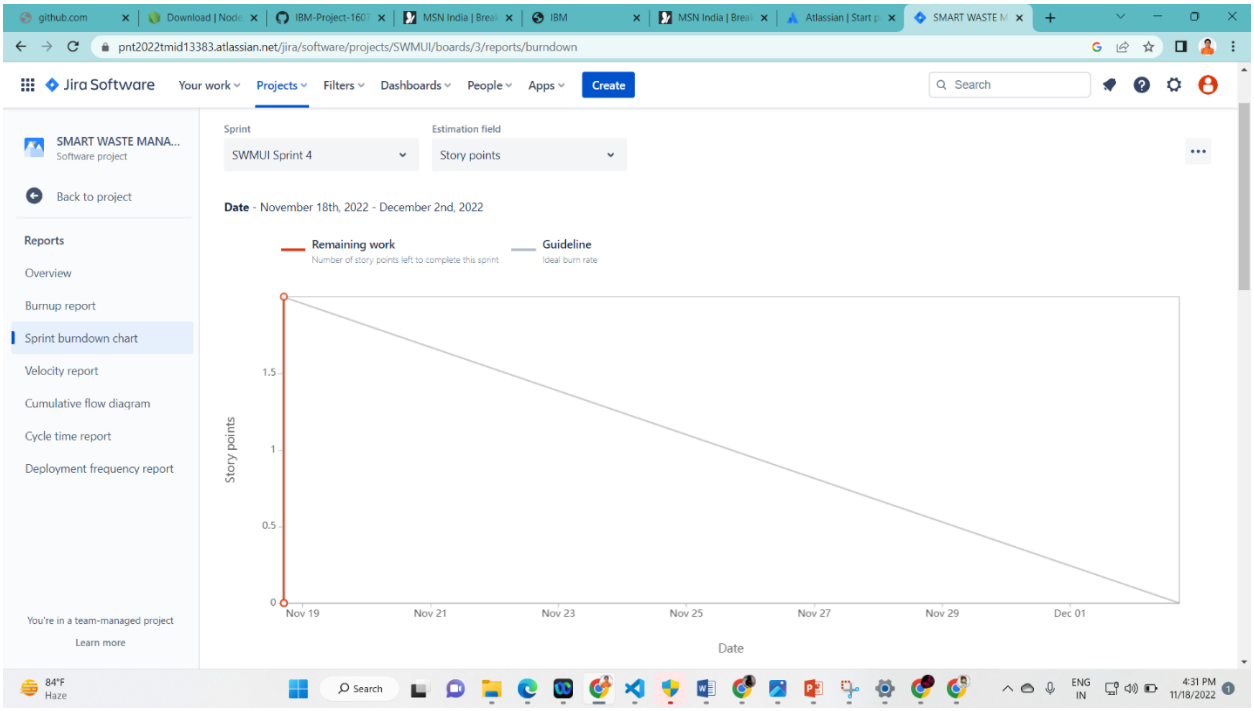
6.2 Sprint Delivery Schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As a Administrator, I need to give user id and passcode for ever workers over there in municipality	2	High	Dhanya Madhushree Kiruba Devadharshini
Sprint-1	Login	USN-2	As a Co-Admin, I'll control the waste level by monitoring them vai real time web portal. Once the filling happens, I'll notify trash truck with location of bin with bin ID	2	High	Dhanya Madhushree Kiruba Devadharshini
Sprint-2	Dashboard	USN-3	As a Truck Driver, I'll follow Co-Admin's Instruction to reach the filling bin in short roots and save time	2	High	Dhanya Madhushree Kiruba Devadharshini
Sprint-3	Dashboard	USN-4	As a Local Garbage Collector, I'll gather all the waste from the garbage, load it onto a garbage truck, and deliver it to Landfills	2	High	Dhanya Madhushree Kiruba Devadharshini
Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	2	High	Dhanya Madhushree Kiruba Devadharshini

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	29 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

6.3Reports from JIRA

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Software project
Back to project
Reports
Overview
Burnup report
Sprint burndown chart
Velocity report
Cumulative flow diagram
Cycle time report
Deployment frequency report
You're in a team-managed project
Learn more
Sprint
SWMUI Sprint 4
Estimation field
Story points
Date - November 18th, 2022 - December 2nd, 2022
Remaining work
Number of story points left to complete this sprint
Guideline
Ideal burn rate
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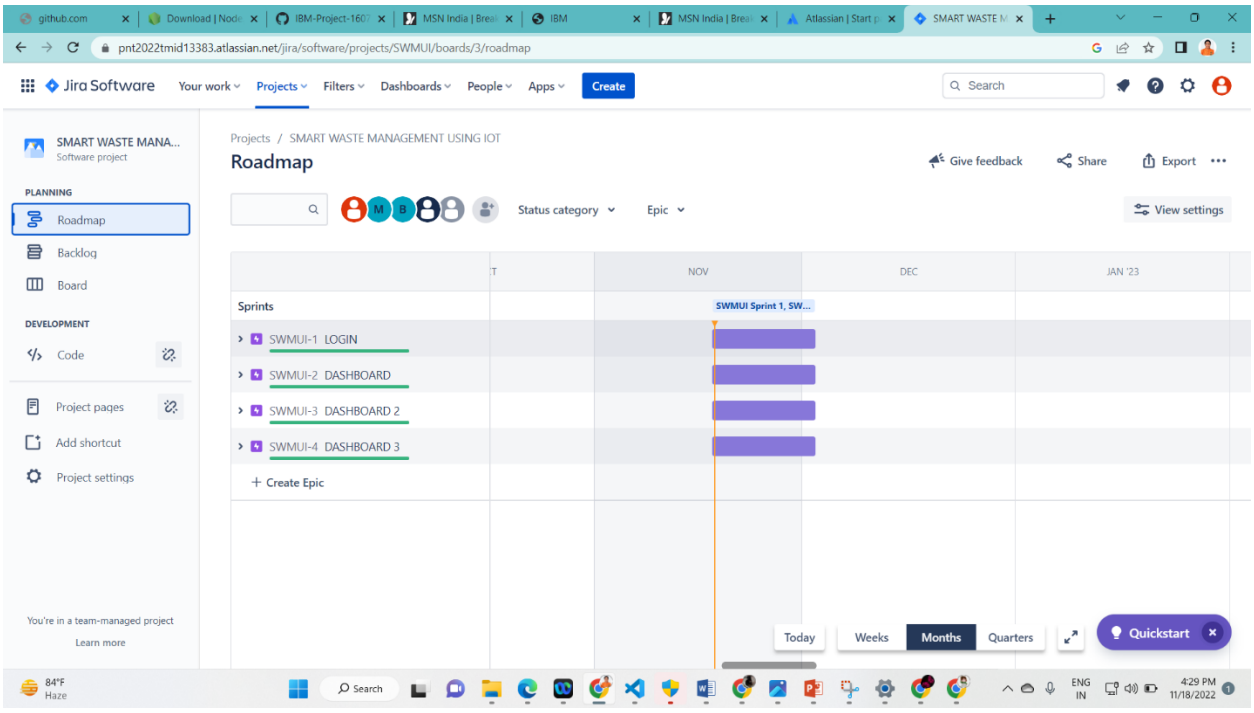
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Backlog
Board
DEVELOPMENT
Code
Project pages
Add shortcut
Project settings
You're in a team-managed project
Learn more
Projects / SMART WASTE MANAGEMENT USING IOT
Roadmap
Give feedback
Share
Export
Status category
Epic
View settings
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SWMUI Sprint 1, SW...
SWMUI-1 LOGIN
SWMUI-2 DASHBOARD
SWMUI-3 DASHBOARD 2
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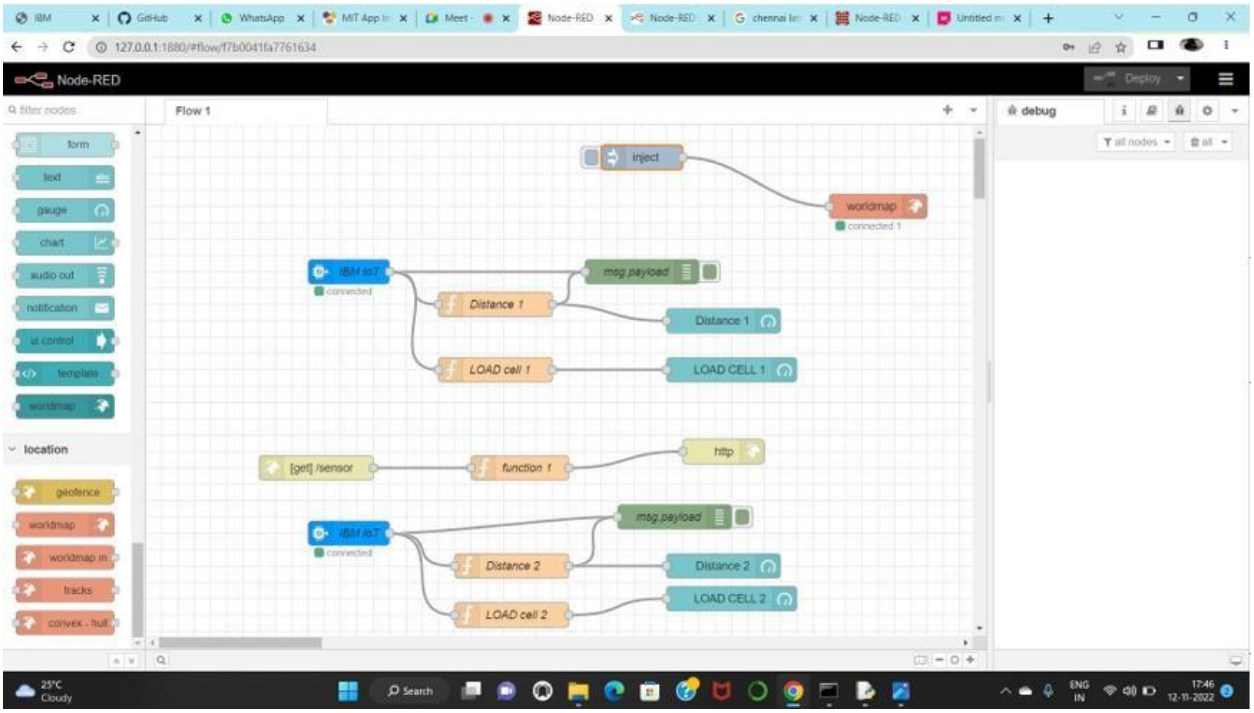
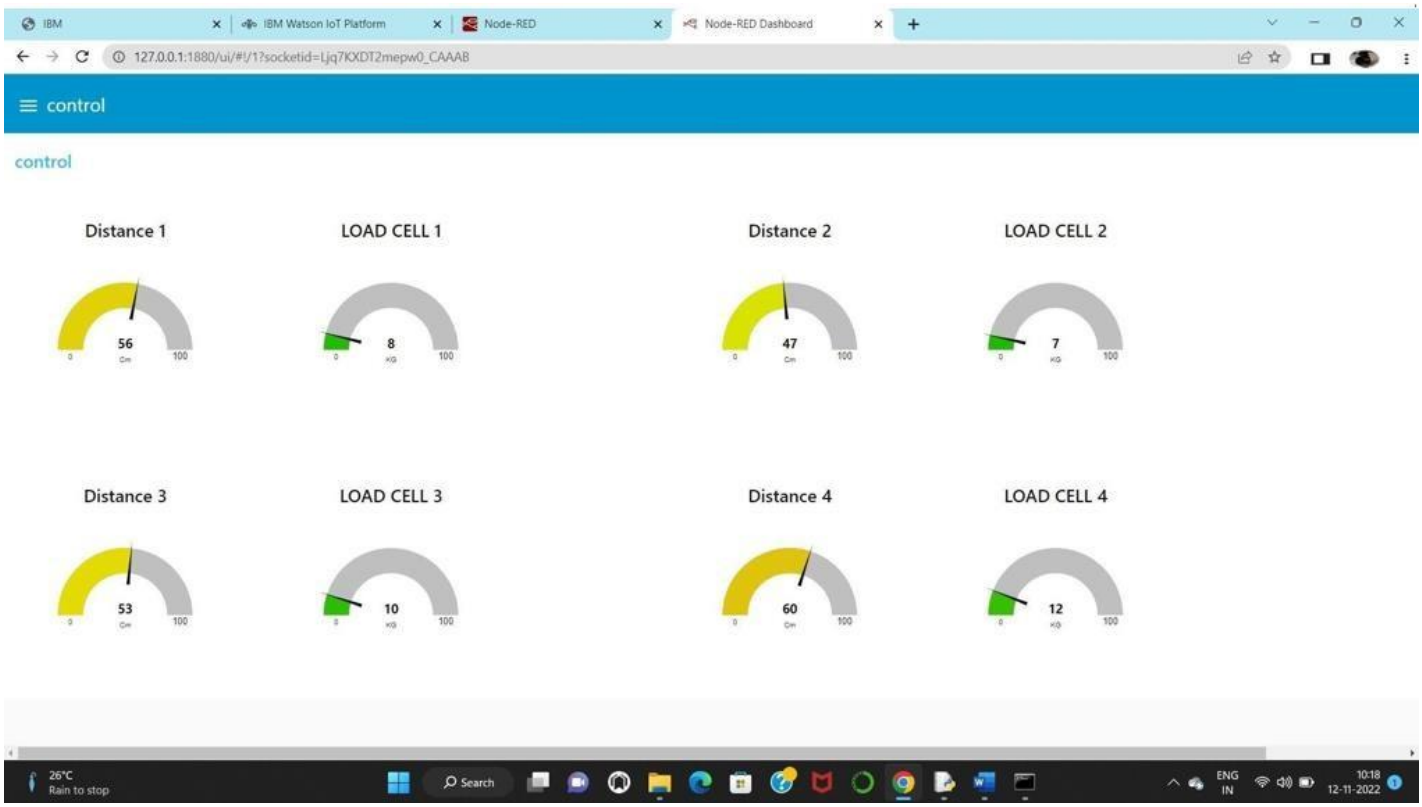
7.CODING & SOLUTIONING

7.1 Feature 1



7.2 Feature 2


IBM
IBM Watson IoT Platform
Node-RED
Node-RED Dashboard
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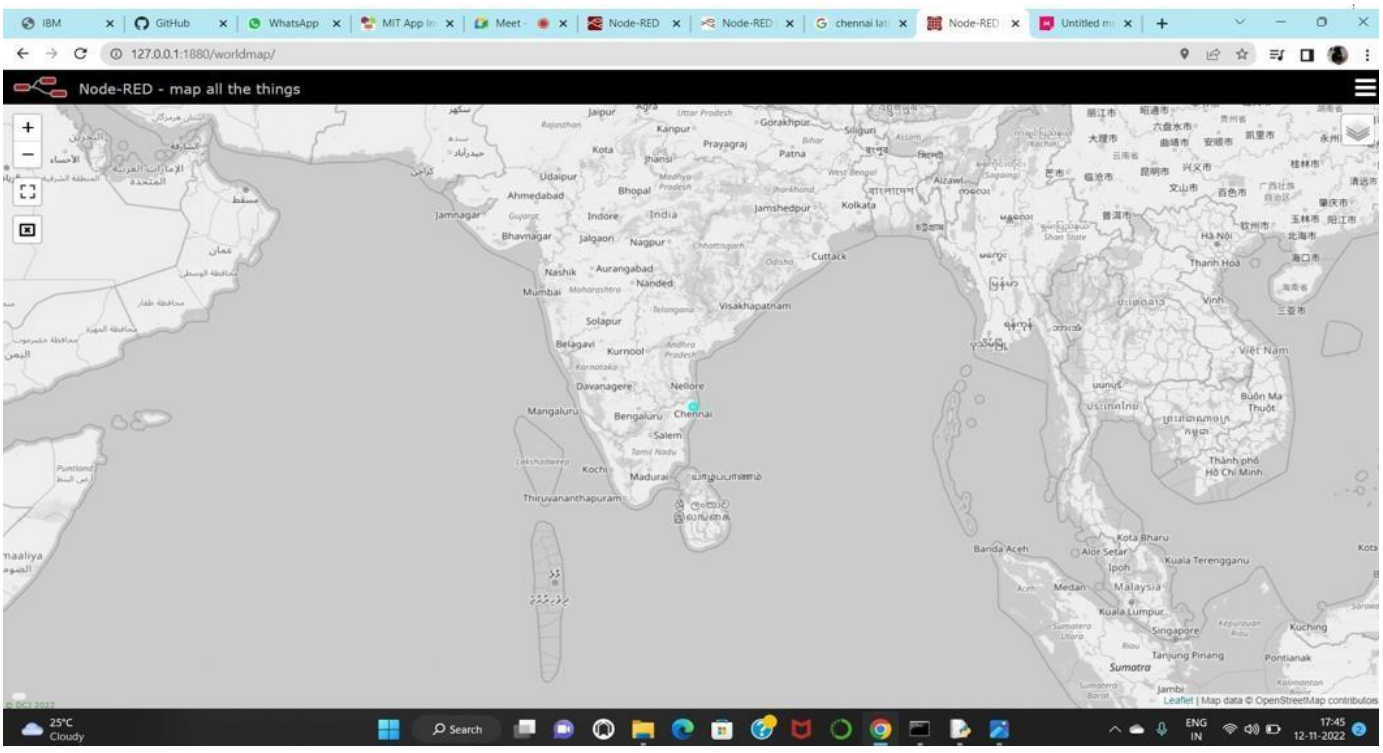
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Node-RED - map all the things
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Udaipur
Ahmedabad
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India
Jamshedpur
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Nashik
Aurangabad
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Vinh
Viet Nam
Buon Ma Thuot
Thanh phố Hồ Chí Minh
Kota Bharu
Alor Setar
Kuala Terengganu
Ipoh
Malaysia
Kuala Lumpur
Singapore
Kuching
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Banda Aceh
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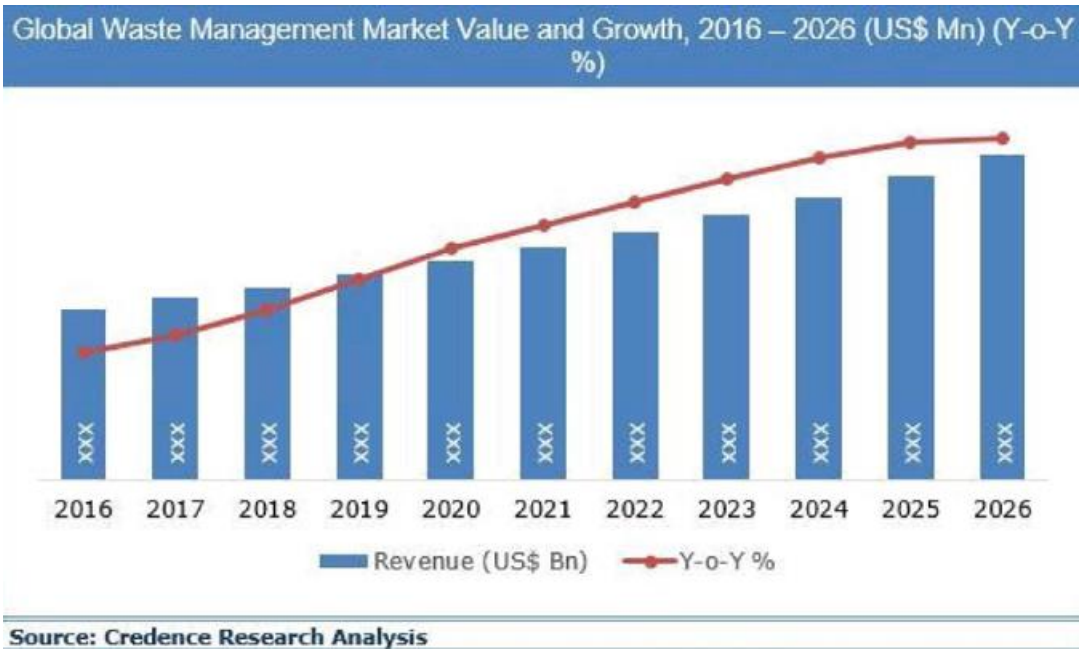
8.TESTING

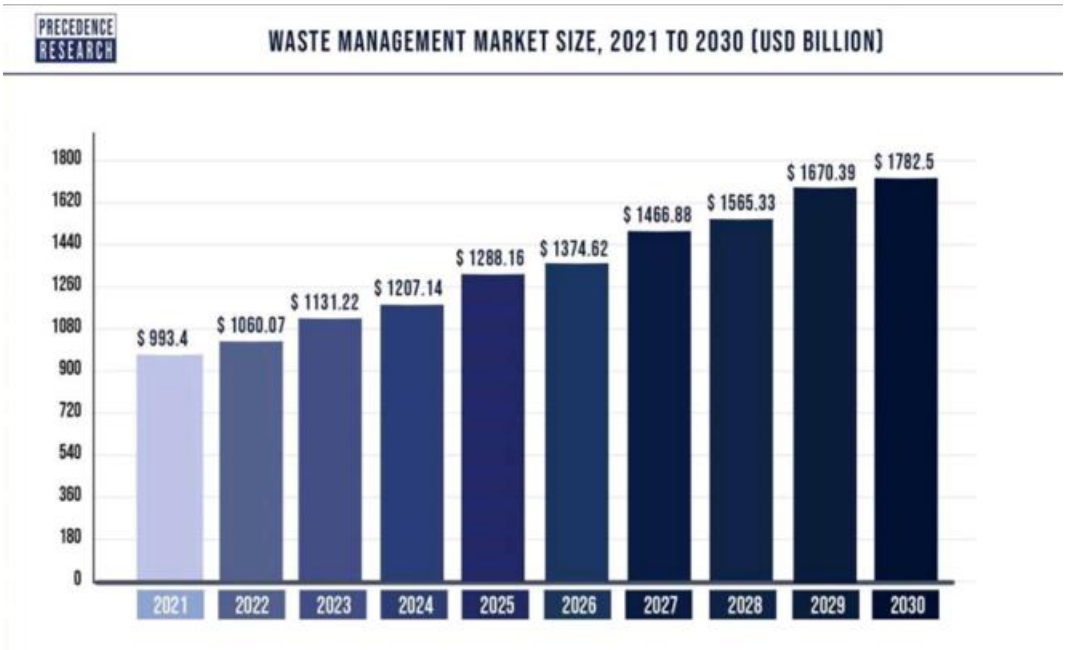
8.1 Test Cases

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 shows 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 shows the 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 shows 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 the whether the pH value is shown are 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 ar connected	node connection	blocks should gets connected	blocks has been connected	PASS	GOOD		MADHUSHREE S
			check whether the output are shown in nodered	output found or not	output should be obtained	output has been obtained	PASS	GOOD		MADHUSHREE S
4	MIT App Invertor	check whether the outputs are shown in	check whether the login is created	id,password	Get into the MIT app invertor	MIT App invertor is getted	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 created	it is created successfully	PASS	GOOD		DHANYA R
			check whether it the block page is created	create block	block should 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 shows 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 install 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 watson is connected	watson	iot watson should produce its output	iot watson has producing its output	PASS	GOOD		DEVADHARSHINI B
			check 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 gets 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:

- Trucks only travel to filled containers, saving time and fuel; fewer trucks on the road means less noise, less traffic, and less air pollution.
- Our sophisticated operating system enables two-way communication between the service provider and the trash cans placed across the city. As a result, the collection of the containers' fill levels based on the route is the only area of concentration.
- Both service providers and citizens benefit from an efficient system that results in significant cost savings and less urban pollution. This is made possible by the sensors put in the containers, which offer real-time information on the fill level.

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.

FUTURE SCOPE:

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

- Change the system of user authentication and atomic lock of bins, which would aid in protecting 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 different days 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.

APPENDIX:

SOURCE CODE:

```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random
#Provide your IBM Watson Device Credentials
organization = "pdgqan"
deviceType = "12345"
deviceId = "MCU"
authMethod = "use-token-auth"
authToken = "vwkMUUgR5IEdOl9(8W"
# 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

 latidude=random.randint(0,100)
 logditude=random.randint(0,100)

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

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

GITHUB LINK:

https://github.com/IBM-EPBL/IBM-Project-1607-1658402409

PROJECT DEMO LINK:

https://youtu.be/P1q8rXidrc8