SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES

TEAM ID: PNT2022TMID50177

A PROJECT REPORT

submitted by

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1. INTRODUCTION:

1.1 ABSTRACT

The proposed system would be able to automate the solid waste monitoring process and management of the overall collection process using IOT (Internet of Things).The Proposed system consists of main subsystems namely Smart Trash System(STS) and Smart Monitoring and Controlling Hut(SMCH).In the proposed system, whenever the waste bin gets filled this is acknowledged by placing the circuit at the waste bin, which transmits it to the receiver at the desired place in the area or spot.In the proposed system, the received signal indicates the waste bin status at the monitoring and controlling system.By having a more convenient route garbage trucks spend less time on the road, therefore, congestion in smart cities can be decreased. This means that truck drivers and citizens are saving less time stuck in traffic jams. Additionally, using iot technology for remote diagnostics also means not having to send staff all the way to monitor assets.With the huge increase in waste, more resources are allocated to waste collection and handling. If unnecessary collections are eliminated, public spending on waste management can be reduced.

2. IDEATION PHASE

2.1 LITERATURE SURVEY

Title of the paper 1: Cloud-based Smart Waste Management for Smart Cities

Authors: Mohammad Aazam, Marc St-Hilaire, Chung-Horng Lung, Ioannis Lambadaris

Algorithm: Internet of Things (IoT),Cloud of Things,Cloud computing

Advantages: Timely waste collection, Waste-based energy production.

Disadvantages: System requires number of waste bins for separate waste collection.

Title of the paper 2: IOT Based Smart Garbage alert system using Arduino UNO

Authors: Sathish Kumar, Vuayalakshmi, Jenifer Prarthana, Shankar

Algorithm: RFID computing technology that is used for verification process and it also enhances the smart garbage alert system by providing automatic identification.

Advantages: It is transportable low price RFID tag, the system provides options for the customers to lodge their complaints in case of discrepancies.

Disadvantages: Complex design of dustbin compared to other methods

Title of the paper 3: Smartbin: Smart Waste Management System

Authors: Fachmin Folianto, Yong Sheng Low, Wai Leong Yeow

Algorithm: Duty cycle technique to reduce power consumption and to maximize operational time.Applying sense-making methods to obtain litter bin utilization.

Advantages: Obtain litter bin utilization - utilization information shows how a bin has been utilized litter bin daily seasonality information.- shows the time when a bin is usually full.

Disadvantages: The sensor node was deployed with battery power. Low power consumption sensor node must be used because of its limited power. The sensor node had limited memory size.

Title of the paper 4: INTERNET OF BINS : Trash Management in India

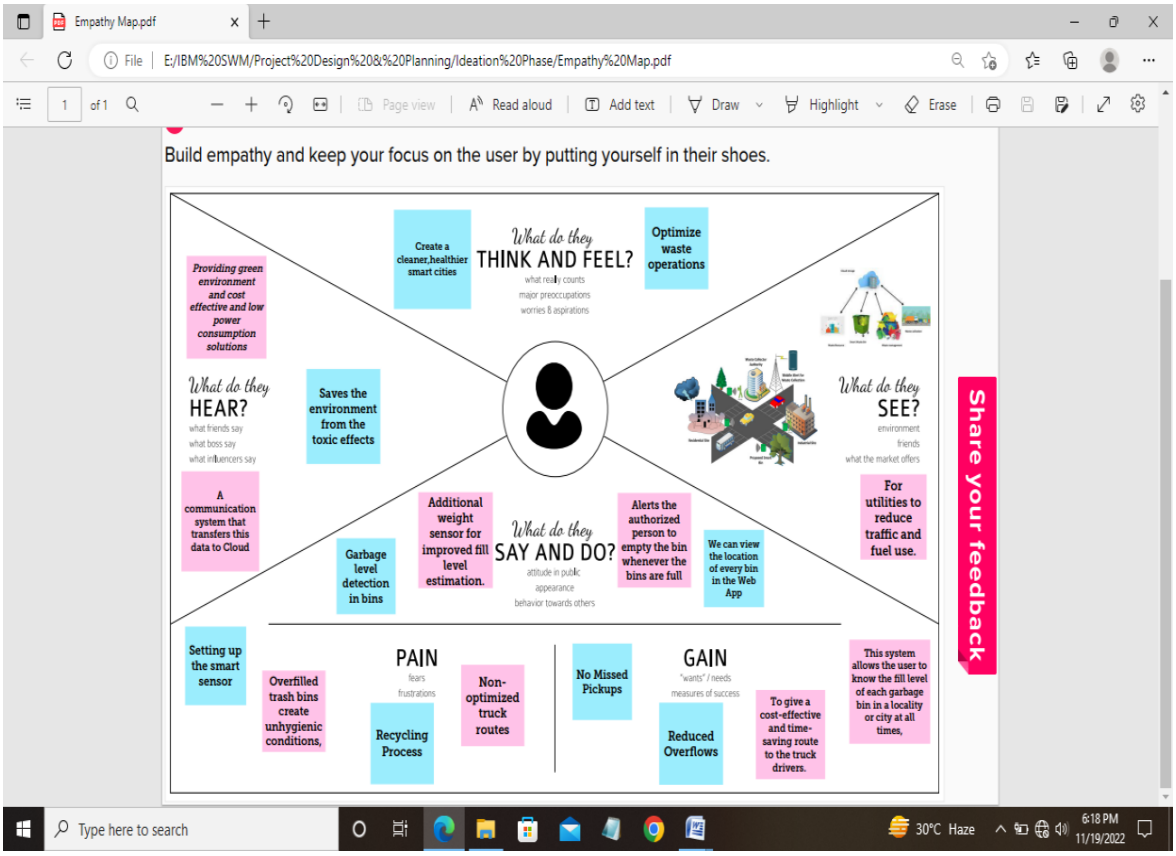
Authors: Keerthana, Kalyani,Suja, Sonali M Raghavendran

Algorithm: Concept of IOT. Data sharing model by using cloud to establish connection between truck drivers,corporation and trash cans to collect and gather waste in a profitable way.

Advantages: Less expensive Lock based System with acknowledgment alert system. Reduces fuel usage. Provides clean locality.

Disadvantages: ZigBee are short range and low data speed.

2.2 EMPATHY MAP



2.3 DEFINING PROBLEM STATEMENT

Title: Smart waste management system for metropolitan cities.

Abstract: Population growth and rapid urbanization lead to a high increase in waste generation, so the traditional methods of waste collection have become inefficient and costly. The most efficient way this extraordinary amount of waste Management with obsolete methods of waste collection.

Benefits of Smart waste management system:

- Reduction in collection cost
- No missed pickups
- Reduce overflows
- Waste generation analysis

• Co2 Emission reduction

Social impact:

• Clean cities

• Healthy Environment

Business impact:

• Offering software as a service model to government.

Step involved in smart waste management system:

• Garbage level detection in bin.

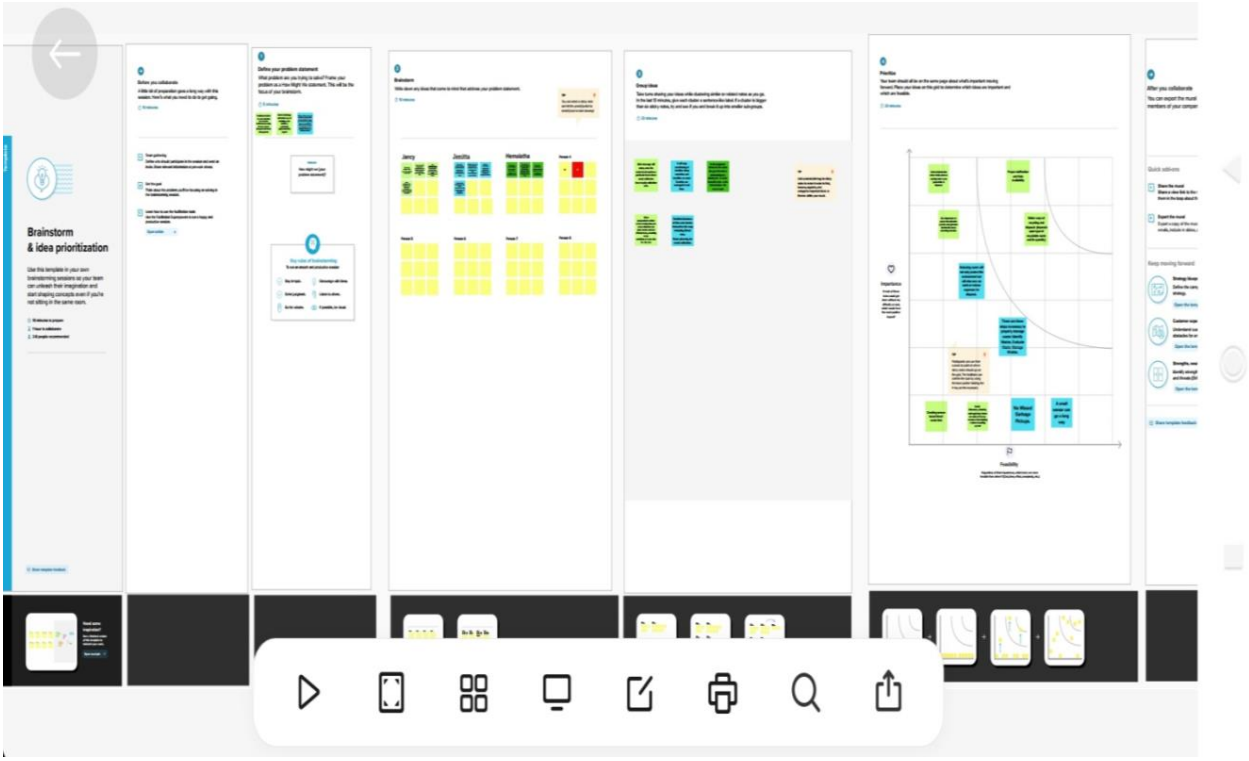
• Getting the weight of the garbage in the bin.

• Alerts the authorized person to empty the bin whenever the bins are full.

• Garbage level of the bins can be monitored through a web application.

• We can view the location of every bin in the web application by sending GPS location from the device

2.4 BRAINSTORMING IDEAS



Group Ideas:

- Alert message will come, once the waste level reaches a particular level where waste collectors have to plan collection of it.
- Detailed database of bins and stands. Interactive bin map including Street view. Route planning for waste collection.

3. PROJECT DESIGN PHASE I

3.1 PROPOSED SOLUTION

Problem statement:

• Smart waste management system would include; a sensor attached to the trash bin that measures fill level; and a communication system that transfers this data to Cloud.

• By exploiting this data, trash collection can be planned as well as truck routes can be optimized.

Idea/solution description:

• This project deals with the problem of waste management in smart cities, where the garbage collection system is not optimized.

• 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.

• The Proposed system consists of main subsystems namely Smart Trash System(STS) and Smart Monitoring and Controlling Hut(SMCH).

Novelty/uniqueness:

1. Solar-powered Trash compactors:

• These machines compress trash as it accumulates to increase bin capacity, and they collect and transmit data on fill and collection times to help streamline the collection process.

2. E-waste kiosks:

• Electronic waste that is improperly disposed of can be harmful to both humans and the environment.

• Fortunately, many companies and organizations have started e-waste recycling programs that will accept — and even reimburse you for — old electronic devices.

3. Recycling Apps:

• These apps provide users with information on recycling rates and center locations, and their comprehensive lists of materials help users determine which items can be recycled.

Social impact/customer satisfaction:

• Improve efficiency - using the resources available to us in a more focused and targeted way.

• Reduce the number of bins required - decluttering and improving the street scene.

• Drive down our carbon emissions - by doing away with the need to drive to bins that still have plenty of space in them.

• Encourage recycling-on-the-go - by ensuring litter bins aren't over-flowing, residents will be encouraged to put the right thing in the right bin when they're out and about.

Business model (Financial Benefit):

1. Reduction in collection cost:

• The solution reduces waste collection frequency dramatically, enabling you to

save on fuel, labor, and fleet maintenance costs.

• It has been seen that the solution has reduced the operational cost of municipalities up to 80%.

2. No mixed pickups:

• Using the solution, the managers, as well as the garbage truck drivers, can see which garbage containers are not picked up and needs to be picked.

• So, there will be no missed pickups, keeping the residents away from the disease which occurs due to bacteria, vermin and insects prosper from the garbage.

3.Reduced overflows:

• The solution takes care of this issue by allowing the waste collectors to keep track of every bin's fill status and schedule the pickup on time.

4. CO2 Emission Reduction:

• The solution decreases the fuel consumption which ultimately reduces carbon emission by up to 70%.

• This is indeed a huge reduction both in terms of finance and environmental impact.

Scalability of solution:

1. Decentralized waste management:

• This is not the waste treatment method but the waste segregation method.

2. Biological Reprocessing:

• Better known as Composting, this waste management solution is a win-win for you.

3. Reduce, Recycle & Reuse:

• Recycling not only saves energy but also prevents the materials from going to landfills & incineration, and provides raw materials for new products.

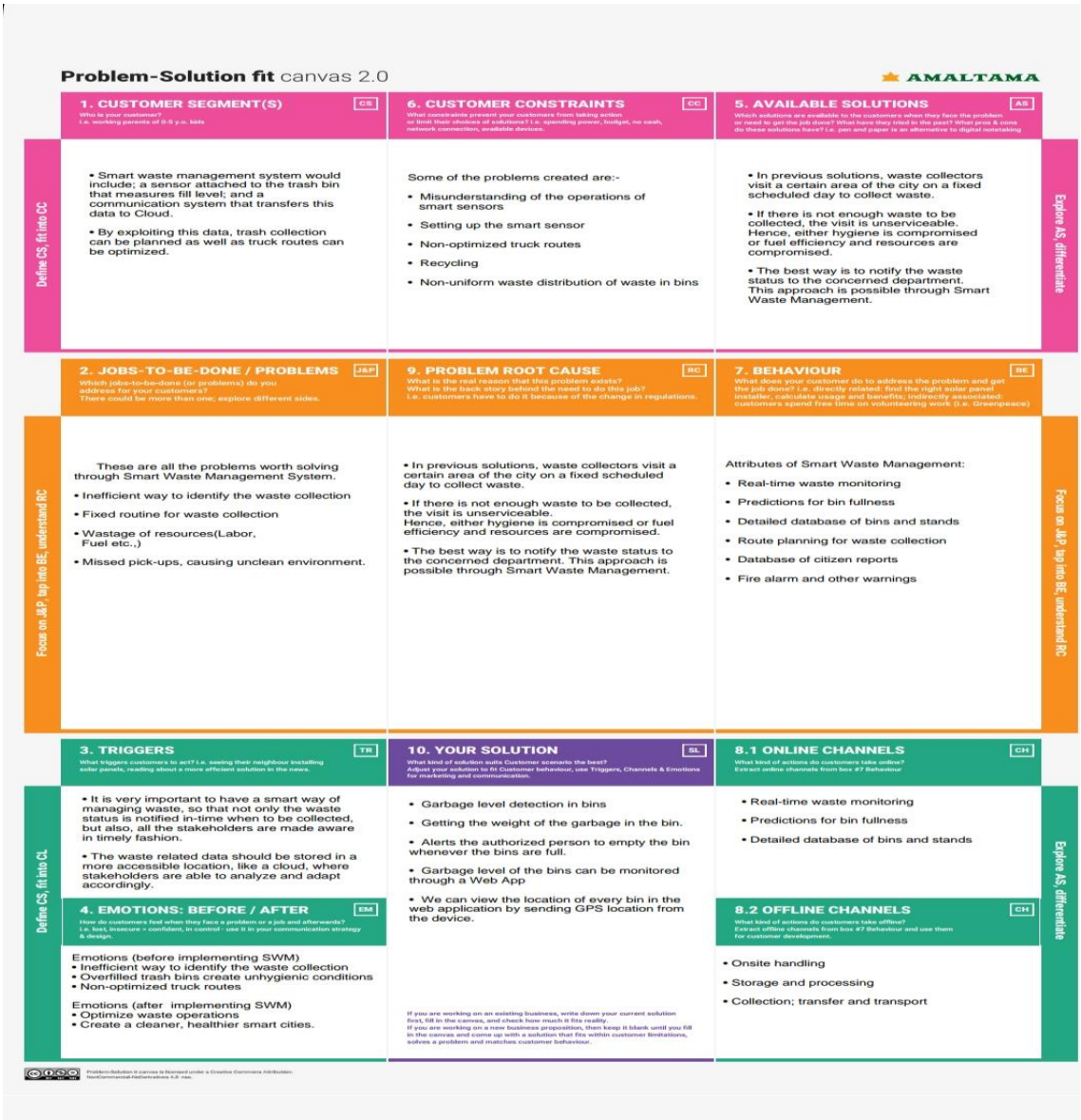
• Installing more bins for collecting recyclables like paper, glass, plastics, etc.,

and then recycling them can be a huge step.

• Also, reuse products wherever possible like reusing plastic bottles instead of simply disposing of them.

• The more you reuse, the more you contribute to keep these items away from the garbage can.

3.2 PROBLEM SOLUTION FIT



3.3 SOLUTION ARCHITECTURE

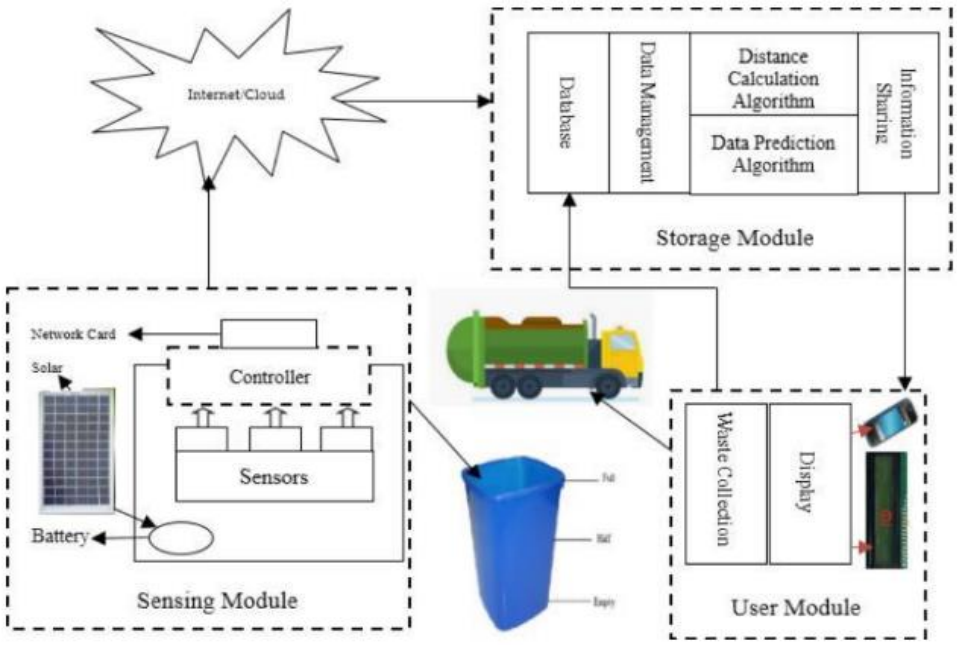


Fig. Solution Architecture for Smart Waste Management System

4. PROJECT DESIGN PHASE II

4.1 REQUIREMENT ANALYSIS

Functional Requirements:

Functional Requirements:

Following are the functional requirements of the proposed solution.

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.
		The report shows how full the bin was when picked. You immediately see any inefficient picks below 80% full.
FR-6	Plan waste collection routes.	The tool semi-automates waste collection route planning. Based on current bin fill-levels and predictions of reaching full capacity, you are ready to respond and schedule waste collection. You can compare planned vs. executed routes to identify any inconsistencies.

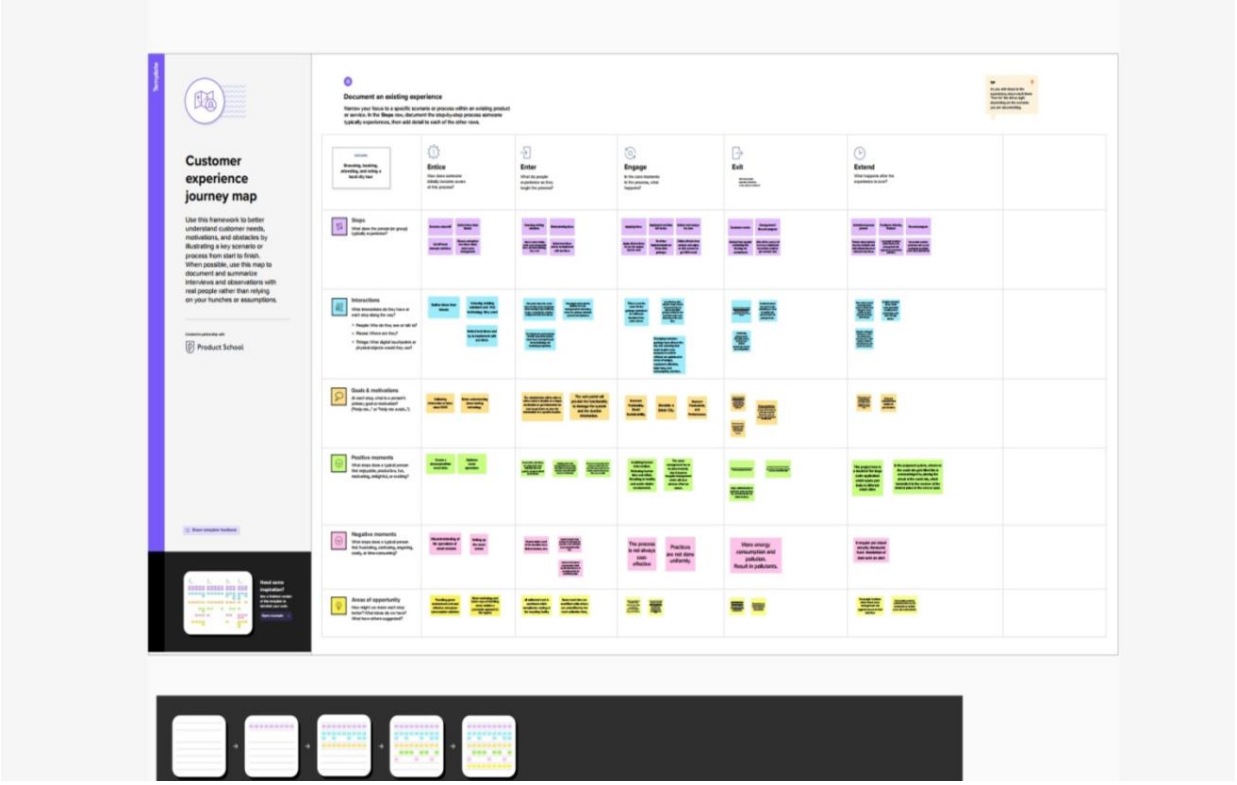
Non-functional Requirements:

Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	IoT device verifies that usability is a special and important perspective to analyze 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, behavior 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 Sensoneo's 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.
NFR-6	**Scalability**	Using smart waste bins reduce the number of bins inside town , cities coz we able to monitor the garbage 24/7 more cost effect and scalability when we moves to smarter.

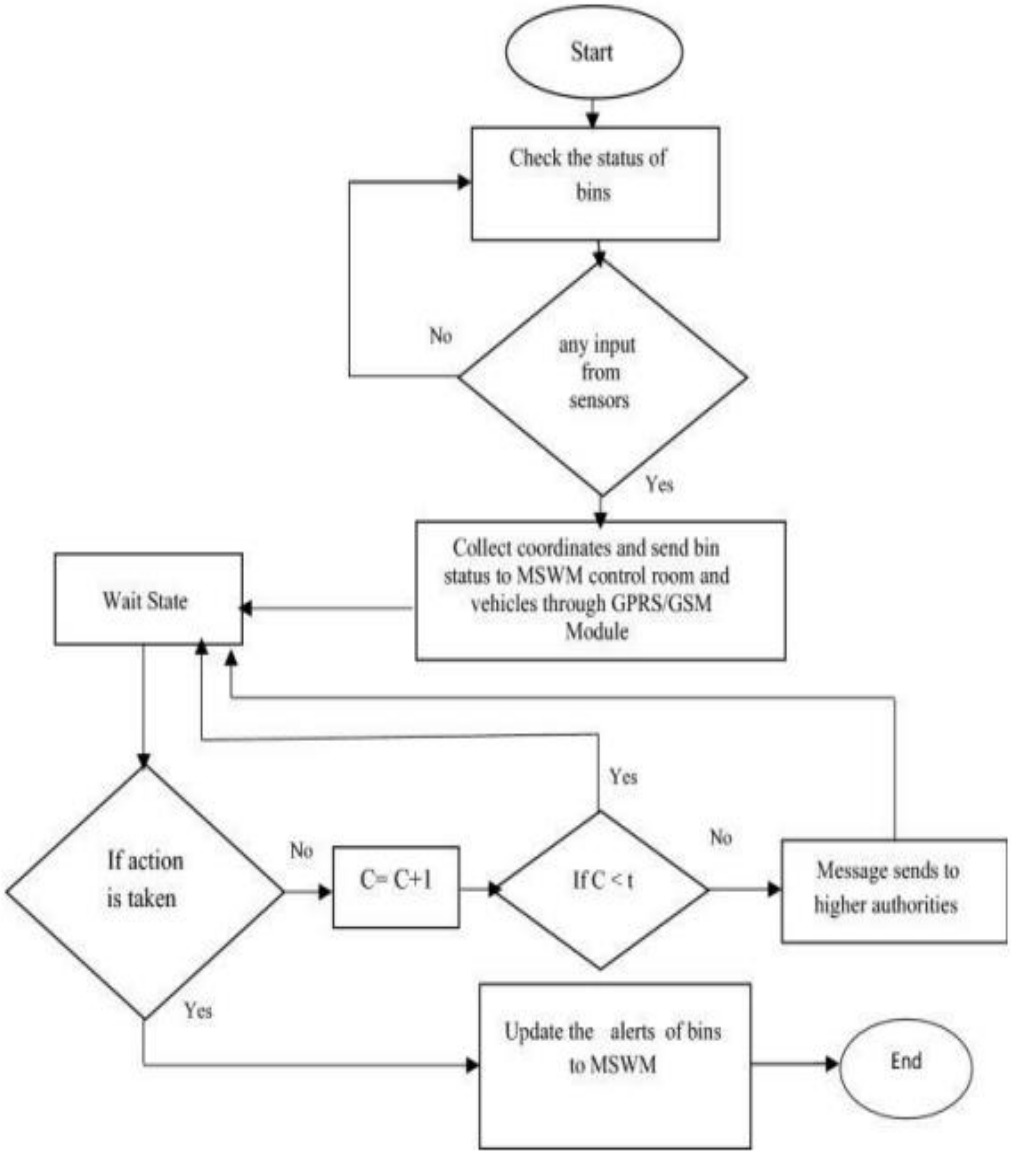
4.2 CUSTOMER JOURNEY



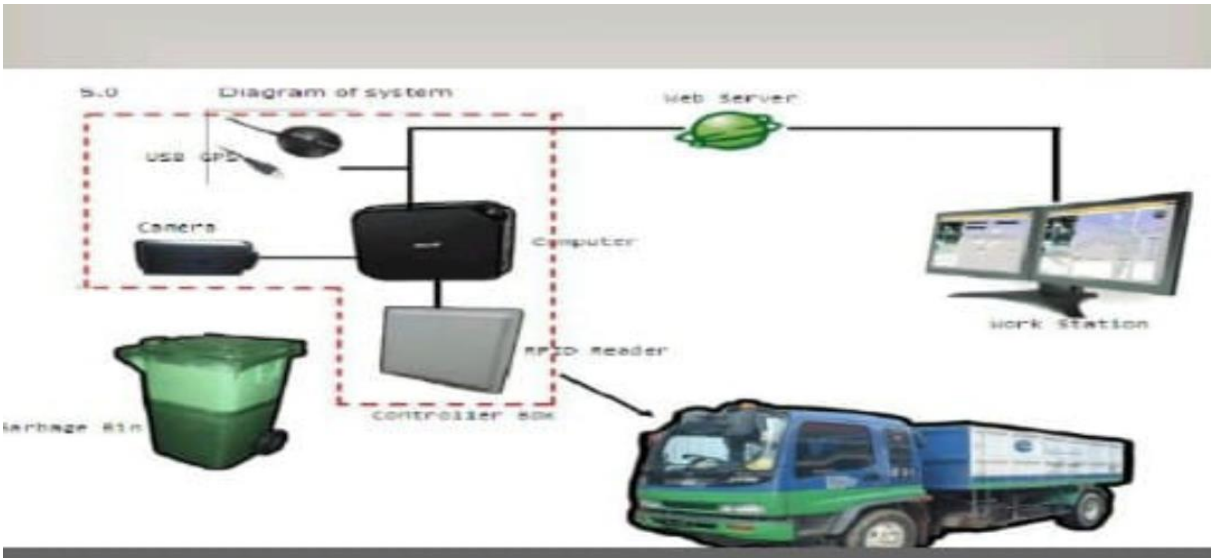
Customer experience journey map

This framework helps to understand customer needs, motivations, and obstacles by illustrating a key scenario or process from start to finish. When possible use this map to document and summarize interviews and observations with real people rather than relying on your hunches or assumptions.

4.3 DATA FLOW DIAGRAMS



4.4 TECHNOLOGY ARCHITECTURE



IOT BASED SMART WASTE MANAGEMENT SYSTEM OF METROPOLITAN CITIES

- Waste bins are part of our lives for decades and mostly its condition are overflowing due to improper waste dumping, collection and management, which leads in foul smell and unhygienic condition, thus inherently results in environment pollution. Therefore, in this paper, design of a Waste Bin with real time monitoring is presented and a smart was.
- 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

5. PROJECT PLANNING PHASE

5.1 MILESTONE & ACTIVITY LIST

Project Planning Phase
Milestone and Activity List

Team ID	PNT2022TMID50177
Project Name	Smart Waste Management System for Metropolitan Cities

TITLE	DESCRIPTION	DATE
Literature Survey & Information Gathering	Literature survey on the selected project & gathering information by referring the, technical papers, research publications etc.	03 October 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements	01 OCTOBER 2022
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	05 OCTOBER 2022
Proposed Solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	12 OCTOBER 2022
Problem Solution Fit	Prepare problem - solution fit document.	23 OCTOBER 2022

Solution Architecture	Prepare solution architecture document.	25 OCTOBER 2022
Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).	12 November 2022
Functional Requirement	Prepare the functional requirement document.	16 November 2022
Data Flow Diagrams	Draw the data flow diagrams and submit for review.	13 November 2022
Technology Architecture	Prepare the technology architecture diagram.	12 NOVEMBER 2022
Prepare Milestone & Activity List	Prepare the milestones & activity list of the project.	16 NOVEMBER 2022
Project Development - Delivery of Sprint-1, 2, 3 & 4	Develop & submit the developed code by testing it.	IN PROGRESS..

5.2 SPRINT DELIVERY PLAN

Product Backlog, Sprint Schedule, and Estimation :

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	1.As a Administrator, I need to give user id and passcode for ever workers over there in municipality. 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	20	HIGH	J.Jancy T.Esther S.Hemalatha A.Jenitta Pushpaleela
Sprint-2	Dashboard	USN-2	As a Truck Driver, I' ll follow Co-Admin' s Instruction to reach the filling bin in short roots and save time	20	LOW	J.Jancy T.Esther S.Hemalatha A.Jenitta Pushpaleela
Sprint-3	Dashboard	USN-3	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	J.Jancy T.Esther S.Hemalatha A.Jenitta Pushpaleela
Sprint-4	Dashboard	USN-4	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	HIGH	J..Jancy T.Esther S.Hemalatha A.Jenitta Pushpaleela

Project Tracker:

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. PROJECT DEVELOPMENT PHASE

6.1 CODING

SPRINT 1

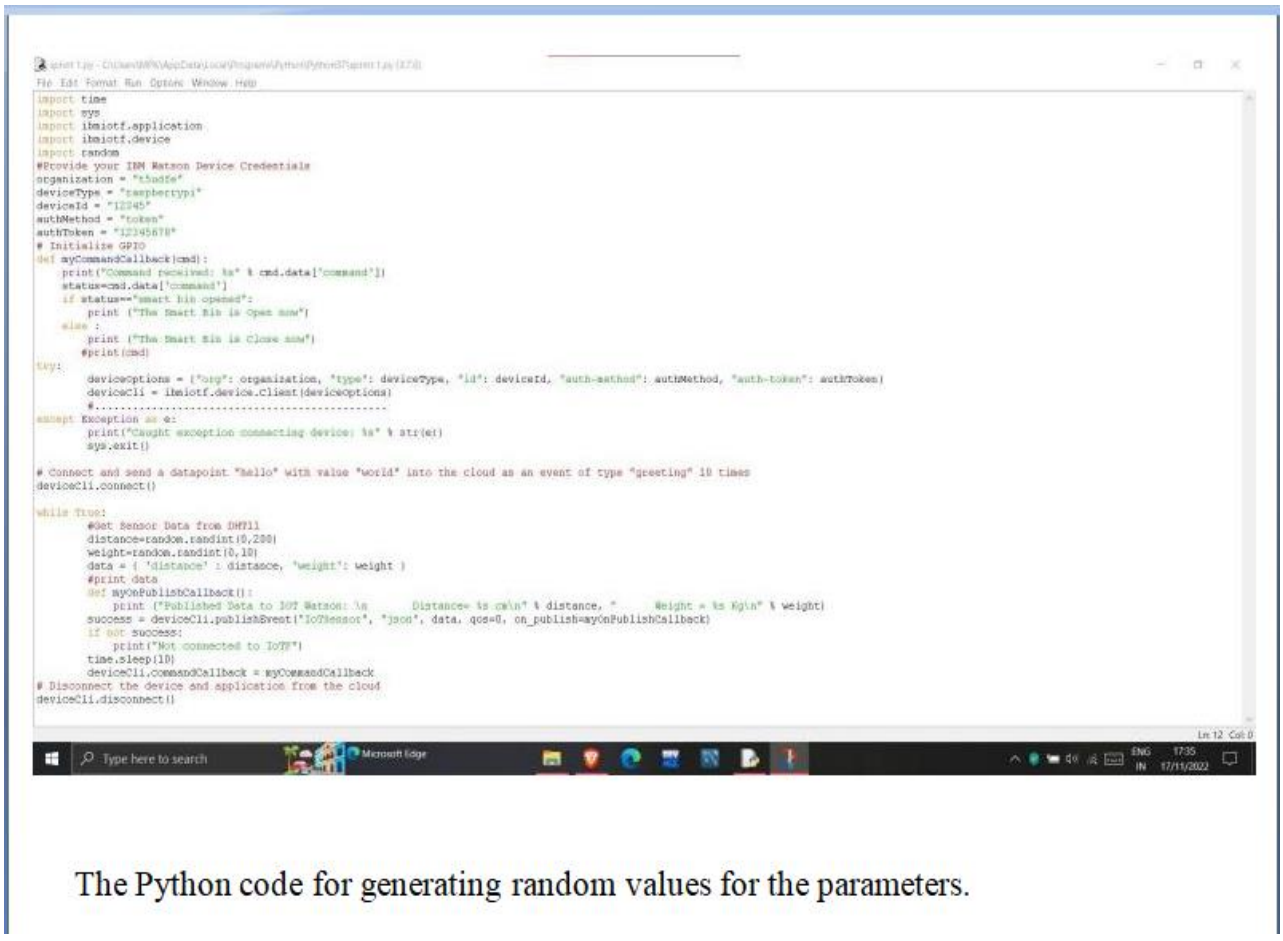
PYTHON CODE:

```
importtime
importsys
```

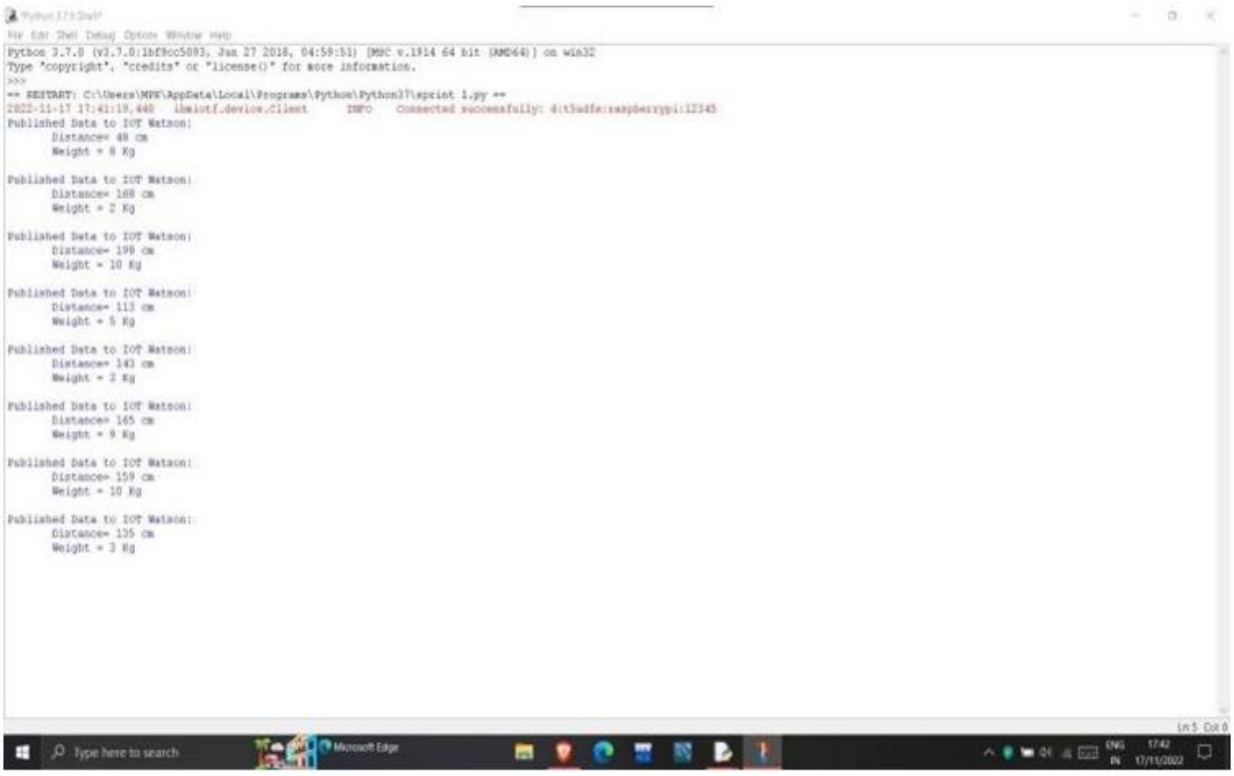
```
importibmiotf.application
importibmiotf.device
importrandom
#ProvideyourIBMWatsonDeviceCredentials
organization="t5udfe"
deviceType="raspberrypi"
deviceId="12345"
authMethod="token"
authToken="12345678"
#InitializeGPIO
defmyCommandCallback(cmd):
    print("Commandreceived:%s"%cmd.data['command'])
    status=cmd.data['command']
    ifstatus=="smartbinopened":
        print("TheSmartBinisOpennow")
    else:
        print("TheSmartBinisClosenow")
      #print(cmd)
try:
        deviceOptions={"org":organization,"type":deviceType,"id":deviceId,
"auth-method":authMethod,"auth-token":authToken}
        deviceCli=ibmiotf.device.Client(deviceOptions)
        #.....
exceptExceptionase:
        print("Caughtexceptionconnectingdevice:%s"%str(e))
        sys.exit()

#Connectandsendadatapoint"hello"withvalue"world"intothecloudasan
eventoftype"greeting"10times
deviceCli.connect()
```

```
whileTrue:
        #GetSensorDatafromDHT11
        distance=random.randint(0,200)
        weight=random.randint(0,10)
        data={'distance':distance,'weight':weight}
        #printdata
        defmyOnPublishCallback():
           print("PublishedDatatoIOTWatson:\n          Distance=%scm\n"%
```

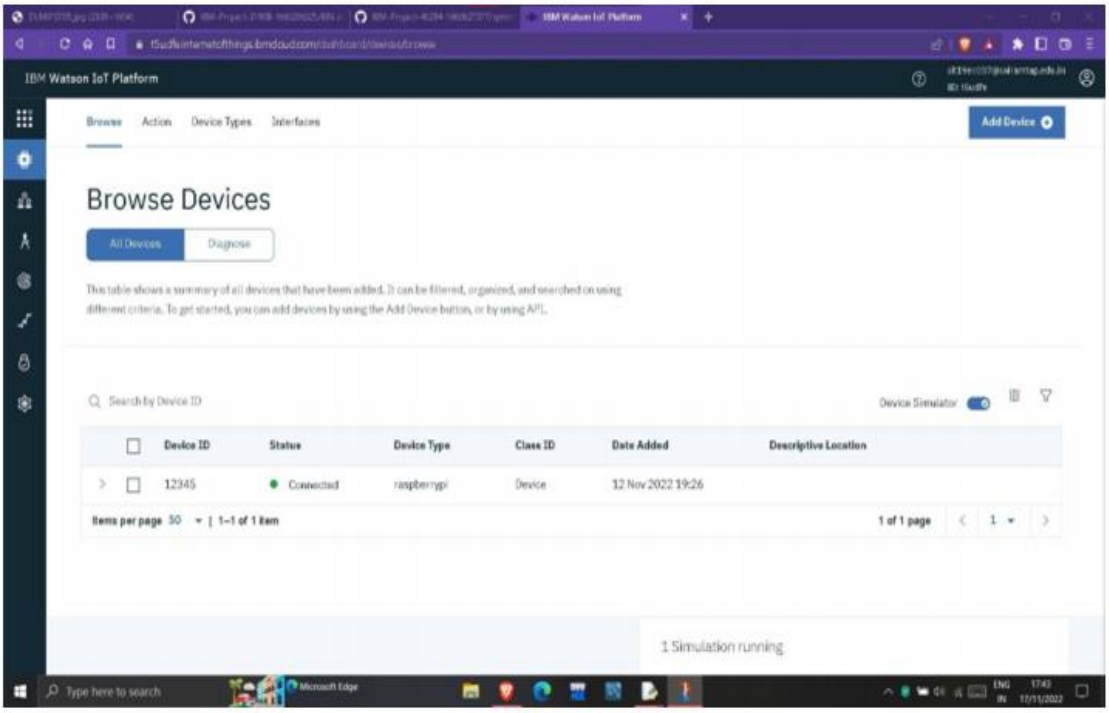
```
distance,"Weight=%sKg\n"%weight)
        success=deviceCli.publishEvent("IoTSensor","json
",data,qos=0,onpublish=myOnPublishCallback)
        ifnotsuccess:
            print("NotconnectedtoIoTF")
        time.sleep(10)
        deviceCli.commandCallback=myCommandCallback
#Disconnectthedeviceandapplicationfromthecloud
deviceCli.disconnect()
```

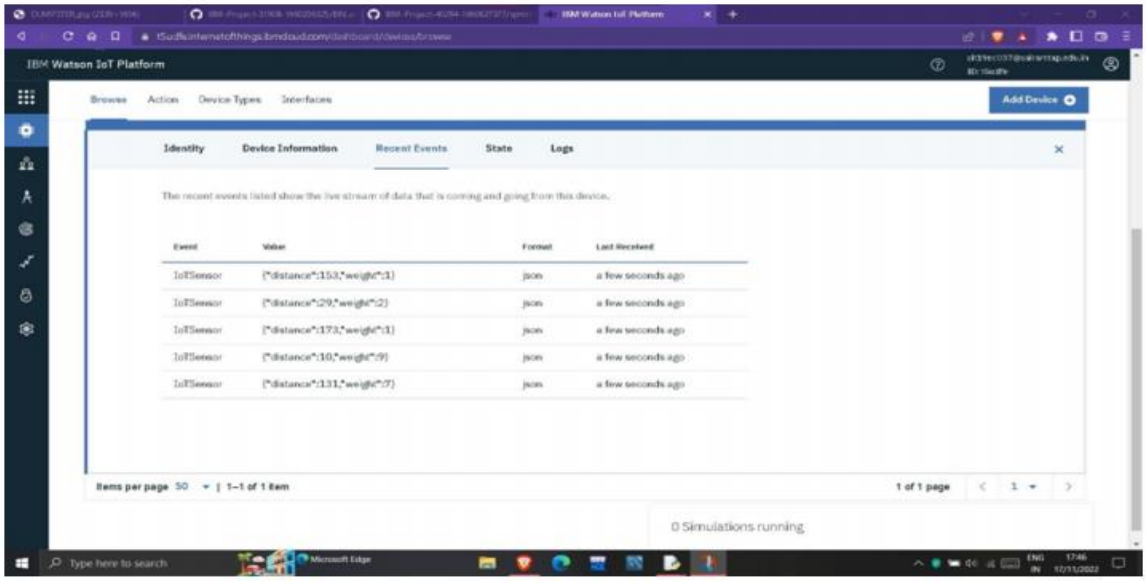


The Python code for generating random values for the parameters.



Here we are generating and random values for both the parameters weight and distance with the help of the random function in python.The weight parameter denotes the weight of smart bin and the distance parameter denotes the amount of garbage present in the smart bin which has a maximum length of 200cm.





A new device is created and the random values from the python code

is connected to the iot sensors. These random values are considered to be sensor values.

SPRINT 2

Aim:

To create device in the IOT Watson Platform and Configure Node Red Services.

Requirement:

IBM cloud, IBM IOT WATSON PLATFORM, NODE RED SERVICES.

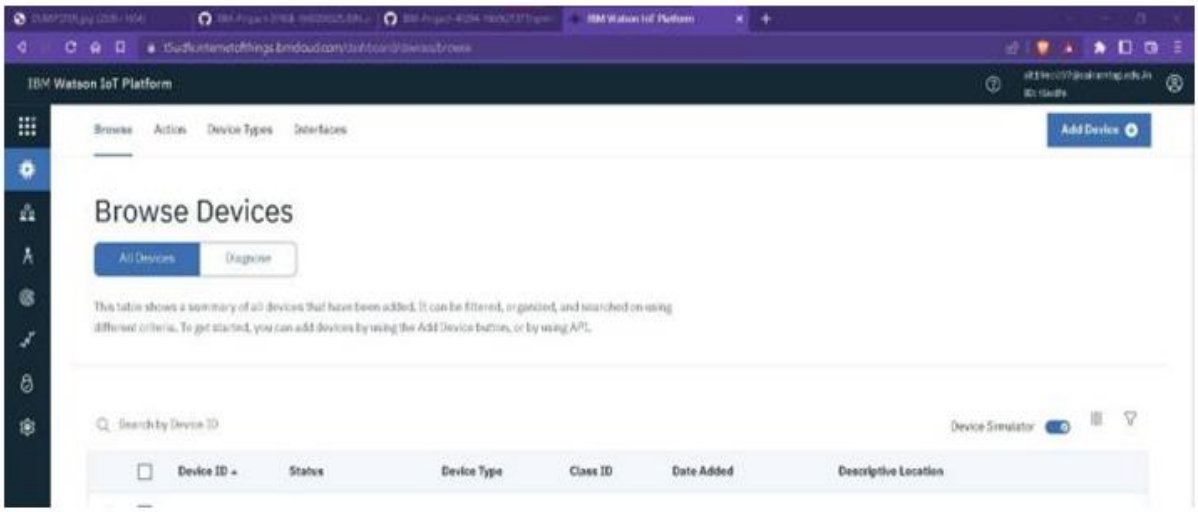
Workflow:

Step 1:

Log on to IBM cloud and create IBM Watson IOT Platform from IBM cloud Dashboard.

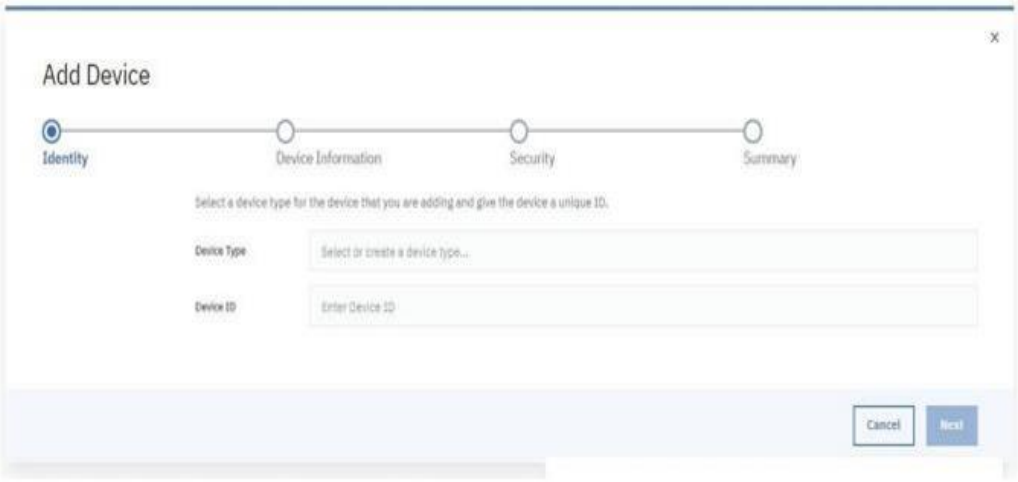
Step 2:

After Creating IBM Watson IOT Platform, create an Organization.



Step 3:

Create an device IBM IOT PLATFORM.



TYPE THE REQUIRED FIELDS(TYPE:Raspberrypi,ID: 12345)GIVEAUTH-TOKEN.

Step 4:

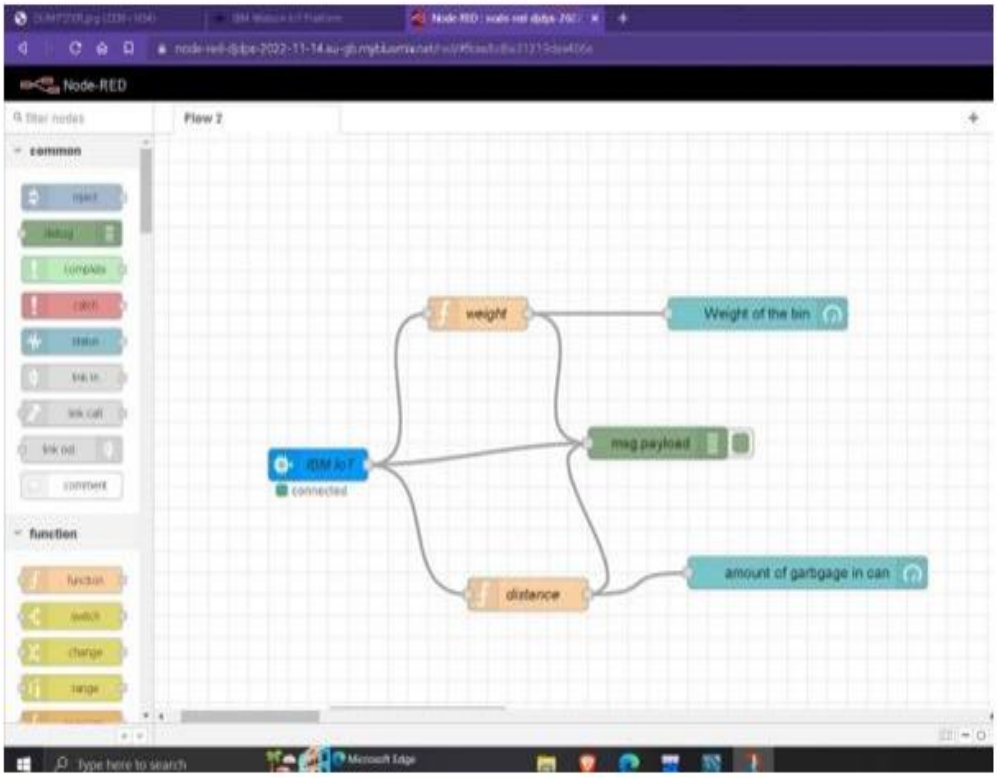
NODE-RED SERVICE

INSTALL IBM IOT IN MANAGE PALETTE.

INSTALL NODE RED DASHBOARD

Step 5:

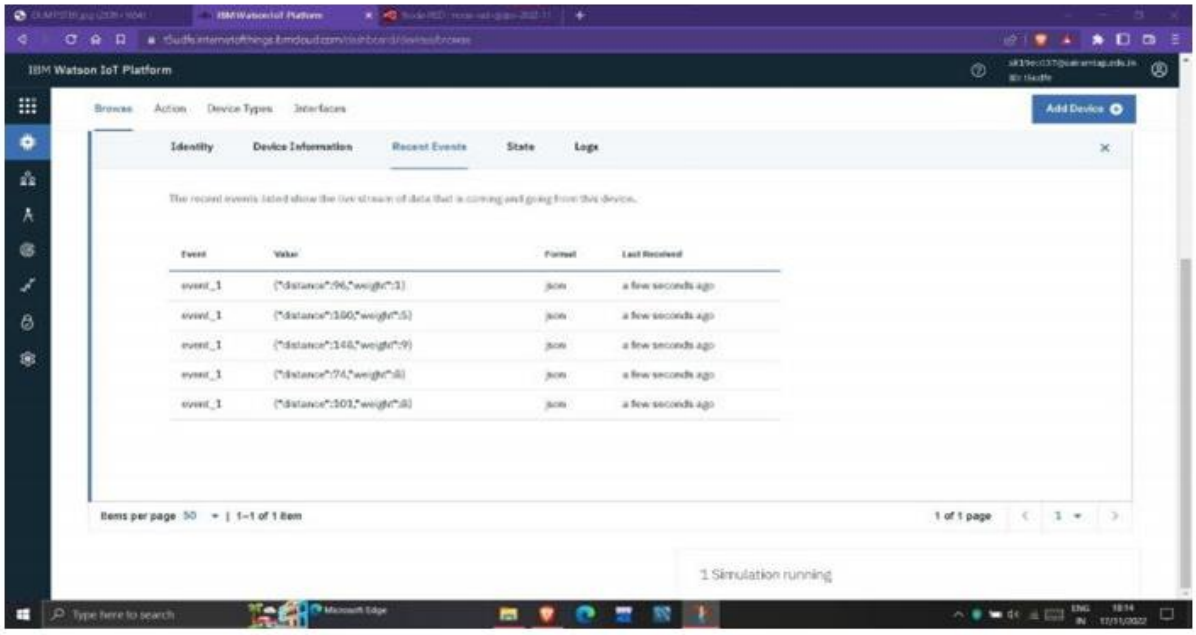
Configuring the corresponding nodes

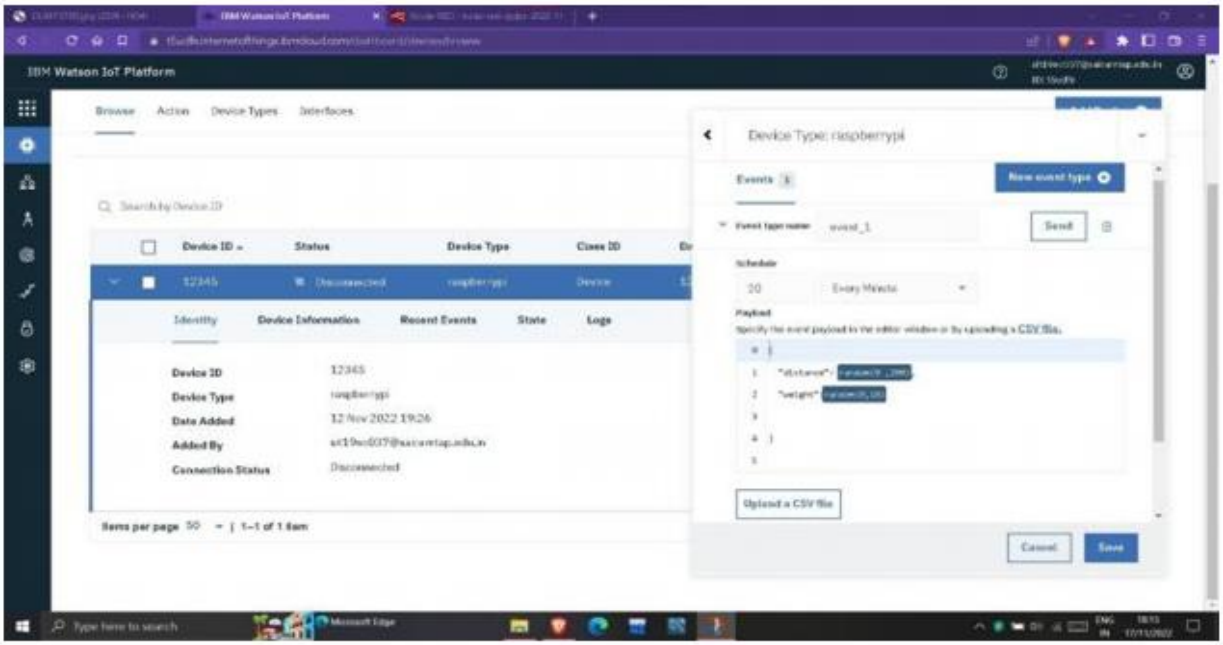


Step 6:

Deploy the Services and verify the output values.

OUTPUT IN IBM WATSON IOT PLATFORM:





SPRINT 3

DESIGN A WEB PAGE:

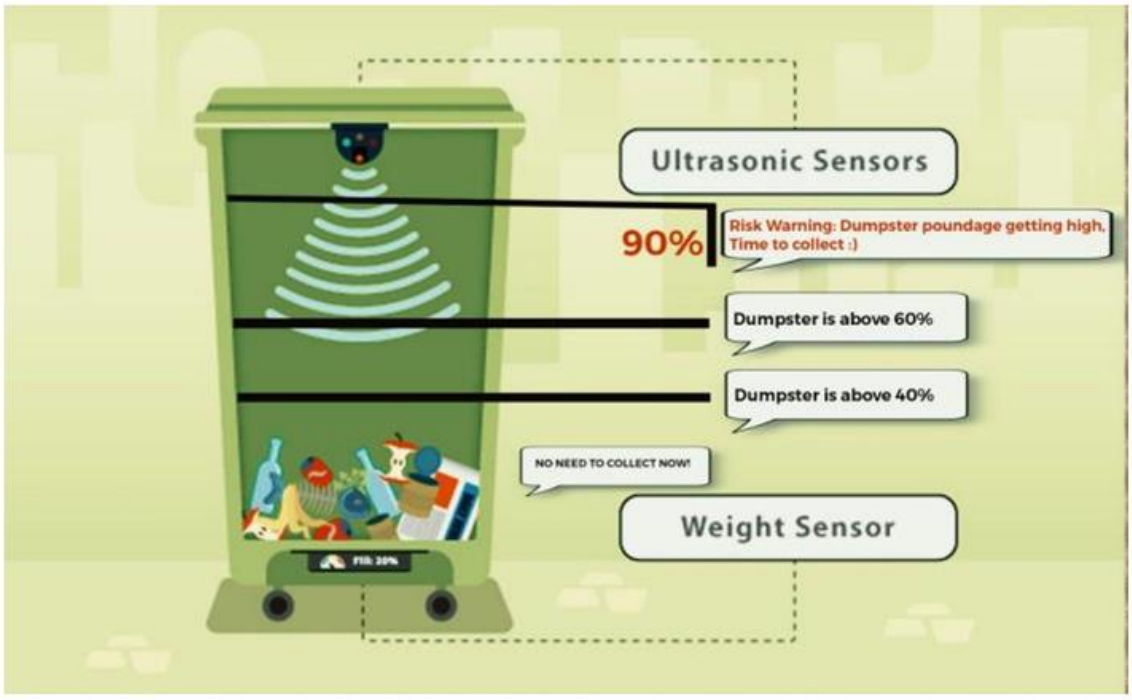
PARAMETERS ARE:

1.DISTANCE

2.WEIGHT

PROJECT MODEL:

The ultrasonic sensor and the weight sensor which are used to calculate the garbage distance and the weight respectively.

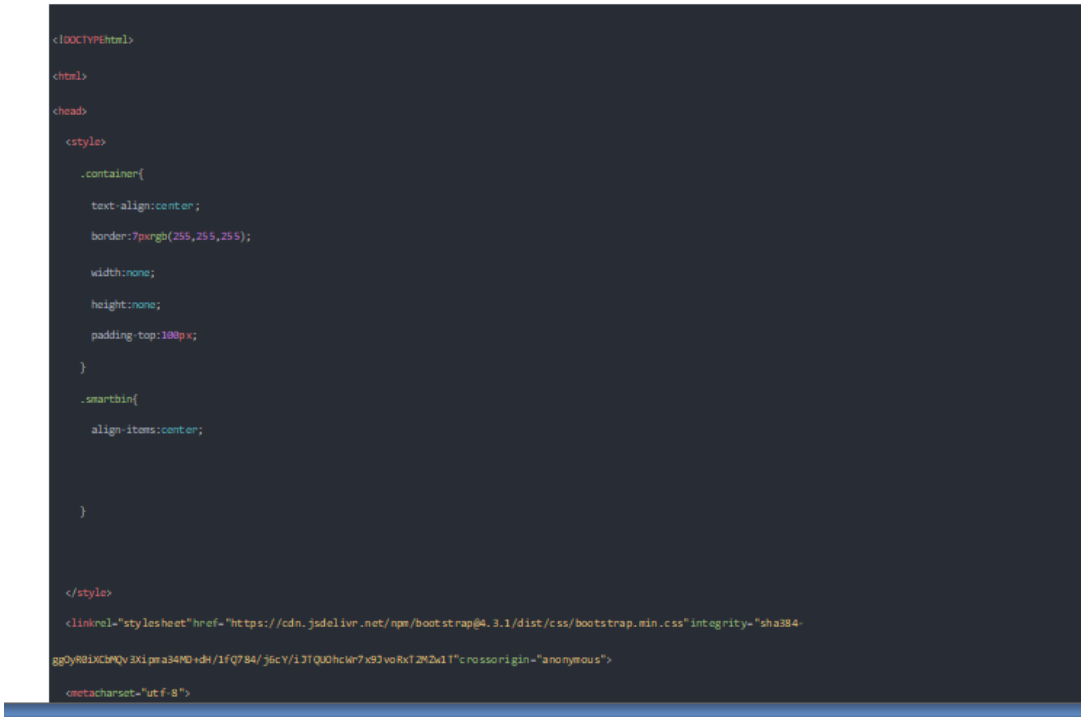


There are certain assumptions assumed by us, They are

- The length of the trashcan is assumed to be 200cm.

- The maximum weight of the can is assumed to be 2Kg.
- If the garbage distance goes more than 180cm i.e more than 90% of the trashcan, the sensor is has to send to send an alert to the garbage collector.
- If the alert is received, then the garbage collector has to come and collect the garbage.
- The current weight and the garbage distance is to be updated periodically, i.e for 5minutes.

WEB PAGE CODE:



```
<!DOCTYPEhtml>
<html>
<head>
  <style>
    .container{
      text-align:center;
      border:7pxrgb(255,255,255);
      width:none;
      height:none;
      padding-top:100px;
    }
    .smartbin{
      align-items:center;


    }


  </style>
  <linkrel="stylesheet"href="https://cdn.jsdelivr.net/npm/bootstrap@4.3.1/dist/css/bootstrap.min.css"integrity="sha384-
ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T"crossorigin="anonymous">
  <metacharset="utf-8">
```

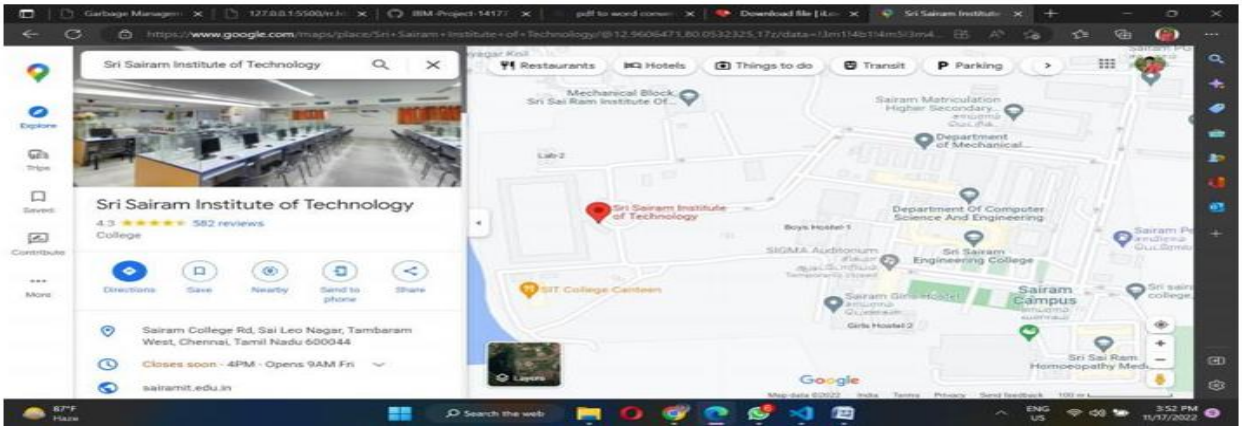
```
<metaname="viewport"content="width=device-width">
<title>GarbageManagementSystem</title>
<linkrel="icon"type="image/x-icon"href="/Images/DUMPSTER.png">
<linkhref="style.css"rel="stylesheet"type="text/css"/>
<scriptsrc="https://www.gstatic.com/firebasejs/8.10.1/firebase-app.js"></script>
<scriptsrc="https://www.gstatic.com/firebasejs/8.10.1/firebase-database.js"></script>
<script>
  varfirebaseConfig=
  {
    apiKey:"AIzaSyB9ysbnaNc31yoCioh-a3QTUCMd5C8F6U",
    authDomain:"fir-test-923b4.firebaseapp.com",
    databaseURL:"https://fir-test-923b4-default-rtdb.firebaseio.com",
    projectId:"fir-test-923b4",
    storageBucket:"fir-test-923b4.appspot.com",
    messagingSenderId:"943542145393",
    appId:"1:943542145393:web:9b5ec7593e6a3cbd7966d0",
    measurementId:"G-8N73NK1Q78"
  };
  firebase.initializeApp(firebaseConfig)
</script>
<scriptdefersrc="database.js"></script>
</head>
<bodystyle="background-color:rgb(255,255,255);">
<scriptsrc="map.js"></script>
```

```
<divid="mapcontainer">
  <divid="map"></div>
  <divid="alertmsg"><ahref="rr.html"target="blank">ALERTMESSAGE!</a></div>
</div>
</div>
<divclass="container">
```

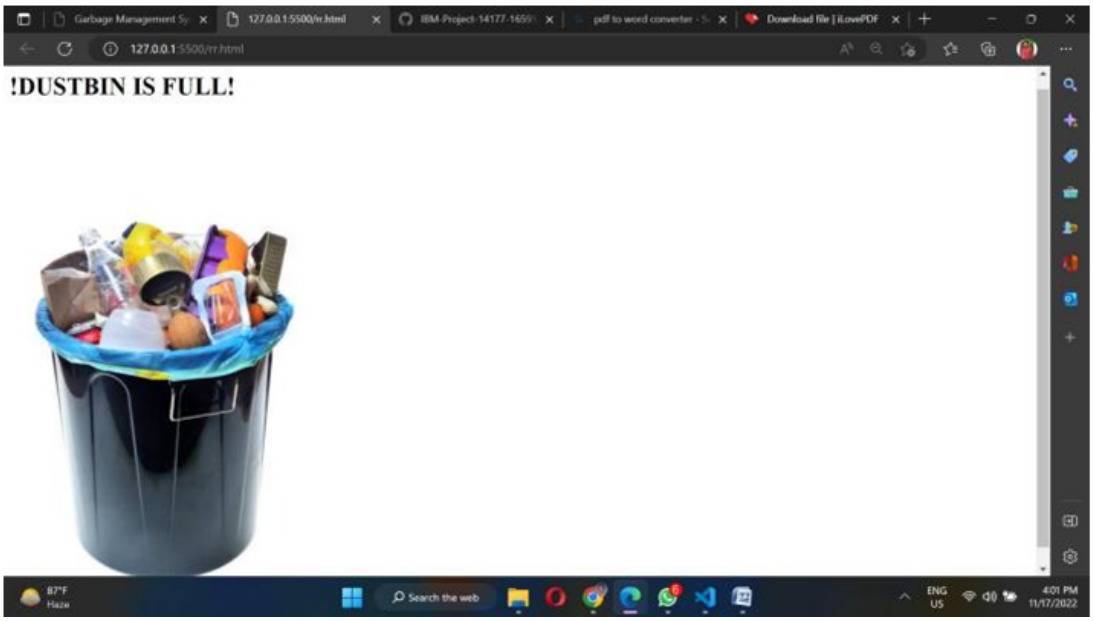
```
<center><ahref="https://g.page/sairamengg?share"
type="button"class="btnbtn-dark">SMARTBIN</a></center></div>
<form>
    Distance:<inputtype="text"name="Distance"value="100">
    Weight:<inputtype="text"name="Weight"value="1kg">
</form>
<divclass="smartbin">
```

OUTPUT:

When you click the smartbin button it will show the exact location where the garbage can is filled.



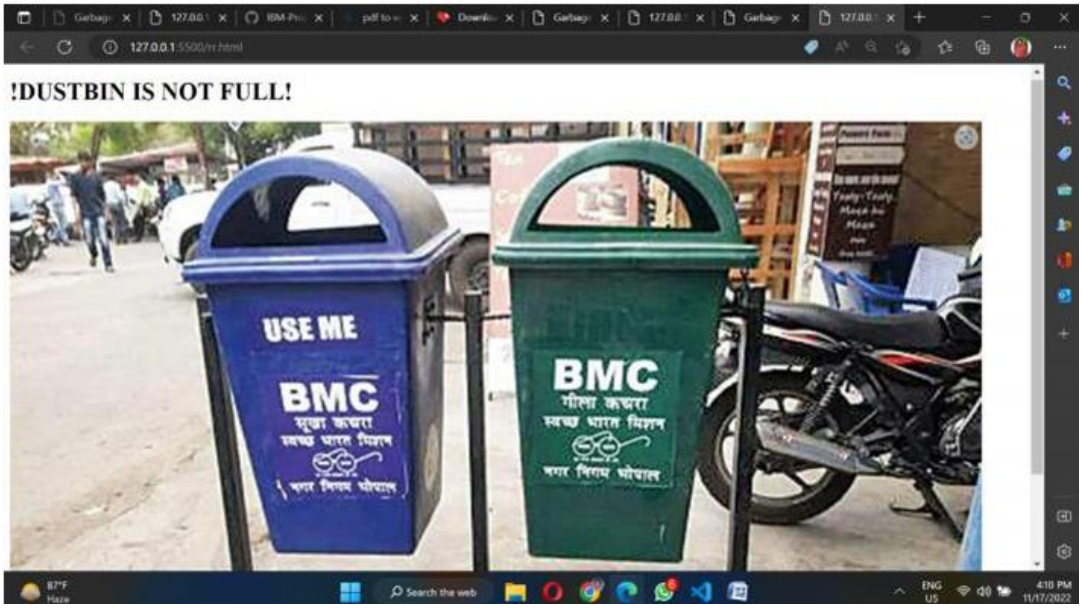
When dustbin is filled:



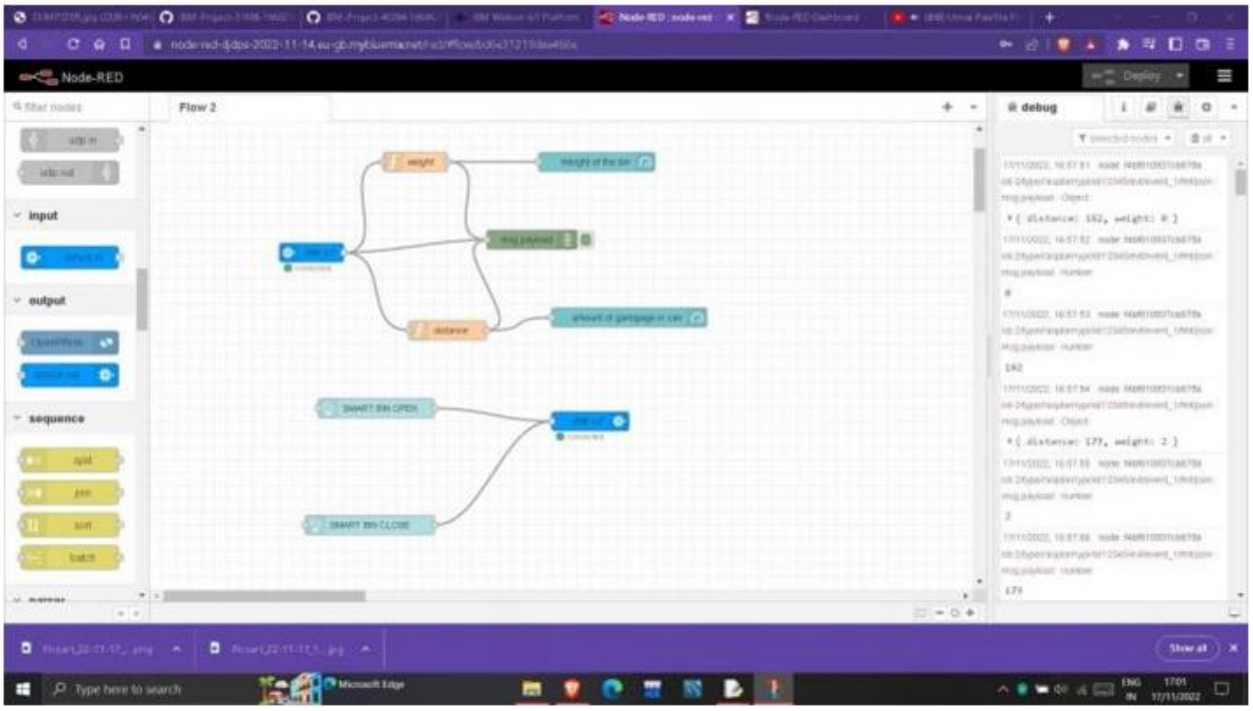
When the smartbin is filled the alert message will be sent to the garbage collector along with the exact location with its co-ordinates.

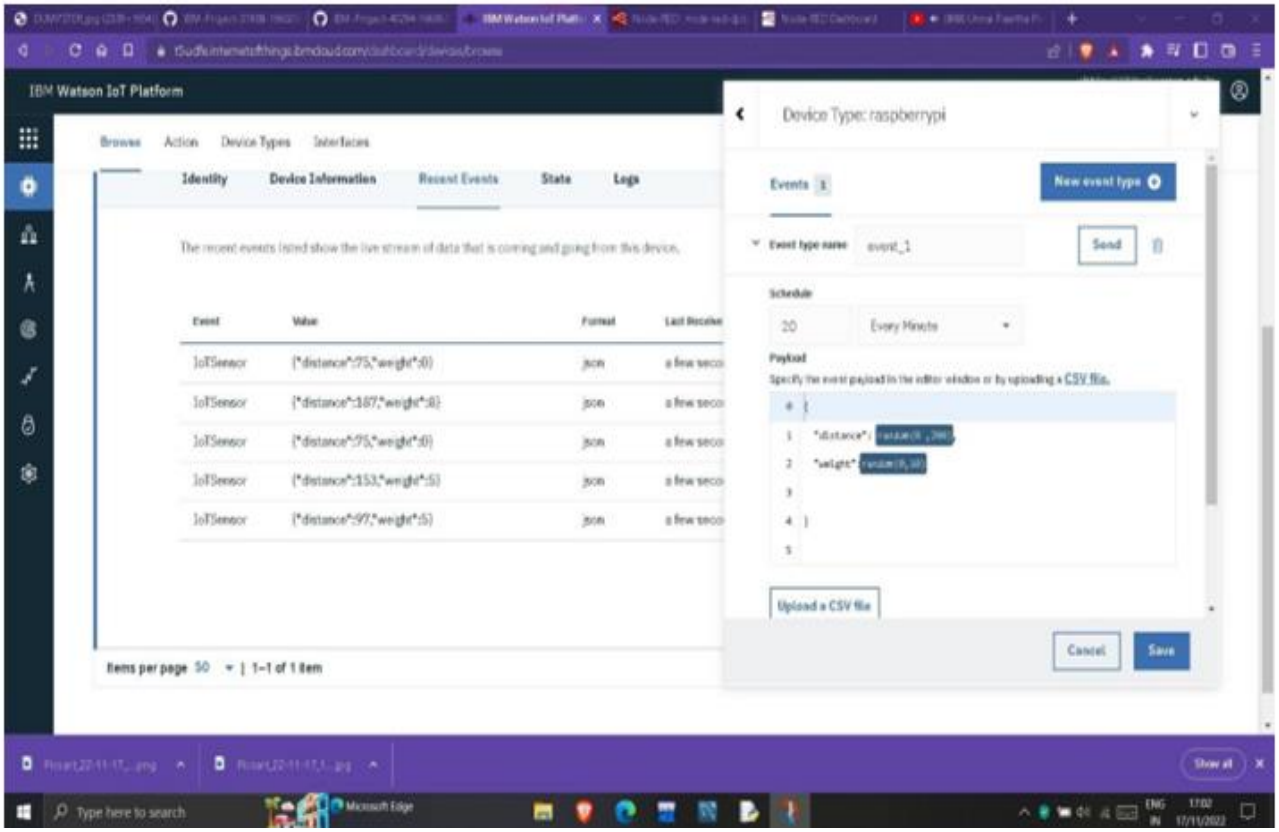
When the garbage is not filled upto 90% the smartbin is ready to collect the garbage.

When dustbin is not filled:



We are sending the data of the garbage can with help of Node-red and iot cloud which composed of the value equal to the weight of the garbage can and the distance of garbage present in the can.





7. CONCLUSION:

Due to the absence of sustainable waste management technology, the current waste disposal situation is likely to worsen.This work presents an enhanced solution to the problem of waste management by the littering of the garbage bins once they are full.