SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITIAN CITIES

NALAIYA THIRAN PROJECT BASED LEARNING

ON

PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

A PROJECT REPORT

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ABSTRACT

Traditional waste management system operates based on daily schedule which is highly inefficient and costly. The existing recycle bin has also proved its ineffectiveness in the public as people do not recycle their waste properly. With increase in population and industrialization of nation throughout the globe, waste has become great concern for all of us. With the development of Internet of Things (IoT) the traditional waste management system can be replaced with smart sensors embedded into the system to perform real time monitoring and allow for better waste management. The aim of this research is to develop a smart waste management system using LoRa communication protocol and Tensor Flow based deep learning model. The system also adapt with network environment, to manage all information from waste management. The GPS module is used to locate the system for easy pickup and to track the bin by using GPS and the very bins are provided with the ID name. Object detection and the waste classification is done in TensorFlow framework with pre-trained object detection model. Ultrasonic sensor is embedded into each waste compartment to monitor the filling level of the waste. RFID module is embedded for the purpose of waste management personnel identification. As the result we proposed a prototype of smart waste-bin that suitable for many kind of conventional waste-bin.

TABLE OF CONTENT

CHAPTER NO	TITLE
	ABSTRACT
1	INTRODUCTION
2	OBJECTIVE
3	IDEATION PHASE 3.1 Literature survey 3.2 Empathy map 3.3 Ideation 3.4 Brainstorm
4	PROJECT DESIGN PHASE-1 4.1 Proposed solution 4.2 Problem solution fit 4.3 Solution Architecture
5	PROJECT DESIGN PHASE-2 5.1 Customer Journey Map 5.2 Solution Requirements 5.3 Data Flow Diagrams 5.4 Technology Stack
6	PROJECT PLANNING PHASE 6.1 Prepare milestone and activity list 6.2 Sprint Delivery Plan
7	PROJECT DEVELOPMENT PHASE 7.1 Project Development-Delivery of sprint-1 7.2 Project Development-Delivery of sprint-2 7.3 Project Development-Delivery of sprint-3 7.4 Project Development-Delivery of sprint-4
	CONCLUSION
	REFERENCES

SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES

1.INTRODUCTION

Internet of things (IoT) is a communication paradigm that able to cater to the long-distance communication needed by the waste management system while sacrificing on the rate of data envisions a future paradigm where everyday life objects will be transmission. Studies in the field of wireless communication equipped with a microcontroller and some form of communication in IoT have also been accelerating. Conversely, communication protocol . IoT is the smart city, technology such as Bluetooth, Wi-Fi, and offer better data which can be defined as a city with smart technology, smart people, transmission rates, but these are limited by their data transmission and smart collaboration . IoT shall transparently and seamlessly ranges incorporate a large number of heterogeneous end systems while Waste management is a costly operation as it takes up a great providing open access to select subsets of data for the development deal of resources and labor. One major topic within the authorities to improve waste management systems by setting up the smart city is smart waste management. The communication technology such as LoRa and SigFox, that the initiatives taken previously were not effective and that a which operate on a low power, wide-area network are smart waste management system needs to be developed to replace the existing infrastructures. It comes the existing waste management system. Sensors implementation in with three compartments, each with its own function monitoring, which is absent in the existing waste management The second compartment consists of an IR sensor and moisture system. Data such as filling level, humidity, and any sensor to detect dry and wet waste. The last compartment is necessary data can be collected from the sensors. IoT application in the waste bin is one step towards smart city.

2.OBJECTIVE:

- Monitoring the level and weight of waste is the one of the process and it is done by through weight sensor and code is generated for it.
- The main requirement is RAM-Minimum 4GB Processor-Min. Configuration OS-Windows/Linux/MAC.
- The process is Garbage level detection in bins. 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 App. We can view the location of every bin in the web application by sending GPS location from the device.
- The software requirement is python IDLE, IBM cloud, IBM IoT platform, Node-RED platform, web UI.

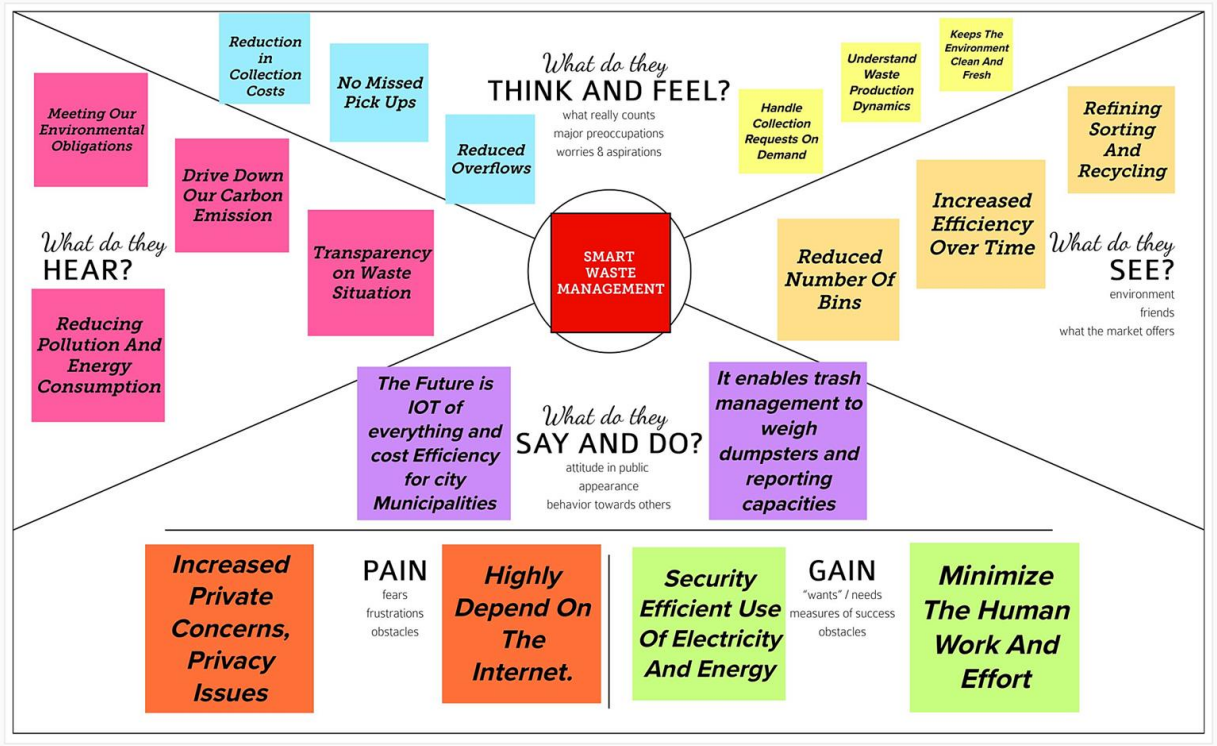
3. IDEATION PHASE

3.1 LITERATURE SURVEY:

Our proposed smart waste-bin system can be adapted into general waste-bin and it consists of the sensing units, a blue tooth and GSM Module for data transmission, and a mobile application and web-based monitoring for interfacing and communication with the waste department for waste management. Load cell is a measuring device used to measure loads either directly or indirectly. To measure the level of waste in the waste-bin we used ultrasonic sensor attached in the top side of waste-bin. A GSM module is used to communicate with server.

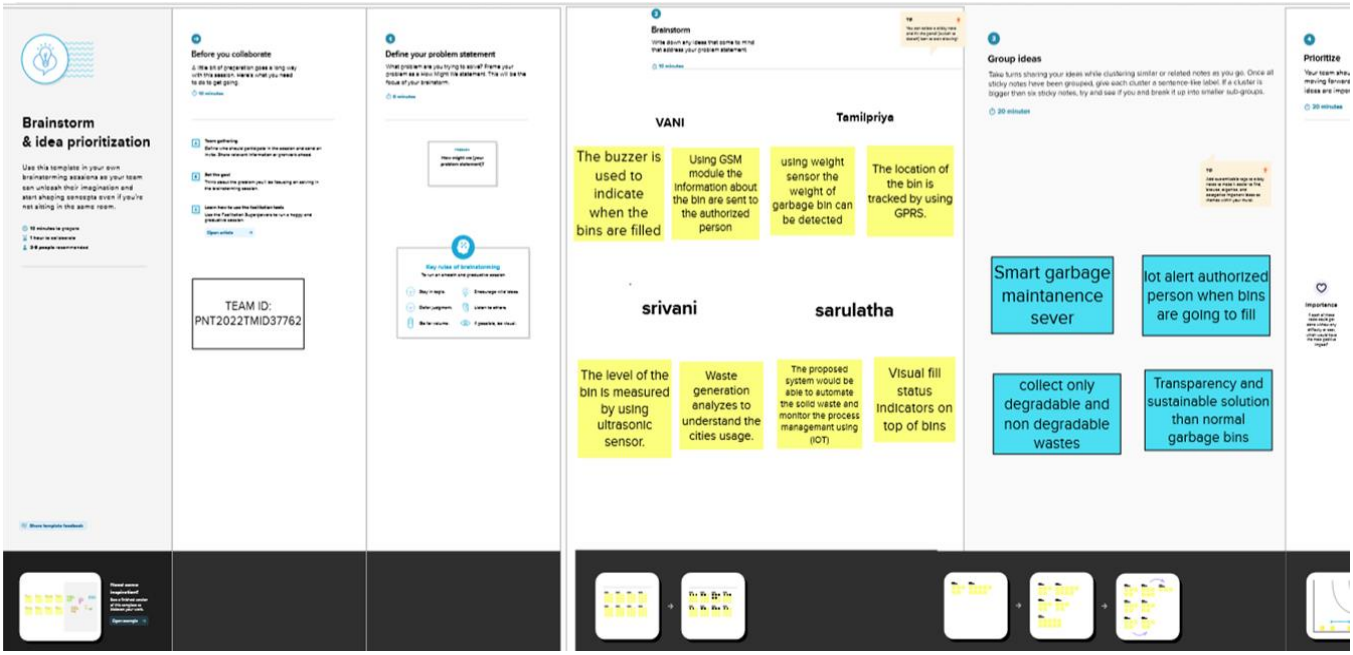
The proposed architecture will have a master slave configuration of dustbins. This would overcome the connectivity issues in remote areas. These slave dustbins communicate their information with their corresponding master dustbins. Each master dustbin shall be equipped with a micro-controller.

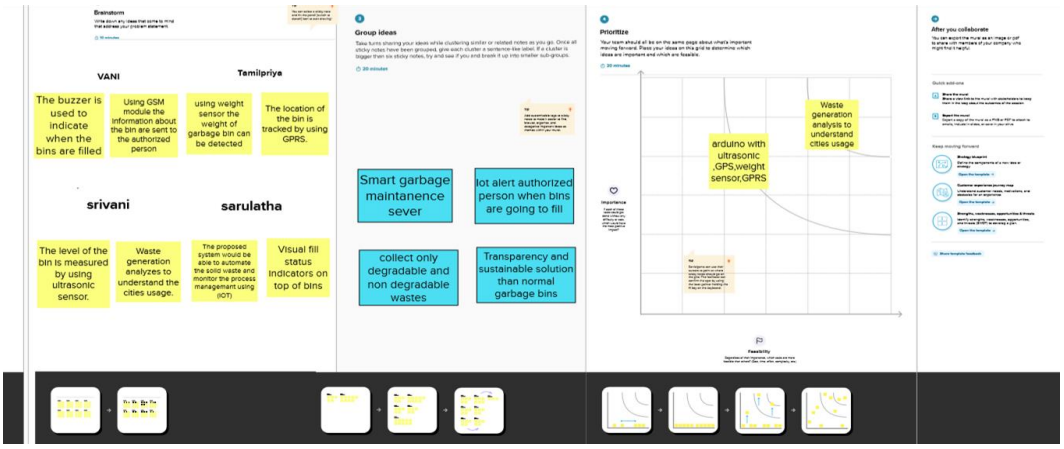
3.2 EMPATHY MAP:



3.3 IDEATION:

3.4 BRAINSTROMING:





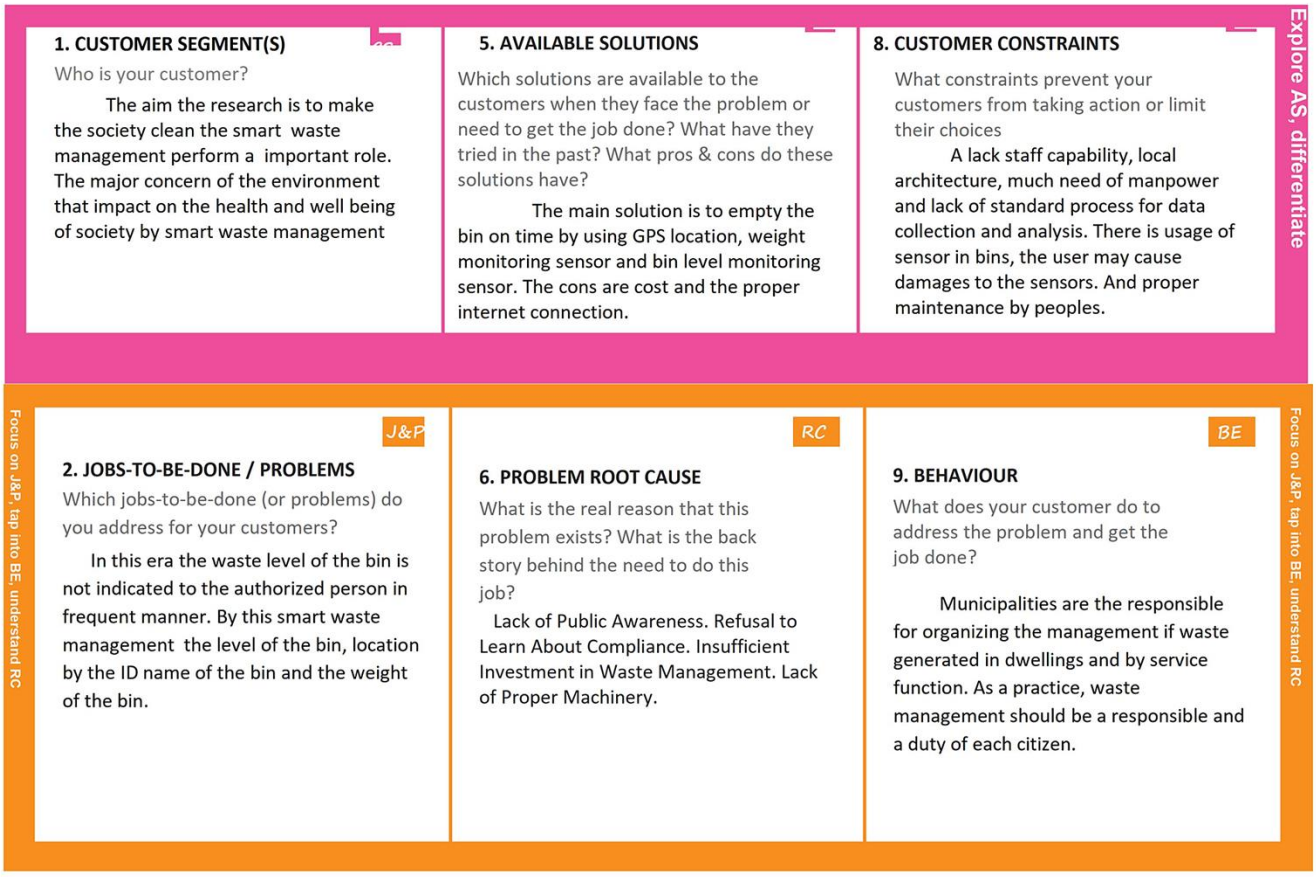
4. PROJECT DESIGN PHASE 1

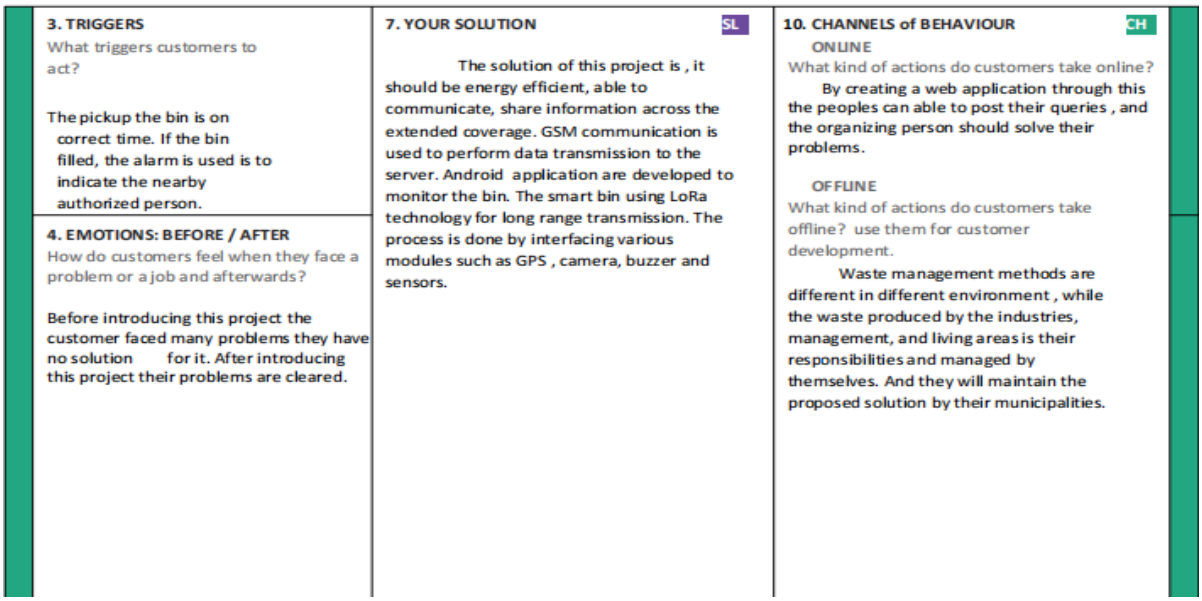
4.1 PROPOSED SOLUTION:

S.NO	Parameter	Description
1	Problem Statement (Problem to be solved)	This project deals with the problem of waste management in cities, when the garbage collection system is notoptimized. This system allows the authorised person to know the fill level of each garbage bin in a localityor city at all times and time saving to the truck drivers.
2	Idea / Solution description	• In the proposed system, whenever the waste bins gets filled this is the acknowledged by placing the circuit at the waste bin ,which transmit it to the receiver at the desired place in the area . • The received signal indicates the waste bin status at monitoring and controlling system. • The solution of this project is , it should be energy efficient ,able to communicate and share information across the extended area coverage. The smart bin using LoRa technology for long transmission . GSM Communication is used to perform data transmission to the server. Android application are developed to monitor the bin. • The overall process is done by interfacing various modules such as GPS, CAMERA, BUZZER, and SENSORS.
3	Novelty / Uniqueness	This paper presented the smart waste management system by implementing sensors to monitor the status of bin, LoRa communication protocol for low power and long range data transmission and Tensor

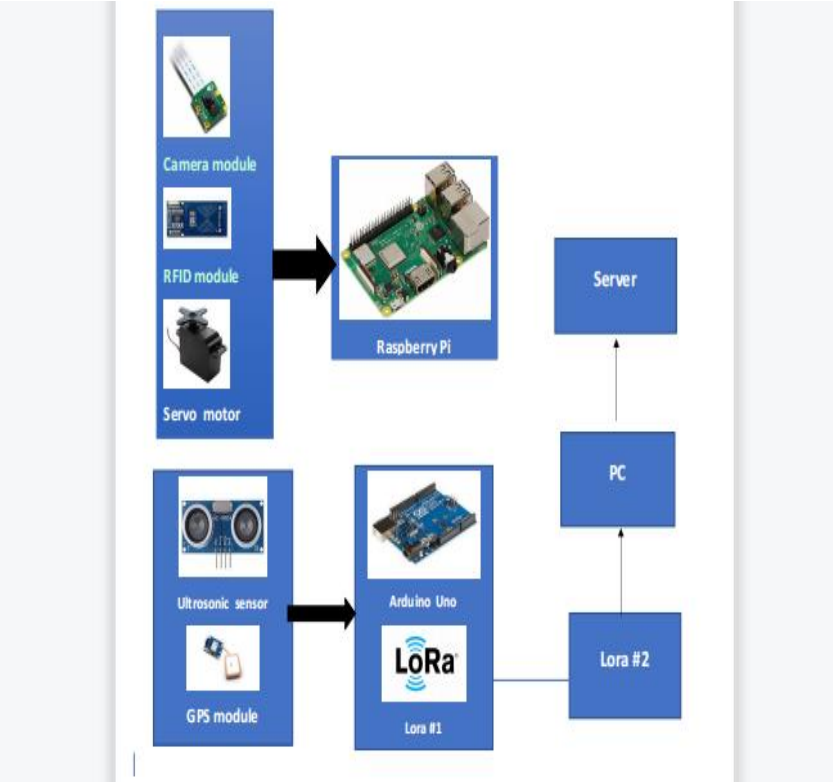
		flow based object detection to perform waste identification and classification. The segregation of waste is interfaced and coordinated well between the object detection can be done using Raspberry pi
5	**Business Model (Revenue Model)**	Waste Management organizes its operations into two reportable business segments: • **Solid Waste**, comprising the Company's waste collection, transfer, recycling and resource recovery, anddisposal services, which are operated and managed locally by the Company's various subsidiaries, which focus on distinct geographic areas. • **Corporate and Other**, comprising the Company's other activities, including its development and operation of landfill gas-to-energy facilities in the US, and its recycling brokerage services, as well as various corporate functions.
6	**Scalability of the Solution**	This paper presented an efficient IoT -based and real-time waste management model for improving the living environment in cities. The proposed system uses sensors and communication technologies where waste data is collected from the smart bin ,in real time and then transmitted to an online platform where the authorized person can access and check the availability of the compartment scattered around the city.

4.2 PROBLEM SOLUTION FIT:





4.3 SOLUTION ARCHITECTURE:



5.PROJECT DESIGN PHASE-2:

5.1 Customer journey:

User journey
by the Design Team of Accenture Interactive NL

User journey and user flow are two tools that are used to describe the process of interaction between a user and a product. Many designers consider user journey and user flow the same thing. While both tools are used to communicate your designs through the lens of your users' goals, they aren't synonyms because they focus on different aspects of created products.

People 2–9 | Time 30 min | Difficulty Beginner

Creating a user journey is a quick way to help you and your team gain a deeper understanding of who you're designing for, aka the stakeholder in your project. The information you add here should be representative of the observations and research you've done about your users.

2 Steps
Detailed actions your user has to perform

3 Feelings
What your user might be thinking and feeling at the moment

4 Pain points
Problems your user runs into

The process is not alwalys cost effective.
The practice is not done in uniformlly.
The sites are often dangerous.
Systen requires more number of dustbins for the separation.
Sensor node used in dustbin have limited memory.

5 Opportunities
Potential improvements or enhancements to the experience

Proper segregating and minimizing waste .
Educating and training your staff.
Implement staintable waste container.
Circulate safety data sheets.
Create an emergency readiness.
Review compliance.
Perform regular audits on waste management and disposal.
Look opportunities for recycle.

Accenture Intera

5.2 Solution Requirements:.

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR NO	FUNCTIONAL REQUIREMENT (EPIC)	SUB REQUIREMENT(Story/ sub task)11
FR-1	Expensive bins.	Depends upon the average waste collected in areas, we can 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 discharge in the area. The tool assigns biarating(110) and calculates distance from discharge.
FR-2	Real time bin monitoring	The percentage 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. It displays real- time data on fill-levels of bins monitored by smart sensors.
FR-3	Detailed about the bin monitoring.	All monitored bins and stands can be seen on the map, and you can visit them at anytime 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-4	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.

Non functional requirements:

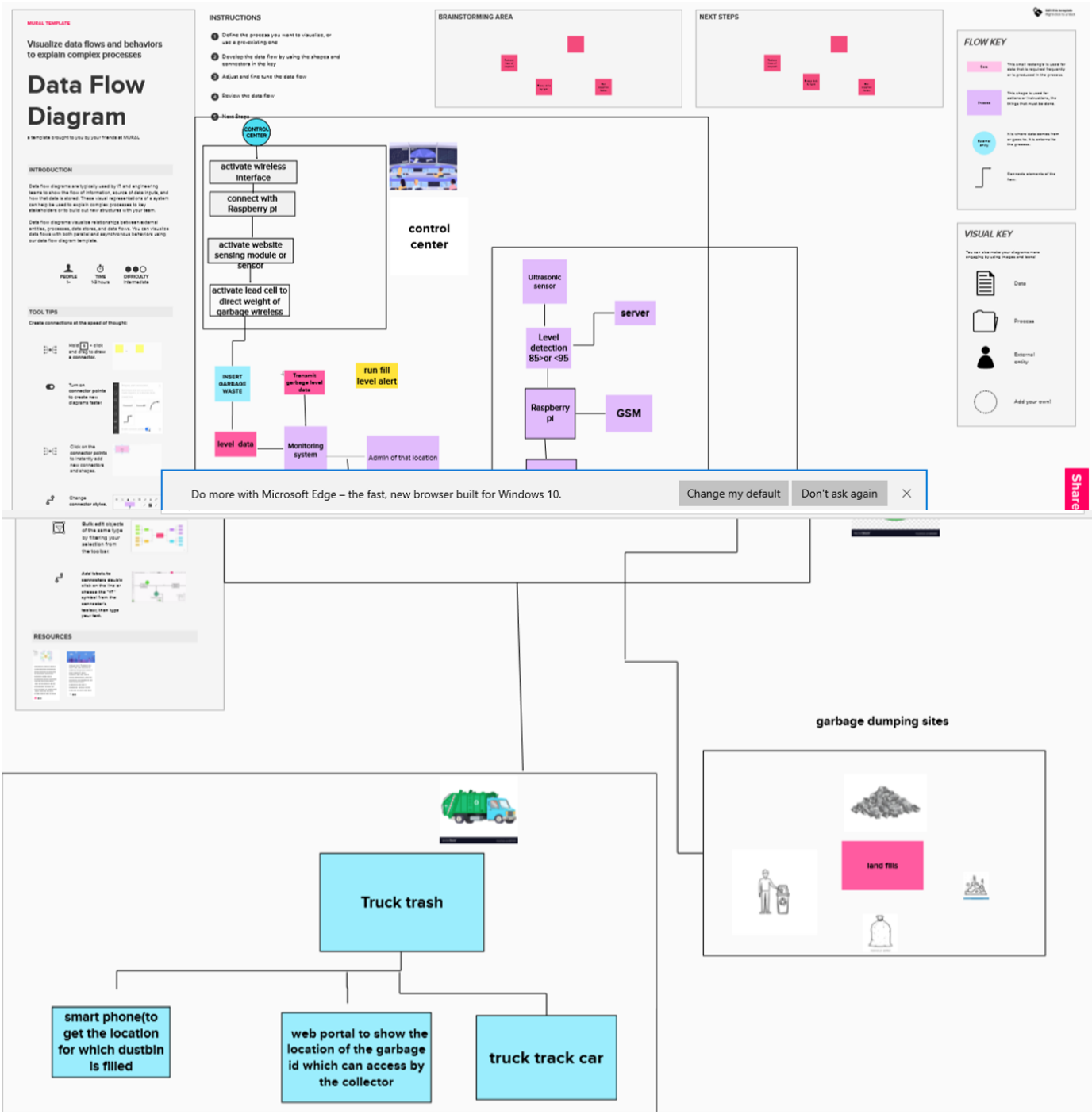
The following are the non-functional requirements of the proposed solution.

FR NO	NON-FUNCTIONAL REQUIREMENTS	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

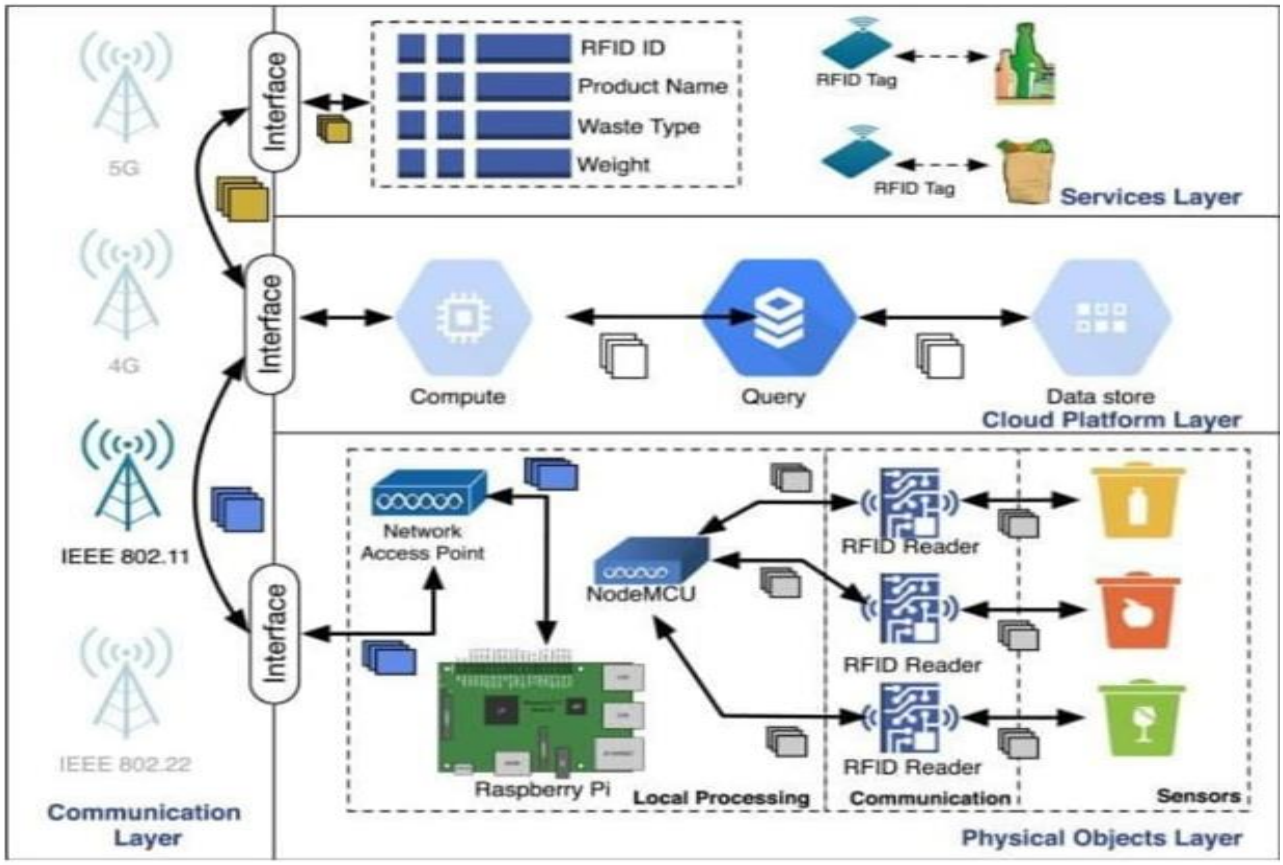
		waste management, behaviour and experience.
NFR-2	**Availability**	By developing & deploying resilient hardware and beautiful software we empower cities, its businesses, and countries to manage waste smarter.
NFR-3	**Performance**	The Smart Sensors use ultrasound technology to measure the fill levels (along with other data) in bins several times a day. Using a variety of IoT networks (GPRS), the sensors send the data to Sensors 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, and frequencies, and vehicle loads resulting in route reduction by at least30%.
NFR-4	**Security**	Use reusable grocery bags Avoid single use food and

		drink containers. Use a reusable bottles Purchase wisely and recycle
NFR-5	Scalability	Using smart waste bins reduce the number of bins inside town , cities because we able to monitor the garbage 24/7 more cost effect and scalability when we moves to smarter.

5.3 DATA FLOW DIAGRAM:



5.4 TECHNOLOGY STACK:



6.PROJECT PLANNING PHASE:

6.1 Prepare Milestone Activity List:

TITLE	DESCRIPTION	DATE
Literature Survey &gathering information	Literature survey on the selected project & gathering information by referring the, technical papers research publications etc..	11th October 2022
Prepare empathy map	Prepare Empathy map canvas to capture the user Pains & Gains, Prepare list of problem statements	11th October 2022
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance	11th October 2022
Proposed solution	Prepare the Proposed solution document, which includes the Novelty, feasibility of idea.	16th October 2022
Solution Architecture	Prepare an solution architecture	17th October 2022
Customer journey	Prepare the customer Journey maps to understand the user interactions & experiences with the application(entry to exit	21st October 2022
Functional requirements	Prepare the functional and non functional document	19th October 2022

Data flow diagram	Draw thee data flow diagram and submit for review	20th Octoberr 2022
Technology Architecture	Prepare the technology architecture diagram.	20th Octoberr 2022
Prepare an Milestone Activity list	Prepare the milestone & activity list of the project	28th October 2022
Sprint delivery plan list	Prepare an sprint delivery plan list	28th October 20222
Sprint Delivery plan	Develop & submit the developed code by testing it	29-17 November 202

6.2 SPRINT DELIVERY PLAN:

Product Backlog ,Sprint ,scheduled Estimation

Sprint	Functional Requirements	User Story Number	User story /Stack	Story Points	Priorty	Team Members
Sprint-1	Log in	USN-2	As a Co-Admin, I'll control the waste level by monitoring them via real time web portal. Whenever the bin is filled, I'll notify trash truck with location of bin with bin ID	10	High	Tamilpriya

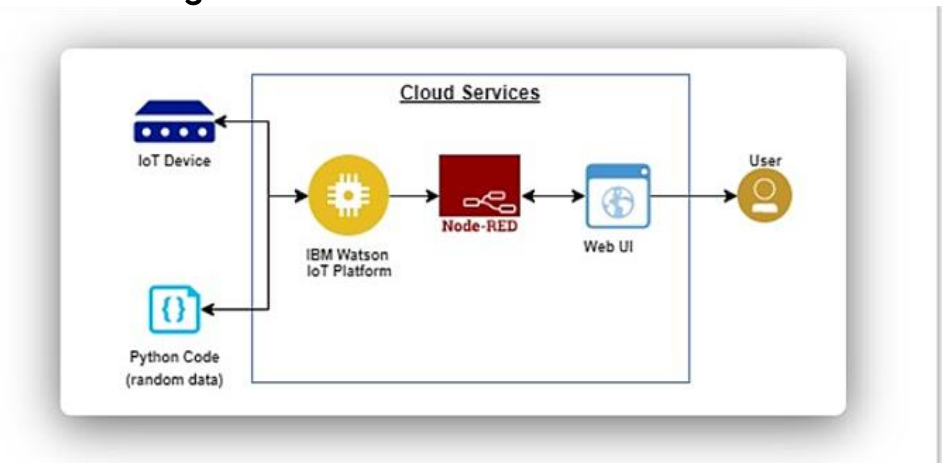
Sprint-2	Dashboard	USN-3	As a Truck Driver, I'll follow Co-Admin's Instruction to reach the filling bin in short roots and save time	20	Medium	Vani
Sprint-3	Dashboard	USN-4	As a Local Garbage Collector, I'll gather all the waste from the garbage, load it onto a garbage truck, and deliver it to Landfills	20	Medium	Sarulatha
Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	High	Srivani

Project Tracker, Velocity & Burndown Chart:

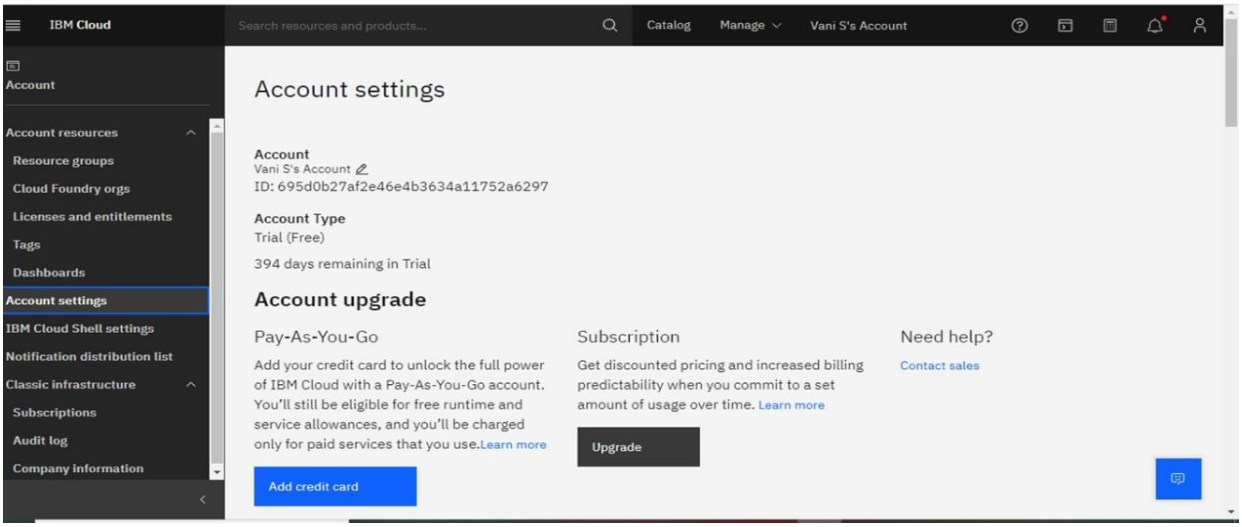
SPRINT	TOTAL STORY POINTS	DURATON	SPRINT START DATE	SPRINT END DATE	STORY POINTS COMPLETED	SPRINT RELEASED DATE
SPRINT-1	20	6 Days	24 Oct 2022	24 Oct 2022	20	29 Oct 2022
SPRINT-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	O5 Nov 2022
SPRINT-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
SPRINT-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	14 Nov 2022

7.PROJECT DEVELOPMENT PHASE:

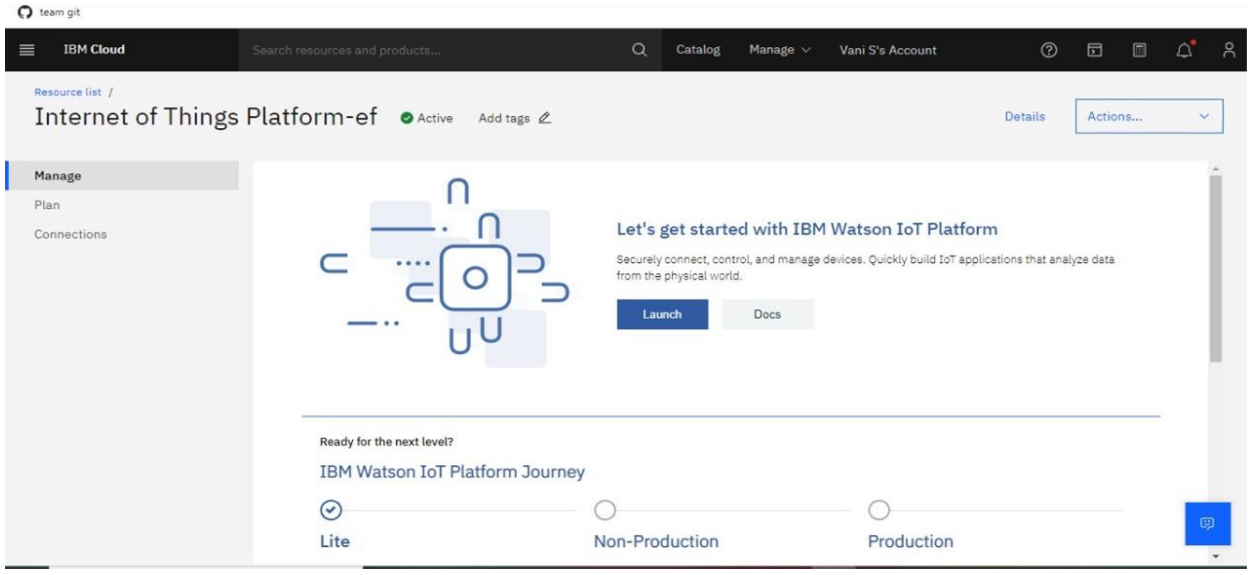
7.1 Project Development-Delivery of Sprint-1:
Basic Block Diagram



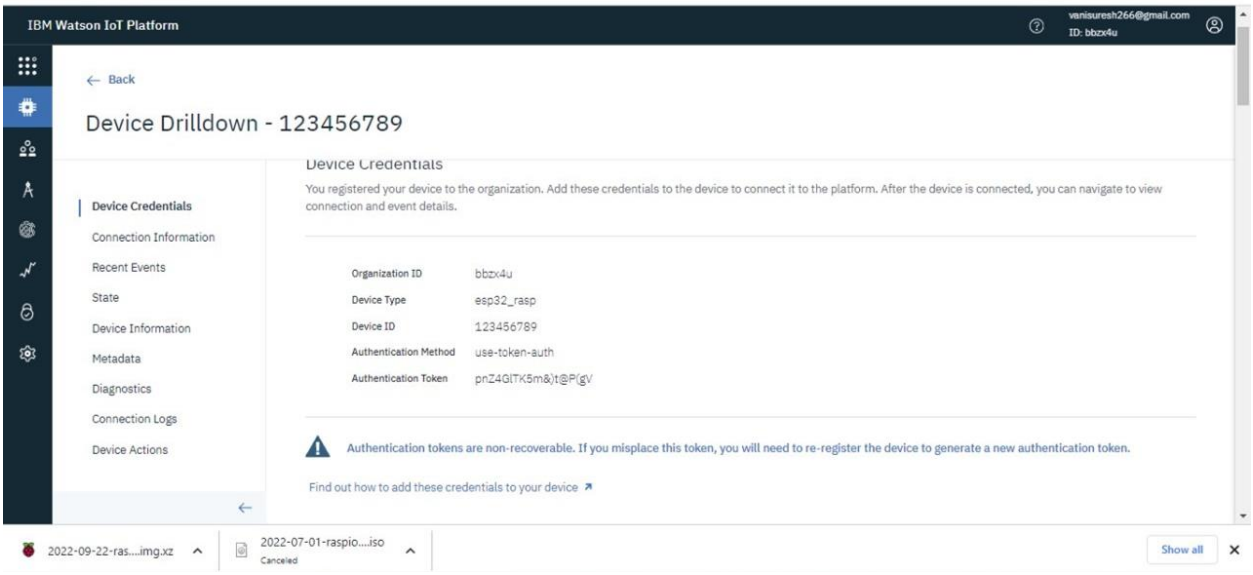
STEP 1: Creation of IBM colud



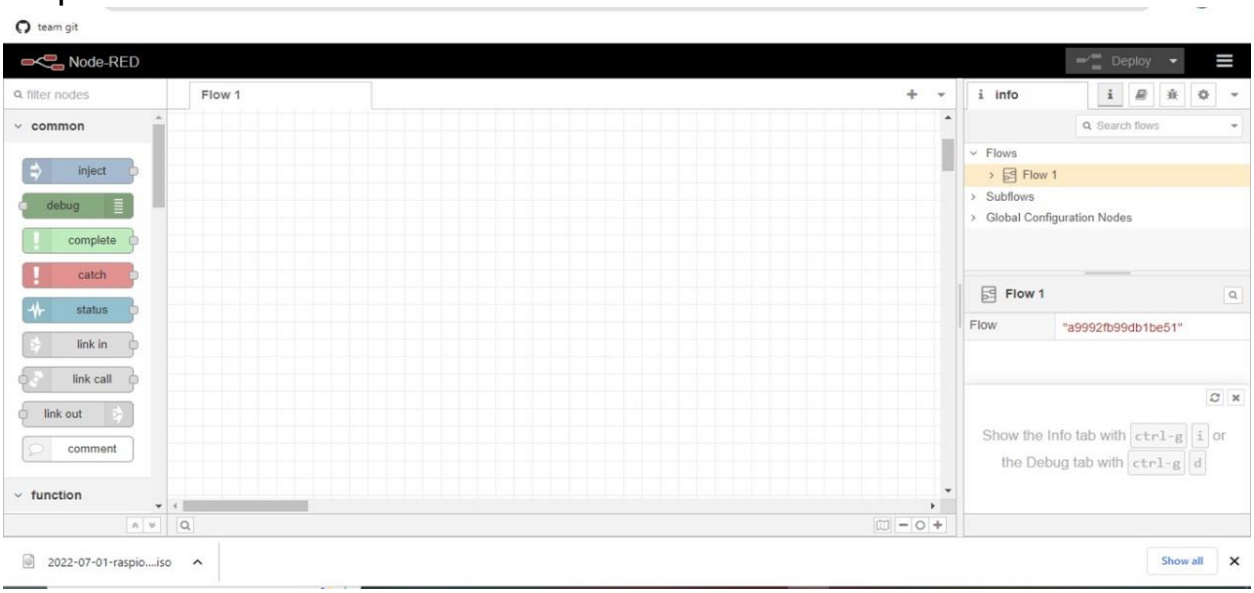
Step-2: Configure IBM Watson Platform



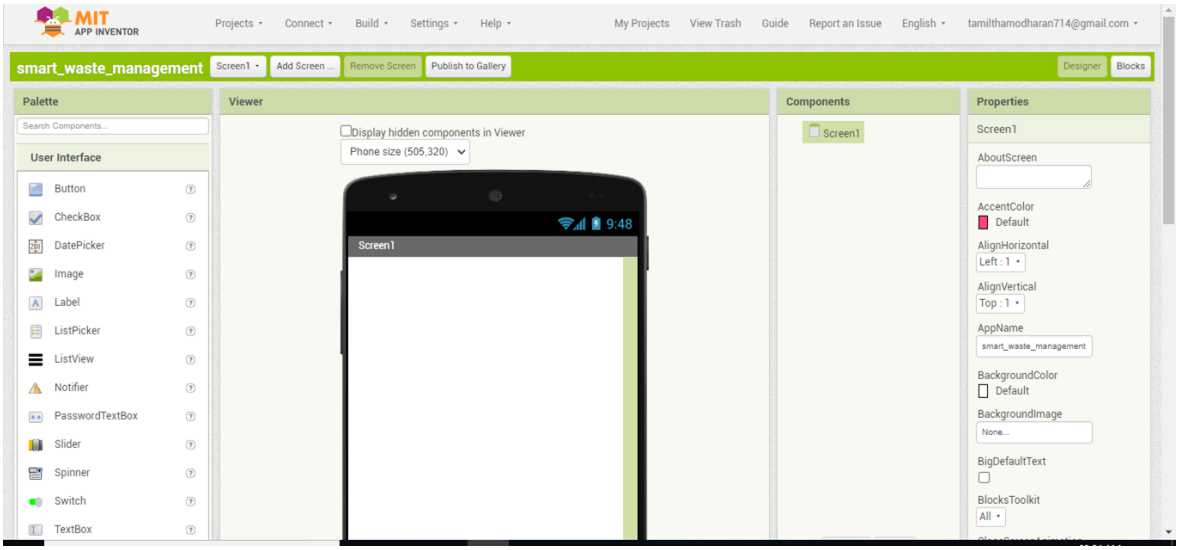
Step-3: Create the device in IBM platform and get device credentials



Step-4: Creation of Node-RED



Step-5 : MIT App inventor



7.2 Project Development -Delivery of Sprint-2:
Python code:

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

organization = "bbzx4u"
deviceType = "esp32_rasp"
deviceId = "123456789"
authMethod= "token"
 authToken= "pnZ4GlTK5m&)t@P(gV"
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}
        deviceClient = 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 20 seconds
deviceClient.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=12.678991,long=87.177731):       print("Chennai, Porur")
print("published distance = %s " %distance, "loadcell:%s " %loadcell, "lon = %s "
%long,"lat = %s" %lat)
print(load)
print(distance)
print(warn)

 time.sleep(20)

success=deviceClient.publishEvent("IoTSensor","json",warn,qos=0,on_publish=
myOnPublishCallback)

if not success:
      print("not connected to ibmiot")

 time.sleep(40)
```

deviceClient.commandCallback=myCommandCallback

#disconnect the device
deviceClient.disconnect

OUTPUT IN PYTHON IDLE

7.3 Project Development -Delivery of Sprint 3:

PROGRAM

```
#include <cstdlib>
#include <time.h>
#include <WiFi.h>
#include <PubSubClient.h>
#define ORG "zuhtbq"
#define DEVICE_TYPE "Rasp"
#define DEVICE_ID "12345"
#define TOKEN "12345678"
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/data/fmt/json";
```

```
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
WiFiClient wifiClient;
PubSubClient client(server, 1883, wifiClient);
int weight = 0;
[6:25 AM, 11/19/2022] Priya: String location = "Coimbatore";
String status = "";
void setup() {
Serial.begin(99900);
wifiConnect();
mqttConnect();
}
void loop() {
srand(time(0));
int p;
weight = random(0,80);
if(weight > 0 && weight < 25){
p = 0;
}
else if(weight > 25 && weight < 50){
p = 1;
}
else{
p = 2;
}
switch (p) {
case 0:
status = "Low";
break;
case 1:
status = "Half";
break;
case 2:
status = "Full";
break;
}
String payload = "{";
payload+="\"Weight \":";
payload+=weight;
payload+=",";
```

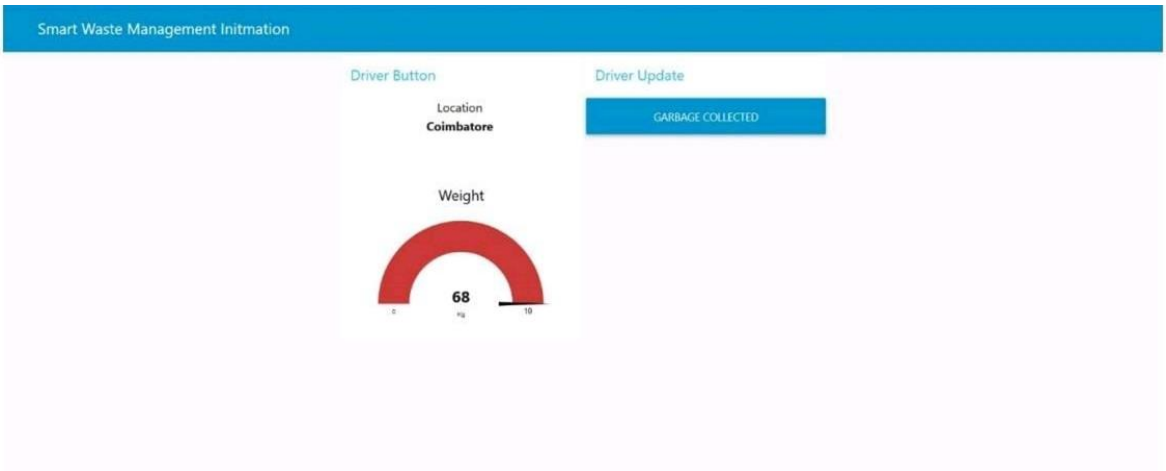
```
payload+="\"Loaction\":";
payload+="Coimbatore";
payload+=",";
payload+="\"Status\":\""+status+"\"}";
Serial.println(payload);
if(client.publish(publishTopic, (char*) payload.c_str()))
{
Serial.println("Publish OK");
}
else{
Serial.println("Publish failed");
}
delay(1000);
if (!client.loop())
{
mqttConnect();
}
}
void wifiConnect()
{
Serial.print("Connecting to ");
Serial.print("Wifi");
WiFi.begin("Wokwi-GUEST", "", 6);
while (WiFi.status() != WL_CONNECTED)
{
delay(500);
Serial.print(".");
}
Serial.print("WiFi connected, IP address: ");
Serial.println(WiFi.localIP());
}
void mqttConnect()
{
if (!client.connected())
{
Serial.print("Reconnecting MQTT client to ");
Serial.println(server);
while (!client.connect(clientId, authMethod, token))
{
Serial.print(".");
delay(500);
```

```
}
Serial.println();
}
}
```

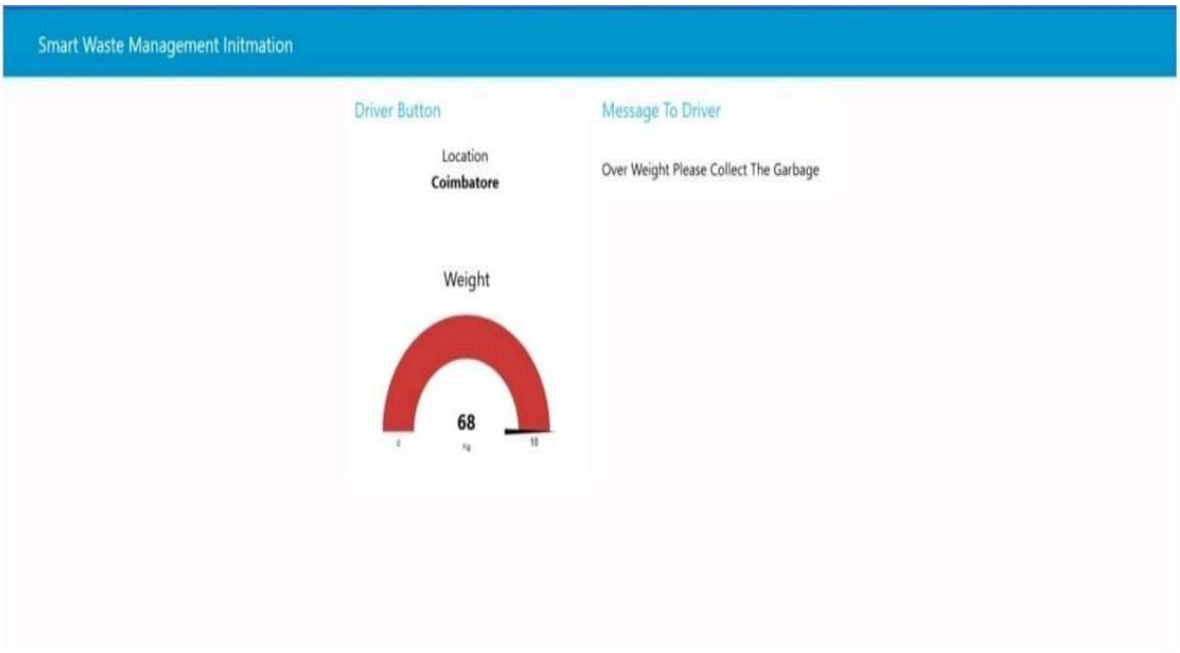
OUTPUT :

7.4 Project Development-Delivery of Sprint-4:

INTIMATION FROM DRIVER:



INTIMATION TO DRIVER:



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

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