PROJECT REPORT

TEAM ID:

PNT2022TMID28587

TEAM MEMBERS:

1.TIMILA R(Team leader)

2.SOWMIYA S

3.KOKILA AISWARYA M

4.AJAY ASLEEN J

PROJECT NAME:

SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES.

1.INTRODUCTION

1.1 PROJECT OVERVIEW:

The Internet of Things (IoT) is a concept in which surrounding objects are connected through wired and wireless networks without user intervention. In the field of IoT, the objects communicate and exchange information to provide advanced services for users.

This project deals with the problem of waste management in smart cities, where the garbage collection system is not optimized. This project enables the organizations to meet their needs of smart garbage management systems. This system allows the user to know the fill level of each garbage bin in a locality or city at all times, to give a cost-effective and time-saving route to the truck drivers.

In this project, a system is introduced to manage the problem of unorganized and non-systematic waste collection is solved by designing an embedded IoT system. For detecting the presence of any waste IR sensor can be used. The containers are embedded with ultrasonic sensors at the top, makes it possible to measure the amount of waste in the containers. Design of a Waste Bin with real time monitoring is presented and a smart waste management system is proposed using the recent technical advancements of automation and Internet of Things (IoT).

Smart bins are connected to the cloud, where the bin status are communicated, recorded and monitored by the local bodies through and android app or a centralized server.

1.2 PURPOSES:

1.Smart waste management is characterized by the usage of technology in order to be more efficient when it comes to managing waste.

2.The waste management services take care of a healthy environment allowing optimization of the utilities and prevent overloading the carrier for waste disposal.

3.Smart waste management also contributes to the overall waste recycling efficiency and provides the route optimization opportunity for utilities to reduce traffic and fuel use.

4.Meeting the environmental obligations and making it easier for waste collection.

5.Systematic control of individual as well as citizens waste disposal issues.

The main purpose of Smart Waste Management System for Metropolitan cities are when cities take a zero-waste approach minimizing, recovering, and treating waste rather than disposing of waste in landfill or incinerators they save money, protect the local environment, create jobs, build resilience, reduce emissions and promote community.

The proper solid waste management conservation of natural resources are ,

- Reduction of air, water and land pollution,
- Support for community development
- The advantages go beyond simply protecting our health and environment.

2.LITERATURE SURVEY

2.1 EXISTING PROBLEM:

Population growth and particularly the development of megacities is making SWM in India a major problem. The current situation is that India relies on inadequate waste infrastructure, the informal sector and waste dumping. There are major issues associated with public participation in waste management and there is generally a lack of responsibility towards waste in the community. There is a need to cultivate community awareness and change the attitude of people towards waste, as this is fundamental to developing proper and sustainable waste management systems.

Sustainable and economically viable waste management must ensure maximum resource extraction from waste, combined with safe disposal of residual waste through the development of engineered landfill and waste-to-energy facilities. India faces challenges related to waste policy, waste technology selection and the availability of appropriately trained people in the waste management sector. Until these fundamental requirements are met, India will continue to suffer from poor waste management and the associated impacts on public health and the environment.

2.2 REFERENCES:

[1] “IoT-Enabled Smart Waste Management Systems for Smart Cities: A Systematic Review”,INNA SOSUNOVA 1 AND JARI PORRAS , https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9815071

[2] Manju Mohan, Kuppan Chetty Ramanathan, Vijayram Sriram,”IOT Enabled Smart Waste Bin with Real Time Monitoring for efficient waste management in Metropolitan Cities” http://www.kscst.iisc.ernet.in/spp/39_series/SPP39S/01_Seminar%20Projects/068_39S_BE_0321.pdf

[3]“IOT Enabled Smart Waste Bin with Real Time Monitoring for efficient waste management in Metropolitan Cities” https://www.researchgate.net/publication/338342002_IOT_Enabled_Smart_Waste_Bin_with_Real_Time_Monitoring_for_efficient_waste_management_in_Metropolitan_Cities

[4]Joel Rodrigues,Sergei Arkadevich Kozlov,Neeraj Kumar,”Actuator Networks Sensor and IoT-Based Solid Waste Management Solutions: A Survey” https://www.researchgate.net/publication/330038645_Actuator_Networks_Sensor_and_IoT-Based_Solid_Waste_Management_Solutions_A_Survey

5]Harit Priyadarshi, Sarv Priya, Ashish Jain, Ashish Jain,“A Literature Review on Solid Waste Management: Characteristics, Techniques, Environmental Impacts and Health Effects in Aligarh City”, Uttar Pradesh, India. Gary Davidson Waste Management Projects Officer Office of Sustainability – Dalhousie University,June 2011

[6]Krishna Murali, K K Baseer, Thirumalakonda, Abbas Ali Poralla“Smart Garbage Monitoring System using IoT” https://www.researchgate.net/publication/353234708_Smart_Garbage_Monitoring_System_using_IoT

2.3 PROBLEM STATEMENT DEFINITION:

With the existing methods of collecting and disposal it is nearly impossible to manage such amount of waste in future. Around 30% of waste end up on roads and public places due to ineffective disposing and collecting methods. Waste management suffers from a pervasive under-pricing which means that the costs of waste management are not fully appreciated by consumers and industry and waste disposal is preferred over other options. Few waste treatment options are available than landfill costs.

The transformation of an urban habitation into a smart zone consists of multiple parameters for optimal implementation, where primary parameters include technology, data, and people. The genesis of smart cities has evolved from the need of sustainable development and a better future for humankind. The shortcomings and issues associated with the current urban waste management practices can be suitably dealt through the integration of tools such as the ‘internet of things’ (IoT)

Recycling not only saves energy but also prevents the materials from going to landfills & incineration, and provides raw materials for new products. Installing more bins for collecting recyclables like paper, glass, plastics, etc., and then recycling them can be a huge step. The biggest challenge in the direction of Effective Waste Management is to educate and aware of the masses because in a country with a huge population, the waste management issues can’t be resolved without the proper contribution of its population. Some of the possible measures in this direction could be establishing a proper awareness system, developing policies related to the throwing of waste, etc.

3. IDEATION AND PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS:

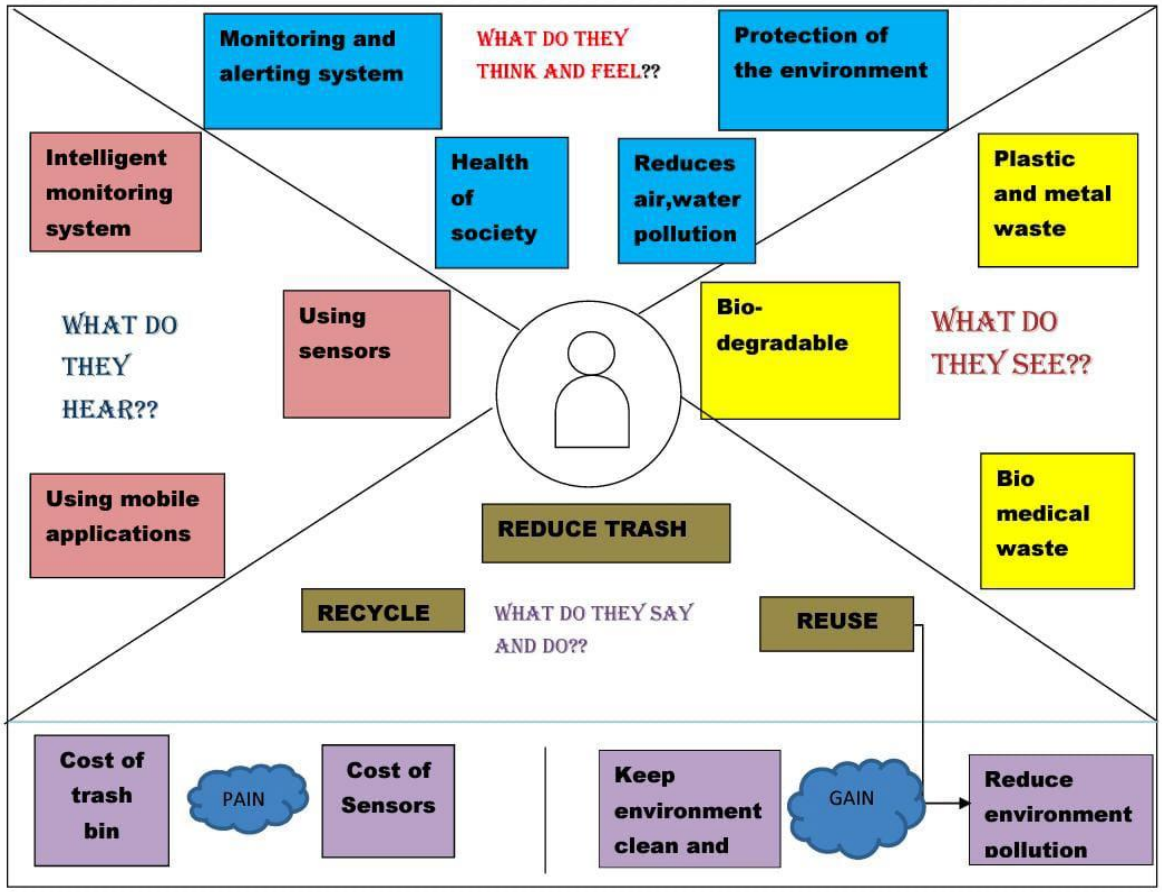
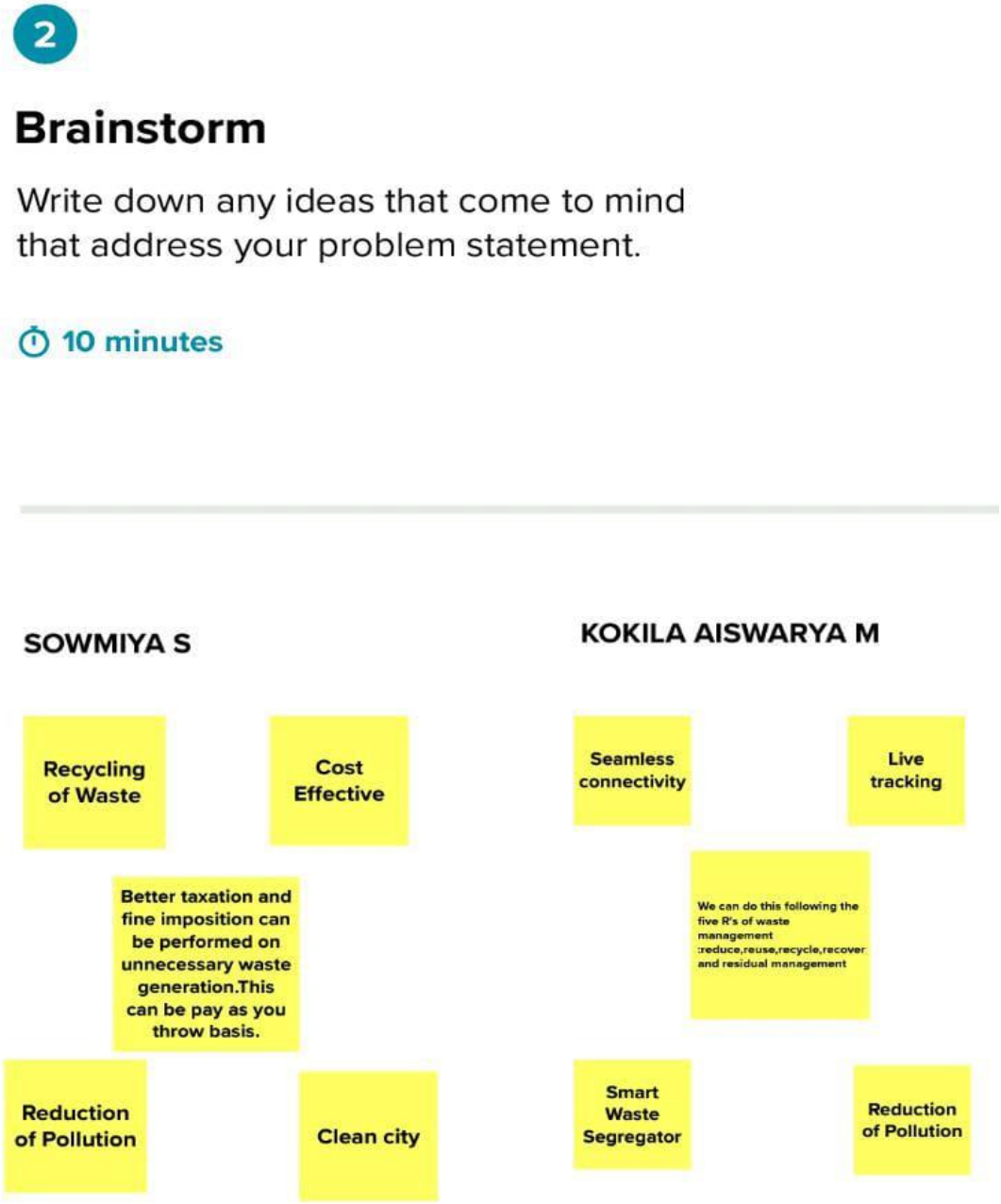


Fig : Empathy Map

3.2 IDEATION AND BRAINSTORMING:



TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

TIMILA R

Solid waste disposal

Reduction of fuel

In the proposed whenever the waste bin gets filled is acknowledge by placing the at waste transmit to the at the desired place the area or spot

Smart Assist

Garbage bin monitor

AJAY ASLEEN J

Data Observation

Cloud Service

It will stop overflowing of dustbins along roadsides and localities as smart Dustbins are managed in real time

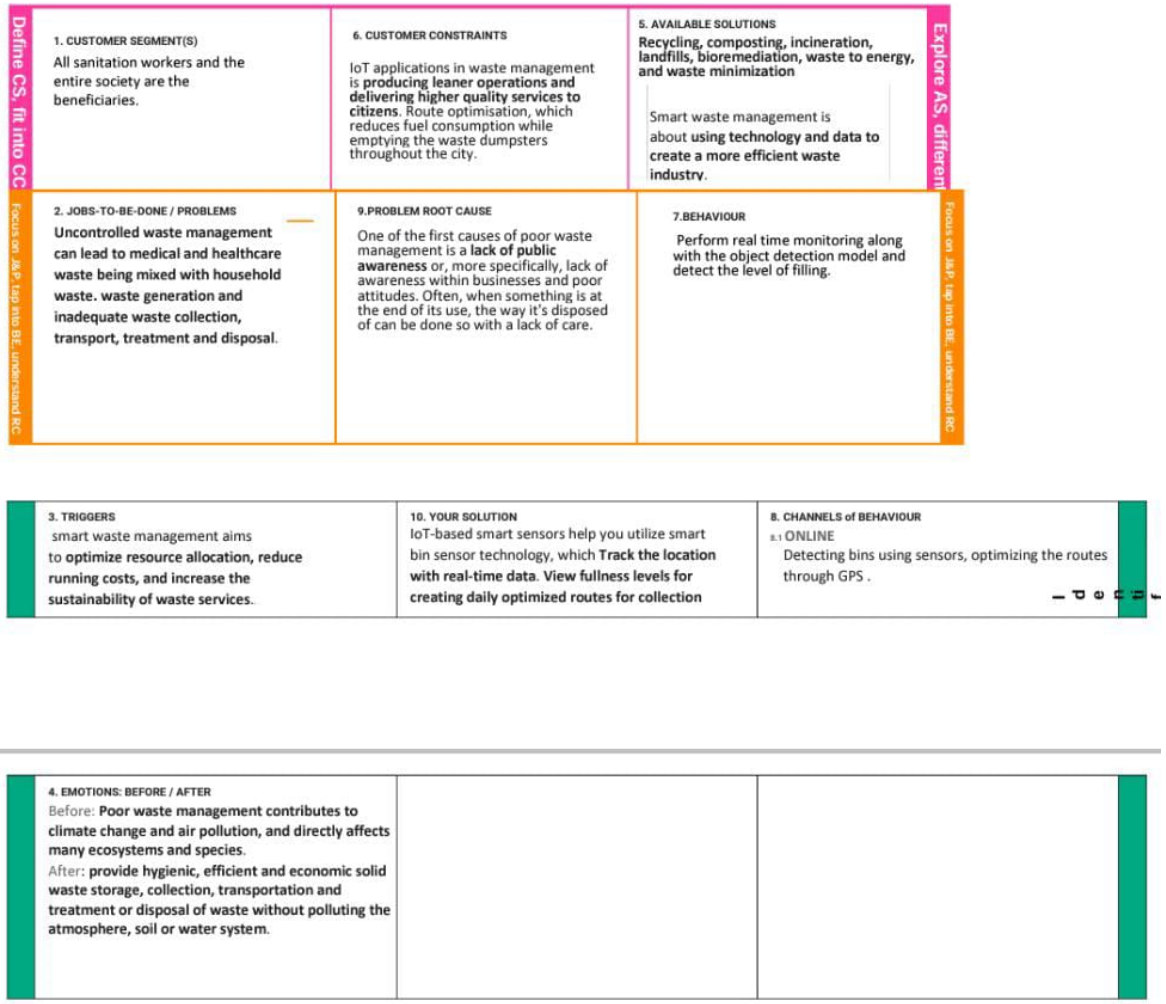
Waste truck routing

Sensor monitor bins

3.3 PROPOSED SOLUTION:

- A Mobile Application for raising requests to collect/remove 24×7 monitoring system is designed for monitoring dumpsters.
- solid waste in a public community.
- Public participation in raising requests for solid waste collection/removal through the mobile application.
- Provides scope for citizens to raise a complaint to the municipality bodies.
- Users can keep track of the current status of their complaints.
- All the complaints raised by the public are distributed by the authority to the different groups of workers.
- Provides the best route plan for municipal workers for garbage collection effectively.
- Administrator can monitor all the complaints that are raised by the user.

3.4 PROBLEM SOLUTION FIT:



4. REQUIREMENT ANALYSIS:

4.1 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	**Analysing the Bin level**	Acquire the levels of Waste bins in a regular interval of time.
FR-4	**Transport Router**	To make a efficient route for the collection of garbages around a area.
FR-5	**GPS Access**	To Know the location.

4.2 NON FUNCTIONAL REQUIREMENT:

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

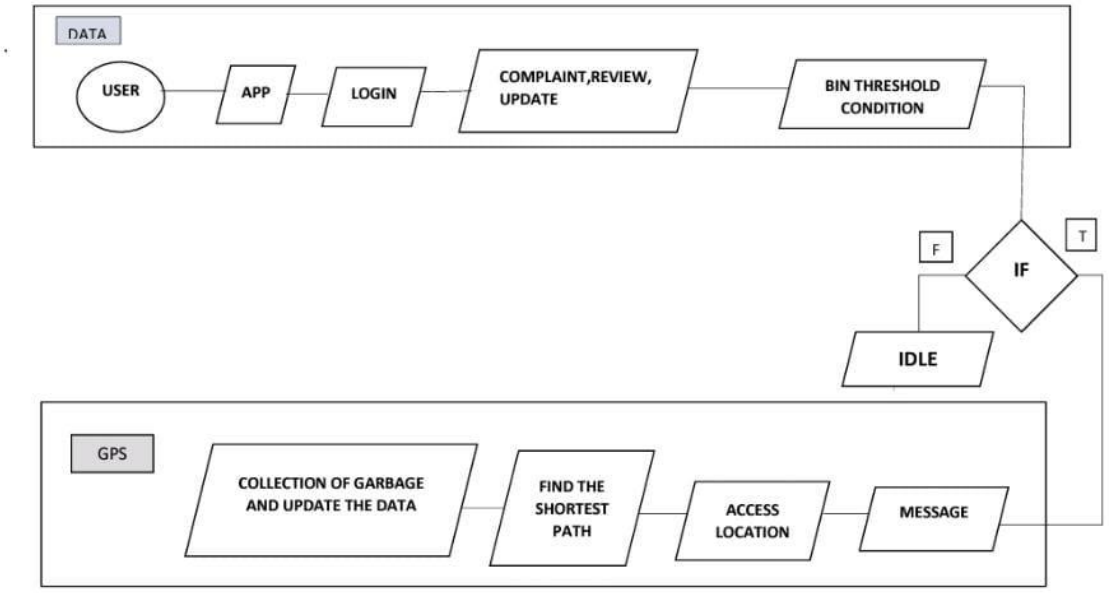
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	○ It aims to optimize ease of use while offering maximum functionality. ○ A smart solution has been proposed to make the waste sorting more simple and accurate,and improve the user experience, usability, and satisfaction.
NFR-2	**Security**	○ The information of the users will be highly secured, the accounts are verified with Gmail. ○ If the products are misplaced then the GPS driven sensor gives an alert.
NFR-3	**Reliability**	○ Operates in a defined environment without failure resulting in less manpower, emissions, fuel use and traffic congestion.
NFR-4	**Performance**	○ The real-time monitoring of the garbage level with the help of sensors and wireless communication will reduce the total number of trips required of Garbage collecting truck. ○ The system will provide accurate reports, thus increasing the efficiency of the system.This will reduce the total expenditure associated with the garbage collection.
NFR-5	**Availability**	○ The smart waste bins are available in Convention centers, buildings, stadiums, and transportation facilities and captures high-quality waste data and informs staff when it gets full.

5. PROJECT DESIGN

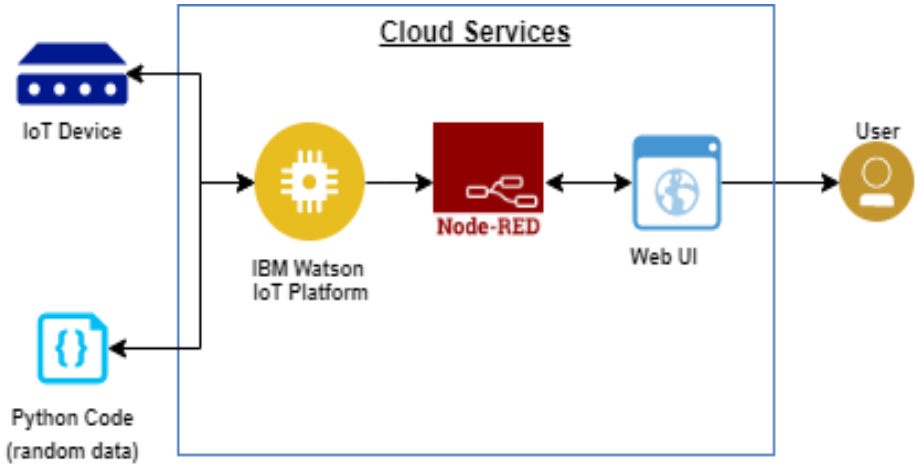
5.1 DATA FLOW DIAGRAMS:

DATA FLOW:

CLOUD/DATABASE:



5.2 SOLUTION AND TECHNICAL ARCHITECURE



5.3 USER STORIES:

USER TYPE	FUNCTIONAL REQUIREMENT	USER STORY/TASK	ACCEPTANCE CRITERIA
Public/People	Registration& Login	Firstly, creating an account in the application. If user find the dumped solid waste can be immediately reported by filling a complaint to the concerned authority with the help of this developed mobile application.	The login process was easy and simple to access the dashboard.
Customer Care Executive	-	A customer care executive will always be available for the interaction with the customer to clarify the queries.	An executive will clarify the doubts and note down the complaints of the application if any .
Administrator	-	Admin can access the data or information provided by the customers to analyse their needs and provide required service.	The details of the locality of the user is provided to the municipal corporation when a complaint is received, required action is taken and report is updated to the app.

6.PROJECT PLANNING AND SCHEDULING

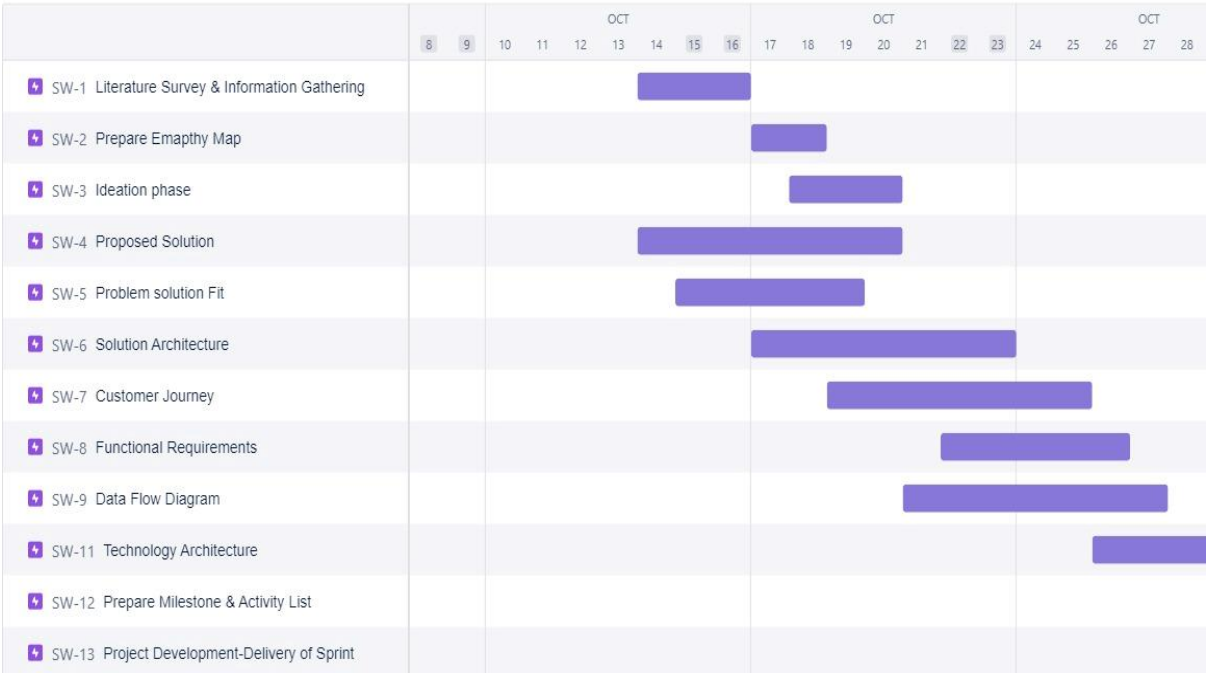
6.1 SPRINT PLANNING AND ESTIMATION:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Weight of the garbage bin	USN-1	This is the first stage in which the weight of the garbage bin is monitored at different location	2	Medium	Timila R, Sowmiya S
Sprint-1	Level of the garbage bin	USN-2	This is also the first stage in which level of the bin is monitored in different location.	1	High	Kokila Aiswarya , Ajay Asleen
Sprint-2	Alerting authorised person	USN-3	An alert message is sent to the authorized person.so that they can empty the filled bins in specified location.	2	High	Timila , Kokila Aiswarya , Sowmiya
Sprint-1	GPS sharing location	USN-4	The concerned authorized person can get to know about the location through GPS location tracking system.	2	High	Sowmiya , Kokila Aiswarya , Ajay Asleen
Sprint-1	Cloud database management	USN-5	Data about garbage bin details of locationsstored in cloud which helps authorized person to complete their work effectively.	1	High	Timila , Sowmiya , Kokila Aiswarya , Ajay Asleen

6.2 SPRINT DELIVERY SCHEDULE:

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	18 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	25 Oct 2022	30 Oct 2022	20	5 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	11 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.3 REPORT FROM JIRA:



7. CODING AND SOLUTIONING

7.1 FEATURES:

S.NO	FEATURES	FUNCTIONS
1	Technology	Real-time waste monitoring.
2	Sensors	Predictions for bin fulness
3	Cloud database	Detailed database of bins and stands.
4	Efficiency	Interactive bin map including Street view.
5	Tracking system	Route planning for waste collection
6	Optimization	Overview of scheduled and executed route
7	Progress	Database of citizen reports

FEATURES OF SMART WASTE MANAGEMENT SYSTEM

- The smart, sensor based dustbin will judge the level of waste in it and send the message directly to the municipal corporation.
- It can sense all the type of waste material either it is in the form of solid or liquid.
- According to the filled level of the dustbin, the vehicles from the municipal corporation will choose the shortest path with the help of the "TRANSPORTATION SOFTWARE" which will save their time.
- It emphasizes on "DIGITAL INDIA".
- The system is simple. If there is any problem with any equipment in the future, that part is easily replaceable with new one without any difficulty and delay.

7.2 Code for Binlevel(bin 1):

```
#importing a packages
import requests
import json
import ibmiotf.application
import ibmiotf.device
import time
import random
import sys

# watson device details

organization = input(“Enter a organisation”);
devicetype =input(“Enter a devicetype”);
deviceId = input(“Enter a deviceId”);
authMethod= input(“Enter a authMethod”);
authToken= int(input(“Enter a authToken”));
#generate random values for randomo variables
(temperature&humidity)

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,"authtoken":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 "temp" 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 :' ' 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=10.678991,long=78.177731):
        print("Anna Salai, 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)
```

```
if not success:
 print("not connected to ibmiot")
time.sleep(30)

    deviceCli.commandCallback=myCommandCallback

#disconnect the device deviceCli.disconnect()
```

8.TESTING

8.1 TEST CASES:

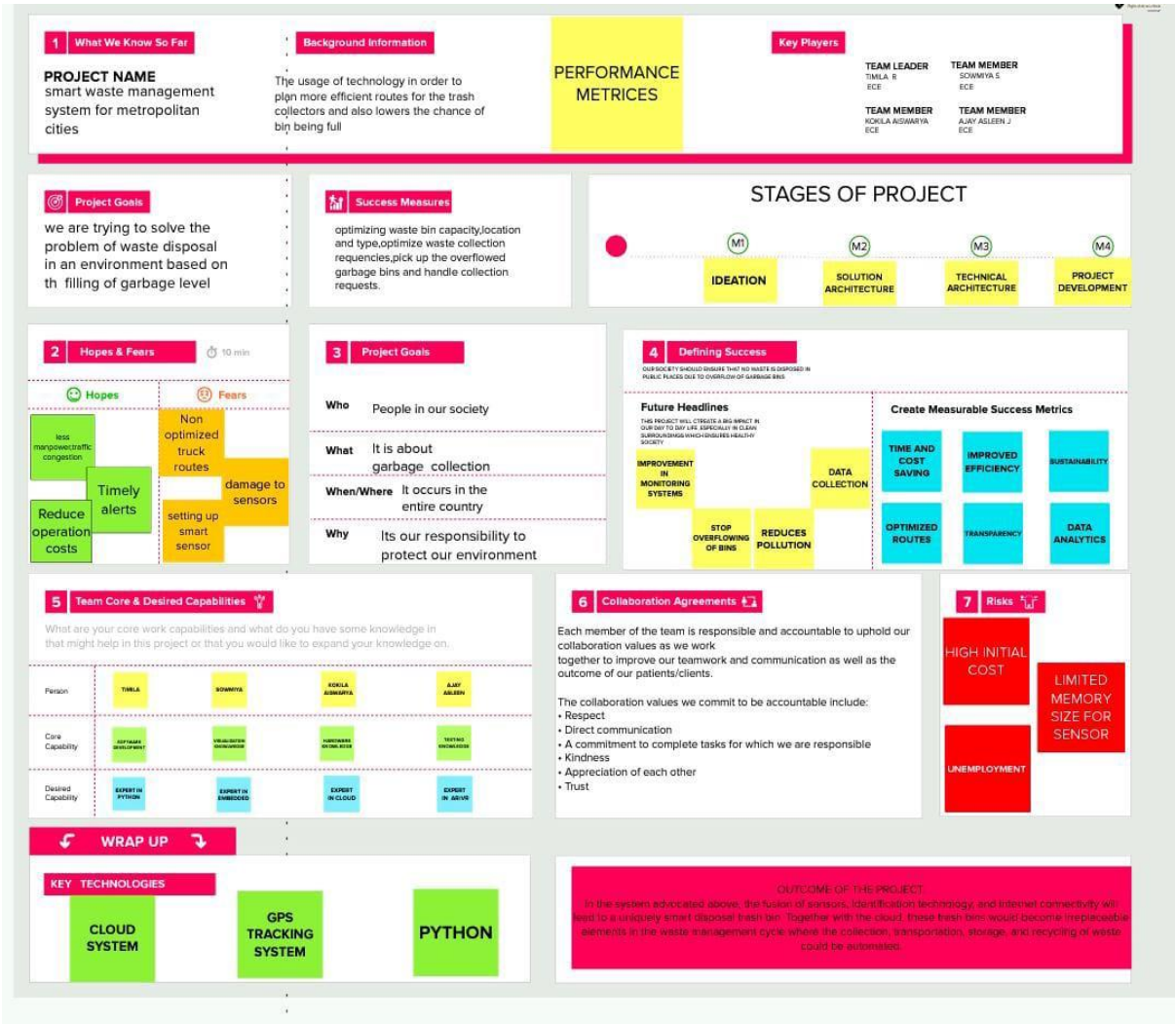
- To predict the weight of the garbage bin
- To locate the location of the bin
- To send alerts to the local authorities about the garbage level

8.2 USER ACCEPTANCE TESTING:

- To access the dashboard and to login using the login credentials given to particular individuals
- To monitor the garbage level using the mobile web application
- To locate the garbage bin using the global positioning system
- Collecting the garbage from the garbage bins
- Dumping the solid waste to the scrap yard or other storage area
- Placing the garbage bin again in that same location

9.RESULTS

9.1 PERFORMANCE METRICES:



10.ADVANTAGES:

Following are the benefits or advantages of Smart Waste Management:

➡It saves time and money by using smart waste collection bins and systems equipped with fill level sensors. As smart transport vehicles go only to the filled containers or bins. It reduces infrastructure, operating and maintenance costs by upto 30%.

➡It decreases traffic flow and consecutively noise due to less air pollution as result of less waste collection vehicles on the roads. This has become possible due to two way communication between smart dustbins and service operators.

➡It keeps our surroundings clean and green and free from bad odour of wastes, emphasizes on healthy environment and keep cities more beautiful.

➡It further reduces manpower requirements to handle the garbage collection process.

➡Applying smart waste management process to the city optimizes management, resources and costs which makes it a "smart city".

➡It helps administration to generate extra revenue by advertisements on smart devices.

DISADVANTAGES:

Following are the drawbacks or disadvantages of Smart Waste Management:

➡System requires more 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.

➡Wireless technologies used in the system such as zigbee and wifi have shorter range and lower data speed. In RFID based systems, RFID tags are affected by surrounding metal objects (if any).

➡It reduces man power requirements which results into increase in unemployments for unskilled people.

➡The training has to be provided to the people involved in the smart waste management system.

11.CONCLUSION:

The rate at which solid wastes are produced in most developing countries is becoming alarming. This increase may be due to recent population growth and rural-urban migration. Garbage is made up of non-renewable resources used daily to meet our needs then throw away.

Solid waste management is faced with a number of issues which include lack of throughput, inadequate solid waste data, efficiency problem, delays in collection and resistance to new technologies. Presently, waste management is a major problem for authorities who are responsible for such task because it's a costly service and it huge-ly impacts the environment as a whole.

In the system advocated above, the fusion of sensors, identification technology, and internet connectivity will lead to a uniquely smart disposal trash bin. Together with the cloud, these trash bins would become irreplaceable elements in the waste management cycle where the collection, transportation, storage, and recycling of waste could be automated. The use of technology in waste collection services not only increases the efficiency of waste management through automation but also increases environmental responsibility which is one of the pillars of the Smart City with automation.

12.FUTURE SCOPE:

The future scope of the smart waste management systems include adding surveillance facilities to that locality so that the waste management system can also include ensuring the security of the society they live in.

The smart waste management can also be upgraded by implementing sensors to recognize the bio degradable waste and non bio degradable waste. The bio degradable waste can be processed and can be used as a fertilizer for the kitchen garden or it can even be provided to the farmers of urban area to facilitate organic farming among the farmers.

The non biodegradable waste can be either disposed by means of land filling or by incinerating so that the waste does not cause any harm to the society by spreading various diseases and by spreading odour in the locality.

13.APPENDIX

13.1 SOURCE CODE:

```
#importing a packages
import requests
import json
import ibmiotf.application
import ibmiotf.device
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import random
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deviceId = input("Enter a deviceId");
authMethod= input("Enter a authMethod");
authToken= int(input("Enter a authToken"));
#generate random values for randomo variables
(temperature&humidity)

def myCommandCallback(cmd):
```

```
    global a
    print("command recieved:%s" %cmd.data['command'])
        control=cmd.data['command']
        print(control)


try:
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       deviceCli = ibmiotf.device.Client(deviceOptions)
except Exception as e:
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#connect and send a datapoint "temp" with value integer value
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while True:
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       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:
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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 %'
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            if load == "90 %" or distance == "90 %":
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       deviceCli.commandCallback=myCommandCallback


#disconnect the device deviceCli.disconnect()
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GITHUB AND PROJECT DEMO LINK:

GITHUB LINK:

https://github.com/IBM-EPBL/IBM-Project-30369-1660145030

PROJECT DEMO LINK:

https://youtu.be/YjuRL7R2_To