PROJECT REPORT

Team ID	**PNT2022TMID51674**
Project Name	**Smart Waste Management System For Metropolitan Cities**
Team Members	**SIVAJITH S G - TEAM LEADER** **PRIYANKA B** **BIJO JACOB** **JEWEL ANIL**

1. INTRODUCTION:

Project Overview:

The waste collection process is a critical aspect for the service providers. The traditional way of manually monitoring the wastes in waste bins is a complex, cumbersome process and utilizes more human effort, time and cost which is not compatible with the present-day technologies. Irregular management of waste typically domestic waste, industrial waste and environmental waste is a root cause for many of the human problems such as pollution, diseases and has adverse effects on the hygiene of living beings. In order to overcome all these problems, we are proposing the idea of smart waste management system which helps in auto-management of waste without human interaction in order to maintain a clean environment.

Purpose:

Smart waste management is an idea where we can control lots of problems which disturbs the society in pollution and diseases. The waste management has to be done instantly else it leads to irregular management which will have adverse effect on nature. The Smart waste management is compatible mainly with concept of smart cities. The main objectives of our proposed system are as follows:

- Monitoring the waste management.
- Providing a smart technology for waste system.
- Avoiding human intervention.
- Reducing human time and effort
- Resulting in healthy and waste ridden environment.

This project falls under the category of embedded systems and Node red applications.

2. LITERATURE SURVEY:

Existing problem:

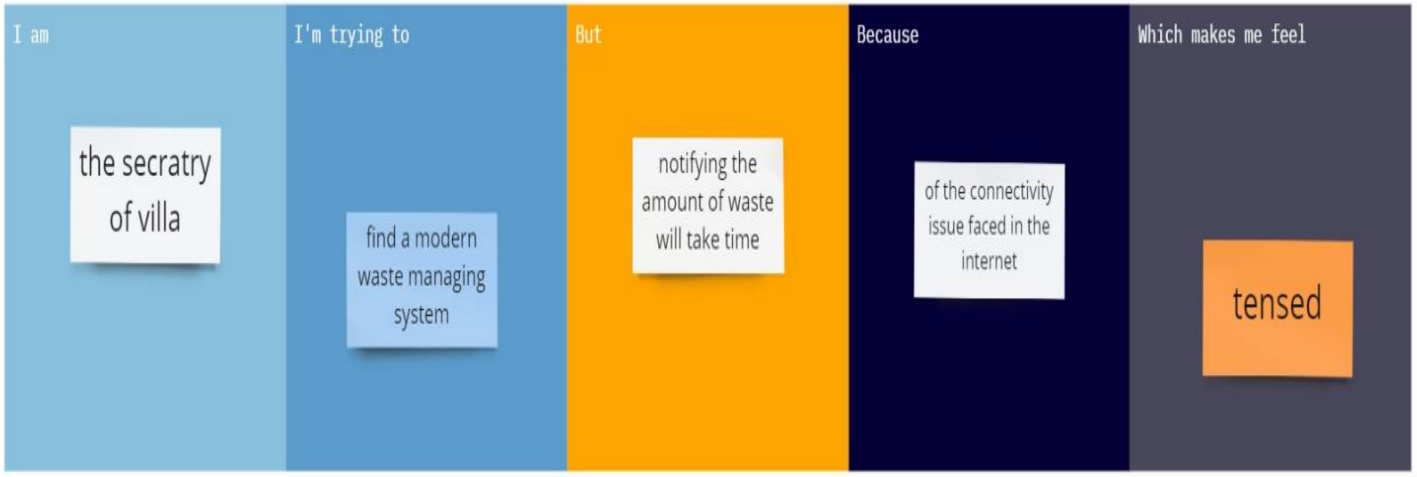
The idea of smart garbage bins and systems have been in discussion for quite a long time. The technologies used at disposal to develop this smart system have also evolved, Internet of Things (IoT). Each idea seems to be similar but is slightly different at its core and our proposed work is no exception from the same. After the IoT field, finding its hold in our lives, this is our original plan for designing a smart garbage collection system which has provision for citizen participation and analysis of data for better decision making. At hardware level, the smart system is a garbage bin with ultrasonic sensor, a micro- controller and Wi-Fi module for transmission of data. The worldwide implementation of Internet of Things is possible with a Cloud centric vision. This work exploits the future possibilities, key technologies and application that are likely to drive IoT research. But a strong foundation to our work is provided, where the basics and applications of Arduino board is explained . It is quite interesting as it implements a GAYT (Get As You Throw) system concept as a way to encourage recycling among citizens. As we would discuss further, the citizen participation part of our system is quite influenced by their work.

References:

S.NO	TITLE	AUTHOR & YEAR	DESCRIPTION
1.	Smart Waste Management usin g WSN and IOT	Sivasankari, Bhanu Shri, Y. BevishJinila 2017	In this paper, they use Wireless Sensor Networks and IOT. The garbage bins are deployed with sensors and are networked together using WSN. The sensorsdeployed in the garbage bins collect the data for every determined interval. Once the threshold is reached, it raises a requestto the GCA (garbage collector agent). This agent collects the requests of all the filled vehicles and communicates using the IoT framework.

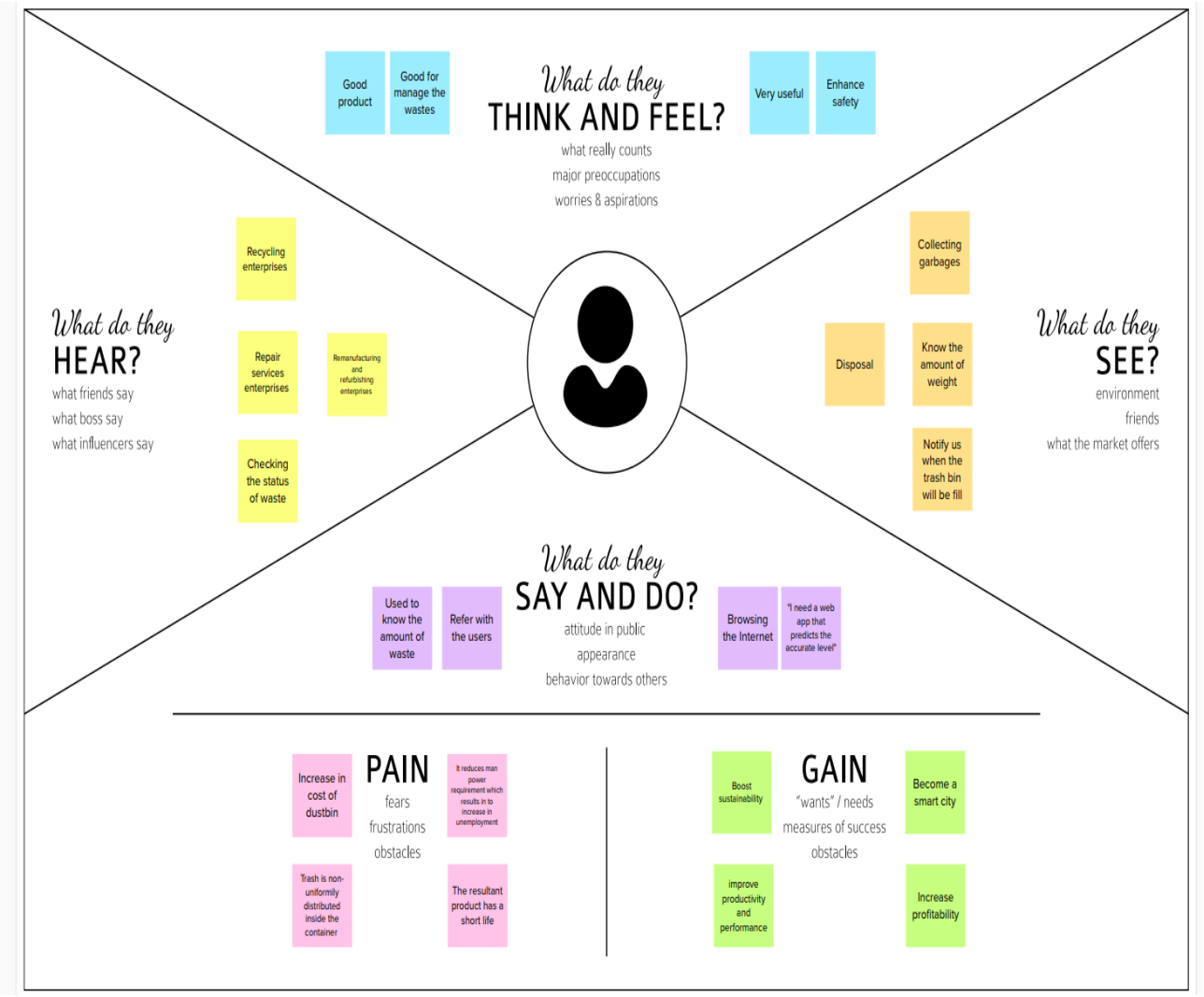
2.	Smart Waste Management System using IOT	Tejashree Kadus, PawankumarNirmal, Kartikee Kulkarni 2020	In this paper, they use an Arduino boardinterfaced with a load sensor, an IR sensor, and a Wi-Fi module instead of a PIR sensor and an ultrasonic sensor. In addition to electrical components,they use mechanical components like the load sensing plate and shredder to crash the trash and then measure the load.
3.	Smart Waste Management System	Bindushree, Manasa, Sanjana Rao, Vidhya Shree, Gowra PS 2021	In this paper, they use sensors, which include an IR sensor for detecting the presence of any waste and a soil moisture sensor to detect whether the waste is dry or wet. The emphasis is primarily on waste segregation, followed by analysis via the website.

Problem Statement Definition:

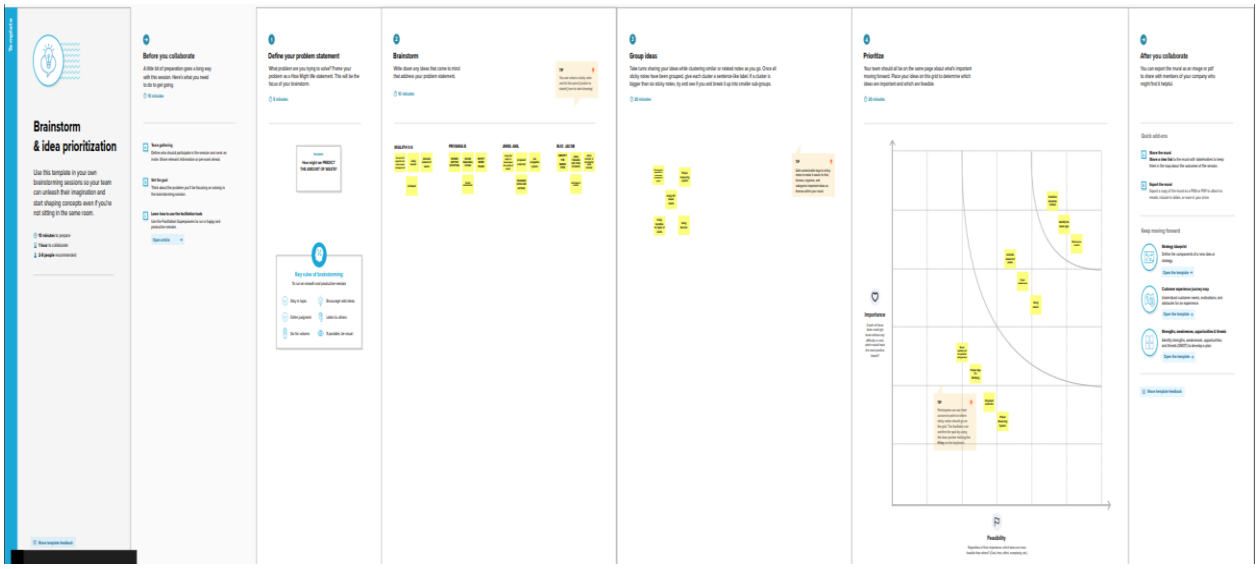


3. IDEATION & PROPOSED SOLUTION

Empathy Map Canvas:


Good product
Good for manage the wastes
What do they
THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations
Very useful
Enhance safety
Recycling enterprises
Repair services enterprises
Remanufacturing and refurbishing enterprises
Checking the status of waste
What do they
HEAR?
what friends say
what boss say
what influencers say
Collecting garbages
Disposal
Know the amount of weight
Notify us when the trash bin will be fill
What do they
SEE?
environment
friends
what the market offers
Used to know the amount of waste
Refer with the users
What do they
SAY AND DO?
attitude in public
appearance
behavior towards others
Browsing the Internet
"I need a web app that predicts the accurate level"
Increase in cost of dustbin
PAIN
fears
frustrations
obstacles
It reduces man power requirement which results in to increase in unemployment
Trash is non-uniformly distributed inside the container
The resultant product has a short life
Boost sustainability
GAIN
"wants" / needs
measures of success
obstacles
Become a smart city
improve productivity and performance
Increase profitability

Ideation & Brainstorming:



Proposed Solution:

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Indiscriminate disposal of solid waste is a major issue in urban centers of most developing countries and it poses a serious threat to healthy living of the citizens. Access to reliable data on the state of solid waste at different locations within the city will help both the local authorities and the citizens to effectively manage the menace
2.	Idea / Solution description	To develop the intelligent solid waste monitoring system using Internet of Things (IoT) and cloud computing technologies. The fill level of solid waste in each of the containers, which are strategically situated across the communities, is detected using ultrasonic sensors.
3.	Novelty / Uniqueness	Analysing the different type of waste.

4.	Social Impact / Customer Satisfaction	Customer satisfaction is an important goal. To meet this goal ,it is necessary to use an evaluation model for measuring the customer satisfaction level. Some important criteria such as, Quality of trash bin ,responsibility of municipal etc. are distinguished and used in the proposed model.
5.	Business Model (Revenue Model)	Smart waste management is one of the essential component of today's technology. It will reduce the waste in cities and reduce the man power.It help to calculate types of waste and amount of the waste. The waste management services take care of a healthy environment allowing optimization of the utilities and prevent overloading the carrier for waste disposal
6.	Scalability of the Solution	We can use the capacitance sensor in the bin continuously monitors the level of the bin in real time and communicates to the central cloud where the bins are connected. Ultrasonic sensor is used to open and close the lid of the bin whenever the persons are nearby the bin

Problem Solution fit:

Project Title: Smart Waste Management System For Metropolitan Cities

Project Design Phase-I - Solution Fit Template

Team ID: PNT2022TMID51674

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Who is your customer?

Customers will be the corporation officers in metropolitan cities

6. CUSTOMER CONSTRAINTS

What constraints prevent your customers from taking action or limit their choices of solutions?

Budget friendly,network connection.

5. AVAILABLE SOLUTIONS

Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? is an alternative to digital notetaking

There will be a support care to get jobs done

Explore AS, differen

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS

Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.

A good network connection is the main task and will be solve by giving a stable connectivity

9. PROBLEM ROOT CAUSE RC

What is the real reason that this problem exists? What is the back story behind the need to do this job?

There will be connectivity issues or a lag in passing message in the app

7. BEHAVIOUR BE

What does your customer do to address the problem and get the job done?

Customers can directly contact the support care of the system they will guide to solve that job done

Focus on J&P, tap into BE, understand RC

3. TRIGGERS TR

What triggers customers to act?

This system in an city will force an another city to follow that system if It is a successful system

10. YOUR SOLUTION SL

If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.

If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.

The team of that system will put there maximum

8. CHANNELS of BEHAVIOUR CH

8.1 ONLINE

What kind of actions do customers take online? Extract online channels from #7

8.2 OFFLINE

What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.

FR-6	Detailed bin inventory.	On the map, you can see every monitored bin and stand, and you can use Google Street View at any time to visit them. On the map, bins or stands appear 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. REQUIREMENT ANALYSIS:

Functional requirement:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User Authentication	Authentication with OTP via SMS/email Authentication via social networks
FR-4	User Authorization	Role-Based Access Controls(RBAC) OpenID Authorization
FR-5	External Interfaces	Interaction logic between user and software Software interfaces like frontend, backend, etc. Buttons, functions on the model
FR-6	Reporting	SMS notification for reports/alerts Email notification for reports/alerts

Non-Functional Requirements:

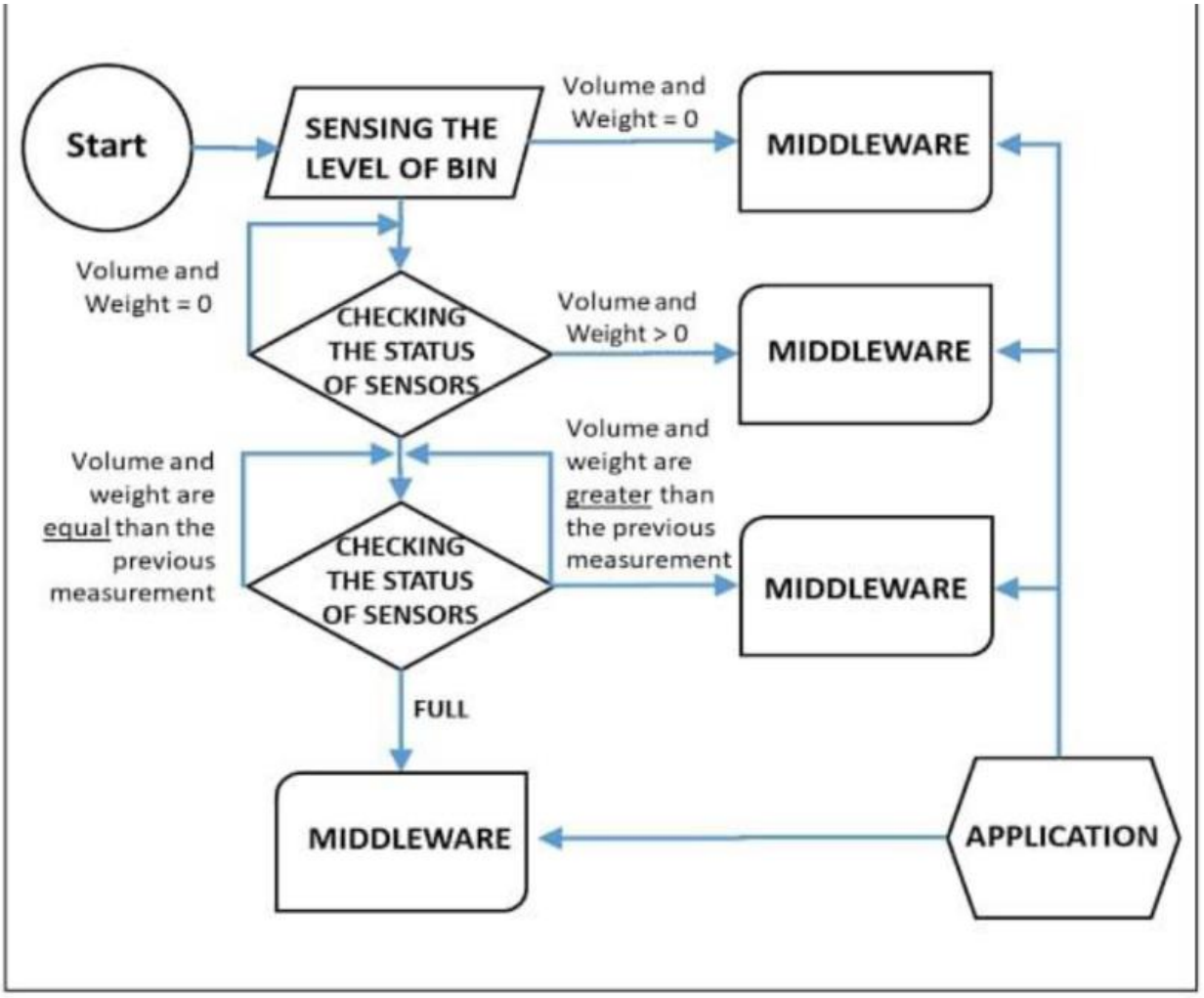
Following are the non-functional requirements of the proposed solution**.**

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Smart City technology evolved together with the developments in wireless sensor networks (WSN) and the Internet of Things (IoT). Smart cities essentially combine the use of ICT to provide services for better living conditions inside cities
NFR-2	**Security**	The model predicts the correct and accurate result. It is protected to avoid the large amount of waste which is filled in trash bins .
NFR-3	**Reliability**	This model is predicts the amount of wastes ,notify when the trash is fill,differentiate the types of waste in the trash.

NFR-4	**Performance**	It measures the full trashbins completely .Production of reports shall take less than minutes.
NFR-5	**Availability**	Before the man have to check the trash bins.But now this model will all the things through the application via mobilephones or other devices.
NFR-6	**Scalability**	This model can reduce the man power

5. PROJECT DESIGN:

Data flow diagram:



A data flow diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirements graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored. A smart waste management platform uses analytics to translate the data collected in your bins into actionable insights to help you improve your waste services.

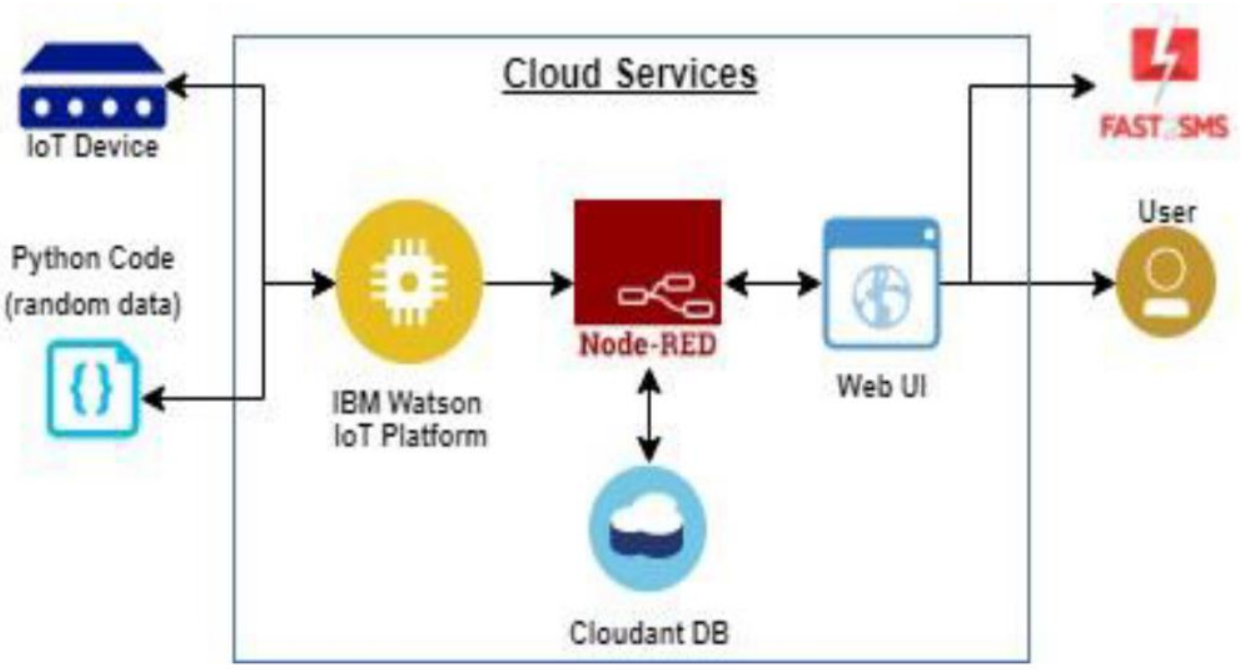
You can receive data on metrics such as:

- The first email alert sent by the system is sent when the garbage bin is empty or has a very low garbage level.

- The second SMS notification sent by the system indicates that the bin is at least 90% 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 saved

Solution & Technical Architecture:

S. No	Component	Description	Technology
1.	Raspberry pi	Control the overall devices and sensors	Python
2.	Ultrasonic Sensor	Senses the level of bins	Sensing technology used
3.	Load sensor	Senses the weight of bins	Sensing technology used
4.	GSM module	Establishes communication between mobile device and GSM	Mobile Communication Technology used
5.	GPS Module	Sends location of bins	Global positioning technology used
6.	Cloud Database	Database Service on Cloud	IBM Cloudant
7.	Web UI	Displays the data	Node Red
8.	IOT platform	Manages an IOT ecosystem	IBM Watson IOT platform


Cloud Services
IoT Device
Python Code
(random data)
IBM Watson
IoT Platform
Node-RED
Cloudant DB
Web UI
FAST SMS
User

User Stories:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	I can register & access the dashboard with Gmail login	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Sprint-1
	Dashboard	USN-6	As a user, I can log into the dashboard by entering username & password	I can access the website	High	Sprint-1
Customer (Web user)	Analysis of water quality	USN-7	As a user, I can access the water quality prediction section.	I can get the water quality	High	Sprint-1
Customer Care Executive	Customer queries	USN-8	As a customer care Executive, I can check the customer queries they posted in the website.	I can improve the customer satisfaction.	High	Sprint-1
Administrator	Maintaining website	USN-9	As an administrator, I can maintain website and enhance the online presence.	I can improve the website's appearance & usability.	High	Sprint-2
		USN-10	As an administrator, I can maintain issues in analysing values.	I can improve the accuracy of predicting values.	High	Sprint-2
		USN-11	As an administrator, I can update the website content	I can ensure the content is in harmony with the customer's overall objectives	Medium	Sprint-2
		USN-12	As an administrator, I can improve the website.	I can enhance user experience	High	Sprint-2

6. PROJECT PLANNING AND SCHEDULING:

Sprint Planning and Scheduling:

TITLE	DESCRIPTION	DATE
Literature Survey & Information Gathering	**Literature survey on the selected project & gathering information by referring the, technical papers,research publications etc.**	**13 OCTOBER 2022**
Prepare Empathy Map	**Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements**	**16 SEPTEMBER 2022**
Ideation	**List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.**	**13 OCTOBER 2022**
Proposed Solution	**Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.**	**14 OCTOBER2022**

Problem Solution Fit	**Prepare problem - solution fit document.**	**14 OCTOBER 2022**
Solution Architecture	**Prepare solution architecture document.**	**14 OCTOBER 2022**
Customer Journey	**Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).**	**23 OCTOBER 2022**
Functional Requirement	**Prepare the functional requirement document.**	**14 OCTOBER 2022**
Data Flow Diagrams	**Draw the data flow diagrams and submit for review.**	**23 OCTOBER 2022**
Technology Architecture	**Prepare the technology architecture diagram.**	**23 OCTOBER 2022**
Prepare Milestone & Activity List	**Prepare the milestones & activity list of the project.**	**07 NOVEMBER 2022**
Project Development - Delivery of Sprint-1, 2, 3 & 4	**Develop & submit the developed code by testing it.**	**IN PROGRESS..**

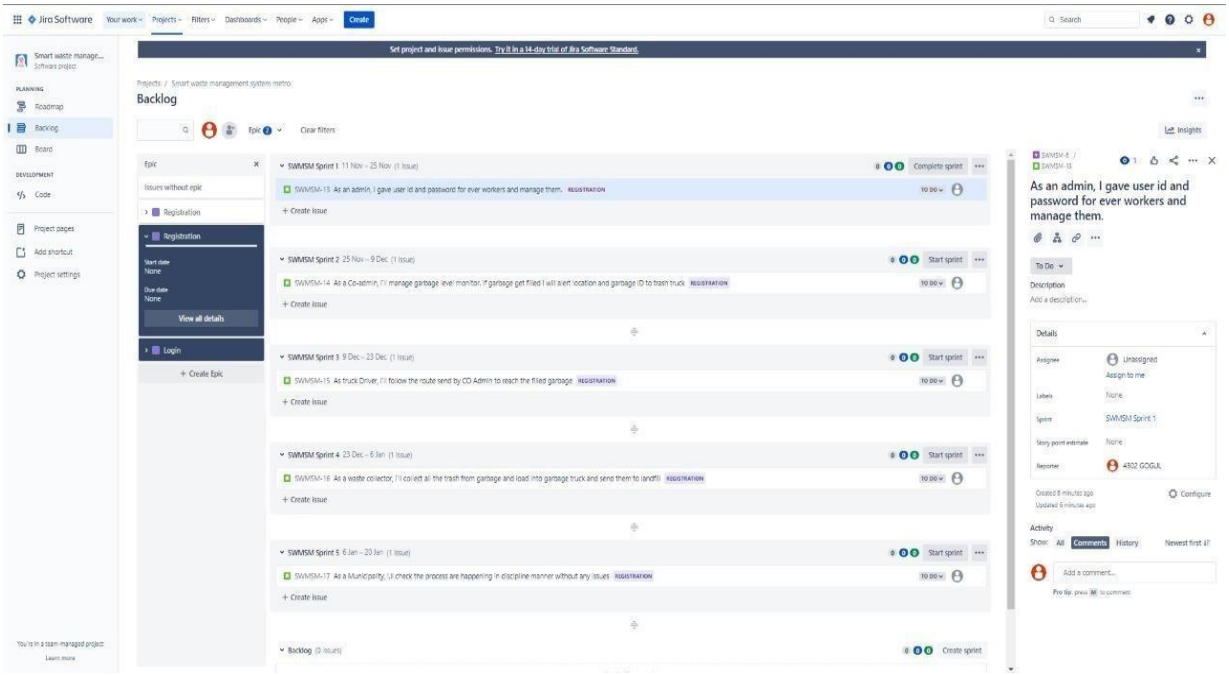
Sprint Delivery Schedule:

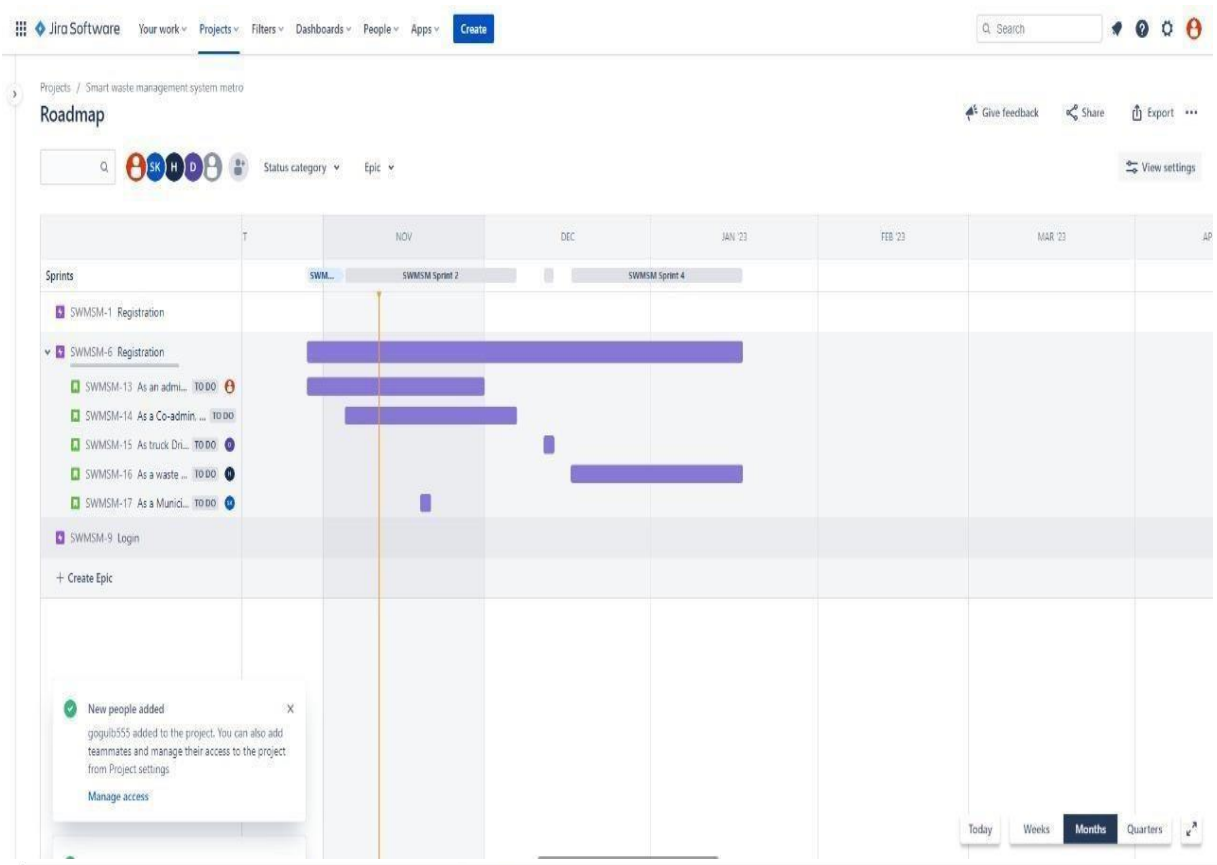
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	Sivajith S G Priyanka B Jewel Anil Bijo Jacob

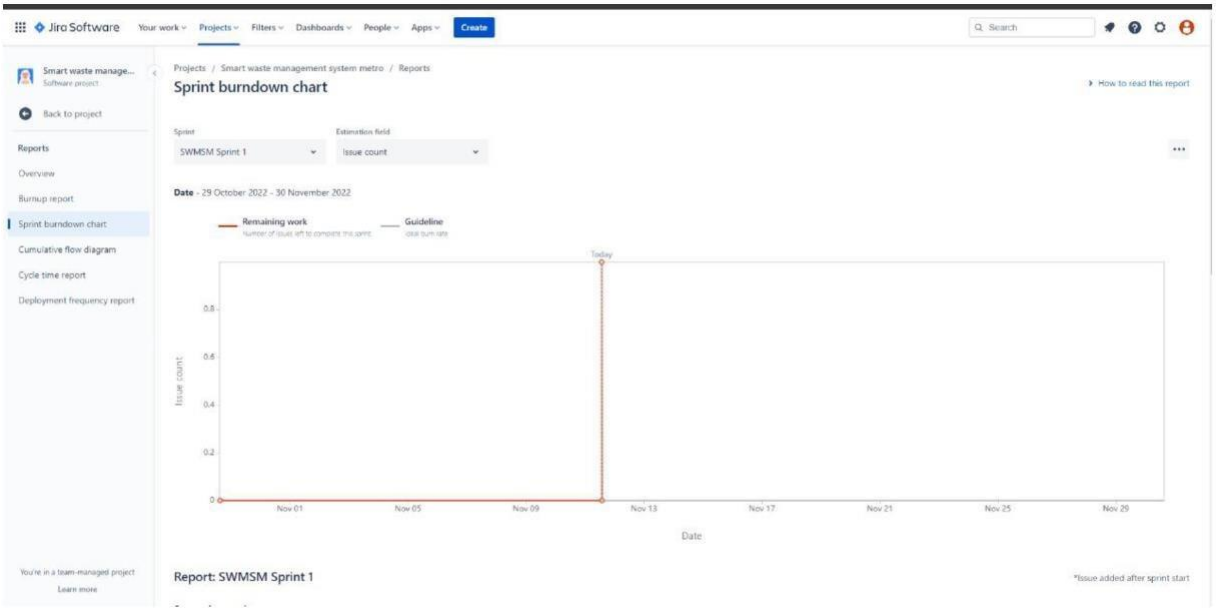
Sprint-1		USN-2	As a user, I can register for the application through gmail,linkedin	1	High	Sivajith S G Priyanka B Jewel Anil Bijo Jacob
Sprint-2	Login	USN-2	As a user,I can login by using valid user name and password.	2	High	Sivajith S G Priyanka B Jewel Anil Bijo Jacob
Sprint-3	Dashboard	USN-3	As a user,I can view the garbage storage level.	2	Medium	Sivajith S G Priyanka B Jewel Anil Bijo Jacob
Sprint-4	Blynk-App	USN-4	Blynk Server is responsible for all the communications between the smartphone and hardware.	2	High	Sivajith S G Priyanka B Jewel Anil Bijo Jacob

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	3 Days	8 Nov 2022	10 Nov 2022	20	10 Nov 2022
Sprint-2	20	3 Days	11 Nov 2022	13 Nov 2022	20	13 Nov 2022
Sprint-3	20	3 Days	14 Nov 2022	16 Nov 2022	20	16 Nov 2022
Sprint-4	20	3 Days	17 Nov 2022	19 Nov 2022	20	19 Nov 2022

Reports from JIRA:

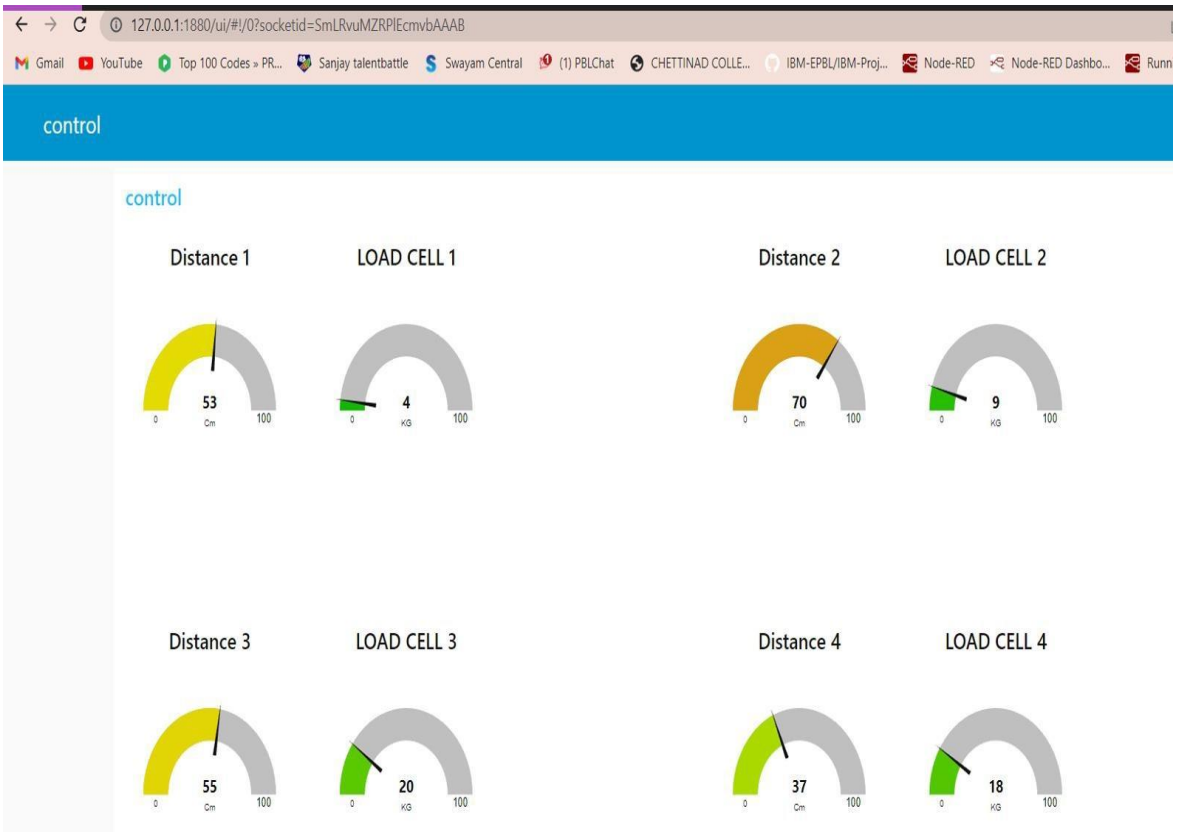






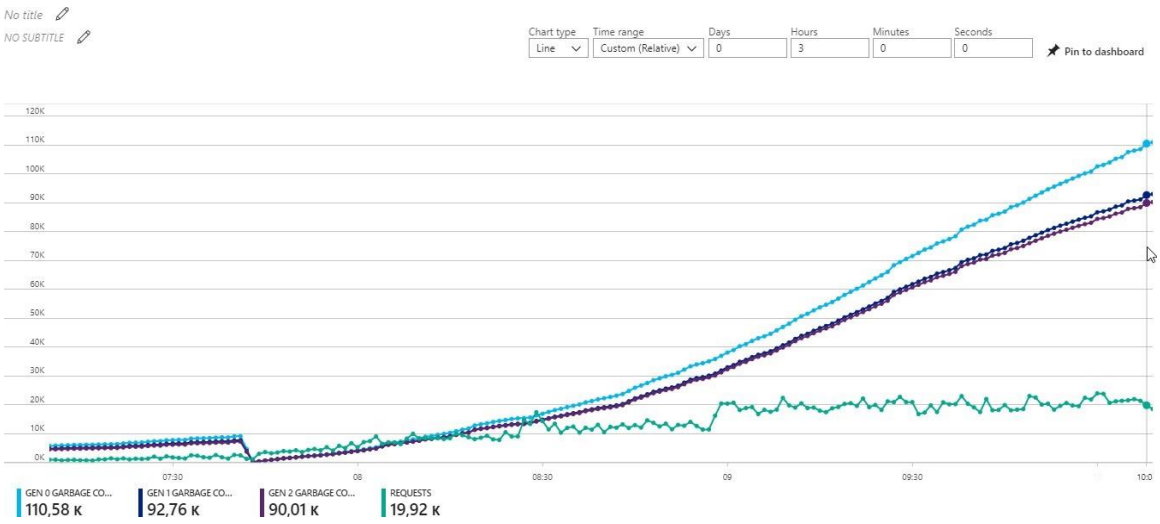
7. CODING AND SOLUTIONING:

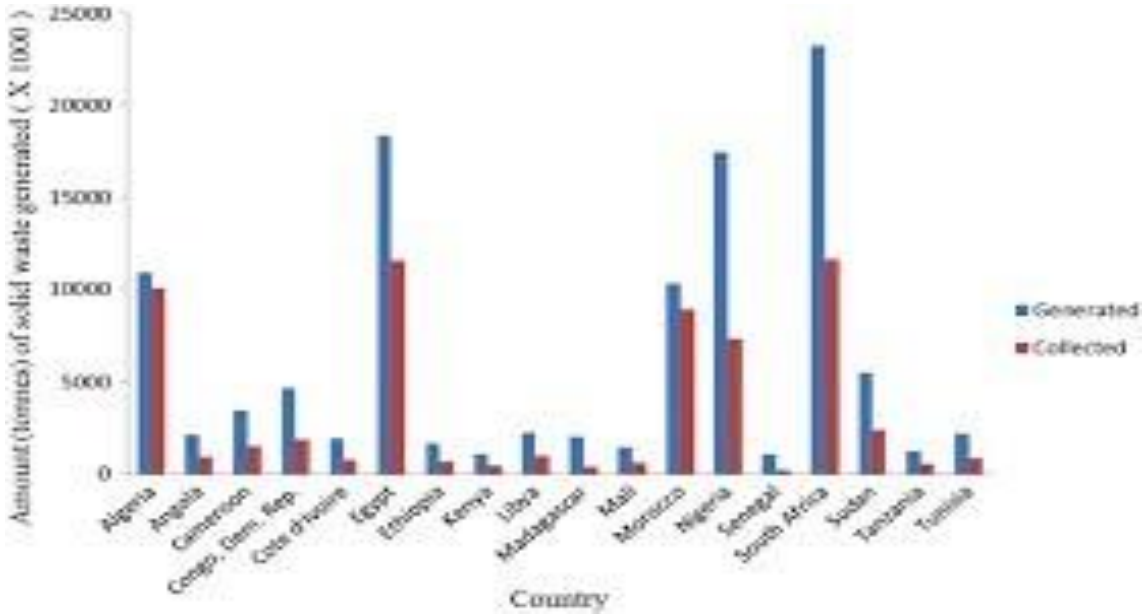
Feature 1: Web UI showing Level and Load of bin



8. RESULTS:

Performance Metrics:





9. ADVANTAGES & DISADVANTAGES:

ADVANTAGES:

- Provides the real-time level and load of bins as well as the location.
- Reduction of CO2 gas.
- Provides a hygienic environment by preventing the overflow of waste.

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. CONCLUSION:

Monitoring the fullness of bins through the use of sensors, it is possible to achieve a more efficient system than the current existing. Our idea of “Smart waste management system”, mainly concentrates on Monitoring the waste management, providing a smart technology for waste system, avoiding human intervention, reducing human time and effort and which results in healthy and waste ridden environment. The proposed idea can be implemented for smart cities where the residents would be busy enough with their hectic schedule and wouldn’t have enough time for managing waste. The bins can be implemented in a city if desired where there would be a large bin that can have the capacity to accumulate the waste of solid type for a single apartment. The cost could be distributed among the residents leading to cheaper service provision.

11. FUTURE SCOPE:

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

- In case there are more dustbins, we can also make separate dustbins for dry waste and wet waste.
- The proposed solution is flexible. And decoupled with respect to the determination of optimal number of bins and vehicles, or to the algorithm that defines the best route for vehicles.

11. APPENDIX:

Source code:

```
import time import
random import sys
import requests import
json import
ibmiotf.application
import ibmiotf.device #
watson device details
organization = "3w5ire"
devicType = "Dustbin"
deviceId = "DustbinID"
authMethod= "token"
authToken=
"987654321"
#generate random values for random variables (Distance and load)
def myCommandCallback(cmd):
  global a
  print("command recieved:%s" %cmd.data['command'])
  control=cmd.data['command']
```

```
    print(control)
try:
deviceOptions={"
org": organization,
"type":
devicType,"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 "Distance" with value integer value into the cloud as a type
of event for every 10 seconds
deviceCli.connect()
while True:
    lat= 10.9368
    lon= 78.1366
    location= "Puliyur karur"
    Distance= random.randint(1,75)
    Loadcell= random.randint(0,20)
    data=
    {'dist':Distance,'load':Loadcell,'Latitude':lat,'Longitude':lon,'Location':location} if
    Loadcell<5 and Loadcell>0:
        load="20%"
    elif Loadcell<10 and
        Loadcell>5: load="40%" elif
    Loadcell<15 and
```

```
        Loadcell>10: load="60%" elif
    Loadcell<18 and
        Loadcell>15: load="80%" elif
    Loadcell<20 and
        Loadcell>18: load="90%"
    else:
        load="100%"
    if Distance<7 and Distance>1:
        level="90%"     elif
    Distance<15 and
        Distance>7: level="80%" elif
    Distance<30 and
        Distance>15: level="60%" elif
    Distance<45 and
        Distance>30: level="40%" elif
    Distance<60 and
        Distance>45: level="20%" elif
    Distance<75 and
        Distance>60: level="10%"
    else:
        level="0%"
if level=="90%" or load=="90%":
        warn = 'alert:"Dustbin is almost filled in latitude:10.9368 and longitude:78.1366
        Puliyur
  karur'
    def myOnPublishCallback(latitude=10.9368,longitude=78.13
        66): print("Puliyur,Karur,Tamilnadu")
```

```
        print("published Level of bin = %s " %level,"Load = %s " %load, "Latitude = %s "
    %latitude,"Longitude = %s " %longitude) print(load) print(level) print(warn)
    time.sleep(0)
       success=deviceCli.publishEvent
    ("IoTSensor","json",warn,qos=0,on_publish= myOnPublishCallback)
       success=deviceCli.publishEvent ("IoTSensor","json",data,qos=0,on_publish=
    myOnPublishCallback)
       if not success:
          print("not connected to ibmiot") time.sleep(20)
       deviceCli.commandCallback=myCommandCallbac
       k
    #disconnect the device
    deviceCli.disconnect()
```

Github Link : https://github.com/IBM-EPBL/IBM-Project-48845-1660813583