PROJECT BASED EXPERIMENTAL LEARNING (NALAIYA THIRAN)

SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES

TEAM MEMBERS:

Project report submitted by

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TEAM ID: PNT2022TMID05224

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Smart Waste Management System For Metropolitan Cities

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1 INTRODUCTION:

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 intelligent services for users.

1.1 PROJECT OVERVIEW:

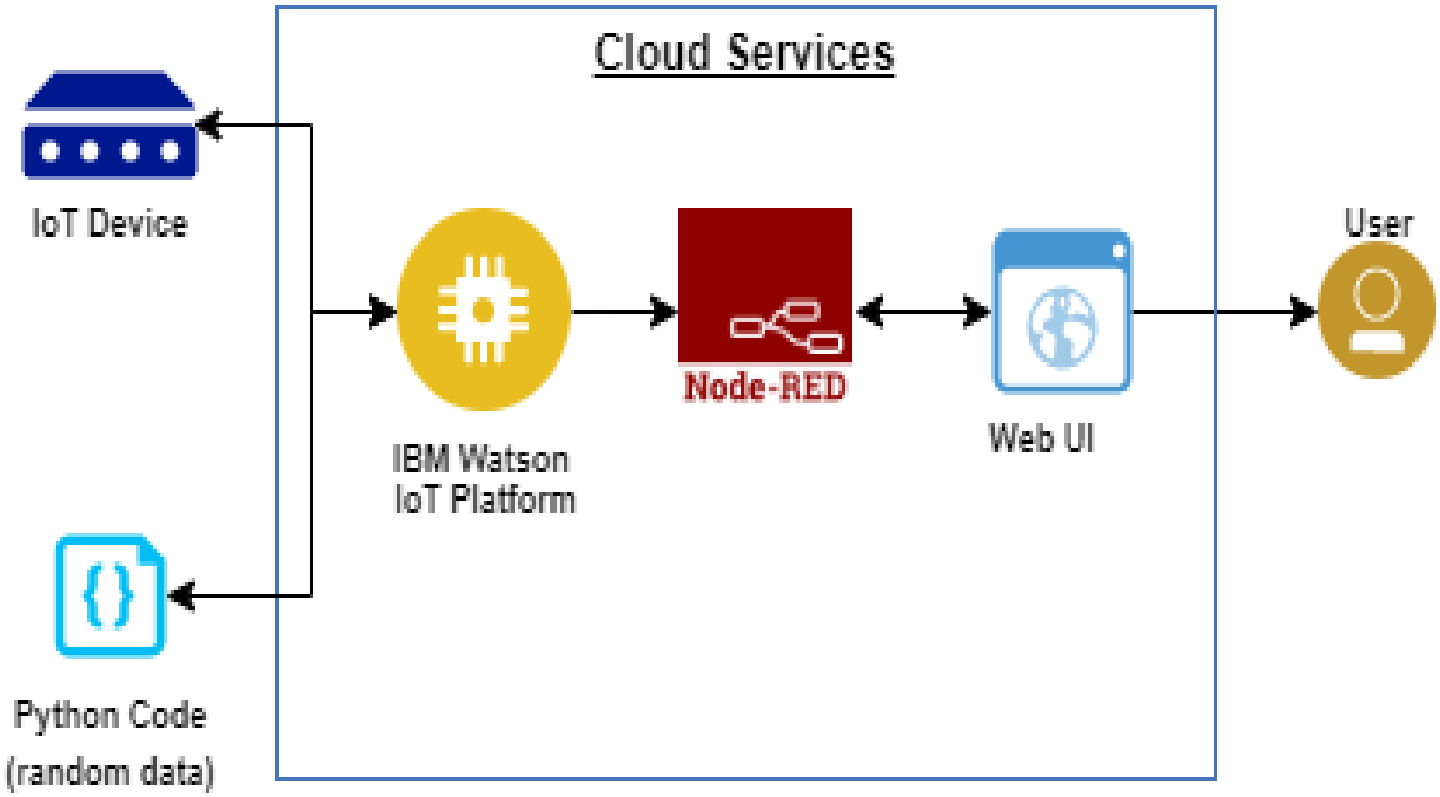
- This project deals with the problem of waste management in smart cities, where the garbage collection system is not optimized. This project enables the organizations to meet their needs of smart garbage management systems. This system allows the user to know the fill level of each garbage bin in a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

- The amount of waste produced everyday by the industries and the households is increasing at an appalling rate, and the major reason for this is soaring use of packaged items, textiles, paper, food, plastics, metals, glass etc., thus management of this refuse becomes a crucial part in our everyday life.in most of the developed countries there are many efficient techniques which are used for the proper management of this waste, but in some countries especially the developing ones the careless attitude of people towards maintaining clean surroundings, along with this many issues such asno stringent laws for using the biodegradable materials, no proper environ policies ,no laws for sustainable development are the seed for the fatal results of waste management. Due to the increasing waste, the public bins which are used for collecting this waste are overflowing, the locality is

Jumbled of trash, causing not only malodorous streets but also a negative impact on the health and environment.

1.2 PURPOSE:

- Waste is a crucial issue, which needs to be addressed smartly. We segregate the waste at our homes for ease of processing and recycling. We observed trash vans come irregular to homes creating a despoliation of households. Due to this many civilians empty their overloaded dustbins in open spaces. This in turn increases environmental pollution



Basic workflow of our project

2 LITERATURE SURVEY:

2.1 EXISTING PROBLEM:

- As we have seen number of times the dustbins are getting overflown and concern individual don't get the information within a time and due to which unsanitary condition shaped within the environment, at the same time awful scent spread out due to squander, awful see of the city which clears the way for discuss contamination and to a few destructive illnesses around the region which is effortlessly spreadable and this is not reported to the municipality officers properly on time.

2.2 REFERENCES:

- Smart waste bin Management Parthasarathi Manickaraja Uses the Ultrasonic sensor to level the dustbin and also uses the GSM module Provides an alert message once the level has reached to the authority - 2022

- Smart waste management using IOT Tejashree Kadus Technology used is a load cell and a Wi-Fi module Segregate the waste in the dustbin and provides and alert message - 2020

- Smart waste management systems using machine learning David Rutgvist Uses automated machine learning for area life smart waste management It focusses on problems of detection of emptying of a recycling container using sensor measurements - 2019

- Real time solid waste bin monitoring system framework using wireless sensor network Thiyaga priyadharshini Smart bin based on a microcontroller based platform Arduino which is interfaced with GSM module Waste management efficiency and it avoids lumping of wastes - 2019

2.3 PROBLEM STATEMENT DEFINITION:

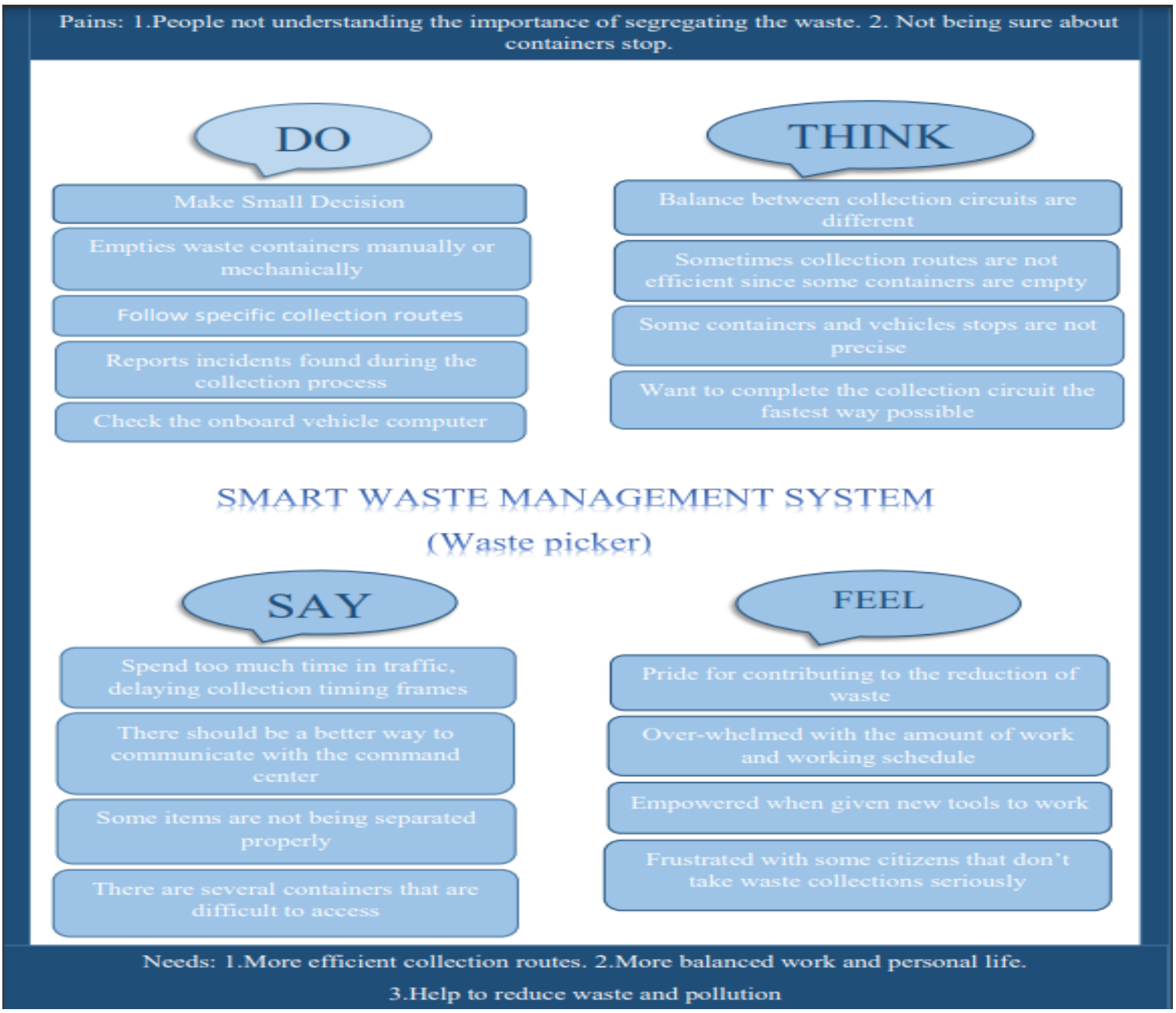
- Develop a method for separating different types of solid trash so that it may be collected by municipal authorities in an efficient way while allowing residents to dispose of it. These clever garbage collectors addressed the local

Authorities by demonstrating the live state of the trash cans in every conceivable street. We can trace the amount of trash in these bins and map the geo coordinates of the bins for this purpose. We can solve this issue with the aid of IoT. We can finish this little project by utilizing Node Red.

3 IDEATION AND PROPOSED SOLUTION:

3.1 EMPATHY MAP CANVAS:

3.2 IDEATION AND BRAINSTORMING:



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

TEAM ID : PNT2022TMID05224

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

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

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

How might we (your problem statement)?

Key rules of brainstorming
To run an smooth and productive session

Stay in topic.
Encourage wild ideas.
Defer judgment.
Listen to others.
Go for volume.
If possible, be visual.

Brainstorm

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

10 minutes

KAVINILAVU AR

IOT platform to manage the waste management solution networks

GPS enabled to track the location

HARISH M

Using ultrasonic sensor and placing it at the top

Solar panels that can power the trash function

KAVITHA N

Using IR sensor and placing it at the top

Data analytics to understand the usage

JOTHI N

A powerful network that manages the network and trash bins to transmit the data

Weight sensor integrated with Arduino

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

Reduction in collection costs

IOT solution uses the data & selects routes

IOT helps to identify the empty trash bins

Waste collection trucks, leadsto pickup

Transparency on waste situation increase efficiency over time

Data analytics can help assess trends to better plan

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

Using ultrasonic sensor and GPS

Data analytics to understand the usage

Importance

Feasibility

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

Share the mural
Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

Export the mural
Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint
Define the components of a new idea or strategy.

Open the template

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.

Open the template

Strategic, business, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.

Open the template

Share template feedback

Need some inspiration?
See a finished version of this template to get started.
View example

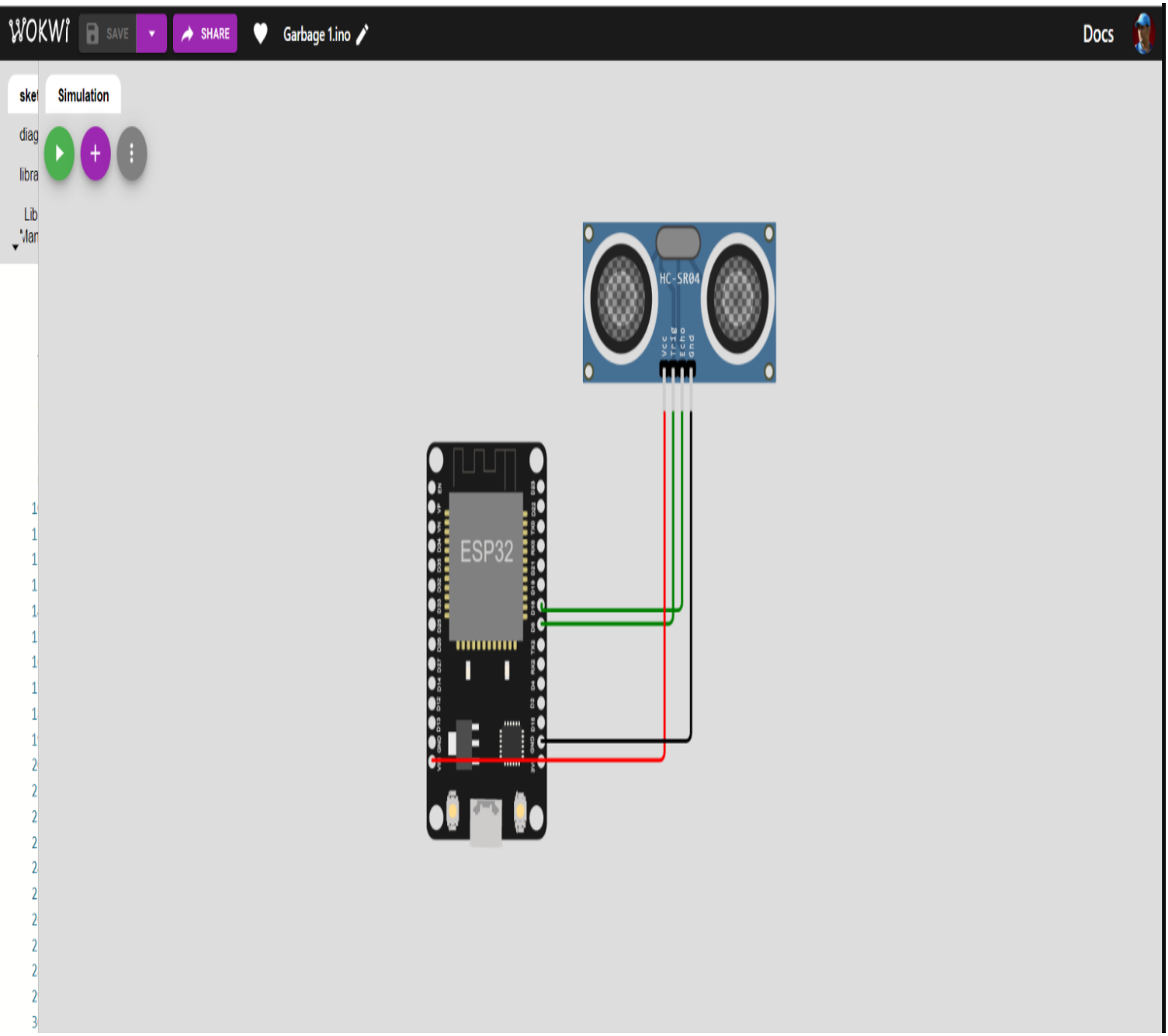
Idea 1:

By **KAVINILAVU AR**, Dustbins (or Garbage bins, Trash Cans) are small plastic (or metal) containers that are used to store trash (or waste) on a temporary basis. In implementing the smart cities the great challenge is how to manage waste with low cost and high performance. Waste has a negative impact on the society which smart cities aim to improve. Makkah and holy sites are very congested areas where waste management is a big challenge. Three factors make ita big challenge, behind its natural, small area, short period of time and the increasing number of the Pilgrimages' members. The process of collecting waste, separating it, and transporting the containers daily and quickly to avoid any prospect of a spread of diseases is a complex process. This paper aims to study the concept of the waste management and proposed smart systems for waste management system with recycling .The proposed system will use the sensors technique in site the container, as a lower level, to separate the waste into 4 categories [food, plastics, papers, and metal] and use actuator at a top level to inform the management system to collect the container. The proposed system will save time, money and efforts compared to the recent process of the waste management system and improve society quality as all.

Idea 2:

By **HARISH ADITHYAA M**, They are often used in homes, offices, streets, parks etc. to collect the waste. In some places, littering is a serious offence and hence Public Waste Containers are the only way to dispose small waste .With urbanization, rising income and consumption, the production of waste increases. One of the most important directions in the field of sustainable development is the design and implementation of monitoring and management systems for waste collection and removal. Smart waste management (SWM) involves for example collection and analytics of data from sensors on smart garbage bins (SGBs), management of waste trucks and urban infrastructure; planning and optimization of waste truck routes; etc. The purpose of this paper is to provide a comprehensive overview of the existing research in the field of systems, applications, and approaches vis-à-vis the collection and processing of solid waste in SWM systems. To achieve this objective, we performed a systematicliterature review. This study consists of 173 primary studies selected for analysis and data extraction from the 3,732 initially retrieved studies from 5 databases. We
1) identified the main approaches and services that are applied in the city and SGB-level SWM systems, 2) listed sensors and actuators and analyzed their application in various types of SWM systems, 3) listed the direct and indirect

stakeholders of the SWM systems, 4) identified the types of data shared between the SWM systems and stakeholders, and 5) identified the main promising



directions *and research gaps in the field of SWM systems. Based on an analysis of the existing approaches, technologies, and services.*

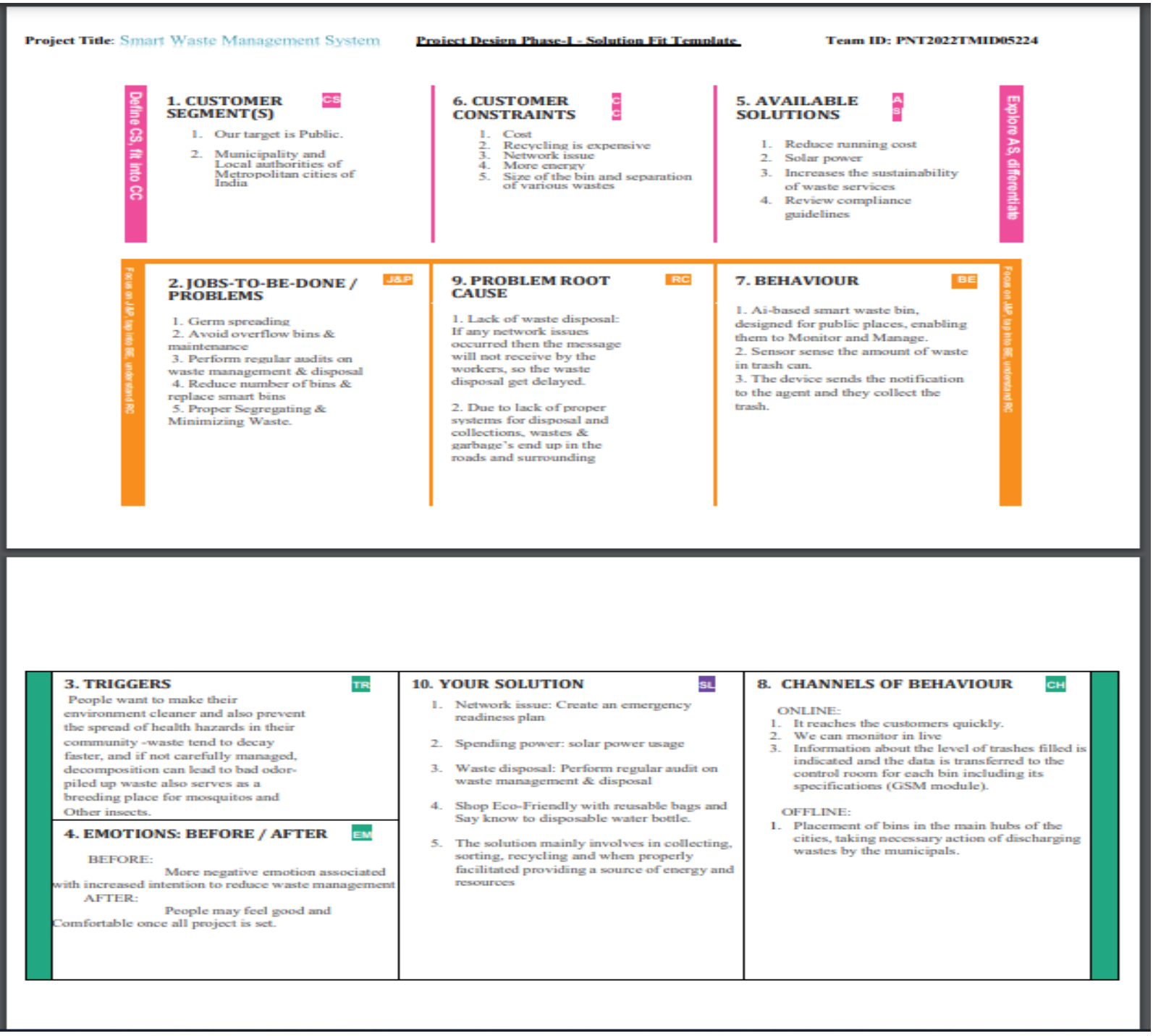
Idea 3:

By **KAVITHA M**, Usually, it is a common practice to use separate bins for collecting wet or dry, recyclable or non-recyclable waste *The* Internet of Things (IoT) is constantly evolving and isgiving unique solutions to the everyday problems faced by man. “Smart City” is one such implementation aimed at improving the lifestyle of human beings. One ofthe major hurdles in most cities is its solid waste management, and effective management of the solid waste produced becomes an integral part of a smart city. This paper aims at providing an IoT based architectural solution to tackle the problems faced by the present solid waste management system. By providing a complete IoT based system, the process of tracking, collecting, and managing the solid waste can be easily automated and monitored efficiently. By taking the example of the solid waste management crisis of Bengaluru city, India, we have come up with the overall system architecture and protocol stack to give a IoT basedsolution to improve the reliability and efficiency of the system. By making use of sensors, we collect data from the garbage bins and send them to a gateway using LoRa technology. The data from various garbage bins are collected by the gatewayand sent to the cloud over the Internet using the MQTT (Message Queue Telemetry Transport) protocol.

Idea 4:

By **JOTHI LAKSHMI M**, The idea presents smart waste management using an IoT based waste bin for collection and monitoring the level of waste inside the bin. Thesystem is implemented using two ultrasonic sensors which are controlled by Node MCU. One of the ultrasonic sensors detects the level of the waste in the bin and another detects the person approaching the bin to dispose of the waste. This detection helps in automatic opening and closing of the lid. Servo motor is connected to the lid which serves the action of closing and opening of the lid. In this system, the level of waste in the bin will be sent to concerned authorities. The IoT data is stored and monitored using the Blynk app. The proposed system is reliable, cost effective and can be easily implemented.

3.3 PROPOSED SOLUTION:



3.4 PROBLEM SOLUTION FIT:

Customer segment(s):

1. Our target is Public.
2. Local authorities of Municipality and Metropolitan cities of India

Jobs to be done:

1. Germ spreading
2. Avoid overflow bins & maintenance
3. Perform regular audits on waste management & disposal 4. Reduce the number of bins & replace smart bins. Proper Segregating & Minimizing Waste.

Triggers:

1. People want to make their environment cleaner and also prevent the spread of health hazards in their community -waste tends to decay faster, and if not carefully managed, decomposition can lead to bad odor- piled up waste also serves as a breeding place for mosquitos and other insects.

EMOTIONS: BEFORE/AFTER

1. BEFORE:
   More negative emotion associated with increased intention to reduce waste management
2. AFTER:
   People may feel good and comfortable once all projects are set.

AVAILABLE SOLUTIONS:

1. Reduce running cost
2. Solar power
3. Increases the sustainability of waste services
4 Review compliance guidelines

:

OUR SOLUTION:

1. Network issue: Create an emergency readiness plan
2. Spending power: solar power usage
3. Waste disposal: Perform regular audit on waste management & disposal
4. Shop Eco-Friendly with reusable bags and say know how to use disposable water bottles.
5. The solution mainly involves in collecting, sorting, recycling and when properly facilitated providing a source of energy and resources

4 REQUIREMENT ANALYSIS:

4.1 FUNCTIONAL REQUIREMENT:

- These are the requirements that the end user specifically demands as basic facilities that the system should offer. All these functionalities need to be necessarily incorporated into the system as a part of the contract

- Functional requirements for our are as follows:

☐ The GPS coordinates of the garbage bin will be sent to the IBM IoT platform

☐ The location of the bins along with bin status can be viewed in the Web Application by using the World map Node in Node-Red

☐ Notifies the admin if the bin value crosses the threshold value

4.2 NON-FUNCTIONAL REQUIREMENTS:

- These are basically the quality constraints that the system must satisfy according to the project contract. The priority or extent to which these factors are implemented varies from one project to another. They are also called non-behavioral requirements

- Some Non-Functional requirements that deal with Portability, Performance, Scalability etc.

- They are not mandatory for an application to work

- In our project, UI/UX, login pages and forget password pages, *The amount of fuel that could be saved, The driving distance that could be saved,* extra features like garbage collection assist to truck drivers are not mandatory.

5 PROJECT DESIGN:

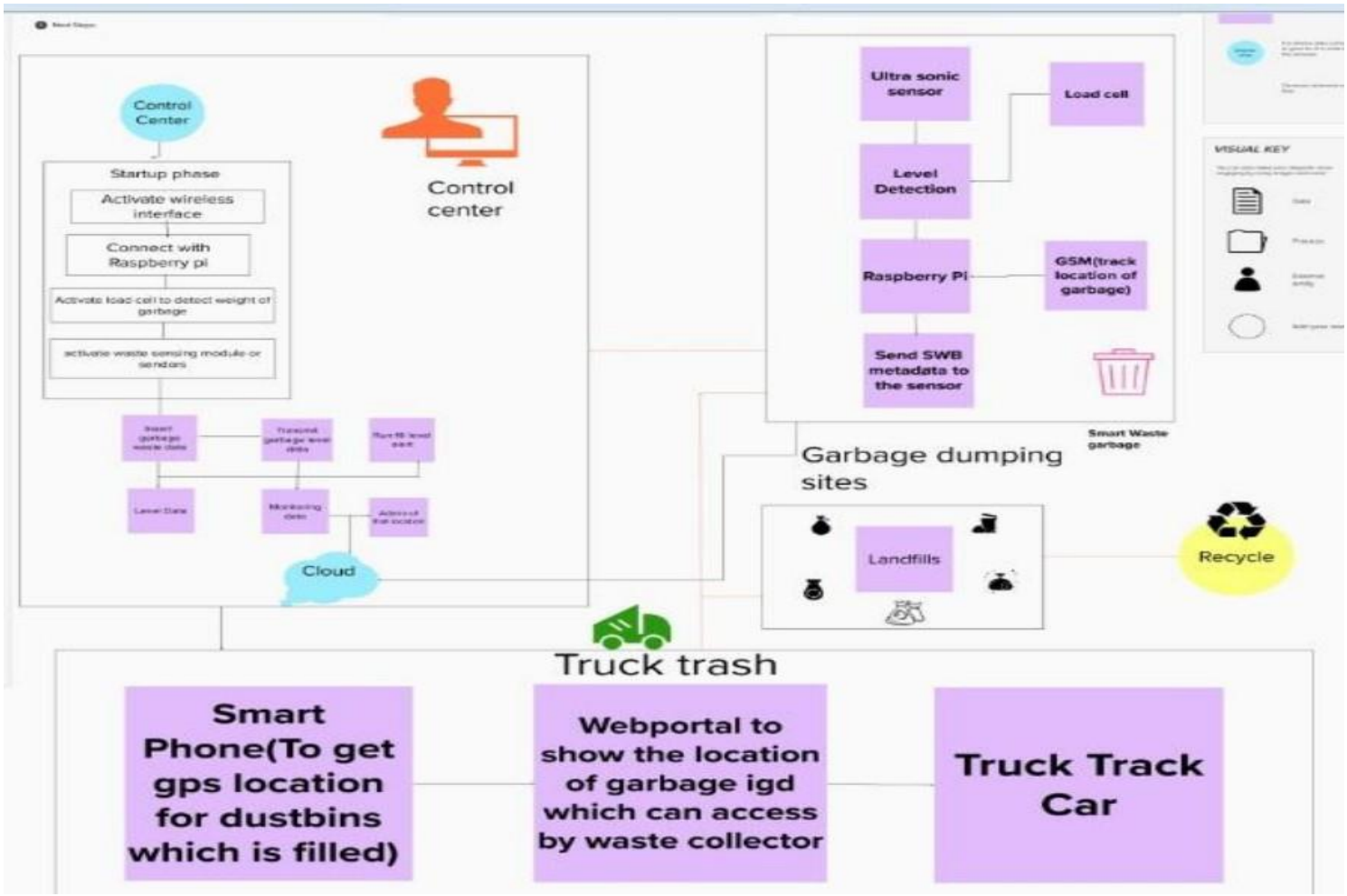
5.1 DATA FLOW DIAGRAM:

The classic visual depiction of how information moves through a system is a data flow diagram (DFD). A tidy and understandable DFD may visually represent the appropriate quantity of the system demand. It demonstrates how information enters and exits the system, what modifies the data, and where information is kept.

Using analytics, a smart waste management platform transforms the information collected in your bins into useful insights that may be used to enhance your trash services. You may obtain information on metrics like*:*

- The first test conducted is the situation where the garbage bin is empty or its garbage is level very low

The Indicator is indicated as Green when the level of waste is up to 35%



- The Indicator Gauge will be indicated in Yellow by the system, once the waste levels between 35% to 85%

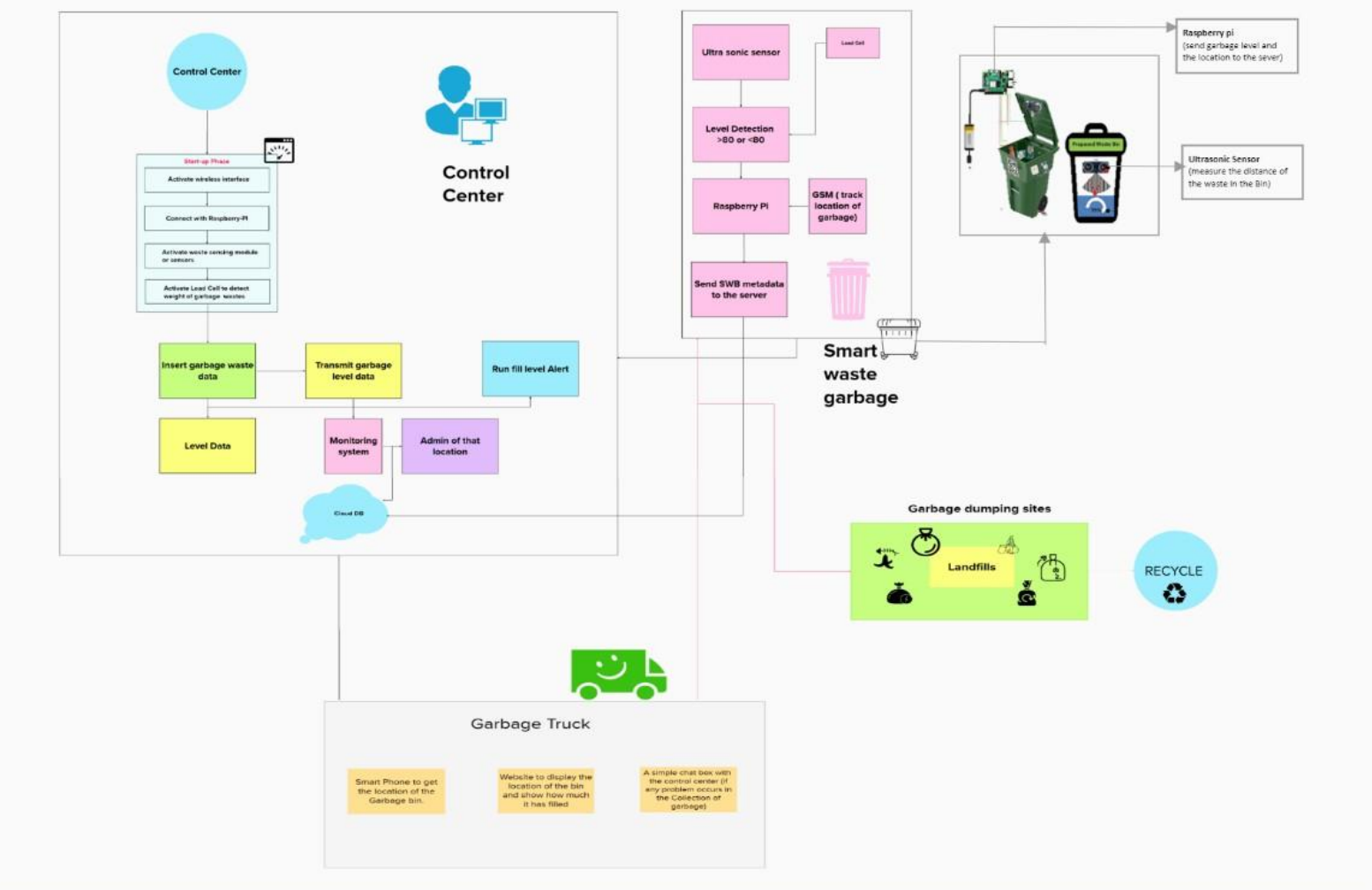
- The indicator gauge will be indicated as red by the system, indicating that bin is at least 95% full and the garbage needs to be collected immediately

- Locations prone to overflow

- The number of bins needed to avoid overflowing waste

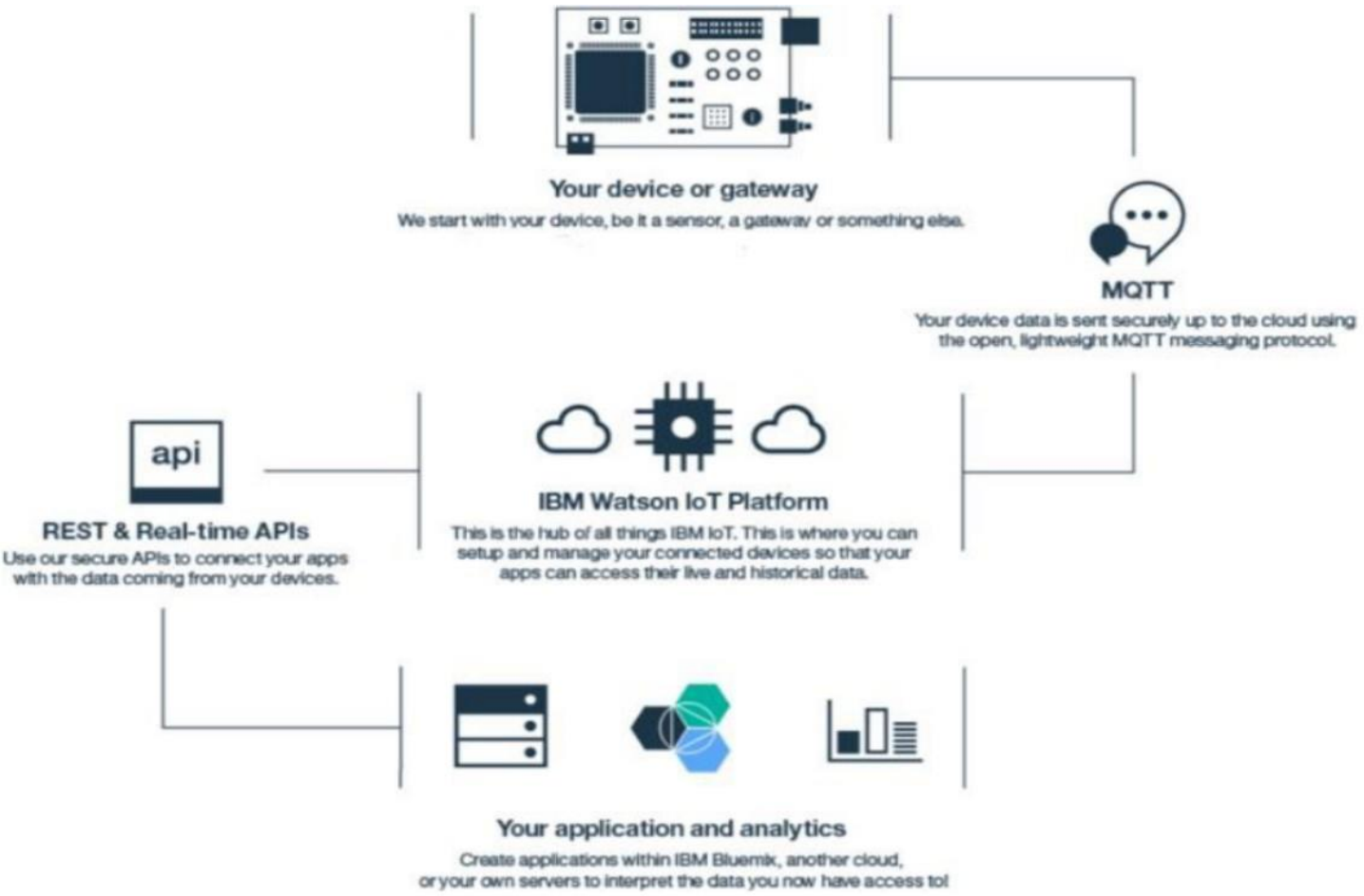
- The number of collection services that could be saved

5.2 SOLUTION AND TECHNICAL ARCHITECTURE:



S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	➢ Ravage and waste can cause environmental pollution. ➢ Rotting garbage is the cause to produce harmful gases in the air and cause breathing problem to people. ➢ Due to improper waste disposal, we may face several problems like unpleasant odour and severe health issues.
2.	Idea / Solution description	➢ To solve this problem of waste disposal , we can design a smart garbage bin with inbuilt sensors and IOT devices such like Arduino UNO , Raspberry pi, etc.... ➢ Garbage level and location intimation mechanism . ➢ AI Recycling Robots.
3.	Novelty / Uniqueness	➢ Identify potential waste streams. ➢ Create a waste management-focused community outreach plane.
4.	Social Impact / Customer Satisfaction	➢ Neighbourhood of landfills to communities, breeding of pests and loss in property values. ➢ The IOT solution uses the data and intimates the information to the local area of management department when it reaches the initial boundary line .
5.	Business Model (Revenue Model)	➢ It generates revenue through the provision of various waste management and disposal services. ➢ Recycling solutions to residential , commercial , industrial, and municipal clients.
6.	Scalability of the Solution	➢ Installing separate bins for collecting recyclable and non-recyclable wastes. ➢ Recycling not only save energy but also prevent the material from going to landfills

Technical Architecture:



- IBM Watson IoT platform acts as the mediator to connect the web application to IoT devices, so create the IBM Watson IoT platform.

- In order to connect the IoT device to the IBM cloud, create a device in the IBM Watson IoT platform and get the device credentials.

- Configure the connection security and create API keys that are used in the Node-RED service for accessing the IBM IoT Platform.

- To create a web application create a Node-RED service.

- Launch the cloudant DB and create a database to store the location data.

Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g.WebUI, Mobile App, Chatbot etc.	HTML, CSS, JavaScript / Angular JS /React JS etc.
2.	Application Logic-1	Logic for a process in the application	Python
3.	Application Logic-2	Logic for a process in the application	IBM Watson service
4.	Application Logic-3	Logic for a process in the application	IBM Watson Cloud service
5.	Database	Data Type, Configurations etc.	MySQL,NoSQL
6.	Cloud Database	Database Service on Cloud	IBM Cloudant
7.	File Storage	File storage requirements	Stored Area Network (SANs)
8.	External API-1	Purpose of External API used in the application	Location Tracking
9.	External API-2	Purpose of External API used in the application	Waste Monitoring
10.	Machine Learning Model	Purpose of Machine Learning Model	Object Recognition Model, etc.
11.	Infrastructure (Server / Cloud)	Application Deployment on Local System / Cloud Local Server Configuration: Cloud Server Configuration :	Local, Cloud Foundry, Kubernetes, etc.

Table-2: Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	List the open-source frameworks used	Monitor and clean
2.	Security Implementations	List all the security / access controls implemented,use of firewalls etc.	Encryptions
3.	Scalable Architecture	Justify the scalability of architecture (3 – tier, Micro-services)	To help prevent clean environment
4.	Availability	Justify the availability of application (e.g. use of load balancers, distributed servers etc.)	Available any time
5.	Performance	Design consideration for the performance of the application (number of requests per sec, use of Cache, use of CDN's) etc.	Monitor & dispose the waste

Thinking Beyond Technology:

At the core of smart bin technology is a series of wireless ultrasonic sensors that detect fill levels. The IoT devices communicate waste data to sanitation department workers in real-time. Workers can then use the insights from this data to make decisions on waste management adjustments. The adoption of these smart waste bins will promote a cleaner and safer environment for companies, citizens, and visitors. Ultimately, this technology will utilize garbage trucks where they are needed most and reduce wasted trips, lowering emissions and, thus, creating a more eco-friendly solution.

5.3 USER STORIES:

Use the below template to list all the user stories for the product.

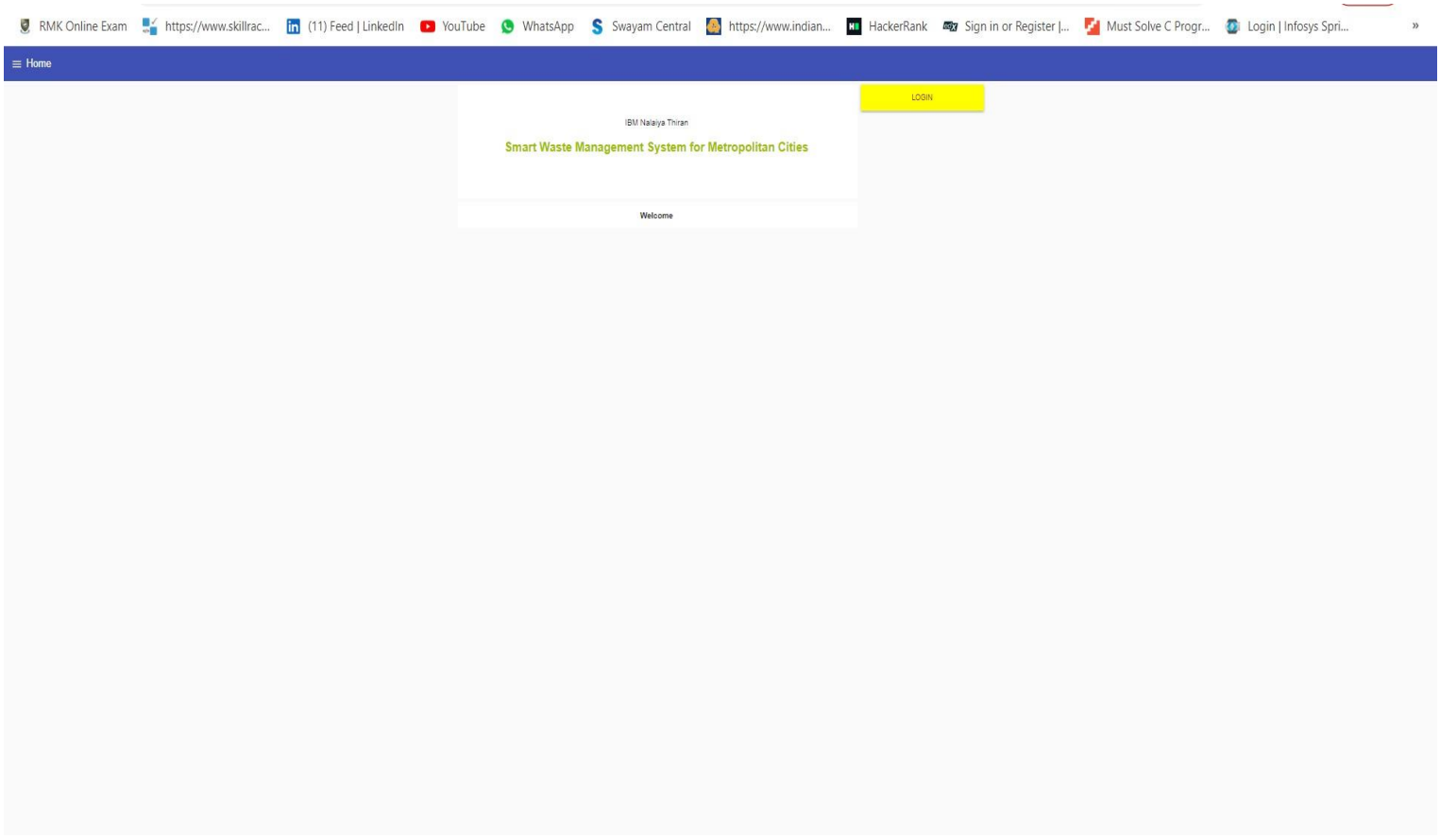
User Type	Functional Requirement (Epic)	User Story Number	User story/ Task	Acceptance Criteria	Priority	Release
Customer	Noticing the bin near by	USN 1	User can sense the level of waste using dashboard	_	High	Sprint 1
		USN 2	Can also see the level of the garbage	_	High	Sprint 1
Administrator	Dashboard	USN 1	Message is sent to the Municipal Authority	To municipal authority only	High	Sprint 2
	Dashboard	USN 1	Indicator indicates garbage level		Medium	
		USN 2	Indicator indicates garbage level		Medium	

6 PROJECT PLANNING AND SCHEDULING:

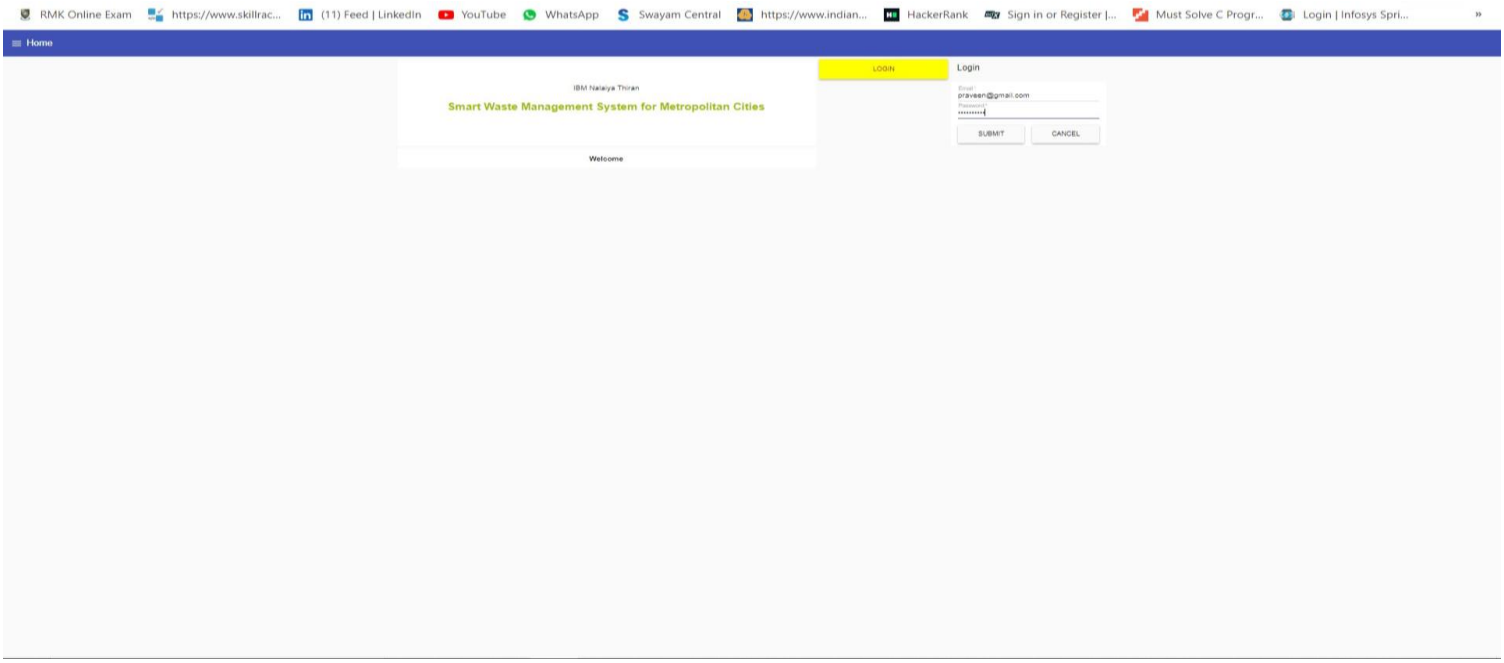
6.1 SPRINT PLANNING AND ESTIMATION:

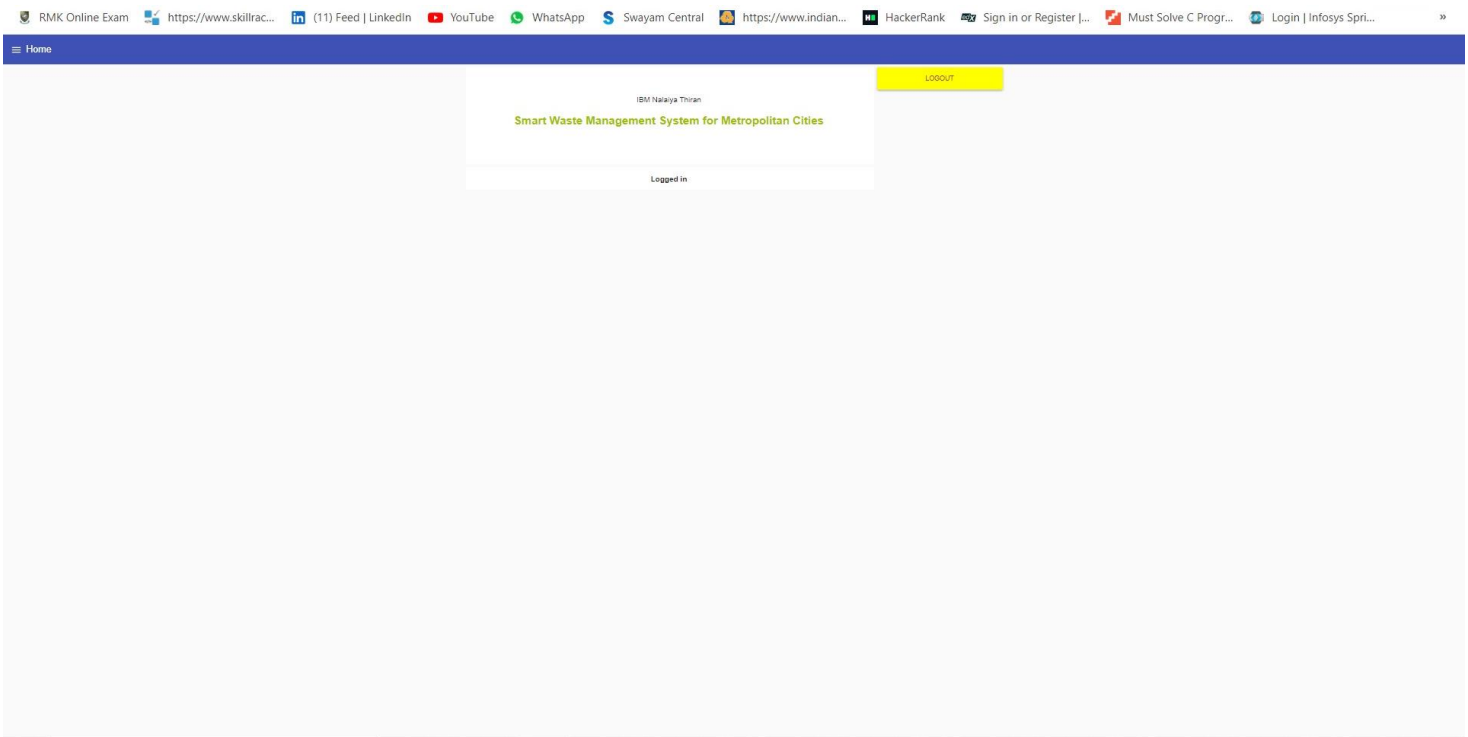
HOME PAGE:

In Sprint 1 we have created the admin page where we can view the dashboard, create, update, remove the co admin. We can also view and delete the truck driver details.

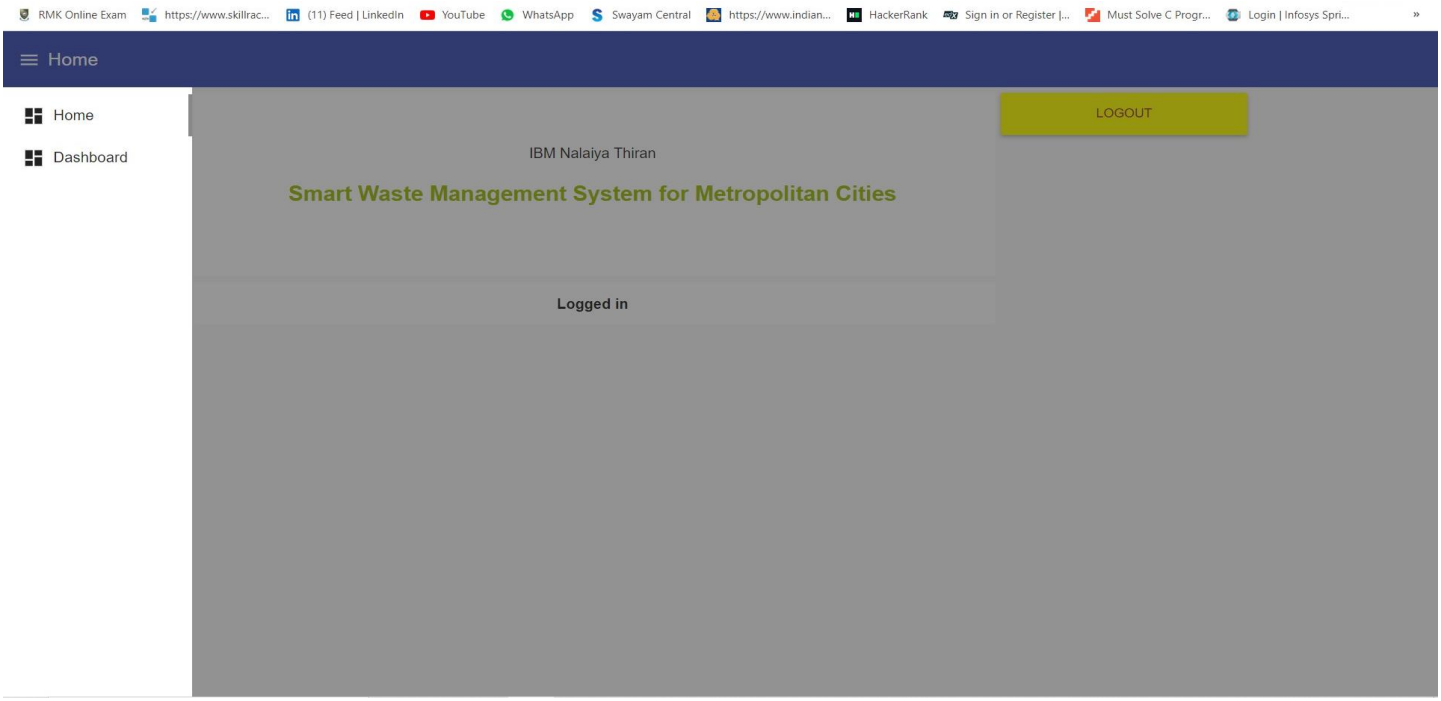


LOGIN PAGE: Once we click on the login button, we can see the Login window appears on the right side. Now we need to enter the admin credentials (i.e.) Email: admin@gmail.com Password: “admin”

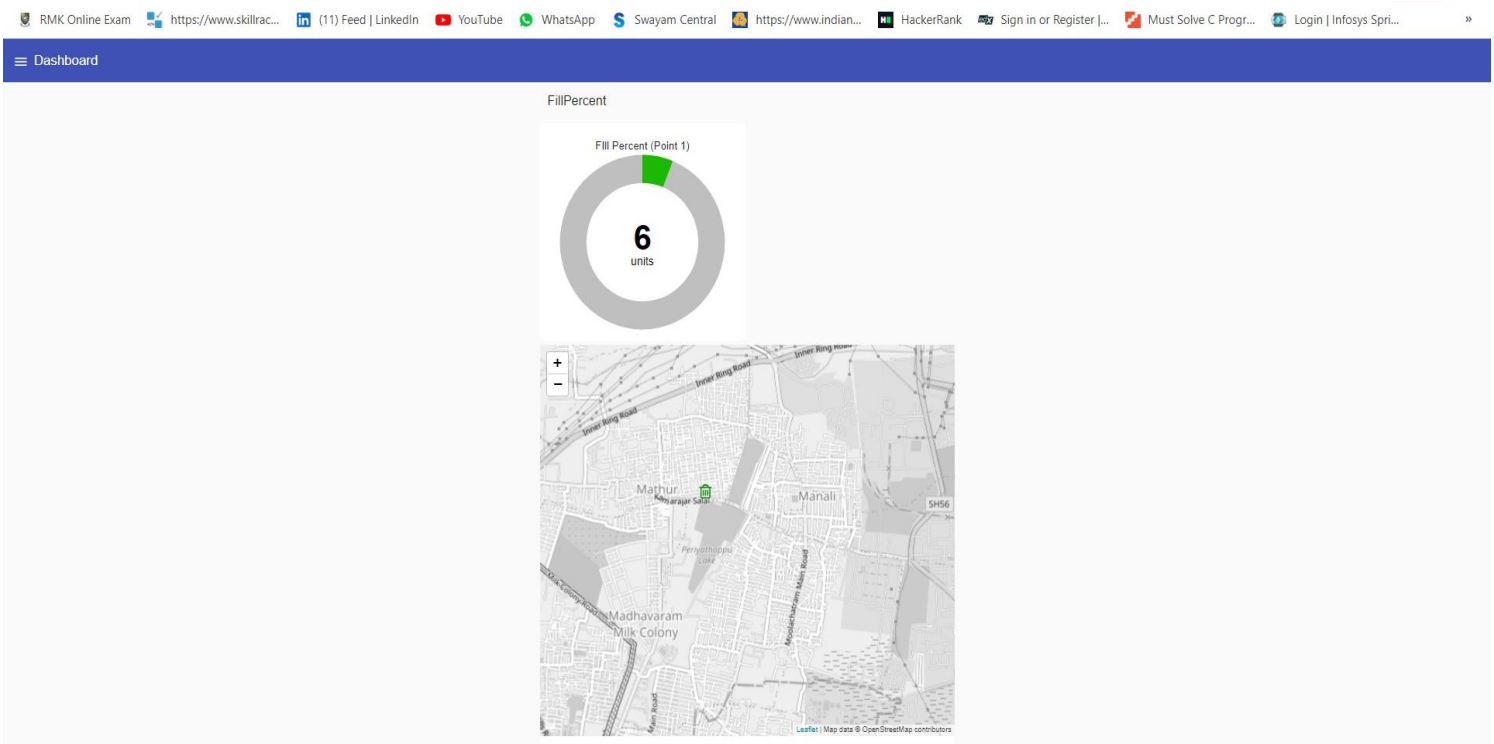




By clicking the dashboard button, we can view the dashboard. Here we can see the



map and the Fill percent for both the garbage bin.



SPRINT 2:

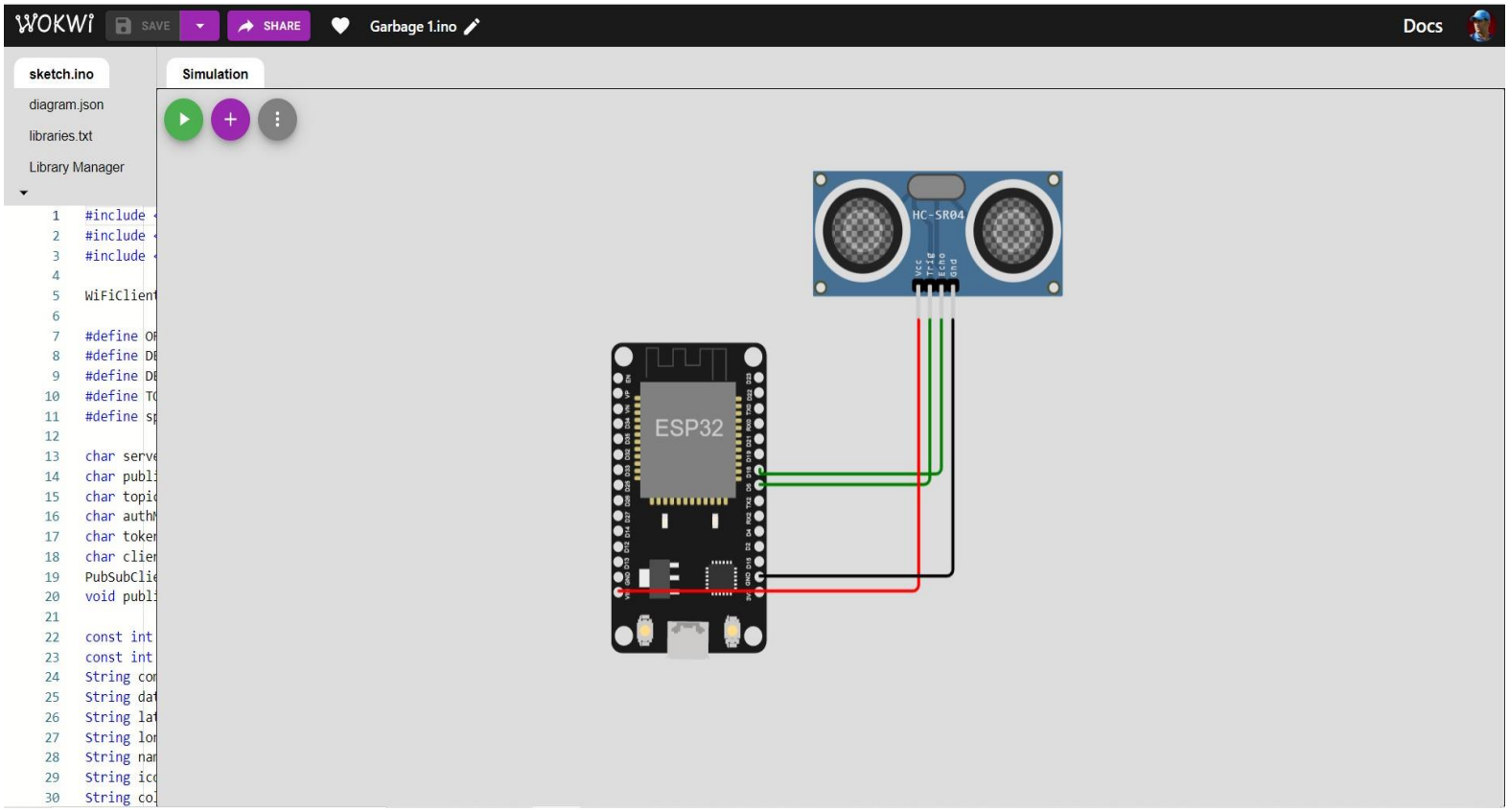
```
#include <WiFi.h>                       //Library for WiFi
#include <PubSubClient.h>               //Library for MQTT
#include <ArduinoJson.h>                //Library for ArduinoJson
WiFiClient wifiClient;
#define ORG "k6spbs"                    //IBM Organisation ID
#define DEVICE_TYPE "MSD"               //Device mentioned in IBM Watson IOT Platform
#define DEVICE_ID "12345" //Device ID mentioned on IBM Watson IOT Platform
#define TOKEN "123456789"               //Token
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";  //Server Name
char publishTopic[] = "iot-2/evt/Data/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";                   //Authentication Method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;       //Client id
PubSubClient client(server, 1883, wifiClient);
void publishData();
const int trigpin=5;
const int echopin=18;
String command;
String data="";
String lat="13.167558";
String lon="80.244510";
String name="point2";
String icon="fa-trash-o";
String color="green";
long duration;
int dist;
void setup()
{
 Serial.begin(115200);
 pinMode(trigpin, OUTPUT);
 pinMode(echopin, INPUT);
 wifiConnect();
 mqttConnect();
```

```
}
void loop() {
 publishData();
 delay(500);
 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(1000);
 }
 initManagedDevice();
 Serial.println();
 }
}
void initManagedDevice() {
 if (client.subscribe(topic)) {
 Serial.println(client.subscribe(topic));
 Serial.println("subscribe to cmd OK");
 } else {
 Serial.println("subscribe to cmd FAILED");
 }
}
void publishData()
```

```
{
 digitalWrite(trigpin,LOW);
 digitalWrite(trigpin,HIGH);
 delayMicroseconds(10);
 digitalWrite(trigpin,LOW);
 duration=pulseIn(echopin,HIGH);
 dist=duration*speed/2;
 dist=dist/4;
 dist=100-dist;
 if(dist>80){
 icon="fa-trash";
 color="red";
 }else{
 icon="fa-trash-o";
 color="green";
 }
 DynamicJsonDocument doc(1024);
 String payload;
 doc["Name"]=name;
 doc["Latitude"]=lat;
 doc["Longitude"]=lon;
 doc["Icon"]=icon;
 doc["FillPercent"]=dist;
 doc["Color"]=color;
 serializeJson(doc, payload);
 delay(3000);
 Serial.print("\n");
 Serial.print("Sending payload: ");
 Serial.println(payload);
 if (client.publish(publishTopic, (char*) payload.c_str())) {
 Serial.println("Publish OK");
 } else {
 Serial.println("Publish FAILED");
 }
}
```

CIRCUIT CONFIGURATION:

SPRINT 3:



In this Phase, I will explain about the flow of our project.

- As we mentioned in the Data flow graph, we are first using an online simulation tool to send the level of the dustbin with the help of an ultrasonic sensor using the WOKWI platform and we also send the required data such as location, bin name etc…

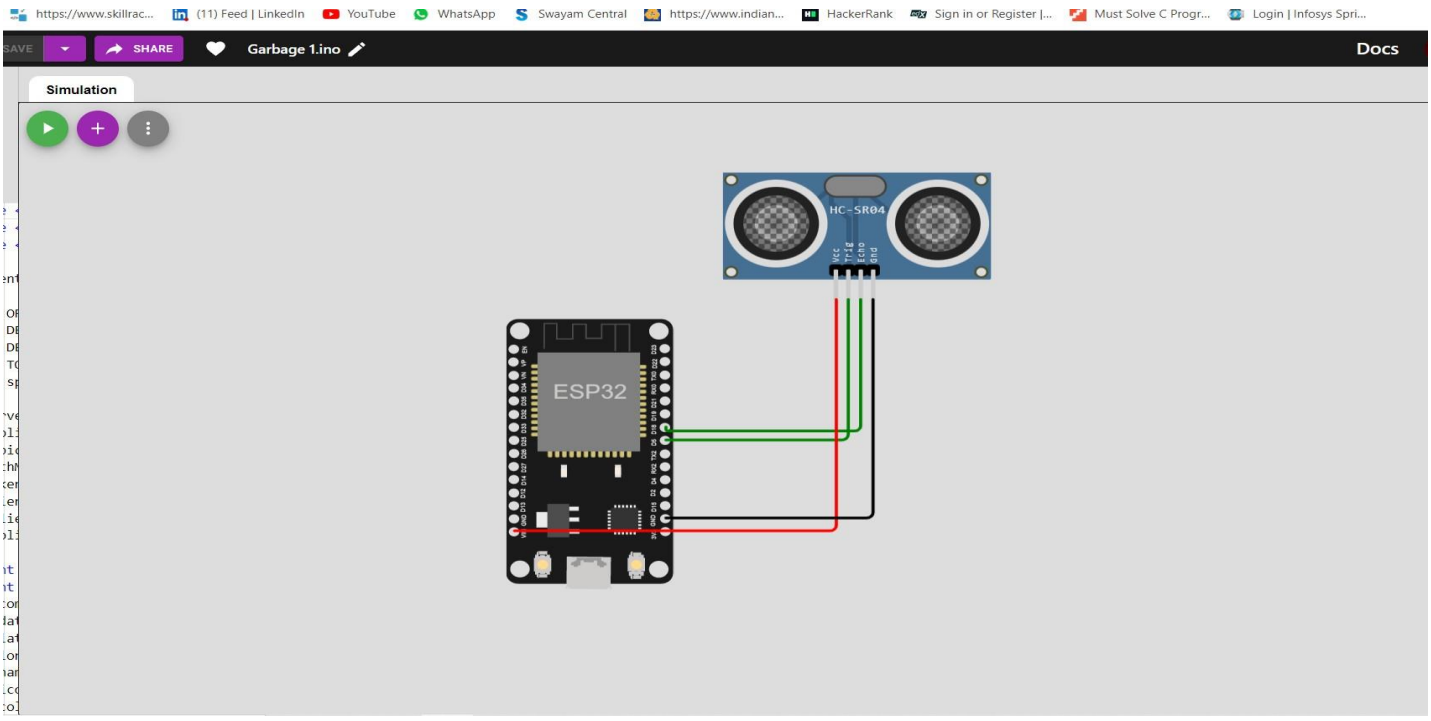
- This data is being sent to the IBM Watson IOT platform and with the help of IBM Watson IOT node we can get the data in node red.

- We designed few flows to make the data to be in a required format like maps, tables, gauge

- Here we store the Admin, Co admin details in the database (Cloudant DB)
- We have also created a python script to generate random BIN values which can also be used instead of WOKWI to send data to the IBM Watson IOT platform.
- I’ve also added a few Screenshots of the things we have done.
- We used a world map node for displaying the latitude and longitude in the Map.

SCREENSHOTS:

WOKWI Platform



Create a Python Script :

Here we can see the Python Code which is used to connect with IBM Watson IOT platform.

ibm dustbin.py - C:\Users\Praveen\Desktop\ibm dustbin.py (3.7.4)

File Edit Format Run Options Window Help

```
#IBM Watson IOT Platform
#pip install wiotp-sdk
import wiotp.sdk
import time
import random
myConfig = {
    "identity": {
        "orgId": "k6spbs",
        "typeId": "MSD",
        "deviceId":"12345"
    },
    "auth": {
        "token": "123456789"
    }
}
lat="13.167589"
lon="80.248510"
name="point1"
icon="fa-trash-o"
color="green"
def myCommandCallback(cmd):
    print("Message received from IBM IoT Platform: %s" % cmd.data['command'])
    m=cmd.data['command']

client = wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None)
client.connect()

while True:
    temp=random.randint(0,100)
    if temp>60:
        icon="fa-trash"
        color = "red"
    else:
        icon = "fa-trash-o"
        color = "green"
    myData={"Name":name,"Latitude":lat,"Longitude":lon,"Icon":icon,"FillPercent":temp,"Color":color}
    client.publishEvent(eventId="status", msgFormat="json", data=myData, qos=0, onPublish=None)
    print("Published data Successfully: %s", myData)
    client.commandCallback = myCommandCallback
    time.sleep(10)
client.disconnect()
```

Ln: 1 Col: 0

Python code overview:

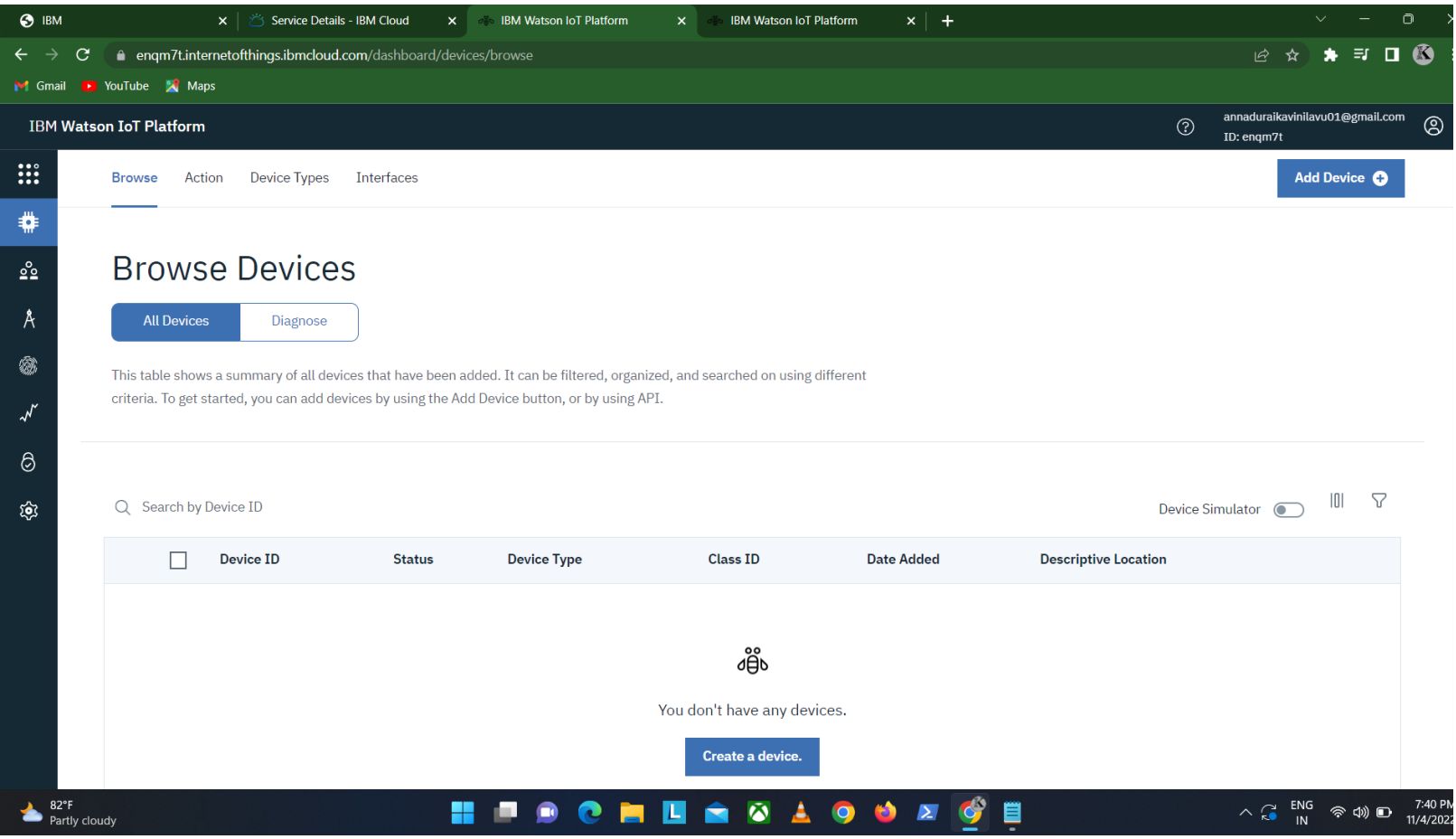
- We are using the Python 3.7.8 IDLE for the generation of random values for the bin
- Import the necessary modules like random, time, wiotp.sdk, etc
- Create a function mycommandcallback() to generate the data response from the Smart bins
- Create an infinite loop by while loop with True as a condition and give random inputs ranging from 10 to 100 to the randint function to generate the random input values.
- The Gauge indicator in the Node Red will be changed according to the random input generated integer values

```
if temp>60:
    icon="fa-trash"
    color = "red"
else:
    icon  =  "fa-trash-o"
    color = "green"
```

- Conditions for the Gauge indicator to show the color for levels of garbage

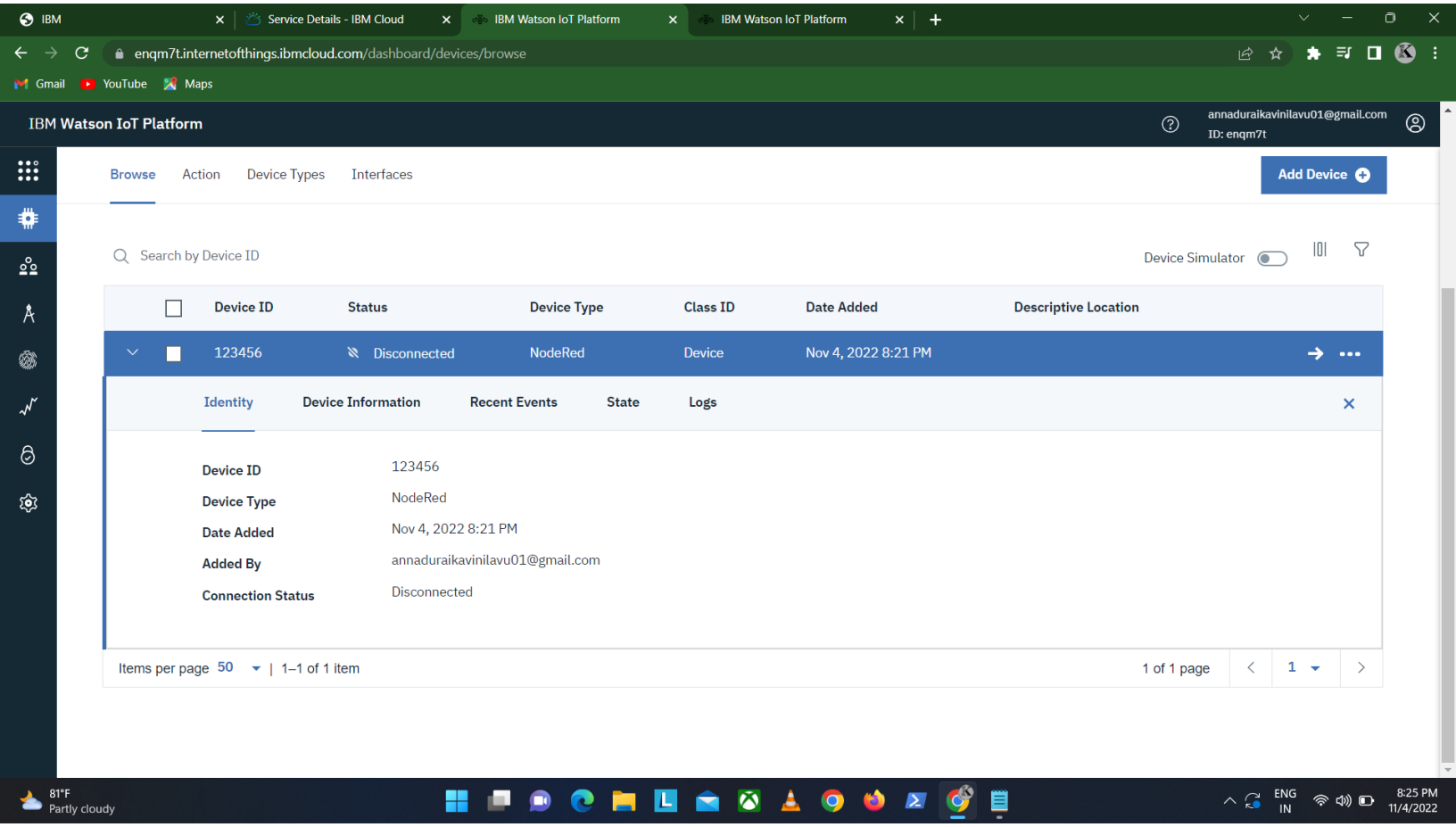
IBM Watson IoT Platform:

The information about the devices are being displayed here

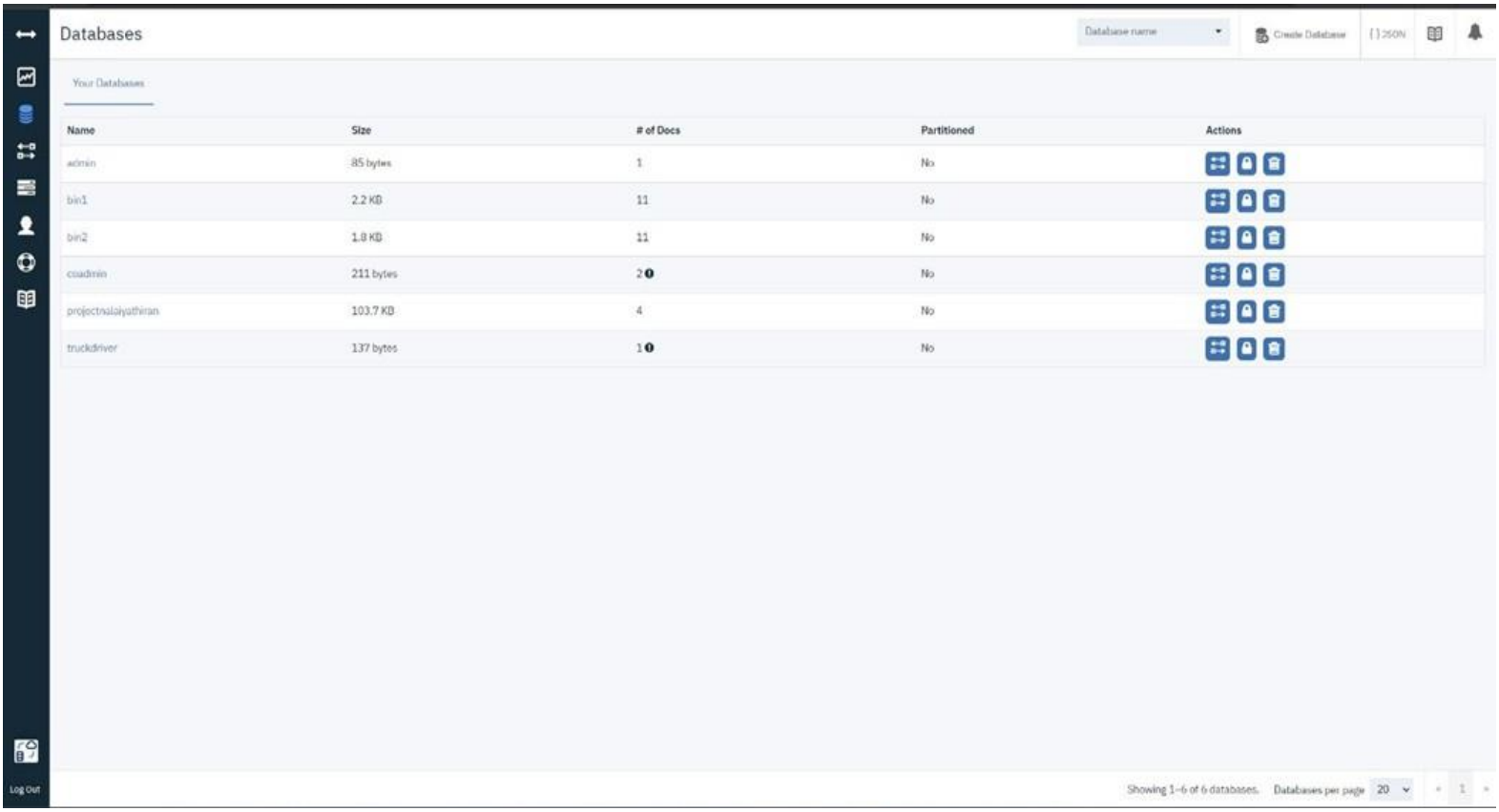


- Here we can see the output which has been passed from WOKWI Platform or Python Script to IBM Watson IOT platform.

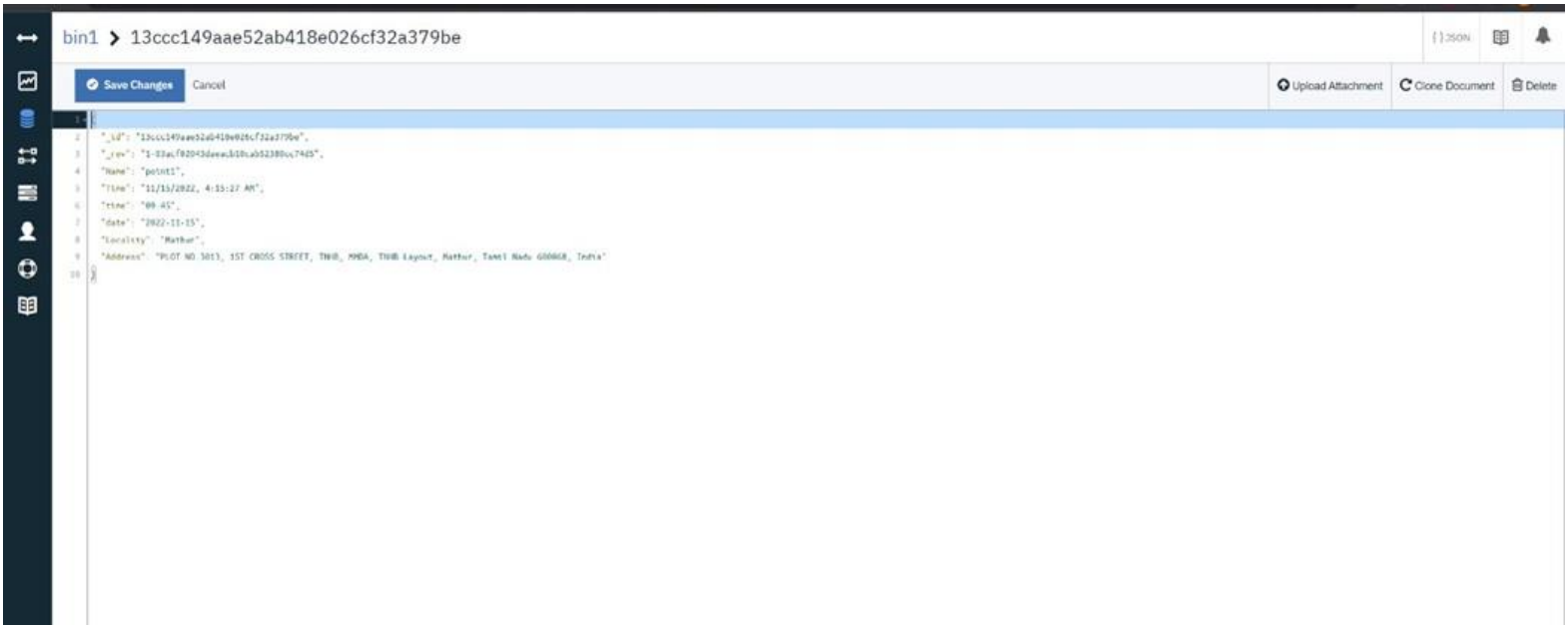
- It will provide the necessary information by the means of API Key. By placing this API Keys to the simulation devices source code, It will acts as an mediator between the simulator tool and the Node-Red platform



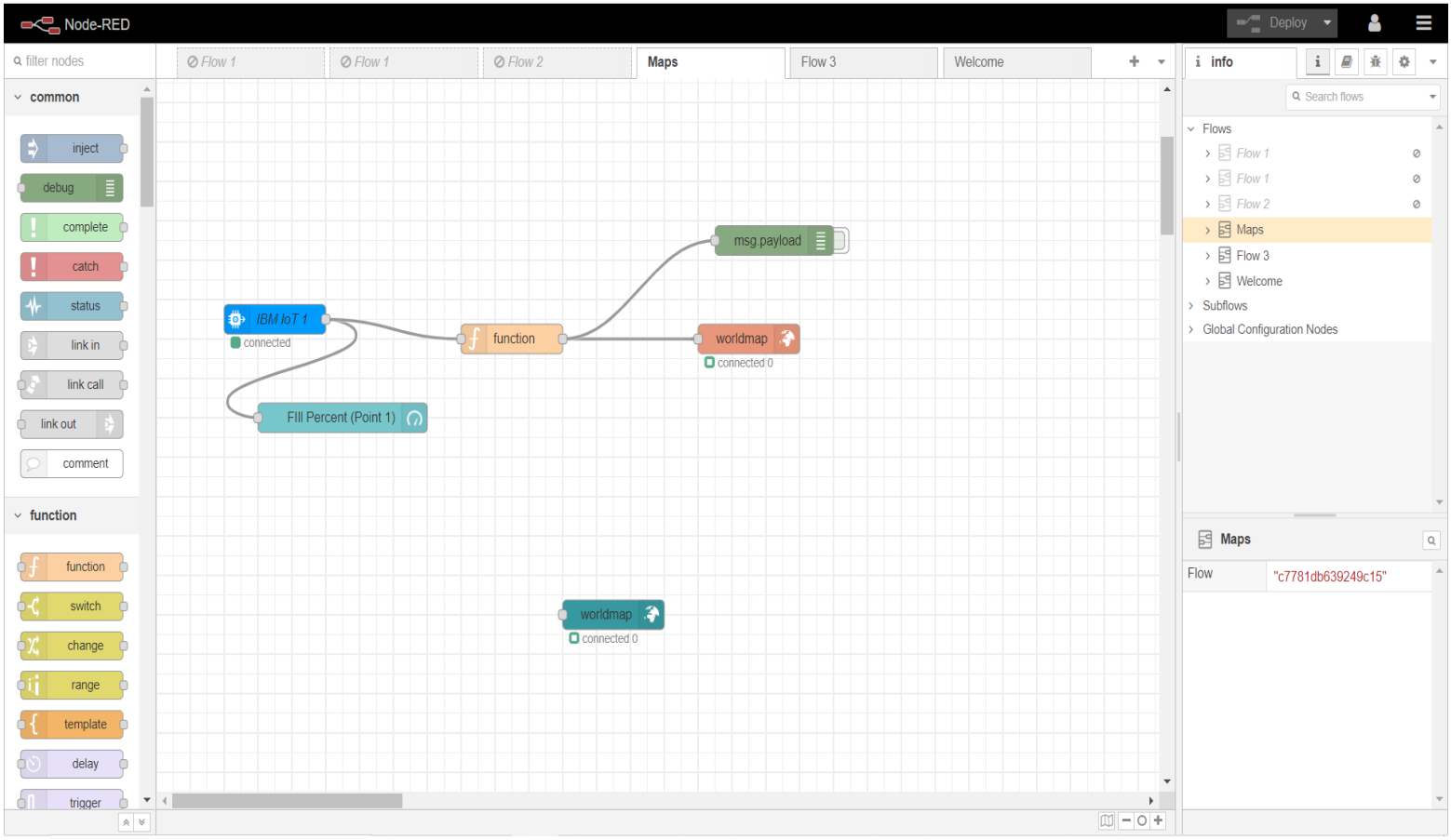
Cloudant DB:



BIN 1 DATABASE:



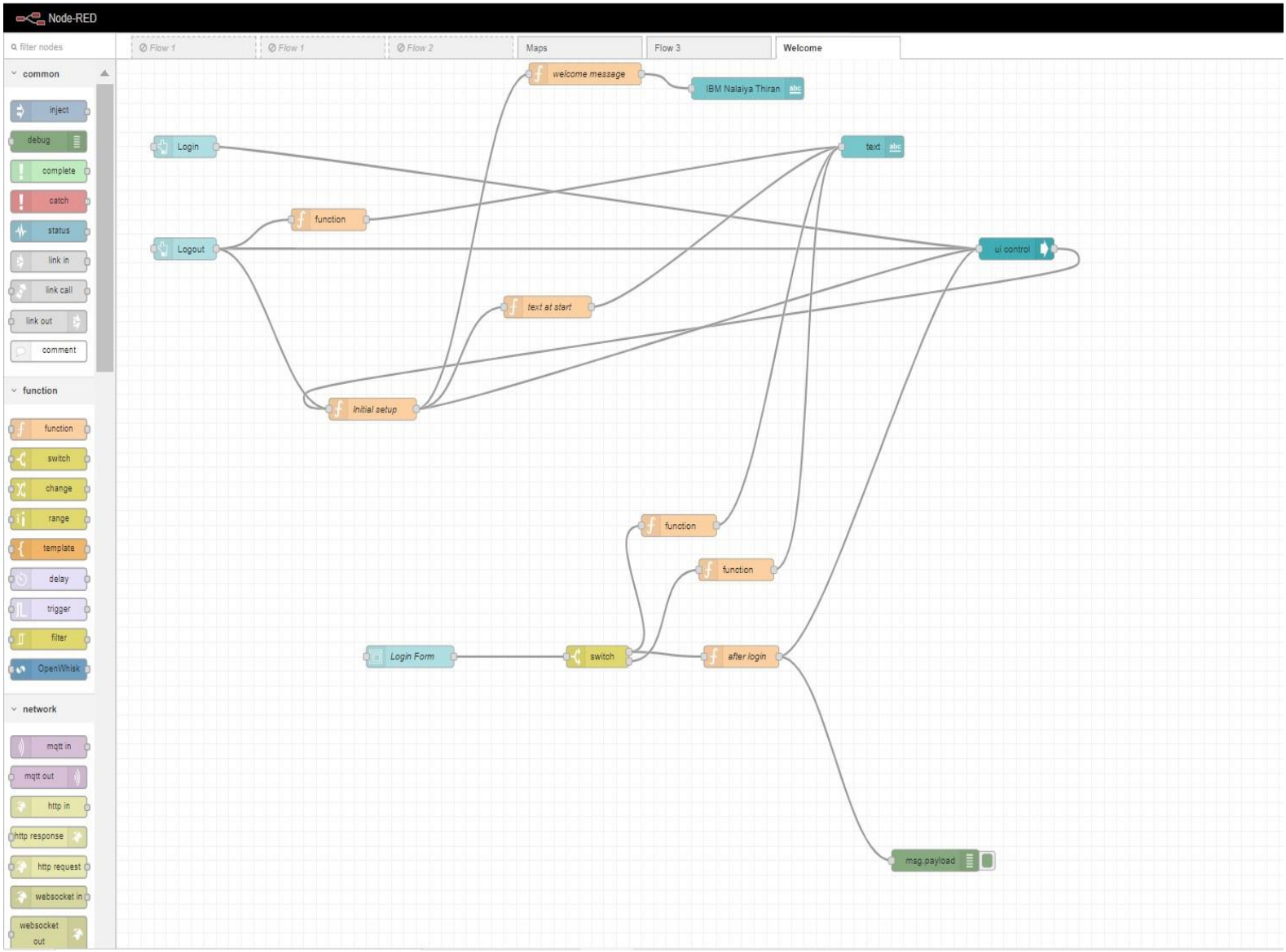
NODE RED FLOW:



- This is the Node Red flow to connecting to the IBM Watson IoT Platform, It use IBM IoT 1 Node for the process of connecting to the simulator

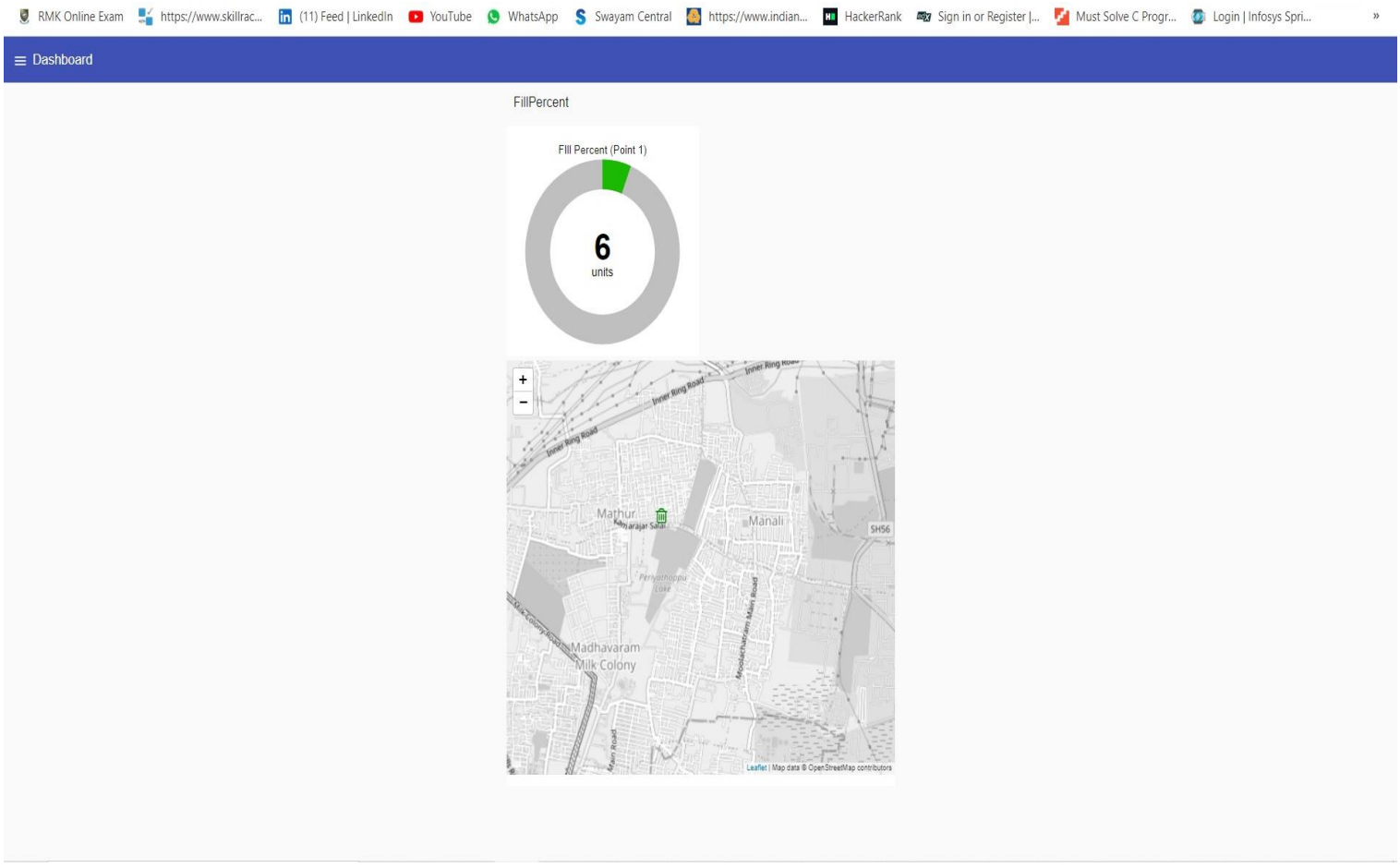
- The World Map node is used to show the geographical locations of each smart bins across the Smart Cities

Welcome Page:



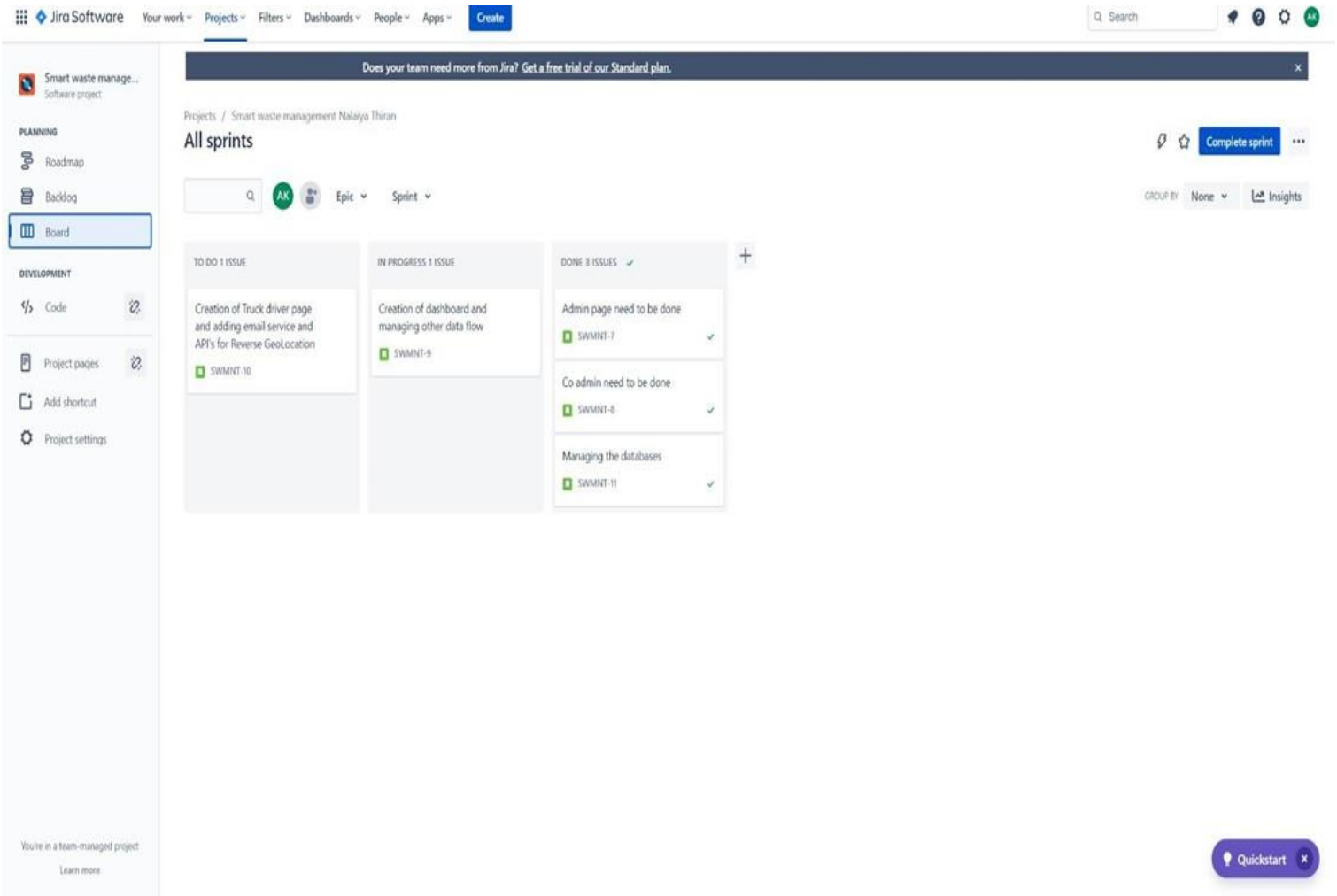
- This Node is used to create a Login page for our dashboard. This is a Non - functional requirement for our project used for authorization purposes.

OUTPUT:

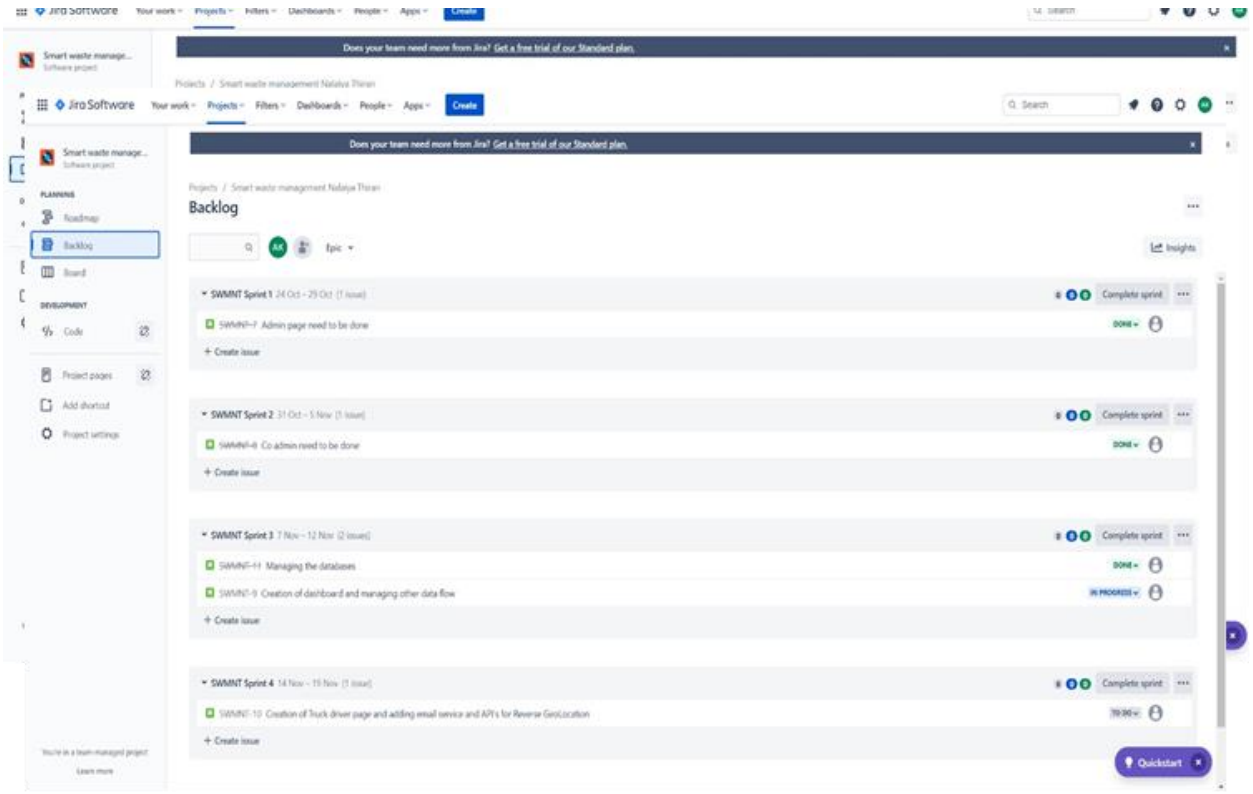

RMK Online Exam
https://www.skillrac...
(11) Feed | LinkedIn
YouTube
WhatsApp
Swayam Central
https://www.indian...
HackerRank
Sign in or Register |...
Must Solve C Progr...
Login | Infosys Spri...
Dashboard
FillPercent
Fill Percent (Point 1)
6
units
Inner Ring Road
Mathur
Manali
SH56
Madhavaram
Milk Colony
Leaflet | Map data © OpenStreetMap contributors

6.3 REPORTS FROM JIRA:

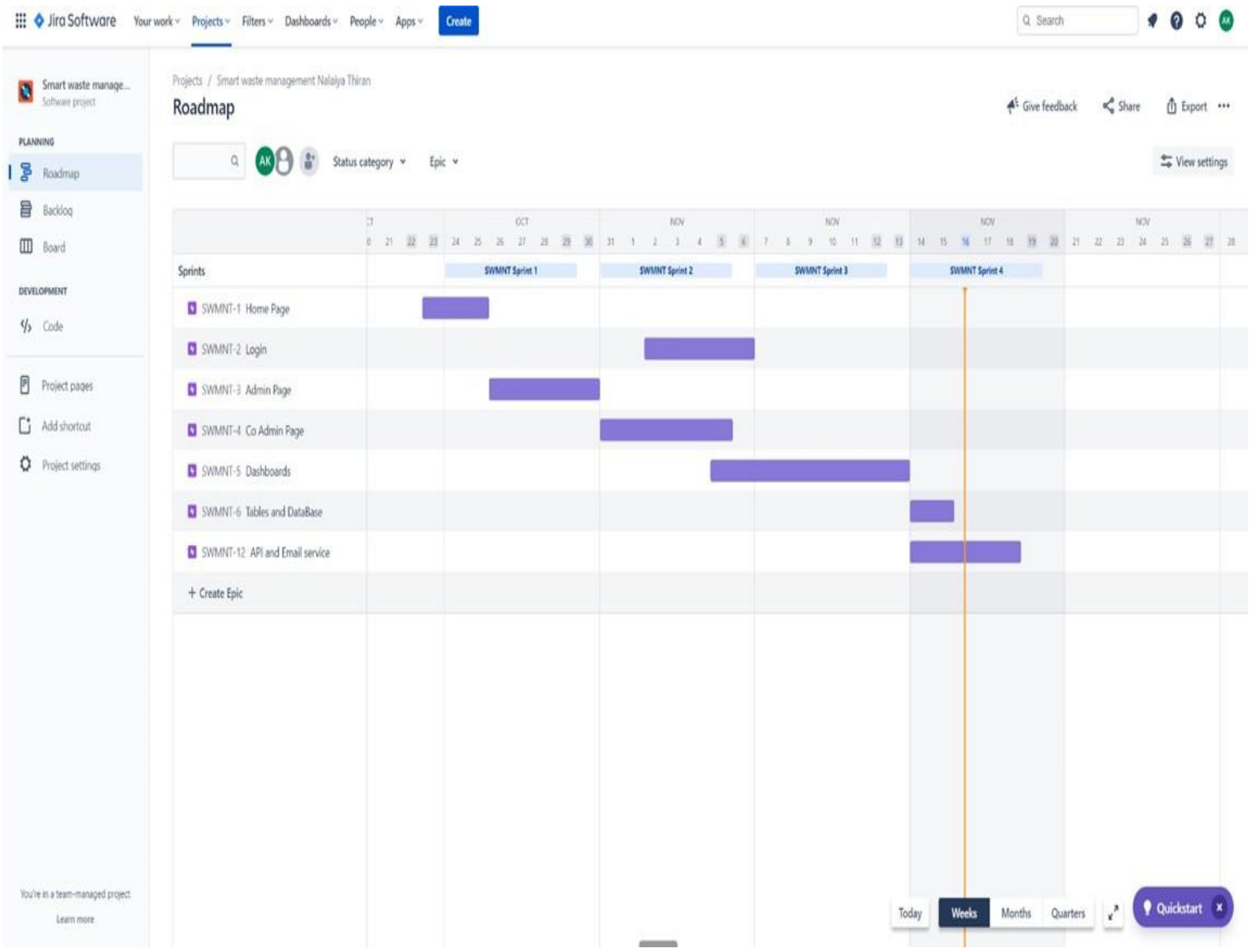
ALL SPRINTS



BACKLOGS:


Jira Software
Backlog
Sprint 1
Sprint 2
Sprint 3
Sprint 4
Complete sprint
Create issue

ROADMAP:


Jira Software
Your work
Projects
Filters
Dashboards
People
Apps
Create
Search
Smart waste manage...
Software project
PLANNING
Roadmap
Backlog
Board
DEVELOPMENT
Code
Project pages
Add shortcut
Project settings
You're in a team-managed project
Learn more
Projects / Smart waste management Nalaiya Thiran
Roadmap
Give feedback
Share
Export
Status category
Epic
View settings
OCT
NOV
NOV
NOV
NOV
Sprints
SWMNT Sprint 1
SWMNT Sprint 2
SWMNT Sprint 3
SWMNT Sprint 4
SWMNT-1 Home Page
SWMNT-2 Login
SWMNT-3 Admin Page
SWMNT-4 Co Admin Page
SWMNT-5 Dashboards
SWMNT-6 Tables and DataBase
SWMNT-12 API and Email service
+ Create Epic
Today
Weeks
Months
Quarters
Quickstart

7 CODING AND SOLUTIONING:

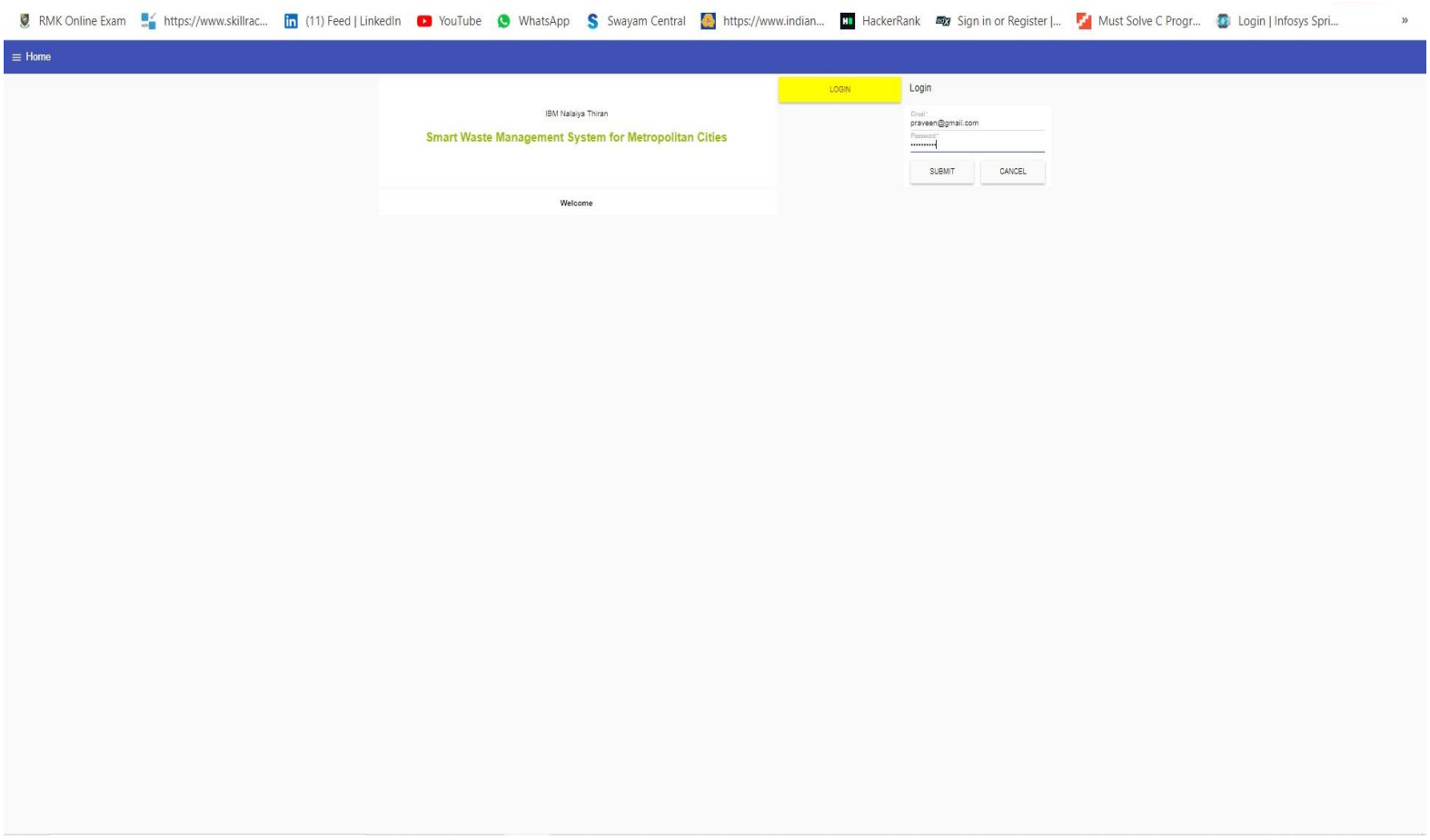
7.1 FEATURE 1:

The powerful cloud-based platform helps customers to configure, monitor and plan everyday waste management activities and belongs to one of the best waste management software on the market these days. The customer sees all the bins on a digital map and via street view including capacity, waste type, last measurement, GPS location, and collection schedule or pick recognition.

Login Dashboard:

- This feature is necessary for our project since it improves the authenticity

- This is implemented by using the Node Red dashboard workflows



- 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 softwares. 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.

7.2 FEATURE 2:

GEO COORDINATES:

- The geo coordinates are very useful for displaying the locations of the bins which are filled and about to be filled.

- This is implemented by using the Map node available in the Node-Red

- There can also be features like tools that predict when the bin will become full, check when the bin was last collected, eliminate the overflowing bins and stop collecting half-empty ones can be modified based on the customer/Municipal Authority's requirement.

- 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.\

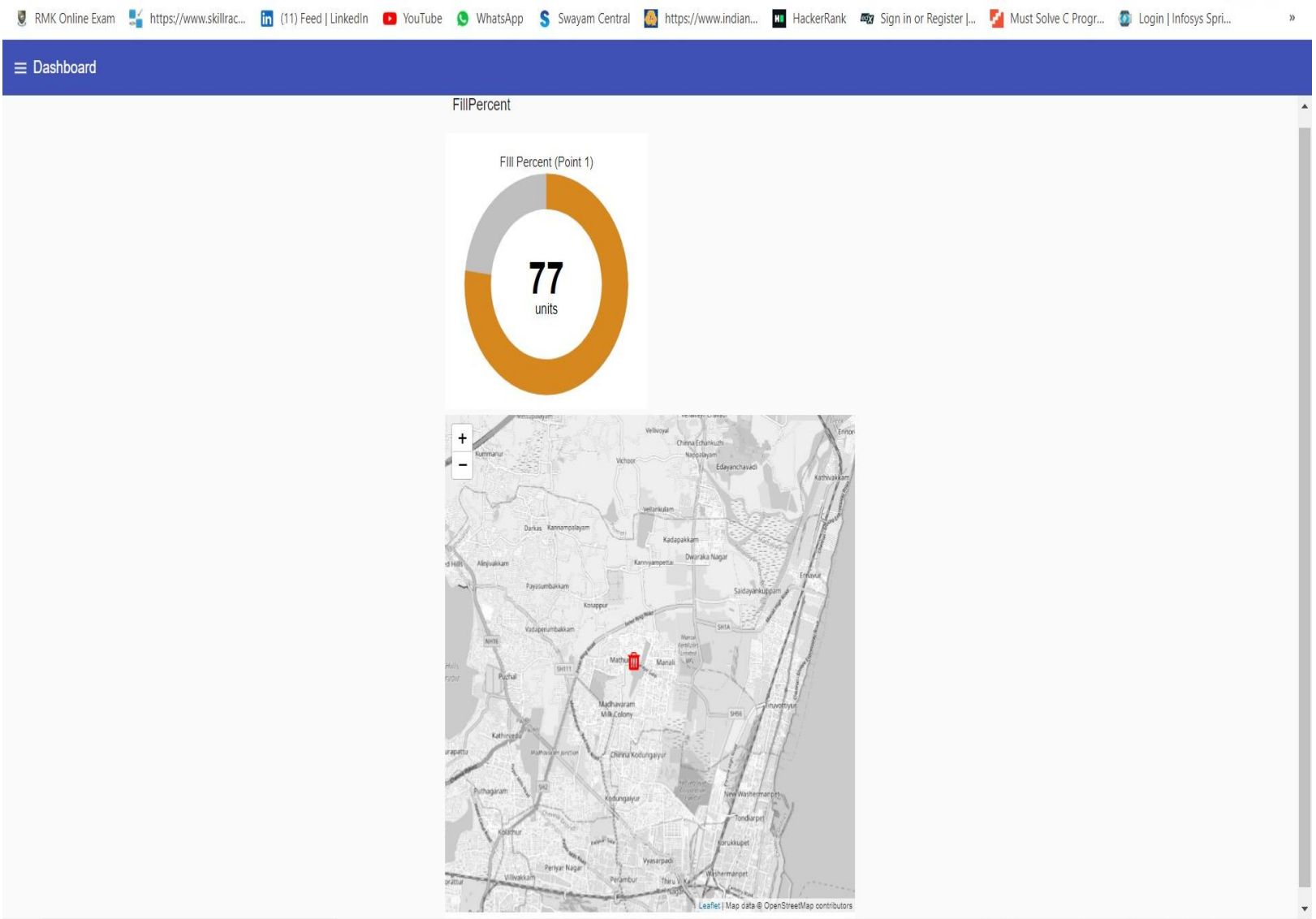
- Based on the historical data, you can adjust bin capacity or location where necessary

- Very helpful method for Real-time waste monitoring.

- The GPS coordinates of the garbage bin will be sent to the IBM IoT platform

- The location of the bins along with bin status can be viewed in the Web Application

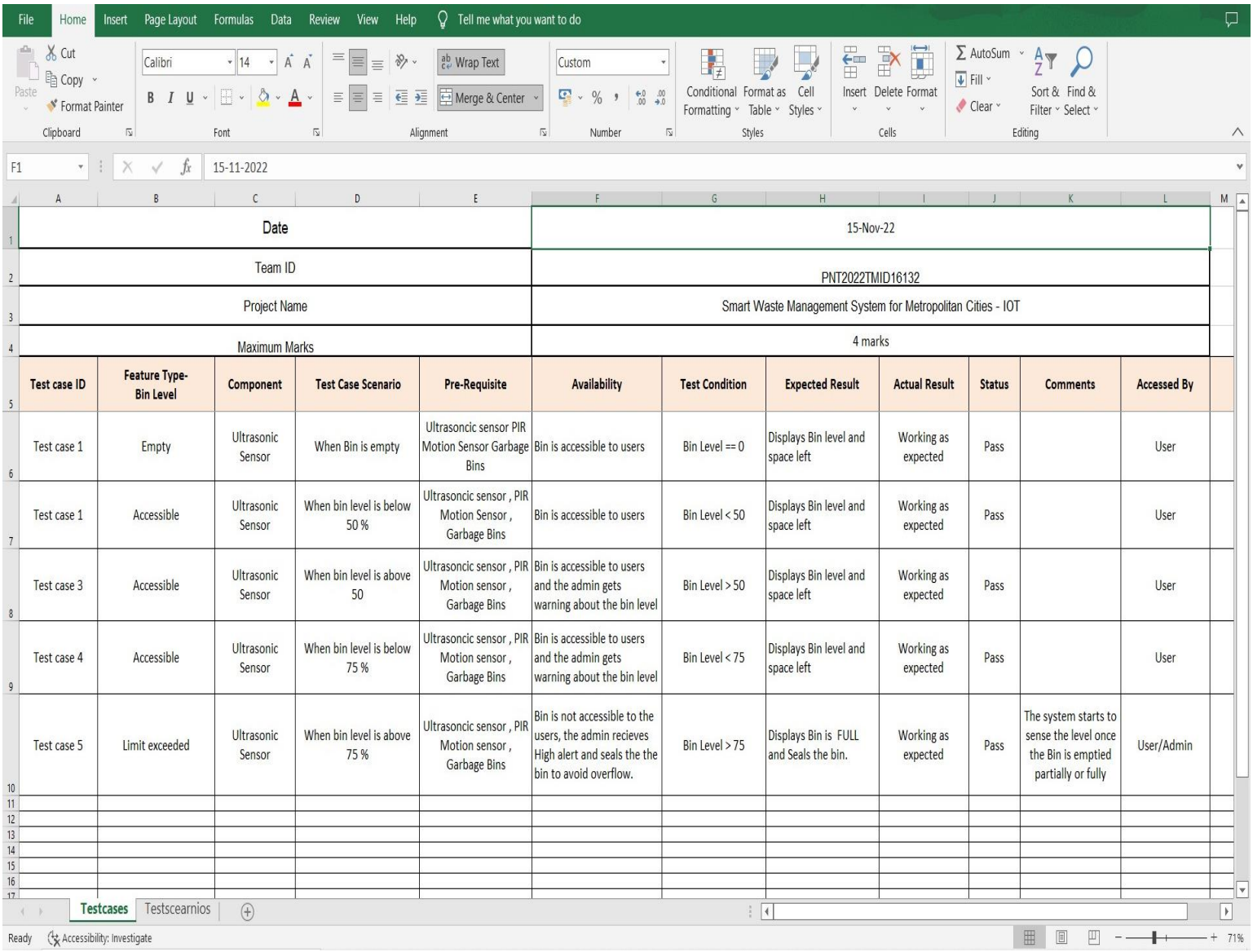
- Notifies the admin if the bin value crosses the threshold value



8 TESTING:

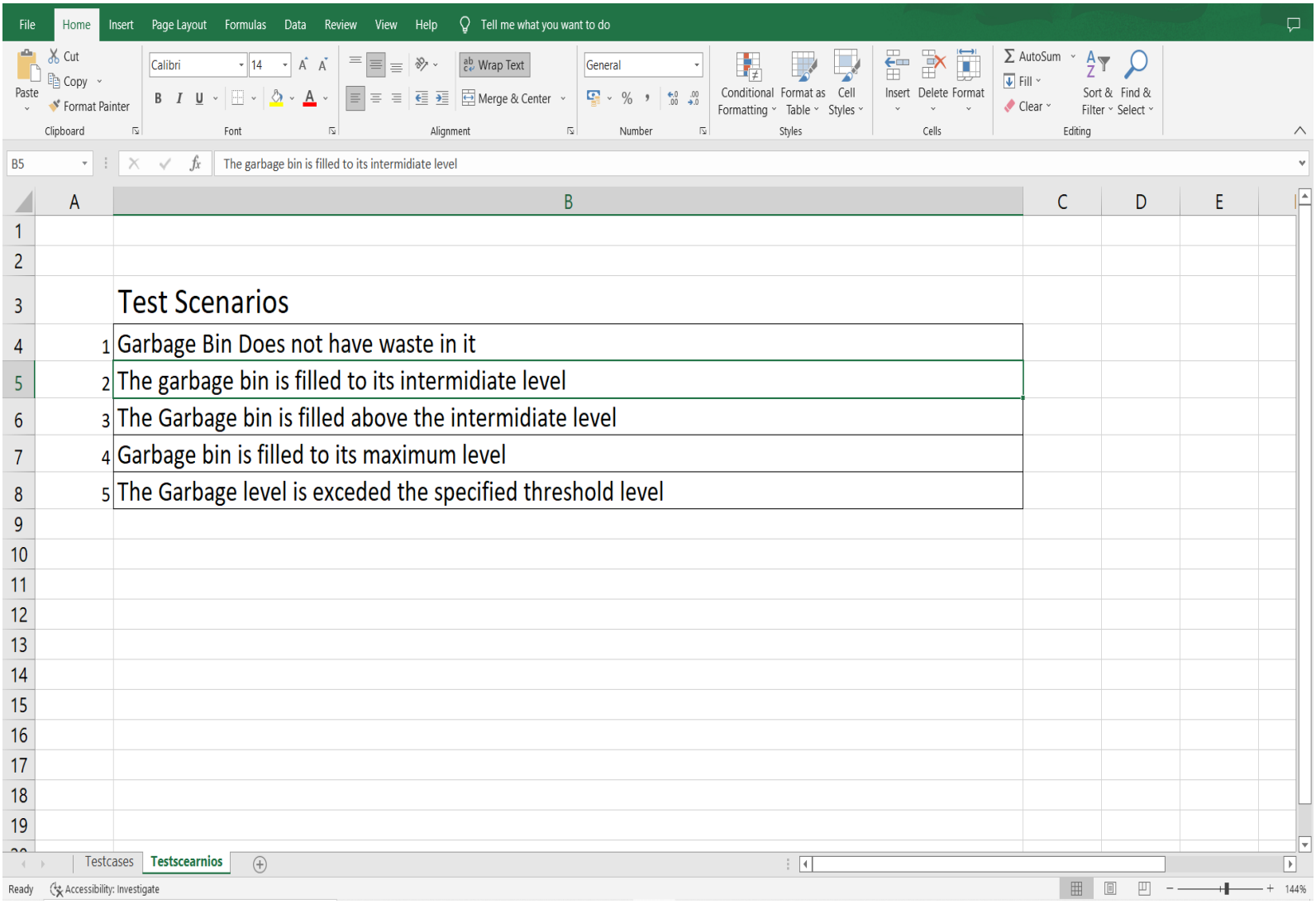
IoT testing includes functional and integration testing relevant to the specifics of distributed architectures, performance testing to check how the app handles large volumes of streaming data, security testing at the application, gateway, and IoT device levels.

8.1 Test Cases:



Date	15-Nov-22
Team ID	PNT2022TMID16132
Project Name	Smart Waste Management System for Metropolitan Cities - IOT
Maximum Marks	4 marks

Test case ID	Feature Type-Bin Level	Component	Test Case Scenario	Pre-Requisite	Availability	Test Condition	Expected Result	Actual Result	Status	Comments	Accessed By
Test case 1	Empty	Ultrasonic Sensor	When Bin is empty	Ultrasoncic sensor PIR Motion Sensor Garbage Bins	Bin is accessible to users	Bin Level == 0	Displays Bin level and space left	Working as expected	Pass		User
Test case 1	Accessible	Ultrasonic Sensor	When bin level is below 50 %	Ultrasoncic sensor , PIR Motion Sensor , Garbage Bins	Bin is accessible to users	Bin Level < 50	Displays Bin level and space left	Working as expected	Pass		User
Test case 3	Accessible	Ultrasonic Sensor	When bin level is above 50	Ultrasoncic sensor , PIR Motion sensor , Garbage Bins	Bin is accessible to users and the admin gets warning about the bin level	Bin Level > 50	Displays Bin level and space left	Working as expected	Pass		User
Test case 4	Accessible	Ultrasonic Sensor	When bin level is below 75 %	Ultrasoncic sensor , PIR Motion sensor , Garbage Bins	Bin is accessible to users and the admin gets warning about the bin level	Bin Level < 75	Displays Bin level and space left	Working as expected	Pass		User
Test case 5	Limit exceeded	Ultrasonic Sensor	When bin level is above 75 %	Ultrasoncic sensor , PIR Motion sensor , Garbage Bins	Bin is not accessible to the users, the admin recieves High alert and seals the the bin to avoid overflow.	Bin Level > 75	Displays Bin is FULL and Seals the bin.	Working as expected	Pass	The system starts to sense the level once the Bin is emptied partially or fully	User/Admin



8.2 User Acceptance Testing:

1. *Purpose of Document:*

The purpose of this document is to briefly explain the test coverage and open issues of the Smart Waste Management System project at the time of the release to User Acceptance Testing (UAT).

2. *Defect Analysis:*

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	3	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	78

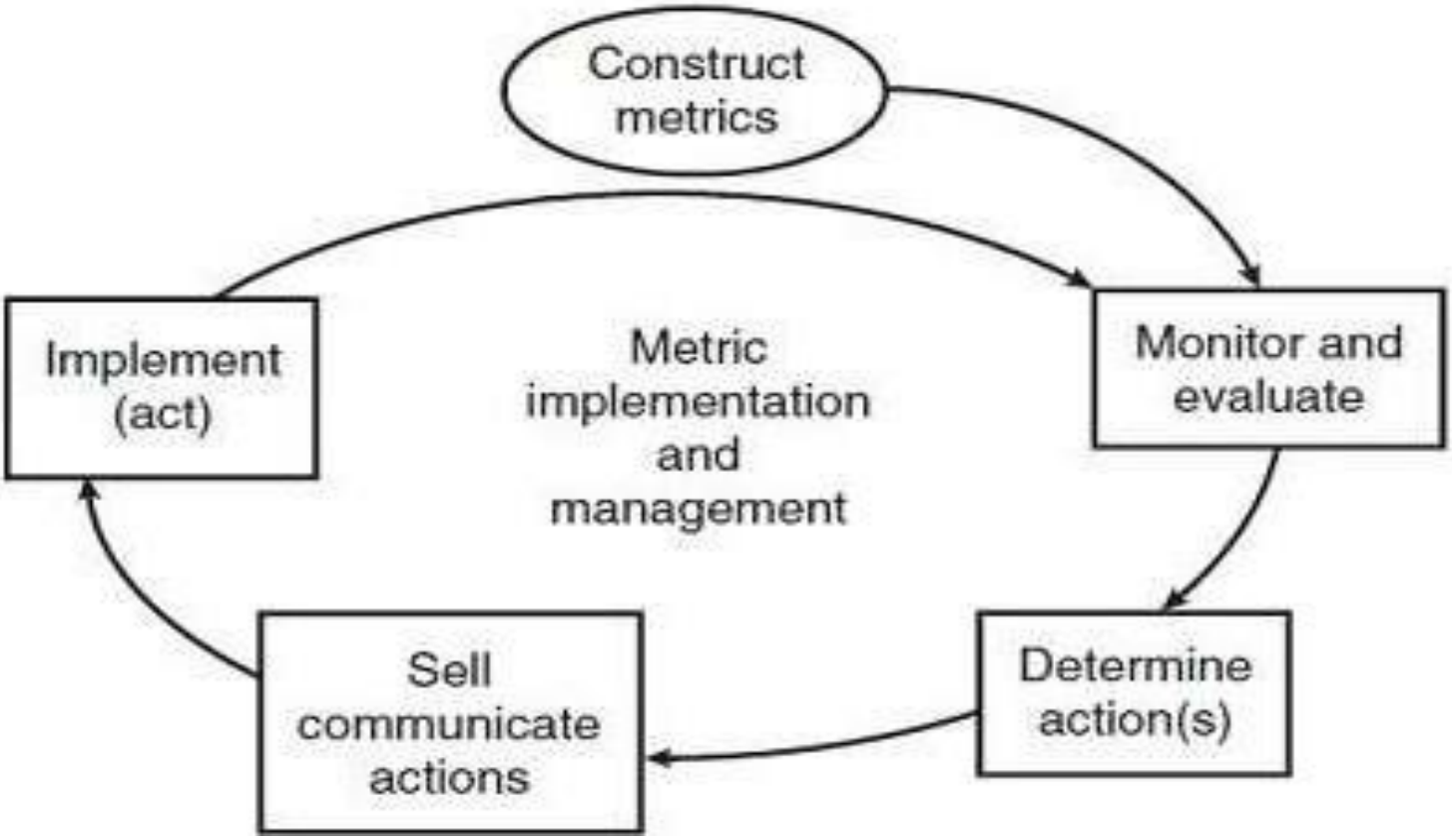
3. Test Case Analysis:

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	51	0	0	51

Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	2	0	0	2

9. RESULTS:

9.1 Performance Metrics:



- Performance metrics are defined as figures and data representative of an actions, abilities, and overall quality.

- How dynamically well the outputs of a system represents the performance metrics of a system.

- Our system has highly sensitive ultrasonic sensors to detect the amount of waste in the garbage. Small changes in the level of waste also be reflected to the Administrator/Municipal officers.

10 ADVANTAGES:

❖ The proposed plan has many advantages, it is also cogent enough to be implemented in every street of a developing nation. The advantages lie in its easy and valuable functioning. This will not only improve the streets we live in, but also provide a pavement for better working system

- Real time information on the fill level of the dustbin.

- Deployment of dustbin based on the actual needs.

- Cost Reduction and resource optimization.

- Improves Environment quality
  -Fewer smells
  -Cleaner cities

- Intelligent management of the services in the city.

- Effective usage of dustbins.

- It significantly minimizes the amount of labor needed to oversee rubbish collection process

DISADVANTAGES:

- Sensor nodes used in the dustbins have limited memory size.
- It reduces manpower requirements which results in an increase in unemployment for unskilled people.
- The training has to be provided to the people involved in the smart waste management system.
- Well-secured information for the user will cost a lot
- System requires more waste bins for separate waste collection as per population in the city. This results in high initial cost due to expensive smart dustbins compared to other methods.
- Rough action and usage of the user may cause damages to the sensors

11 CONCLUSION:

- We have implemented real time waste management system by using smart dustbins to check the fill level of smart dustbins whether the dustbin are full or not
- The goal of this project is to develop a smart trash management system that makes use of an ultrasonic sensor and an Esp8266-wifi module**.**
- In this system the information of all smart dustbins can be accessed from anywhere and anytime by the concern person and he/she can take a decision accordingly
- When the rubbish level reaches its peak, this mechanism guarantees that dustbins will be cleaned as quickly as possible.

- This lowers the total number of trips made by the waste collection truck and, as a result, lowers the overall cost of rubbish collection. In the end, it promotes societal hygiene.

- As a result, the efficient waste management system increases the effectiveness of garbage collection. Smart trash cans aid in the reduction of pollution. This initiative guarantees timely garbage collection, which in turn assures minimal environmental pollution, no disease transmission, and a cleaner environment.

12 FUTURE SCOPE:

- There isn't any dead end for innovation. The longer term scope for this project is the use of an alternate source of energy.

- The scope for the future work is this system can be implemented with time stamp in which real-time clock shown to the concern person at what time dust bin is full and at what time the waste is collected from the smart dustbins

- Even though the system uses solar energy, which is a renewable source of energy, but, during rainy days, constant energy support is required. The piezo-electric power supply can be one of the alternative energy sources to power up the instruments.

- The parallel recycling process means a way of collecting different types of waste that is e-waste, plastic waste, medical waste, food waste, and many more.

- The biodegradable wastes can be used as compost. Vermicompost - compost that is made with the 21 help of earthworms. This can be distributed either to the area of residence or given to the farmers in need, in turn producing a sustainably developed model.

- Providing free internet facilities for a specific time once the trash is dumped into the bin. The proposed system will definitely help to overcome all the serious issues related to waste and keep the environment clean

13 APPENDIX:

Source code:

PYTHON CODE:

```
#IBM Watson IOT Platform
#pip install wiotp-sdk
import wiotp.sdk
import time
import random
myConfig = {
    "identity":  {
        "orgId": "k6spbs",
        "typeId": "MSD",
        "deviceId":"12345"
    },
    "auth": {
        "token": "123456789"
    }
}
lat="13.167589"
lon="80.248510"
name="point1"
icon="fa-trash-o"
color="green"
def myCommandCallback(cmd):
    print("Message received from IBM IoT Platform: %s" % cmd.data['command'])
    m=cmd.data['command']

client = wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None)
client.connect()
```

```
while True:
    temp=random.randint(0,100)
    if temp>60:
        icon="fa-trash"
        color = "red"
    else:
        icon = "fa-trash-o"
        color = "green"

myData={"Name":name,"Latitude":lat,"Longitude":lon,"Icon":icon,"FillPercent":t
emp,"Color":color}
    client.publishEvent(eventId="status", msgFormat="json", data=myData, qos=0,
onPublish=None)
    print("Published data Successfully: %s", myData)
    client.commandCallback = myCommandCallback
    time.sleep(10)
client.disconnect()
```

Wokwi Simulation Code:

```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>

WiFiClient wifiClient;

#define ORG "k6spbs"
#define DEVICE_TYPE "MSD"
#define DEVICE_ID "12345"
#define TOKEN "123456789"
#define speed 0.034

char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/Data/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
```

```
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();

const int trigpin=5;
const int echopin=18;
String command;
String data="";
String lat="13.167558";
String lon="80.244510";
String name="point2";
String icon="fa-trash-o";
String color="green";
long duration;
int dist;

void setup()
{
  Serial.begin(115200);
  pinMode(trigpin, OUTPUT);
  pinMode(echopin, INPUT);
  wifiConnect();
  mqttConnect();
}

void loop() {

  publishData();
  delay(500);

  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(1000);
    }
    initManagedDevice();
    Serial.println();
  }
}

void initManagedDevice() {
  if (client.subscribe(topic)) {
     Serial.println(client.subscribe(topic));
    Serial.println("subscribe to cmd OK");
  } else {
    Serial.println("subscribe to cmd FAILED");
  }
}
void publishData()
{
  digitalWrite(trigpin,LOW);
  digitalWrite(trigpin,HIGH);
  delayMicroseconds(10);
  digitalWrite(trigpin,LOW);
  duration=pulseIn(echopin,HIGH);
  dist=duration*speed/2;
  dist=dist/4;
  dist=100-dist;
  if(dist>80){
    icon="fa-trash";
    color="red";
```

```
  }else{
    icon="fa-trash-o";
    color="green";
  }
  DynamicJsonDocument doc(1024);
  String payload;
  doc["Name"]=name;
  doc["Latitude"]=lat;
  doc["Longitude"]=lon;
  doc["Icon"]=icon;
  doc["FillPercent"]=dist;
  doc["Color"]=color;
  serializeJson(doc, payload);
  delay(3000);
  Serial.print("\n");
  Serial.print("Sending payload: ");
  Serial.println(payload);
  if (client.publish(publishTopic, (char*) payload.c_str())) {
    Serial.println("Publish OK");
  } else {
    Serial.println("Publish FAILED");
  }
}
```

- Final source code – Click here

13.2 GITHUB AND PROJECT SOURCE CODE:

- Demo Video link-Click here
- GitHub Link – Click here