Project Report

Team ID	PNT2022TMID04593
Project Name	Smart Waste Management System for Metropolitian cities

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Waste disposal without consideration is a significant problem in the urban areas of the majority of developing nations, and it seriously jeopardises the residents' ability to live a healthy lifestyle. Both the local government and the populace will benefit from having access to trustworthy data on the situation with solid waste at various points throughout the city.Rapid population development in recent years has increased the amount of rubbish that needs to be disposed 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. Many trash cans can be found around the city or on campus (at educational institutions, businesses, hospitals, etc.). The mission's goal is to visit every part of the nation, both urban and rural, in order to promote it as the ideal nation to the rest of the world. In this study, the Internet of Things (IoT) and cloud computing technologies are used to create an intelligent solid waste monitoring system. Ultrasonic sensors are used to measure the solid waste fill levels in each of the containers, which are placed in strategic locations around the community. This article introduces a trash management system in which each dumpster has a monitoring system built in that will alert the appropriate person when the dumpster is full. Wet and dry garbage can be separated into two different containers using this approach. This technology offers a practical remedy for the waste management issue.

1.2 PURPOSE

The proposed system takes use of sensor and communication technologies, gathering rubbish data from the smart bin in real-time and transferring it to an online platform that city residents may use to check on the availability of the various compartments.

2. LITERATURE SURVEY

2.1 EXISTING PROBLEM

- Manual systems in which employees clear the dumpsters periodically
- No systematic approach towards clearing the dumpsters
- Unclear about the status of a particular location
- Employees are unaware of the need for a particular location
- Very less effective in cleaning city.

2.2 REFERENCES

1. S. Paul et al. smart garbage monitoring system using IoT based on Arduino UNO which monitors the bin level and segregated biodegradable and non-biodegradable waste. The system uses ultrasonic sensor to measure the bin level in the dustbin. A servo motor is used to segregate the bio-degradable and non-biodegradable waste by moving the waste left and right. A RC-A-524 Metal Detector Sensor Module is used to detect whether the waste is metallic or not. If waste has metallic content, it is marked non-biodegradable, otherwise it is marked biodegradable. Two IR sensors are used. First IR sensor is placed on the top of the bin which detects the waste and activates the metal detector. Second IR sensor is placed at the bottom of the bin which checks if the garbage has been kept outside the bin. An OV7670 image sensor collects the image data and a Computer Vision API is used to check whether the waste is an objectionable item or not. All these sensors and circuits are interfaced with Arduino UNO. ESP8266 WIFI module is connected to the system which grants WIFI access to the system. This monitoring also has an alert system for certain wastes such as bombs or weapons.

2. Chen et. al. proposed a Smart Waste Management System that uses a microcontroller unit along with infrared sensor, gas sensor and a 3- axis compass. The microcontroller unit is used as an interface between the sensors and the server. The infrared sensor and gas sensor are used to determine the fill level and the smell level of the dustbin respectively. The readings from these sensors are sent to the server via WiFi module in indoor settings and LongRange module (LoRa) in outdoor settings. The data sent to server is then stored into a MySQL database by the Data manager. The data is monitored periodically by the alert function and when the fill level of dustbins cross the threshold level, a notification function is evoked which sends the notification to the truck driver along with route that is created using Google Maps.

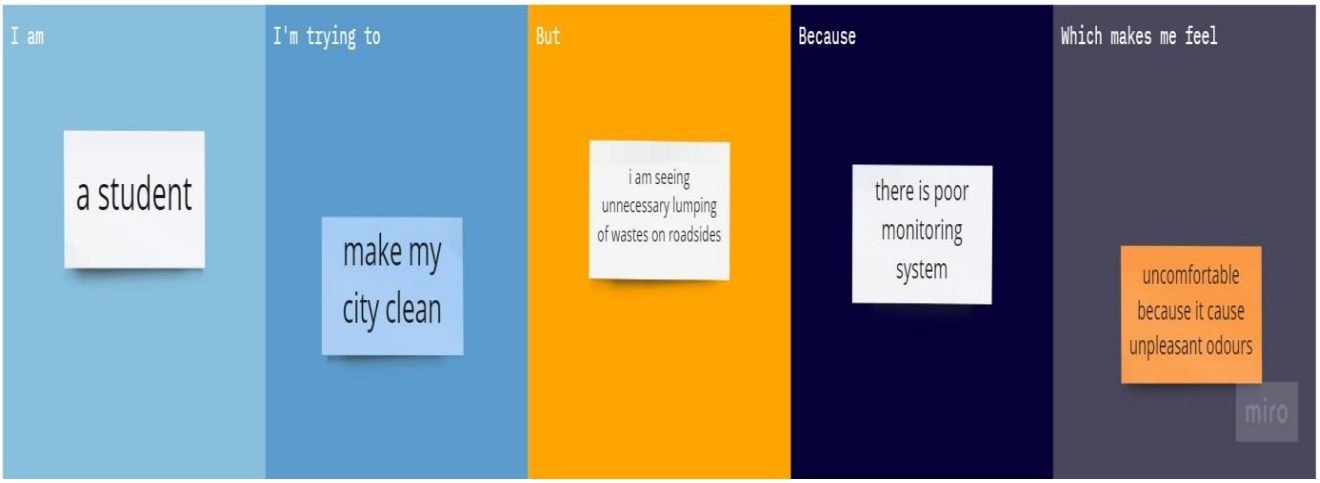
3. Andreasi et.al., accomplished a comparative analysis on solid household waste and its impact on environment in seven European countries such as Germany, Denmark, France, UK, Italy, Poland and Greece. The authors considered those countries to represent the whole European Union. The collection, separation, treatment and disposal process as the waste management in this research. All countries need to update their technology periodically to meet the current challenges in the waste management process. Shilan et al [9] from Iraq developed a smart solid waste monitoring and collection system. Ultrasonic Sensor Arduino Uno and Radio Frequency (RF) transmitter were installed on the top of the waste box for the monitoring task. A message (SMS) will be sent to the mobile phone of the truck driver about the location and ID of the dustbin whenever the waste box is full and needs for disposing the garbage.

4.Thompson A.F, Afolayan A.H, Ibidunmoye E.O projected work about the internet-based platform for the organization and monitoring of waste collection, discarding and carrying etc. This is comprised of the client, server and storage. The client is the device which can access the pages and forms used by web application e.g. PDAs, phones, laptops etc. the desktop is a program that launches the application and makes it performs over the internet. The limitation of this paper is that it only shows the location of the bin in the web page. In the proposed system, the level of waste in the dustbins is detected with the help of Ultrasonic sensor. Force sensor is used to measure the weight of the dust bin. When the measured value of sensors exceeds a

certain threshold value then red led becomes ON (i.e.it indicates dustbin is filled else green led is ON) this information with GPS location where the dust bin is located is communicated to android device through GSM system. Android device will detects, in which area dustbin is located, by comparing coordinates and updates the location and inform the respective vehicle to collect the waste. Microcontroller is used to interface the sensor system with GSM.

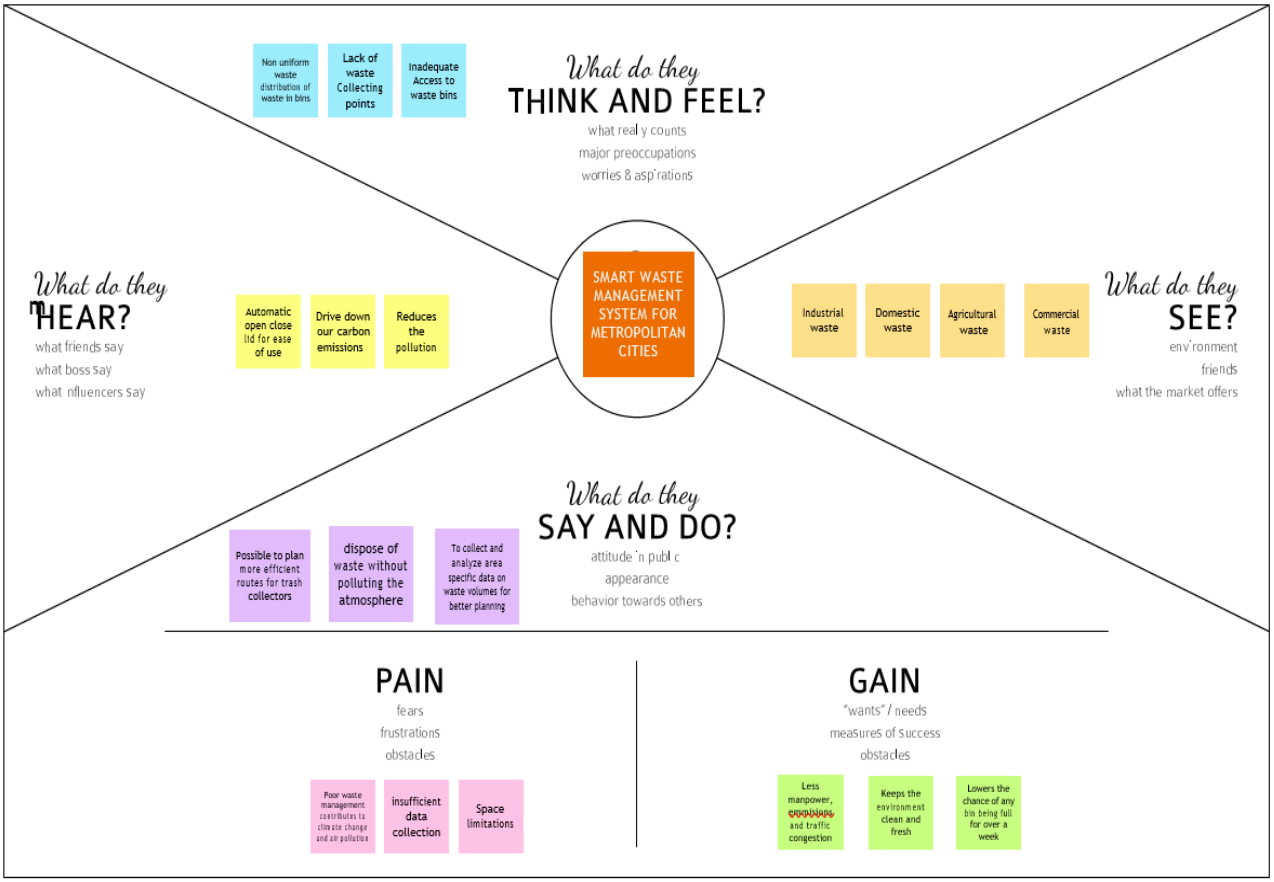
5. Shilan et al [9] from Iraq developed a smart solid waste monitoring and collection system. Ultrasonic Sensor Arduino Uno and Radio Frequency (RF) transmitter were installed on the top of the waste box for the monitoring task. A message (SMS) will be sent to the mobile phone of the truck driver about the location and ID of the dustbin whenever the waste box is full and needs for disposing the garbage.

2.3PROBLEM STATEMENT DEFINITION



3.IDEATION & PROPOSED SOLUTION

3.1EMPATHY MAP CANVAS



3.2IDEATION &BRAINSTORMING

Templat

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 collaborate
2-8 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

A **Team gathering**
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B **Set the goal**
Think about the problem you'll be focusing on solving in the brainstorming session.

C **Learn how to use the facilitation tools**
Use the Facilitation Superpowers to run a happy and productive session.

Open article

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

PROBLEM
How might we [your problem statement]?

Brainstorm

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

10 minutes

Person 1

- Alerts the authorized person to empty the bin whenever the bins are full
- Can view the location of every bin using web application by sending GPS location from the device
- Help to create cleaner, safer, more hygienic environment

Person 2

- Avoids unnecessary lumping of wastes on roadside
- Improvement in monitoring systems, data collection
- Reduce the wastage of plastic bags

Person 3

- Able to get the weight of the garbage in the bin
- Enhanced operational efficiency while reducing management costs
- Less manpower, emissions, fuel use and traffic congestion

Person 4

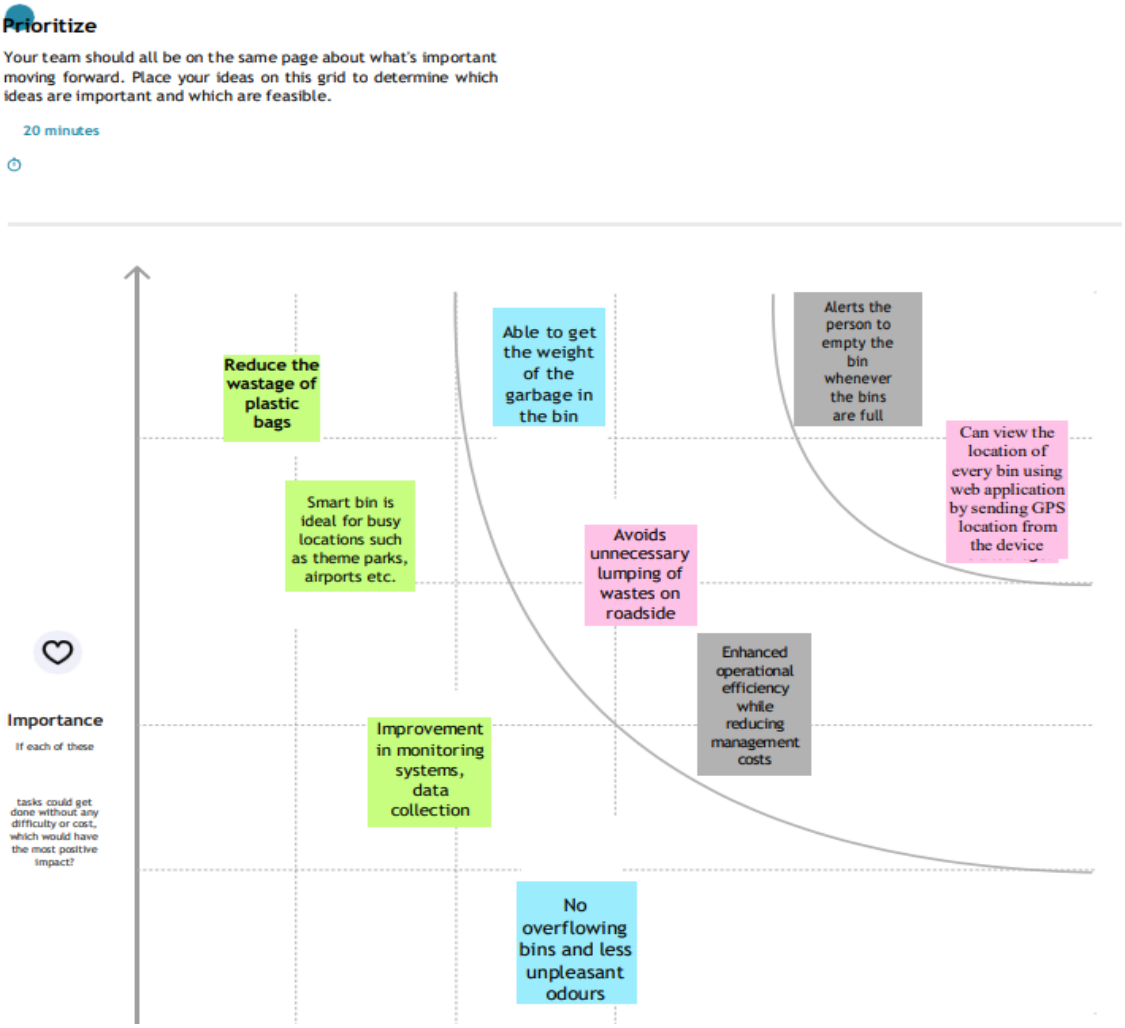
- Reduction in the number of waste bins needed
- Smart bin is ideal for busy locations such as theme parks, airports etc.
- No overflowing bins and less unpleasant odours

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 and break it up into smaller sub-groups.

20 minutes

- Alert to Empty the Bin When Full
- Less Manpower, Emissions
- Real Time Waste Monitoring
- Help to create cleaner and more hygienic environment
- Can view the location of the bin

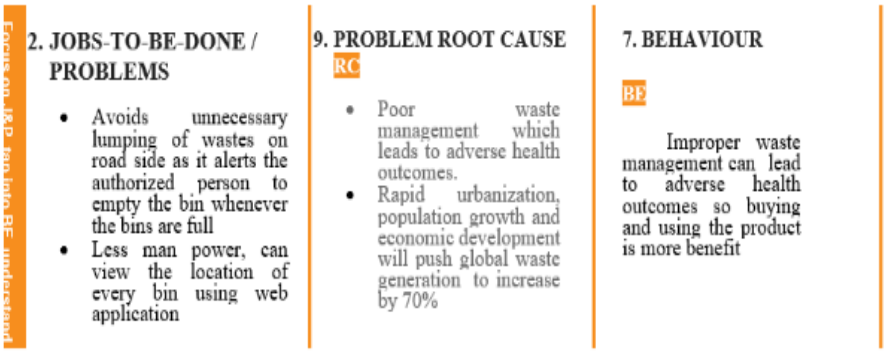


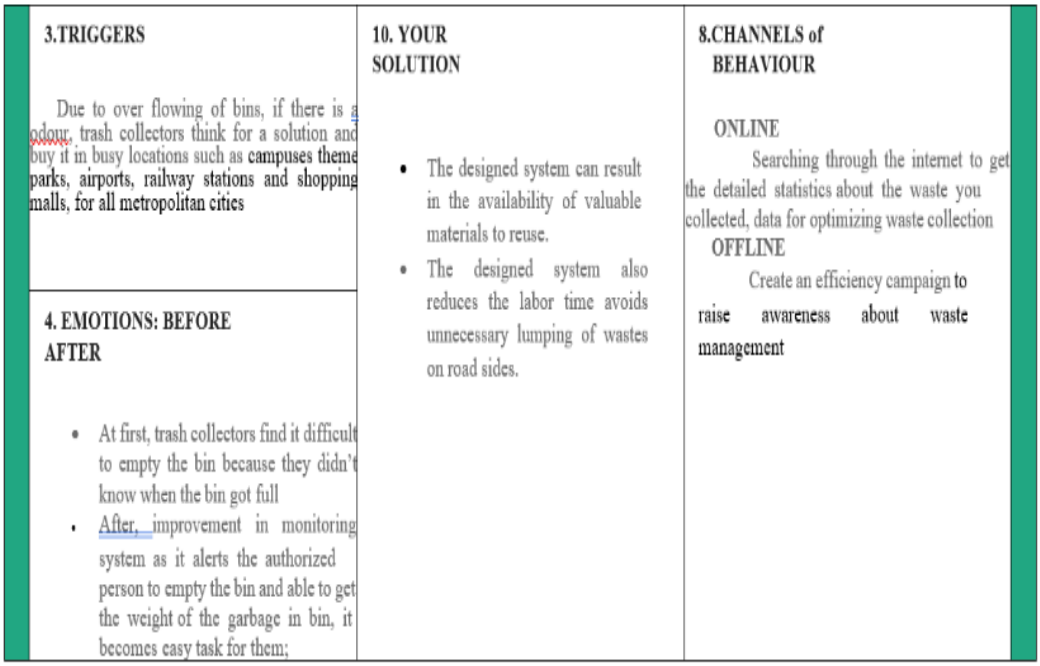
3.3 PROPOSED SOLUTION

S.No.	Parameter	Description
1.	ProblemStatement(Problemtobesolved)	Difficultyingarbageleveldetectioninbins
2.	Idea/Solutiondescription	Garbagelevelofthebinscanbemonitoredthroughawebapp.
3.	Novelty/Uniqueness	We are planning to establish Smart wastemanagementinourcollegebutthereal hardthing is that janitor (cleaner) don't know tooperate these thing practically so here ourteam planned to build a wrist band to them,that indicate via lightblinking.
4.	SocialImpact/CustomerSatisfaction	Fromthecustomerperception neighborhood of landfills to communities,breedingofpestsandlossinpropertyvalues

5.	BusinessModel(RevenueModel)	Solid Waste, comprising the Company's wastecollection, transfer, recycling and resourcerecovery, and disposal services. Corporate and Other, comprising theCompany's other activities, including itsdevelopment and operation of landfill gas-to-energy facilities in the INDIA, and its recyclingbrokerageservices,aswellasvariouscorporate functions.
6.	ScalabilityoftheSolution	Smart city design has beenincreasingly studied and discussed around theworld to solve this problem. Following thisapproach,thispaperpresentedan efficientIOT- based and real-time waste management modelfor improving the living environment in cities. The proposedsystem uses sensor and communicationtechnologies where waste data is collectedfrom the smart bin.

2.1 PROBLEM SOLUTION FIT





3. REQUIREMENT ANALYSIS

3.1 FUNCTIONAL REQUIREMENT

FR No.	FunctionalRequirement(Epic)	SubRequirement(Story/Sub-Task)
FR-1	Detailsofthebin	You can see bin details in the Dashboard – capacity,wastetype,lastmeasurement,GPSlocationa nd collectionscheduleor pickrecognition.
FR-2	BinMonitoring	With real-time data and predictions we can eliminatethe riskof binoverflowingandstopcollectinghalf emptyones.
FR-3	Costof bins	It helps to identify bins that drive up your collectioncosts.Thetoolcalculates aratingforeach binin terms of collectioncosts.
FR-4	AdjustinglevelofGarbage	Ensure the most optimal distribution of bins. Identifyareas with either dense or sparse bin distribution. Makesure alltrashtypesare representedwithinastand. Based on the historical data, you can adjust bin capacityorlocationwherenecessary.

FR-5	Eliminateinsufficientgarbage	Eliminate the collection of half-empty bins. The sensorsrecognize picks. By using real time data on fill-levels andpick recognition, we can show you how full the bins youcollect are. The report shows how full the bin was whenpicked.Youimmediatelysee anyinefficientpicksbelow 80% full.
FR-6	Planningforwaste collection	The application semi-automates waste collection routeplanning. Based on current bin fill levels and predictionsof reaching full capacity, you are ready to respond andschedulewastecollection.Youcancompare plannedvs. executedroutesto identifyanyinconsistencies.

3.2 NON-FUNCTIONAL REQUIREMENT

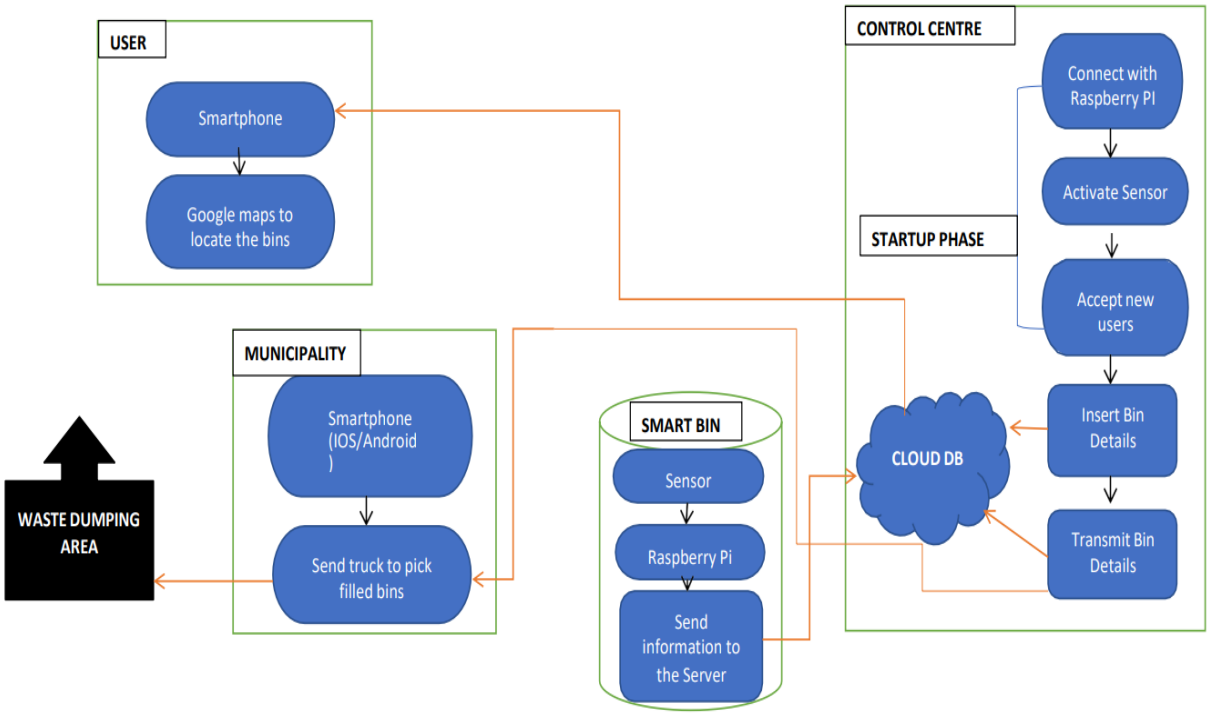
FR No.	Non-FunctionalRequirement	Description
NFR-1	**Usability**	This Smart Waste Management technology allows toempty bins before they become overflowing withtrashorrecycling,andbeforeinfestationbecomes an issue.
NFR-2	**Security**	As the data processed is all about wastes level andbin location there is no fear of attacks in thismechanism. Innovations in waste reductiontechnologiesallow usto bettermonitor,prevent, andmanageourwaste.
NFR-3	**Reliability**	Smart Bins help to create a cleaner, safer, morehygienic environment and enhanced operationalefficiencywhilereducingmanagement costs, resources,androad-sideemissions.
NFR-4	**Performance**	Instead of driving the same collection routes andservicing empty bins, waste collectors will spendtheir timemoreefficiently,takingcareofbins that needservicing.
NFR-5	**Availability**	The system should be available all the time whenrequired. The admin end system should have a highspeedconnectiontoreceivealldataandprocess all complaints andbindata.
NFR-6	**Scalability**	Using smart bin reduces the number of bins insidecities because we able to monitor the garbage 24/7moreefficientandscalabilitywhen wemove Smarter

5.PROJECT DESIGN

Data Flow Diagram

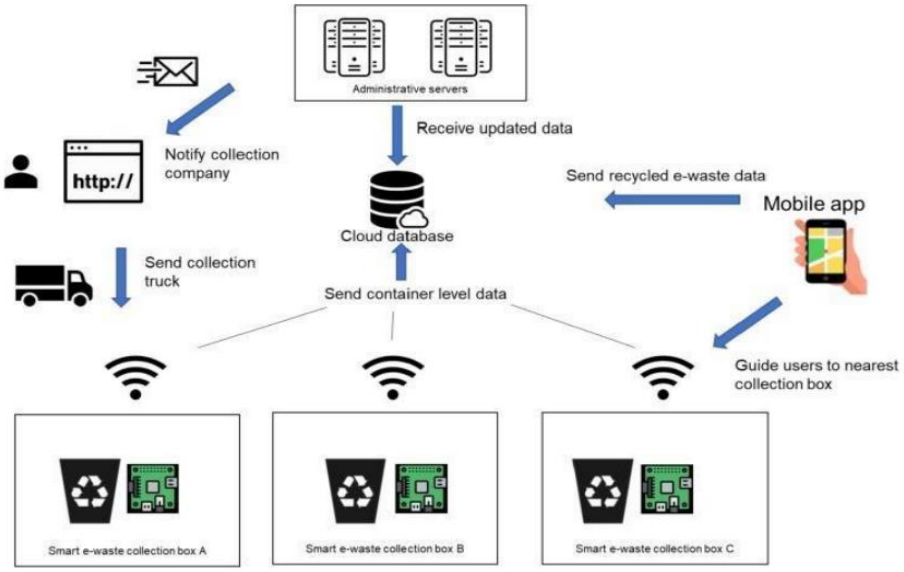
A data flow diagram (DFD) is a graphical or visual depiction that details how data is moved through an organization's activities.

5.1 DATA FLOW DIAGRAMS



5.2 SOLUTION & TECHNICAL ARCHITECTURE

Solution Architecture



5.3 USER STORIES

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user / Web user)	Registration	USN-1	User can sign up using their email and password and confirm the details.	I can access my account/ dashboard	High	Sprint
Admin	Registration and login	USN-2	As an Admin, I will manage the details entered by the user.	I can manage the account	High	sprint
Co Admin	Login	USN-3	As a Co Admin, I will manage bin details and I will send the information to the municipality.	I can handle bin details.	High	sprint
Truck Driver	Login	USN-4	As a Truck driver, I will collect the trash from the filled bins.	I can reach the bin location.	Medium	sprint
Municipality	Login	USN-5	As a Municipality, I will monitor the entire process.	I can manage the entire process.	High	sprint

6.PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

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

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	10	High	GUNANANTHINI S
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	20	High	ABIRAM N V
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	20	Medium	HARI PRASANTH V
Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	Medium	ASWIN K U

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	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

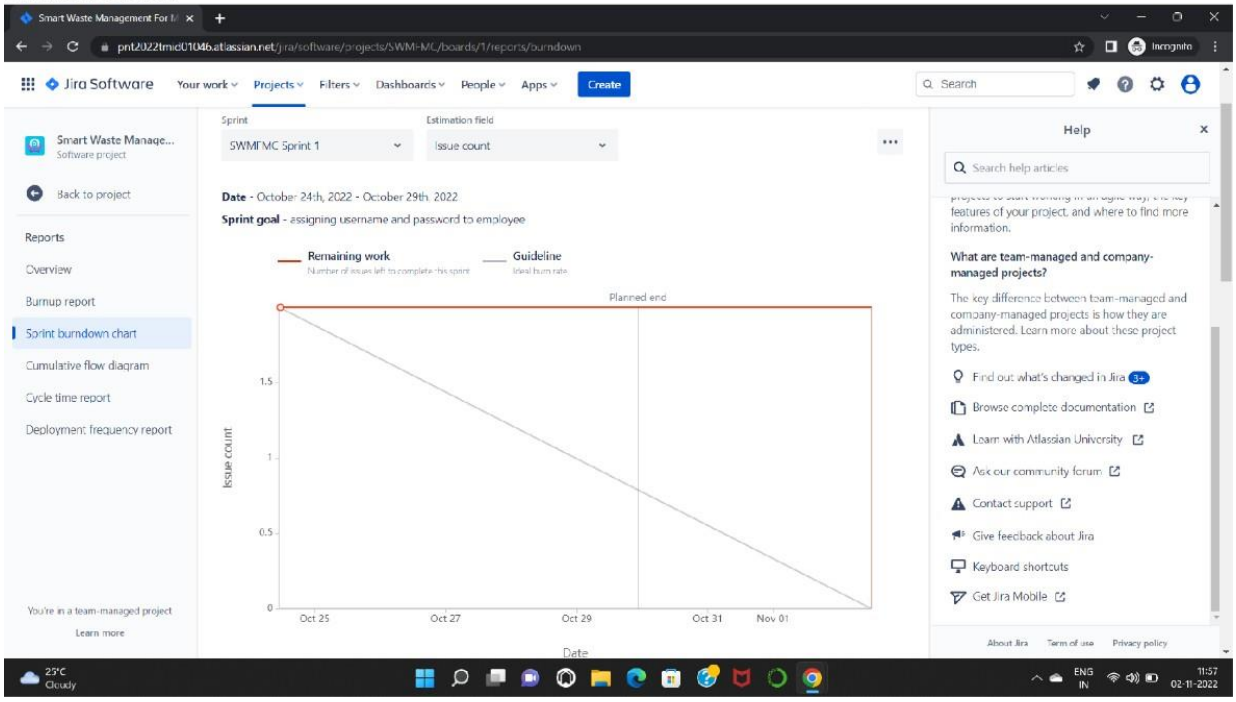
Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

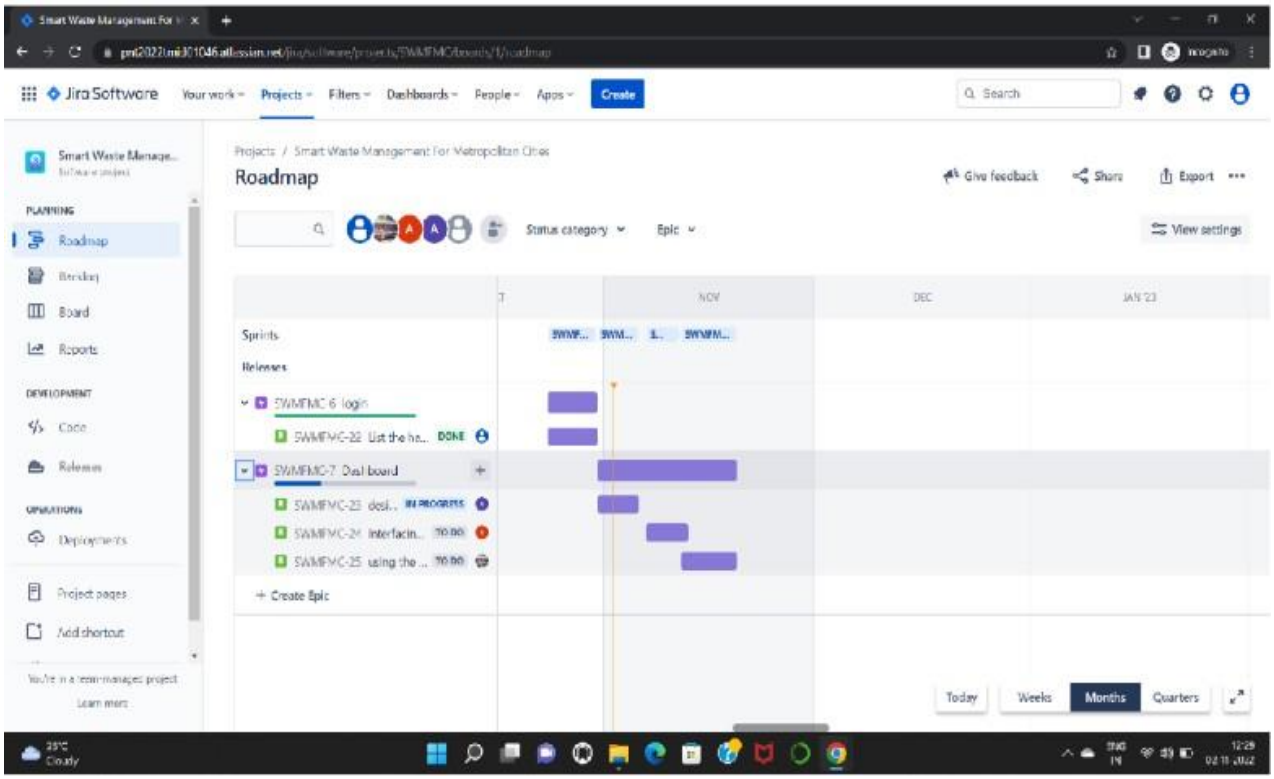
6.3 Reports from JIRA

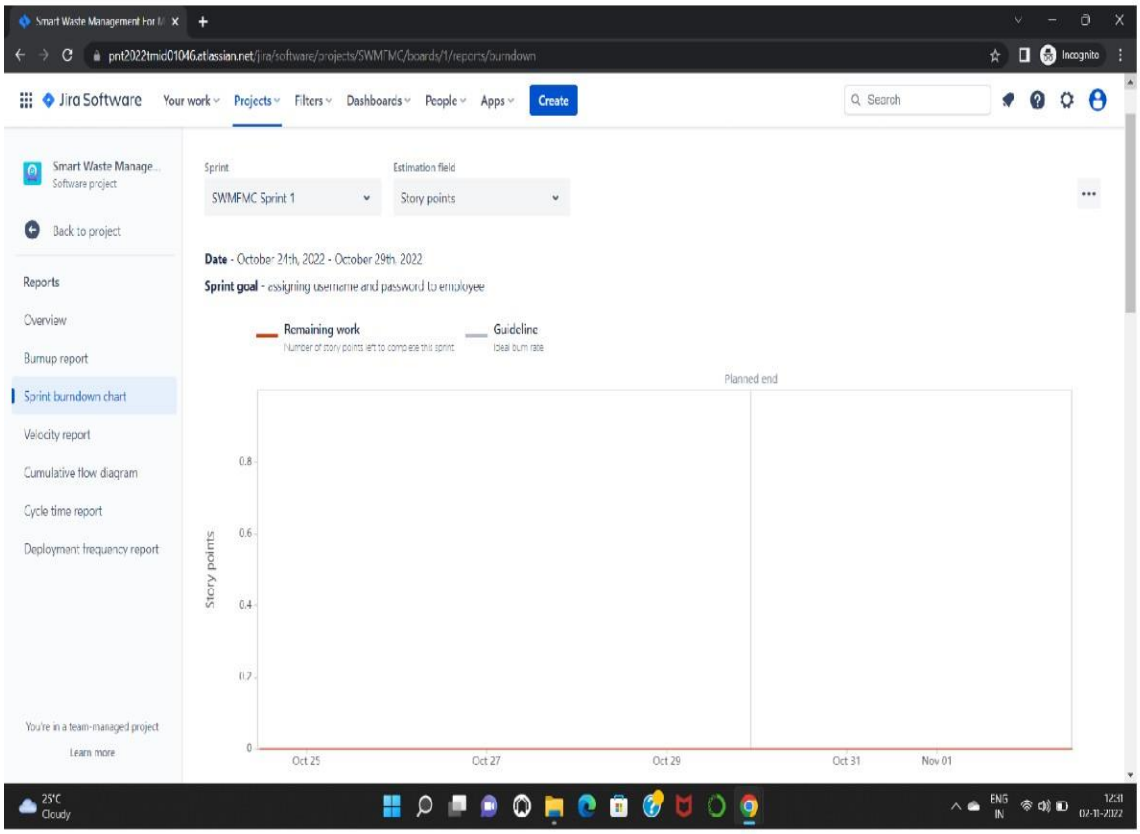
BURNOUT CHART:



Jira Software Screenshots:

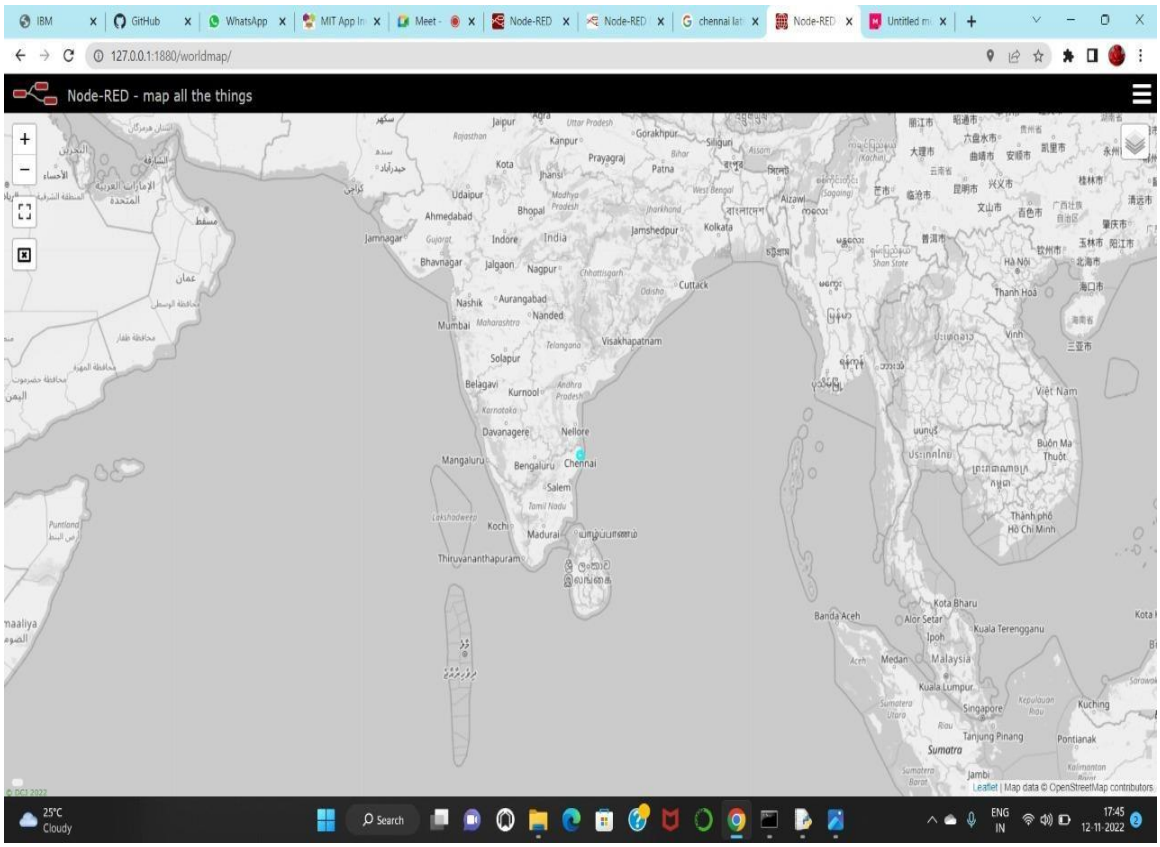
ROADMAP



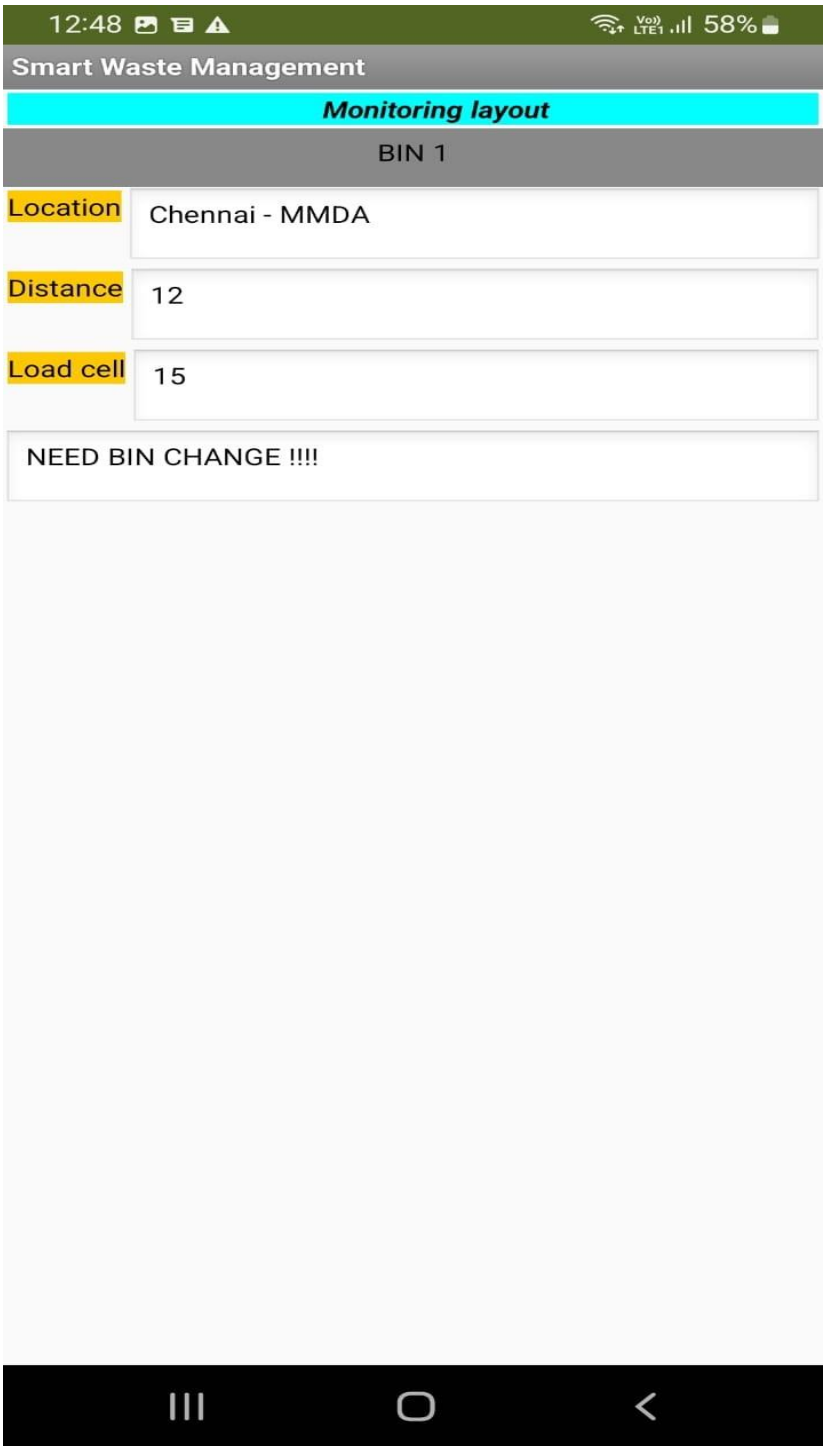


CODING&SOLUTONING(Explainthefeaturesaddedintheprojectalongwithcode)

7.1 Lecture1-LOCATIONTRACKER

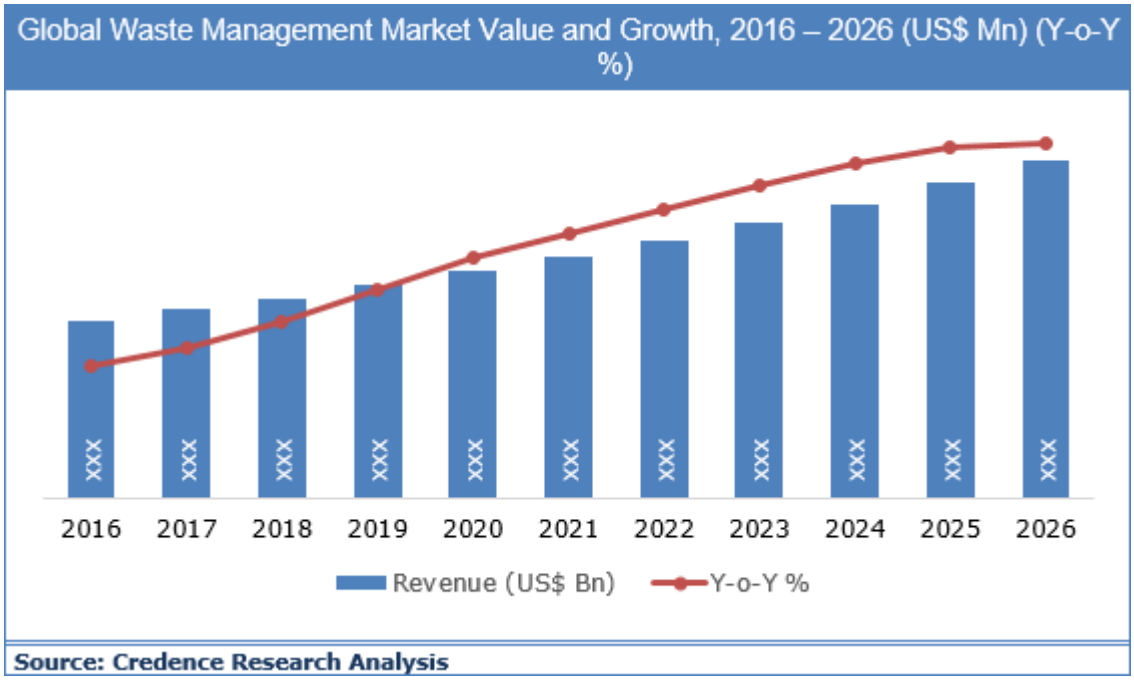


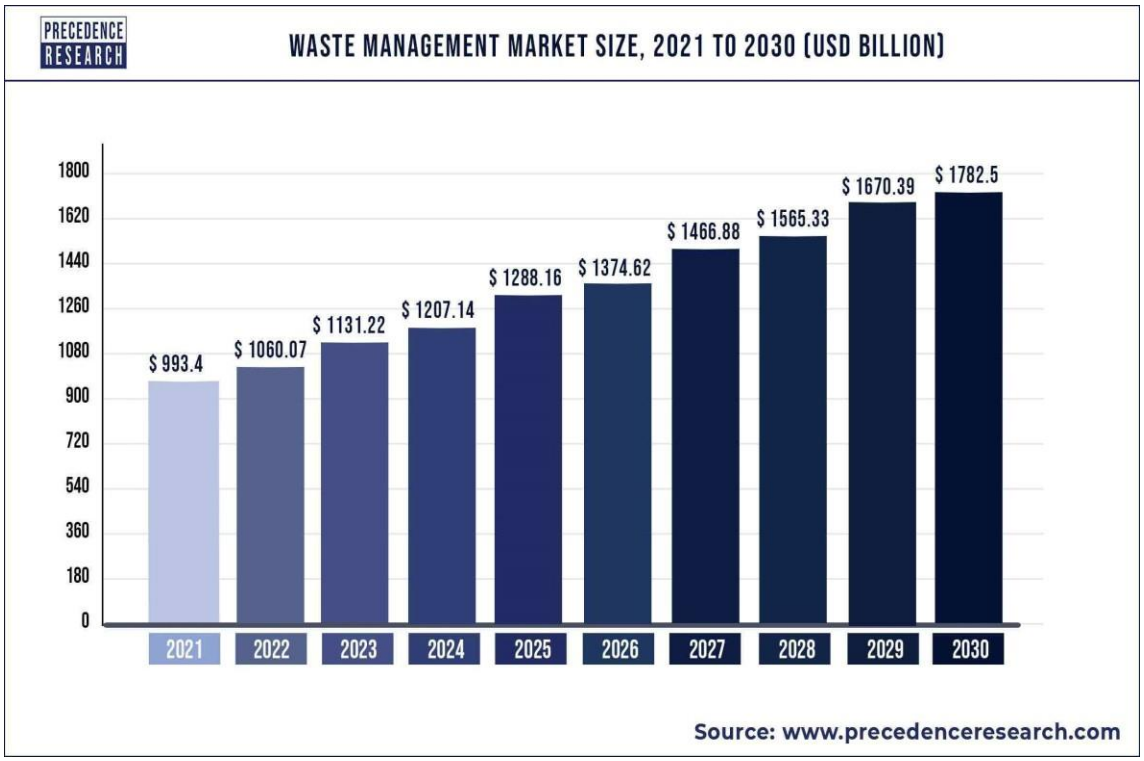
7.2LECTURE2-LIVEUPDATEON COLLECTEDDATA



8.RESULTS

8.1 PerformanceMetrics





9. ADVANTAGES

1. Less Overflows
2. No Missed Pickups
3. Lower Collection Cost
4. CO2 Emission Reduction
5. Waste Generation Analysis

DISADVANTAGES

i. The system requires more trash cans than the city's population, which results in a higher initial cost because smart trash cans are more expensive than those used by other systems.
ii. The memory size of the sensor nodes utilised in the trash cans is constrained.

10.CONCLUSION

By employing sensors to track the filling of bins, a Smart Waste Management system that is more effective than the one now in use can be created. Our idea of a "smart waste management system" focuses on tracking waste management, providing intelligent technology for waste systems, doing away with human intervention, reducing human time and effort, and creating a clean, healthy environment. In smart cities where citizens have hectic schedules that provide little time for garbage management, the suggested solution can be put into practise. If desired, the bins might be placed in a city where a big enough container could carry enough solid waste for one unit. The cost could be substantial.

11.FUTURE SCOPE

The following are a few upcoming tasks and enhancements for the suggested system:

1. Modify the user authentication and atomic lock systems for bins to better safeguard them from theft and damage.

2. The idea of green points will promote resident or end-user participation, making the concept successful and assisting in the accomplishment of cooperative waste management activities, thus realising the idea of Swachh Bharath.

3. Case studies or data analytics on the types of waste that are collected at different times during different days or seasons, predictable bin filling without the need for electronic components, and fixing the coordinates.

4. Improving the graphical user interfaces of the Server and Android

12) APPENDIX

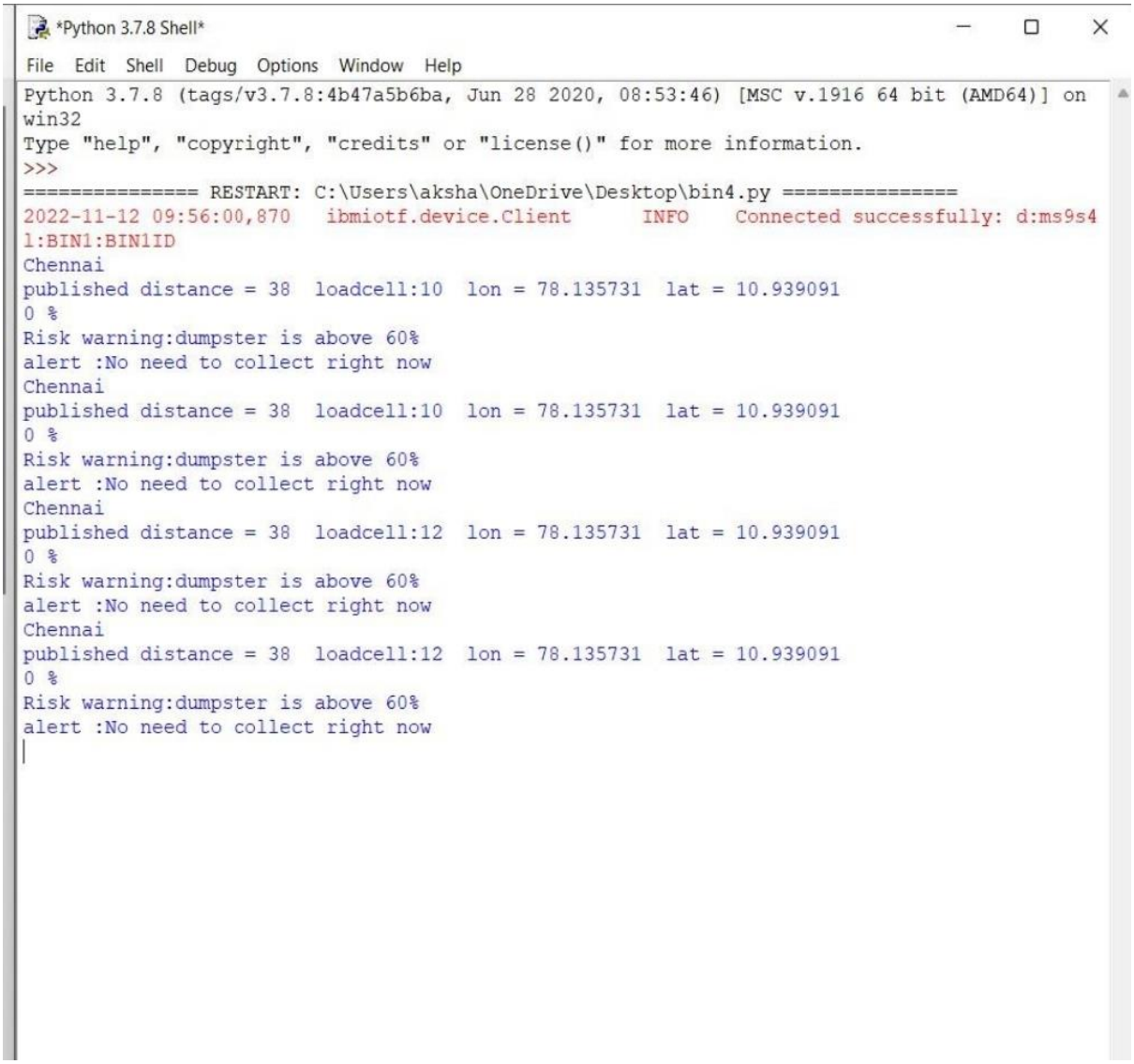
SOURCE CODE

```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random

#Provide your IBM Watson Device Credentials
organization = "kmqq03"
```

```
deviceType = "BIN1"
deviceId = "BINID"
authMethod= "token"
authToken = "123456789"

#generate random values for randomo variables for distance and loadcell
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 and loadcell" with value integer value into the cloud as a type of event for every 10 seconds
deviceCli.connect()

while True:
distance= random.randint(10,70) loadcell= random.randint(5,15)
data= {'dist':distance,'load':loadcell}


if loadcell < 13 and loadcell > 15: load = "90 %"
elif loadcell < 8 and loadcell > 12: load = "60 %"
elif loadcell < 4 and loadcell > 7: load = "40 %"
 else:
load = "0 %"
 if distance < 15:
dist = 'Risk warning:' 'Dumpster poundage getting high, Time to collect :) 90 %'
elif distance < 40 and distance >16:
dist = 'Risk warning:' 'dumpster is above 60%'
 elif distance < 60 and distance > 41: dist = 'Risk warning:' '40 %'
else:
dist = 'Risk warning:' '17 %'
 if load == "90 %" or distance == "90 %":
warn = 'alert :' 'Risk Warning: Dumpster poundage getting high, Time to collect :)'
 elif load == "60 %" or distance == "60 %":
 warn = 'alert :' 'dumpster is above 60%' else :
warn = 'alert :' 'No need to collect right now '


def myOnPublishCallback(lat=10.939091,long=78.135731): print("Chennai")
print("published distance = %s " %distance,"loadcell:%s " %loadcell,"lon = %s " %long,"lat = %s" %lat) print(load)
print(dist) print(warn)


time.sleep(10)
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(10)
deviceCli.commandCallback=myCommandCallback
#disconnect the device deviceCli.disconnect()
```

OUTPUT


Python 3.7.8 Shell
File Edit Shell Debug Options Window Help
Python 3.7.8 (tags/v3.7.8:4b47a5b6ba, Jun 28 2020, 08:53:46) [MSC v.1916 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
========== RESTART: C:\Users\aksha\OneDrive\Desktop\bin4.py ==========
2022-11-12 09:56:00,870 ibmiotf.device.Client INFO Connected successfully: d:ms9s41:BIN1:BIN1ID
Chennai
published distance = 38 loadcell:10 lon = 78.135731 lat = 10.939091
0 %
Risk warning:dumpster is above 60%
alert :No need to collect right now
Chennai
published distance = 38 loadcell:10 lon = 78.135731 lat = 10.939091
0 %
Risk warning:dumpster is above 60%
alert :No need to collect right now
Chennai
published distance = 38 loadcell:12 lon = 78.135731 lat = 10.939091
0 %
Risk warning:dumpster is above 60%
alert :No need to collect right now
Chennai
published distance = 38 loadcell:12 lon = 78.135731 lat = 10.939091
0 %
Risk warning:dumpster is above 60%
alert :No need to collect right now

GitHub Link:

https://github.com/IBM-EPBL/IBM-Project-22424-1659851197