

SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES

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DOMAIN-INTERNET OF THINGS

PROJECT REPORT

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SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES

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ABSTRACT

The main purpose of this project is to design and implement the smart waste management system. In the present day scenario, many times we see that the Garbage bins or Dust bins are placed at public places in the cities are overflowing due to increase in the waste every day. So we are planning to design Garbage Monitoring System using IoT. In this system, the garbage level detection is done and alerts the authorized person to empty the bin whenever the bins are full. The data are transferred to the cloud and from the cloud sends the data to the web application. 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 node red

Our proposed model provide real time monitoring to the garbage bins placed in various locations. The garbage bins are build with a sensor module(Ultrasonic sensor) which continuously monitors the garbage bin. Any moment the garbage level passes over the critical level (i.e 80%), the system generates a

notification to the monitoring panel (admin panel /garbage cleaning team) and so cleaning team collects the garbage from the identified garbage bin.

Keywords: *IOT,Ultrasonic sensor,cloud,GPS*

CHAPTER - 1

INTRODUCTION

1.1 PROJECT OVERVIEW

We frequently observe overloaded trash cans or dustbins in our city, which makes the area unattractive and unsanitary for people to be in while also emitting a foul odour. The authorities are intending to execute a project named IoT Based Smart Garbage and Waste Collection Bins to prevent all such problems. They are turning more and more to smart solutions as a way to deal with budget cuts and aggressive environmental goals as IoT technology and new innovations become commercially available. Cities are experiencing environmental, social, and infrastructure issues as their populations grow, necessitating a new strategy for delivering public services, including garbage management. In order to make our cities livable and future-proof, smart waste management is a critical component of smart cities. Smart Bin sensors, Smart Waste Management Platform, Intelligent Routing, AI Recycling Robots and Container Tracking are efficient solutions to deal with waste fills across cities. Smart waste management offers a wide range of advantages, including increased operational effectiveness, cheaper operating costs, cleaner communities, and smaller carbon footprints along with increased recycling rates. This paper involves reasoning on why smart waste management is so important since the traditional waste management systems are ill-equipped to handle the additional trash produced by expanding populations, and the trash problem across the world isn't going away any time soon. Communities must embrace smart waste management technology that boosts productivity, cut collection costs, and divert more garbage from landfills in order to close the gap.

1.2 PURPOSE

The major purpose of this proposed system is to stop the dustbin overflowing around the road side and localities as smart bins are used in real time. This can create the surrounding area a

neat and clean while eliminating the overflow of the wastage outside the dustbin due to regular cleaning of the dustbin. Our purpose for this project are as follows:

Sensor based smart waste dustbin will judge the level of waste in it and send the message directly to the municipal corporation.

According to the filled level of the smart waste dustbin, the vehicles from the municipal corporation will choose the shortest path which will save their time.

The system is simple. If there is any problem with any equipment in the future, that part is easily replaceable with new one without any difficulty and delay.

CHAPTER 2

LITERATURE SURVEY

2.1 EXISTING PROBLEM

Manual collection of garbage is done former days which makes difficult to the municipal and garbage collector. Even if robot is used in the process of cleaning , it is not implemented in most places because the process is costlier.

2.2 REFERENCE

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2.3 PROBLEM STATEMENT DEFINITION

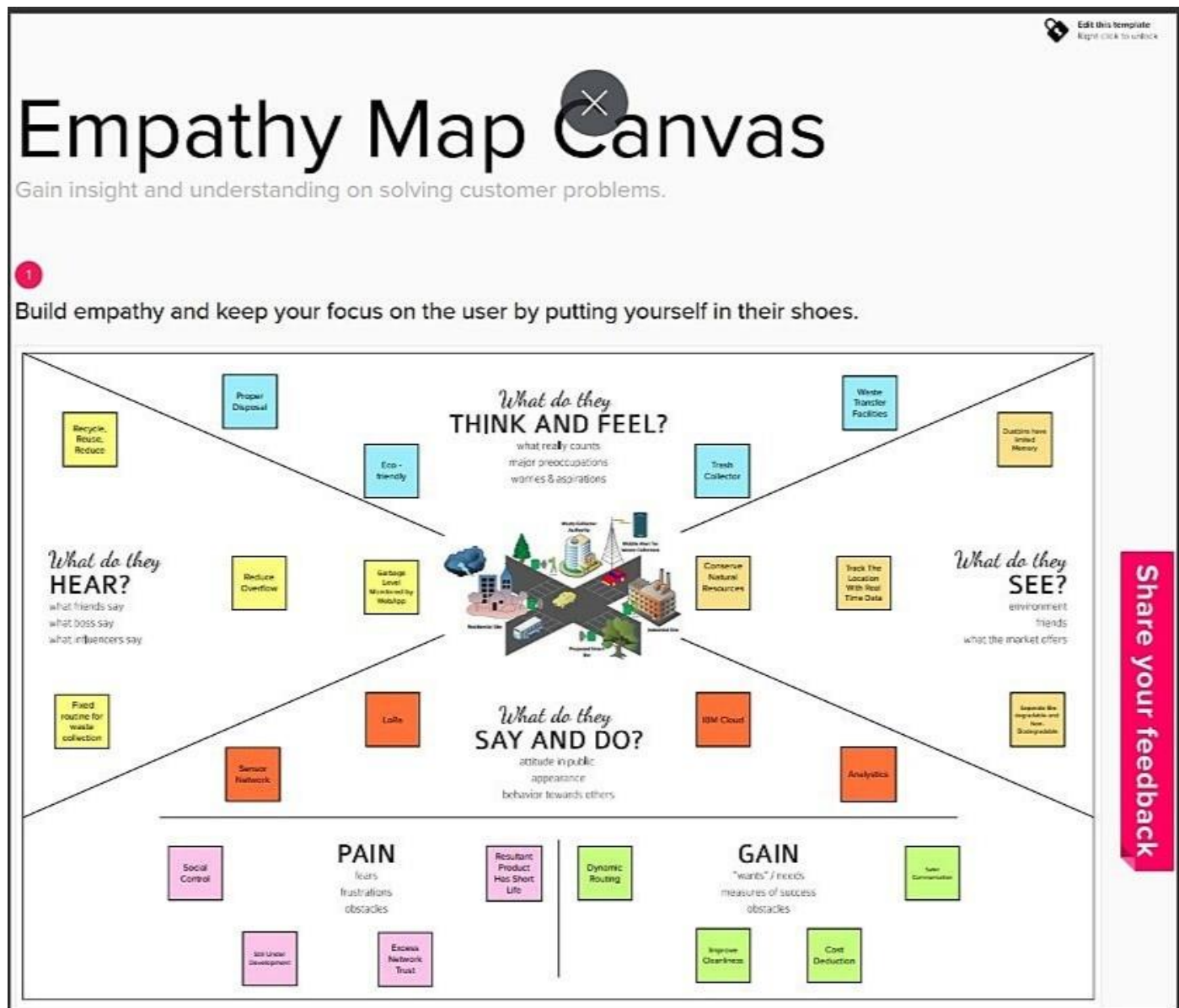
Design a smart waste collection system that allows citizens to segregate the various types of

solid waste they want to dispose and the municipal authorities to efficiently collect the same.
The system should be mobile app (Android) based.

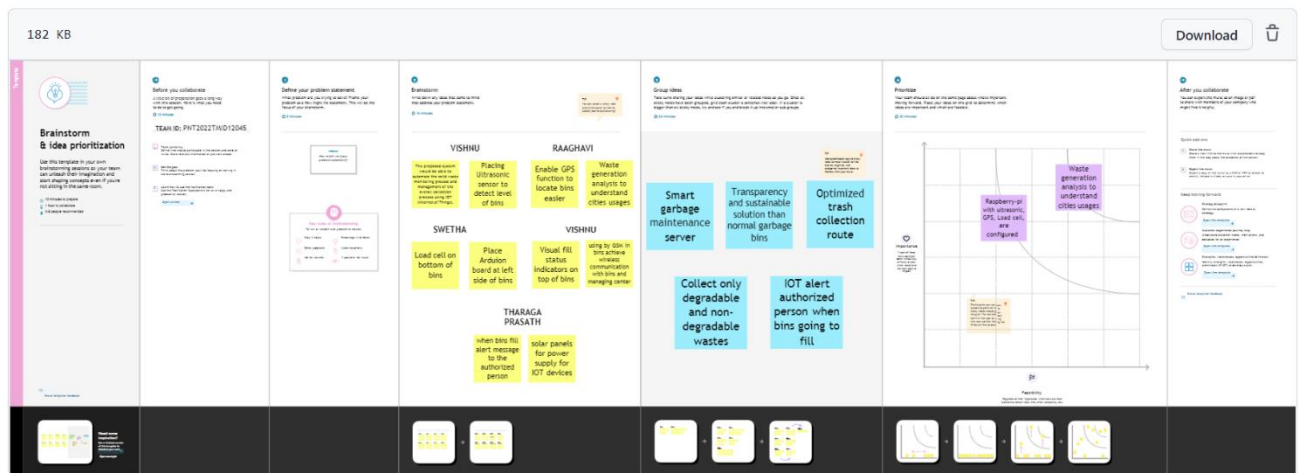
CHAPTER 3

IDEATION AND PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS



3.2 IDEATION & BRAINSTORMING



3.3 PROPOSED SOLUTION

S. No	Parameter	Description
1	Problem statement (problem to be solved)	Collection of garbage management in cities, towns and villages is a major concern and emerging problem in smart city paradigm, also lack of proper resource distribution in the process of garbage collection is great risk to sanitation, cleanliness and health.
2	Idea / Solution description	Collecting data from smart bins and alerting to the wastage collector. Data analysis for a smarter collection process. The data gathered in this process is analyzed and it is useful insights empowering the users in their decision making process.
3	Novelty / Uniqueness	Enhances scalability with computing power and storage available on demand, with no management burden.
4	Social Impact / Customer Satisfaction	It will help us to clean the cities and gives us healthy environment. When waste is disposed or recycled in a safe, ethical, and responsible manner, it helps reduce the negative impacts of the environment.

5	Business Model (financial Benefit)	Offering software as a service model to the government. One can earn good revenue from waste management business besides creating positive impacts in the society.
6	Scalability of Solution	In this model customer gets benefits on using smart bins by providing prediction on day to day analysis in waste management system

This project presents the development of a smart garbage monitoring system in order to measure waste level in the garbage bin in real-time and to alert the authority, in particular cases.

3.4 PROPOSED SOLUTION FIT

Problem-Solution Fit canvas

Purpose / Vision

Version:

Define CS, fit into CL	1. CUSTOMER SEGMENT(S) CS When people started using of technology in order to be more efficient when it comes to managing waste. This makes it possible to plan more efficient routes for the trash collectors who empty the bins, but also lowers the chance of any bin being full for over a week!	6. CUSTOMER LIMITATIONS CL <small>EG. BUDGET, DEVICES</small> 1.Sensor nodes used in the dustbin have limited memory size 2.The smart bin can hold 8 times more waste compare to normal 3.The resultant product has short life	5. AVAILABLE SOLUTIONS AS <small>PLUSSES & MINUSES</small> 1.Identification ,track & control the infrastructure of smart waste management 2. Information point for citizen direction to nearest available bin to the users	Explore AS, differentiate
	2. PROBLEMS / PAINS PR <small>+ ITS FREQUENCY</small> 1.Non-optimized truck rout. 2.Recycling 3.Inadequate management of non industrial hazardous waste 4.Setting up smart sensor	9. PROBLEM ROOT / CAUSE RC Rise in population and modernization has resulted in demand for food and essential supplies. Modern method of packaging for transportation and storage purpose has resulted in large quantities of waste	7. BEHAVIOR BE <small>+ ITS INTENSITY</small> 1.Intension to not throw away Food waste unwantedly 2.Predict future garbage behavior 3.Easier to clean workspace 4.Recycling, composting and waste-to-energy are increasingly being adopted as alternative waste management strategies	
Focus on PR, tap into BE, understand RC	3. TRIGGERS TO ACT TR 1.Bio-degradable waste such as food, paper, wood can be decomposed organically for fertilizer for plants 2.Population Growth that lead more waste	10. YOUR SOLUTION SL 1.Overflow of dustbin will create a unpleasant environment ,so it affects many peoples 2.This project improve the waste management because cleanliness could be maintained	8. CHANNELS of BEHAVIOR CH ONLINE 1.Household waste management 2.A National strategy to reduce food waste at the customer level OFFLINE: It saves the environment from toxic effects of inorganic and Biodegradable element present in waste	Extract online & offline CH of BE
	4. EMOTIONS EM <small>BEFORE / AFTER</small> 1.Air Quality 2.Digital Transformation 3.Sustainable Mobility 1.Energy 2.Tourism & Culture 3.Green Urban Area		11. YOUR SOLUTION SL 1.Overflow of dustbin will create a unpleasant environment ,so it affects many peoples 2.This project improve the waste management because cleanliness could be maintained	

Problem Solution Fit canvas is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.
 Designed by Daria Neprikhina / [ideahackers.nl](https://www.ideahackers.nl/) - we tailor ideas to customer behaviour and increase solution adoption probability.

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENT

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Bin invention	1. Our proposed model provide real time monitoring to the garbage bins placed in various locations. 2. Overflow of dustbins will be notified.
FR-2	Real time monitoring	1. The garbage bins are monitored by smart sensors. 2. In addition to the percentage of fill-level, based on the historical data, the sensor predicts when the bin will become full, one of the functionalities that are not included even in the best waste management software. 3. With real-time data and predictions, you can eliminate the overflowing bins and stop collecting halfempty ones.
FR-3	Processing	1. Through sensor, the percentage of garbage levels will be detected. 2. When the garbage level moves to critical(i.e.80%), it gives alert notification to the security system. 3. After receiving the notification, the curbside collector collects the garbage.

4.2 NON FUNCTIONAL REQUIREMENT

Following are the non-functional requirements of the proposed solution

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	A Smart Smart city waste management technology allows crews to empty bins before they become overflowing with trash or recycling, and before infestation becomes an issue.
NFR-2	Security	Innovations in waste reduction technologies allow us to better monitor, prevent, and manage our waste. This includes appliances that deal with waste sustainably, smartphone apps to track waste and help us develop eco-friendly habits, and sensors to accurately measure what we have and what we're tossing.
NFR-3	Reliability	Smart Bins help to create a cleaner, safer, more hygienic environment and enhanced operational efficiency while reducing management costs, resources, and road-side emissions.
NFR-4	Performance	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-5	Availability	The system should be available all the time when required.
NFR-6	Scalability	Using smart bin reduces the number of bins inside cities because we able to monitor the garbage 24/7 more efficient and scalability when we move smarter.

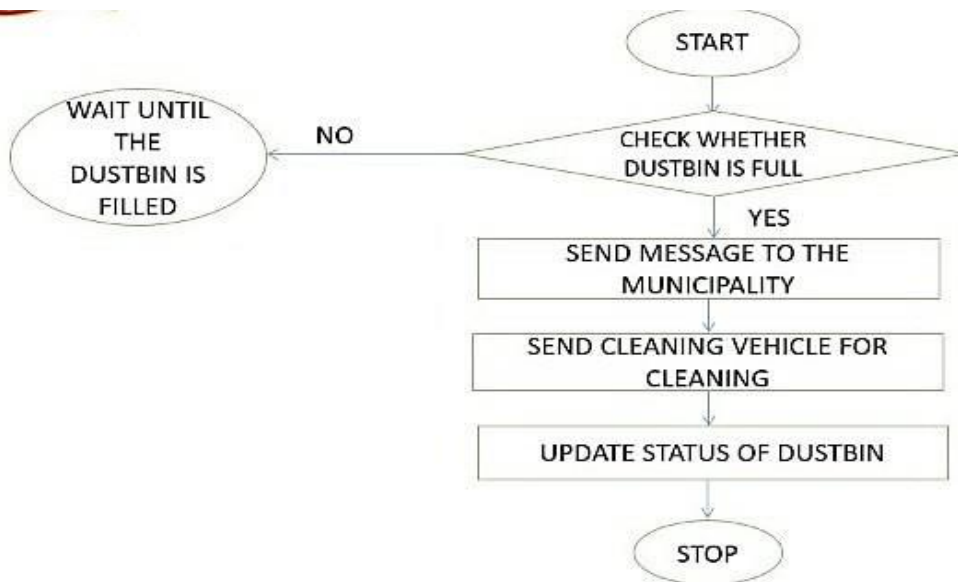
CHAPTER 5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAM

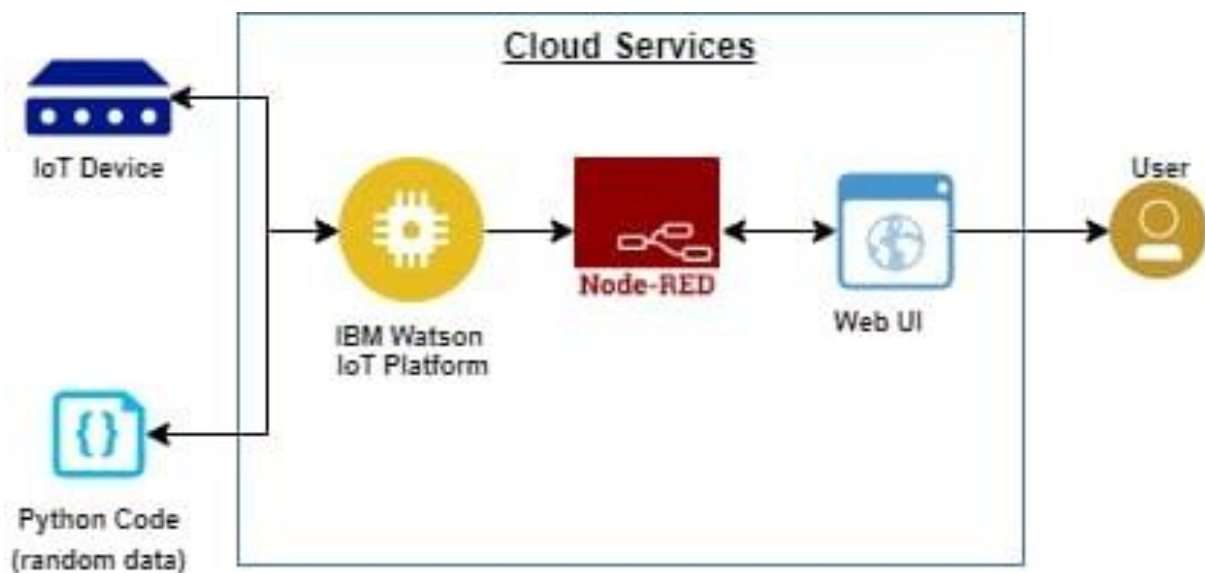
A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and

where data is stored.



5.2 SOLUTION & TECHNICAL ARCHITECTURE

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.



5.3 USER STORIES

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, and password and confirming my password.	3	High	vishnu
Sprint-1		USN-2	As a user, I will receive a confirmation email once I have registered for the application.	2	High	swetha
Sprint-2		USN-3	As a user, I can register for the application through Facebook.	2	Low	raaghavi
Sprint-1		USN-4	As a user, I can register for the application through Gmail.	5	Medium	tharaga Prasath
Sprint 4		USN-5	As a user, I can register for the application through Twitter.	2	Low	vishnu
Sprint-1	Login	USN-6	As a user, I can log into the application by entering my email & password	3	High	swetha
Sprint-2	Dashboard	USN-7	As a user, I need to give permission to access My Contacts, Location, and Storage.	5	High	raaghavi
Sprint-2		USN-8	As a user, I get access to the dashboard which shows a map with marked zones	5	High	tharaga Prasath
Sprint-1	Registration	USN-9	As a management, I need to register my hospitals on the site.	2	high	vishnu

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-3	Login	USN-10	As a management, I need to login into my dashboard with my given hospital id and password.	5	medium	vishnu
Sprint-2	Dashboard	USN-11	As a management, I need to enter the case information of the patient that visits our hospital.	5	high	raaghavi
Sprint-3		USN-12	As a management, I need to store all the patient information on the cloud	5	high	Tharaga Prasath
Sprint-2	Services	USN-13	As an admin, I need to provide valid information about the pandemic out there.	5	high	swetha
Sprint-3		USN-14	As an admin, I need to provide medical advice through a chatbot.	5	medium	vishnu
Sprint-3		USN-15	As an admin, I need to provide medical recommendations by collaborating with top hospitals.	5	low	tharaga Prasath
Sprint-4		USN-16	As an admin, I need to alert the user when they enter pandemic zones.	3	Medium	raaghavi
Sprint-3		USN-17	As an admin, I need to provide preventive measures when they travel through it.	5	high	vishnu
Sprint 4		USN-18	As an admin, I need to provide special services for premium users by giving services like monitoring health by their smart bands.	3	low	swetha

Sprint-4	Data collections	USN-19	As an admin, I need to store all the user information on the cloud	5	Medium	tharaga Prasath
Sprint-4		USN-20	As an admin, I need to collect the list of viruses & bacteria present in this world.	5	High	vishnu

CHAPTER 6

PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

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	29 Oct 2022	swetha
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	05 Nov 2022	vishnu
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	12 Nov 2022	tharaga Prasath
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	19 Nov 2022	raaghavi

6.2 Sprint Delivery Schedule:

Project Tracker, Velocity:

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	30	30 Oct 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	49	07 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	50	14 Nov 2022

CHAPTER 7

CODING & SOLUTIONING

7.1 FEATURE 1

Python code:

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

#Provide your IBM Watson Device Credentials
organization = "owxp6u"
deviceType = "Smartbin"
deviceId = "Bin1"
authMethod = "token"
authToken= "12345678910"

# Initialize GPIO
def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status=="lighton":
        print ("led is on")
    else :
        print ("led is off")

try:
    deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod,
"auth-token": authToken}
    deviceCli = ibmiotf.device.Client(deviceOptions)
    #.....
except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting"
10 times
deviceCli.connect()

while True:
    #Get Sensor Data from DHT11
    time.sleep(5)
    ultrasensor=random.randint(0,80)
    capacity=random.randint(0,100)
    lat=round(random.uniform(12.03,13.05),6)
    lon=round(random.uniform(80.80,85.90),6)
    data = { 'ultrasensorsensor' : ultrasensor, 'capacity': capacity, 'lat':lat, 'lon':lon}
```

```

# print data
def myOnPublishCallback():
    print ("Published ultrasonicsensor = %s Cm" % ultrasensor, "capacity= %s kg" %
capacity,"lat:%s"%lat,"lon:%s"%lon)

    success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
on_publish=myOnPublishCallback)
    if not success:
        print("Not connected to IoT")
        time.sleep(1)

deviceCli.commandCallback = myCommandCallback

```

Disconnect the device and application from the cloud

```
deviceCli.disconnect()
```



```

ibmiotpublshsubscribe.py - C:\Users\senth\AppData\Local\Programs\Python\Python37\ibmiotpublshsubscribe.py (3.9.6)
File Edit Format Run Options Window Help
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random
#Provide your IBM Watson Device Credentials
organization = "owxp6u"
deviceType = "Smartbin"
deviceId = "Bin1"
authMethod = "token"
authToken= "12345678910"
# Initialize GPIO
def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status=="lighton":
        print ("led is on")
    else :
        print ("led is off")
try:
    deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMe
deviceCli = ibmiotf.device.Client(deviceOptions)
#.....
except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()

```

Python code output:

```
IDLE Shell 3.9.6
File Edit Shell Debug Options Window Help
Python 3.9.6 (tags/v3.9.6:db3ff76, Jun 28 2021, 15:26:21) [MSC v.1929 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:\Users\senth\AppData\Local\Programs\Python\Python37\ibmiotpublishsubscribe.py
2022-11-18 21:14:44,456 ibmiotf.device.Client INFO Connected successfully: d:owxp6u:Smart
bin:Binl
Published ultrasonicsensor = 27 Cm capacity= 33 kg lat:12.588476 lon:82.278143
Published ultrasonicsensor = 65 Cm capacity= 98 kg lat:12.258127 lon:82.06083
Published ultrasonicsensor = 63 Cm capacity= 74 kg lat:12.940629 lon:82.516311
Published ultrasonicsensor = 69 Cm capacity= 83 kg lat:12.165361 lon:82.057114
Published ultrasonicsensor = 59 Cm capacity= 76 kg lat:12.106171 lon:82.730997
Published ultrasonicsensor = 23 Cm capacity= 58 kg lat:12.307029 lon:85.329571
```

7.2 FEATURE 2

Wokwi code:

```
#include <WiFi.h> // library for wifi
#include <PubSubClient.h> // library for MQTT
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 20, 4);

//.....credentials of IBM Accounts .....

#define ORG "owxp6u" // IBM organisation id
#define DEVICE_TYPE "ESP-32" // Device type mentioned in ibm
watson iot platform
#define DEVICE_ID "DHT-22" // Device ID mentioned in ibm
watson iot platform
#define TOKEN "harini@2001" // Token

//.....customise above values .....
```

```

char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
// server name
char publishTopic[] = "iot-2/evt/data/fmt/json";
// topic name and type of event perform and format in which data to be
send
char topic[] = "iot-2/cmd/led/fmt/String";
// cmd Represent type and command is test format of strings
char authMethod[] = "use-token-auth";
// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
//Client id

// .....

WiFiClient wifiClient;
// creating instance for wifiClient
PubSubClient client(server, 1883, wifiClient);

#define ECHO_PIN 12
#define TRIG_PIN 13
float dist;

void setup()
{
    Serial.begin(115200);
    pinMode(LED_BUILTIN, OUTPUT);
    pinMode(TRIG_PIN, OUTPUT);
    pinMode(ECHO_PIN, INPUT);
    //pir pin
    pinMode(34, INPUT);

    //ledpins
    pinMode(23, OUTPUT);
    pinMode(2, OUTPUT);
    pinMode(4, OUTPUT);
    pinMode(15, OUTPUT);

    lcd.init();
    lcd.backlight();
    lcd.setCursor(1, 0);
    lcd.print("");
    wifiConnect();
    mqttConnect();
}

float readcmCM()

```

```

{
    digitalWrite(TRIG_PIN, LOW);
    delayMicroseconds(2);
    digitalWrite(TRIG_PIN, HIGH);
    delayMicroseconds(10);
    digitalWrite(TRIG_PIN, LOW);
    int duration = pulseIn(ECHO_PIN, HIGH);
    return duration * 0.034 / 2;
}

void loop()
{

    lcd.clear();

    publishData();
    delay(500);
    if (!client.loop())
    {
        mqttConnect(); // function call
        to connect to IBM
    }
}

/* .....retrieving to cloud.....
   .....*/

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

void initManagedDevice()
{
    if (client.subscribe(topic))
    {
        Serial.println("IBM subscribe to cmd OK");
    }
    else
    {
        Serial.println("subscribe to cmd FAILED");
    }
}

void publishData()
{
    float cm = readcmCM();

    if(digitalRead(34) //pir motion
detection
    {
        Serial.println("Motion Detected");
        Serial.println("Lid Opened");
        digitalWrite(15, HIGH);
    }

    if(digitalRead(34)== true)
    {
        if(cm <= 60) //Bin level
detection
        {
            digitalWrite(2, HIGH);
            Serial.println("High Alert!!!,Trash bin is about to be full");
            Serial.println("Lid Closed");
            lcd.print("Full! Don't use");
            delay(2000);
            lcd.clear();
            digitalWrite(4, LOW);
            digitalWrite(23, LOW);
        }
        else if(cm > 60 && cm < 120)
        {
            digitalWrite(4, HIGH);
            Serial.println("Warning!!!,Trash is about to cross 50% of bin level");
        }
    }
}

```

```

        digitalWrite(2, LOW);
        digitalWrite(23, LOW);
    }
    else if(cm > 120)
    {
        digitalWrite(23, HIGH);
        Serial.println("Bin is available");
        digitalWrite(2, LOW);
        digitalWrite(4, LOW);
    }
    delay(10000);
    Serial.println("Lid Closed");
}
else
{
    Serial.println("No motion detected");
    digitalWrite(2, LOW);
    digitalWrite(15, LOW);
    digitalWrite(4, LOW);
    digitalWrite(23, LOW);
}
}

else
{
    digitalWrite(15, LOW);
}

if(cm <= 60)
{
    digitalWrite(21, HIGH);
    String payload = "{\"High_Alert\":\"";
    payload += cm;
    payload += " }";
    Serial.print("\n");
    Serial.print("Sending payload: ");
    Serial.println(payload);

    if (client.publish(publishTopic, (char*) payload.c_str())) // if
data is uploaded to cloud successfully,prints publish ok else prints
publish failed
    {
        Serial.println("Publish OK");
    }
}

```

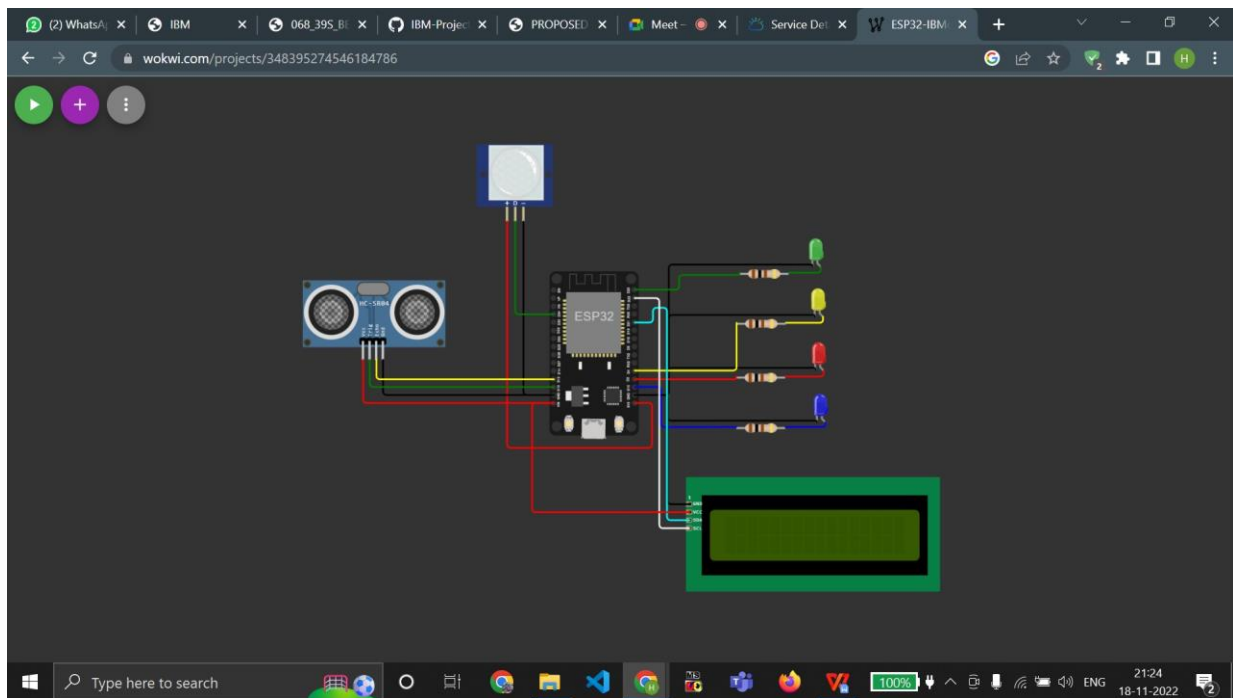


```

}
else if(cm <= 120)
{
digitalWrite(22,HIGH);
String payload = "{\"Warning\":\"";
payload += cm ;
payload += " }";
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");
}
}
else
{
Serial.println();
}

float inches = (cm / 2.54); //print
on lcd
lcd.setCursor(0,0);
lcd.print("Inches");
lcd.setCursor(4,0);
lcd.setCursor(12,0);
lcd.print("cm");
lcd.setCursor(1,1);
lcd.print(inches, 1);
lcd.setCursor(11,1);
lcd.print(cm, 1);
lcd.setCursor(14,1);
delay(1000);
lcd.clear();
}

```



Wokwi code:

WOKWI

SAVE SHARE ESP32-IBMconnection Docs

esp32-blink.ino diagram.json libraries.txt Library Manager

```

1 #include <WiFi.h> // library for wifi
2 #include <PubSubClient.h> // library for MQTT
3 #include <LiquidCrystal_I2C.h>
4 LiquidCrystal_I2C lcd(0x27, 20, 4);
5
6 //----- credentials of IBM Accounts -----
7
8 #define ORG "owxp6u" // IBM organisation id
9 #define DEVICE_TYPE "ESP-32" // Device type mentioned in
10 #define DEVICE_ID "DHT-22" // Device ID mentioned in ibm wa
11 #define TOKEN "harini@2001" // Token
12
13 //----- customise above values -----
14
15 char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
16 char publishTopic[] = "iot-2/evt/data/fmt/json";
17 char topic[] = "iot-2/cmd/led/fmt/String";
18 char authMethod[] = "use-token-auth";
19 char token[] = TOKEN;
20 char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
21
22 //-----
23
24 WiFiClient wifiClient;
25 PubSubClient client(server, 1883, wifiClient);
26
27 #define ECHO_PIN 12
28 #define TRIG_PIN 13
  
```

Simulation

00:13.943 92%

Publish OK

Sending payload: {"High_Alert":26.94 }

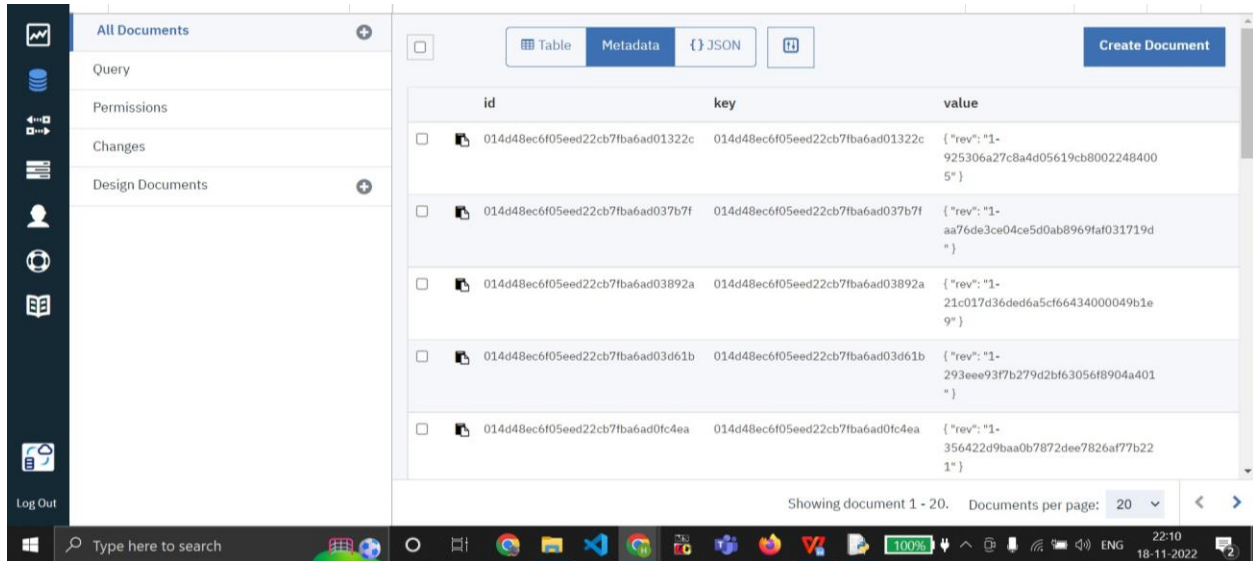
Publish OK

Sending payload: {"High_Alert":26.94 }

Publish OK

7.3 DATABASE SCHEMA

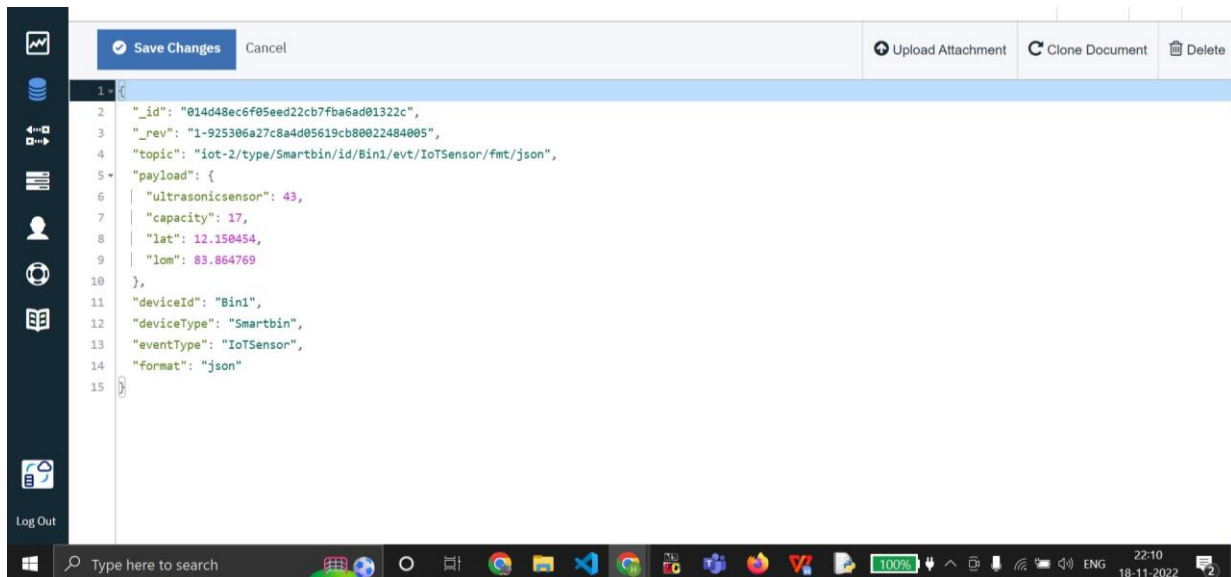
METADATA:



The screenshot shows a web application interface for document management. On the left is a sidebar with icons for various functions. The main area has tabs for 'Table', 'Metadata', and 'JSON'. The 'Metadata' tab is active, displaying a table with columns 'id', 'key', and 'value'. The table contains five rows of document metadata. At the bottom, it indicates 'Showing document 1 - 20. Documents per page: 20'.

id	key	value
014d48ec6f05eed22cb7fba6ad01322c	014d48ec6f05eed22cb7fba6ad01322c	{ "rev": "1-925306a27c8a4d05619cb80022484005" }
014d48ec6f05eed22cb7fba6ad037b7f	014d48ec6f05eed22cb7fba6ad037b7f	{ "rev": "1-aa76de3ce04ce5d0ab8969fa031719d" }
014d48ec6f05eed22cb7fba6ad03892a	014d48ec6f05eed22cb7fba6ad03892a	{ "rev": "1-21c017d36ded6a5cf66434000049b1e" }
014d48ec6f05eed22cb7fba6ad03d61b	014d48ec6f05eed22cb7fba6ad03d61b	{ "rev": "1-293eee93f7b279d2bf63056f8904a401" }
014d48ec6f05eed22cb7fba6ad0fc4ea	014d48ec6f05eed22cb7fba6ad0fc4ea	{ "rev": "1-356422d9baa0b7872dee7826af77b22" }

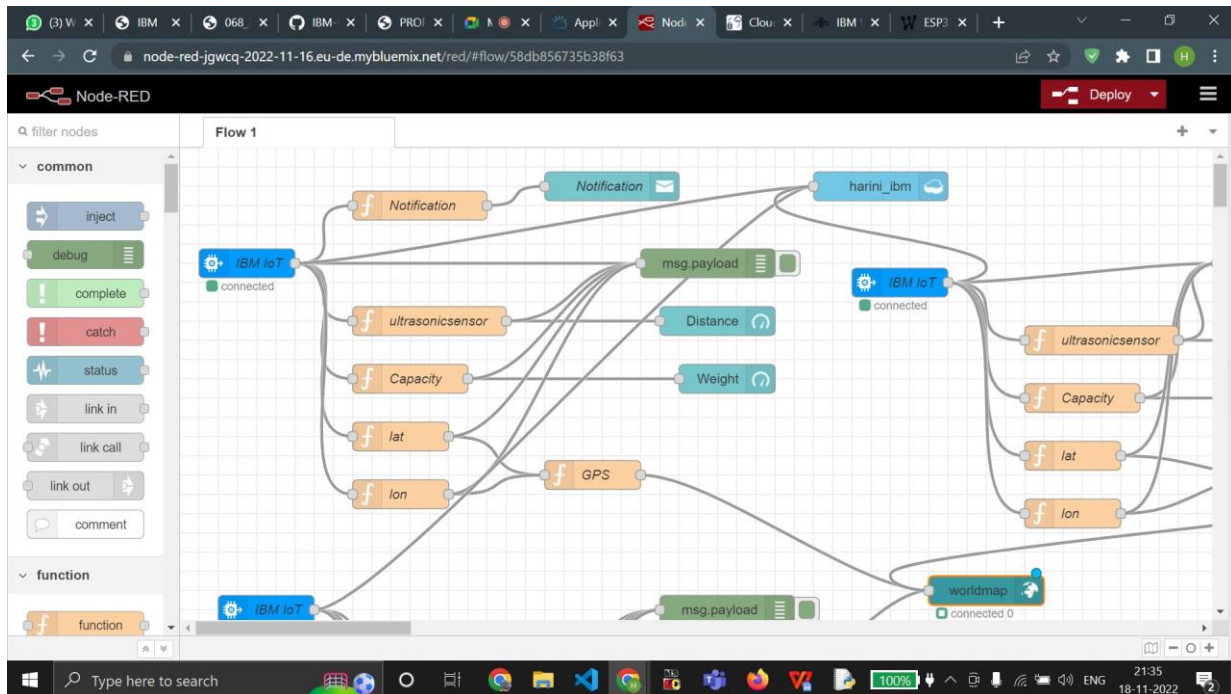
METADATA INFO:



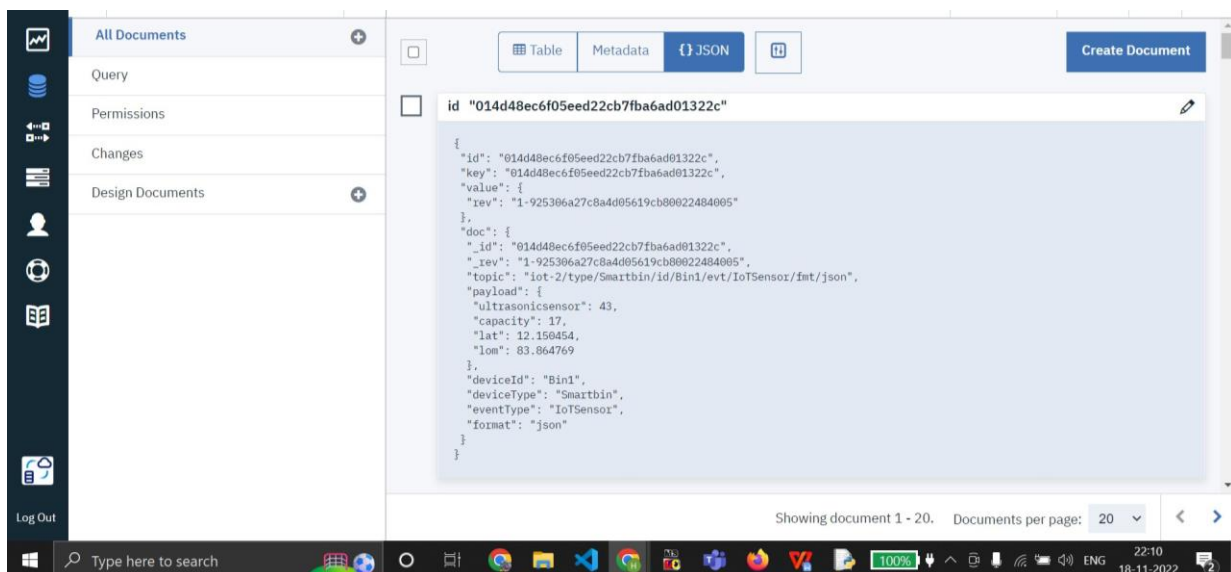
The screenshot shows a document editor interface. At the top, there are buttons for 'Save Changes', 'Cancel', 'Upload Attachment', 'Clone Document', and 'Delete'. The main area displays a JSON payload for a document. The payload includes fields for '_id', '_rev', 'topic', 'payload' (with sensor data), 'deviceId', 'deviceType', 'eventType', and 'format'.

```
1 {
2   "_id": "014d48ec6f05eed22cb7fba6ad01322c",
3   "_rev": "1-925306a27c8a4d05619cb80022484005",
4   "topic": "iot-2/type/Smartbin/id/Bin1/evt/IoTSensor/fmt/json",
5   "payload": {
6     "ultrasonicsensor": 43,
7     "capacity": 17,
8     "lat": 12.150454,
9     "lon": 83.864769
10  },
11   "deviceId": "Bin1",
12   "deviceType": "Smartbin",
13   "eventType": "IoTSensor",
14   "format": "json"
15 }
```

CLOUDANT DIAGRAM:

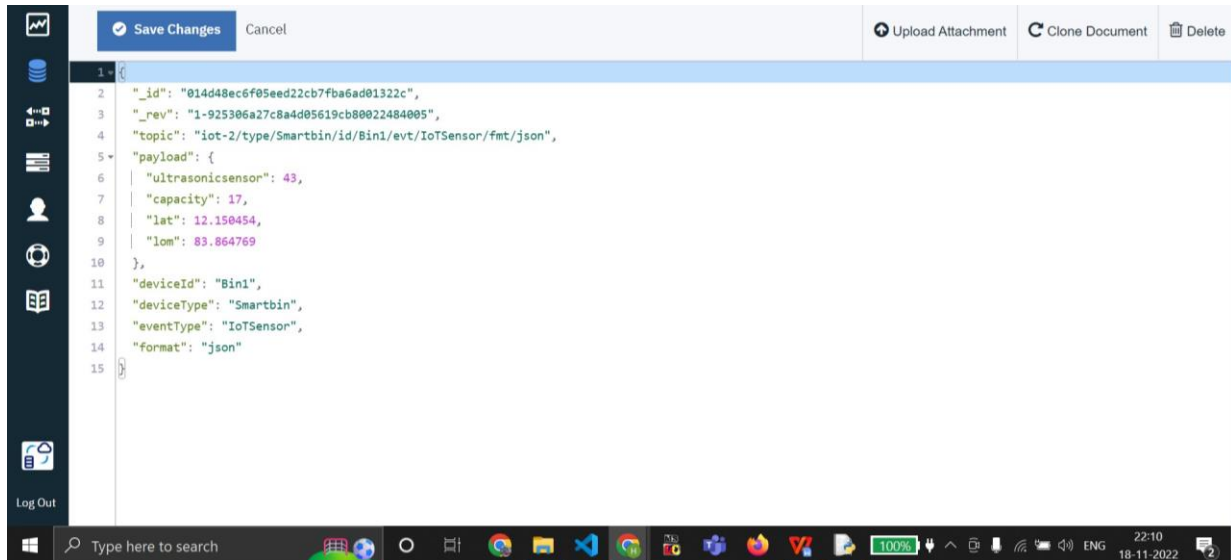


JSON CODE:



CLOUDANT DOCUMENT:

CHAPTER 8

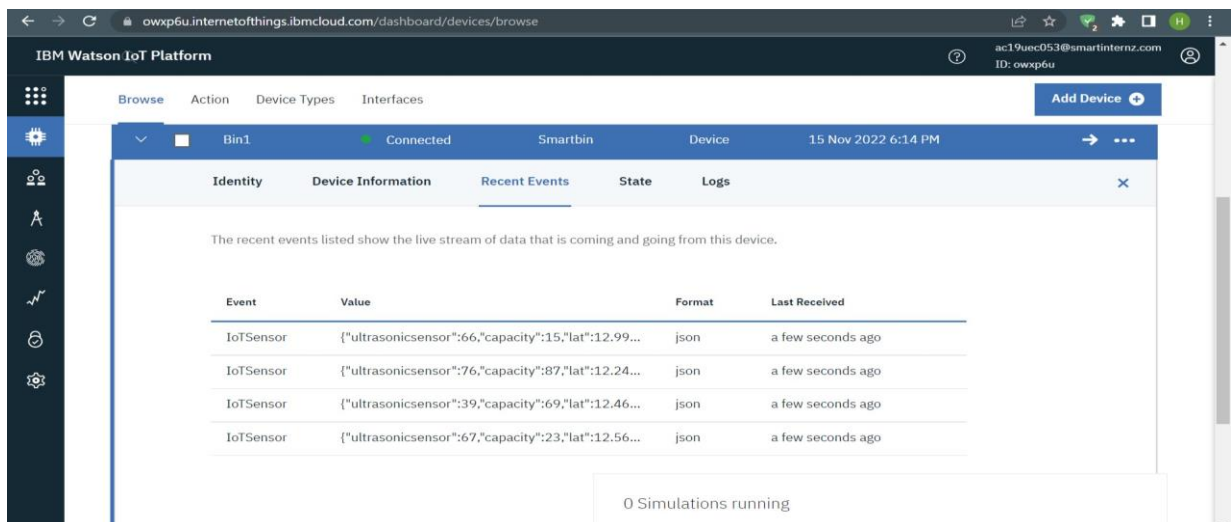


```
1 {
2   "_id": "014d48ec6f05eed22cb7fba6ad01322c",
3   "_rev": "1-925306a27c8a4d05619cb80022484005",
4   "topic": "iot-2/type/Smartbin/id/Bin1/evt/IoTSensor/fmt/json",
5   "payload": {
6     "ultrasonicsensor": 43,
7     "capacity": 17,
8     "lat": 12.150454,
9     "lon": 83.864769
10  },
11   "deviceId": "Bin1",
12   "deviceType": "Smartbin",
13   "eventType": "IoTSensor",
14   "format": "json"
15 }
```

TESTING

8.1 TEST CASES

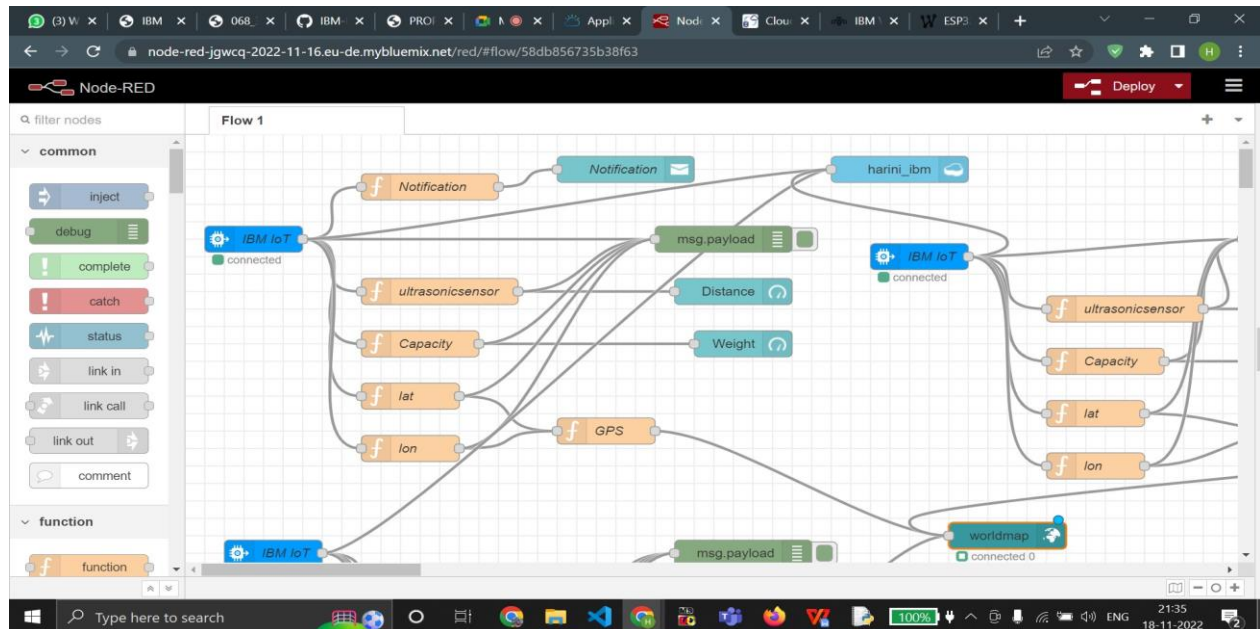
IBM WATSON output



Event	Value	Format	Last Received
IoTSensor	{"ultrasonicsensor":66,"capacity":15,"lat":12.99...	json	a few seconds ago
IoTSensor	{"ultrasonicsensor":76,"capacity":87,"lat":12.24...	json	a few seconds ago
IoTSensor	{"ultrasonicsensor":39,"capacity":69,"lat":12.46...	json	a few seconds ago
IoTSensor	{"ultrasonicsensor":67,"capacity":23,"lat":12.56...	json	a few seconds ago

0 Simulations running

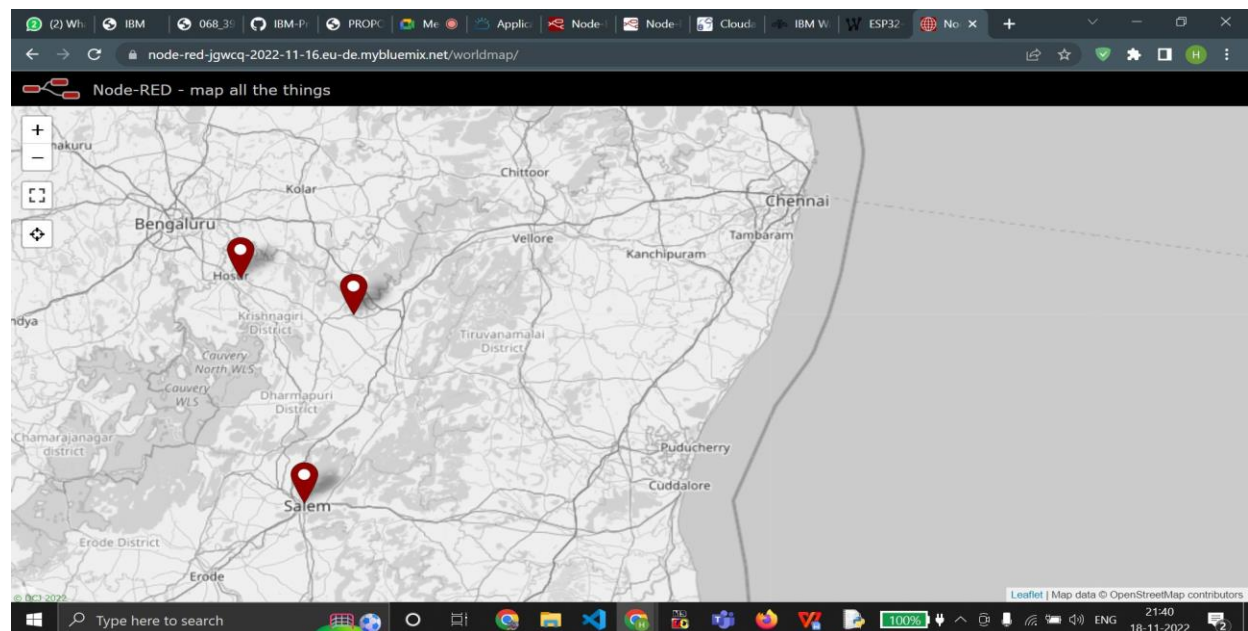
8.2 NODE RED:



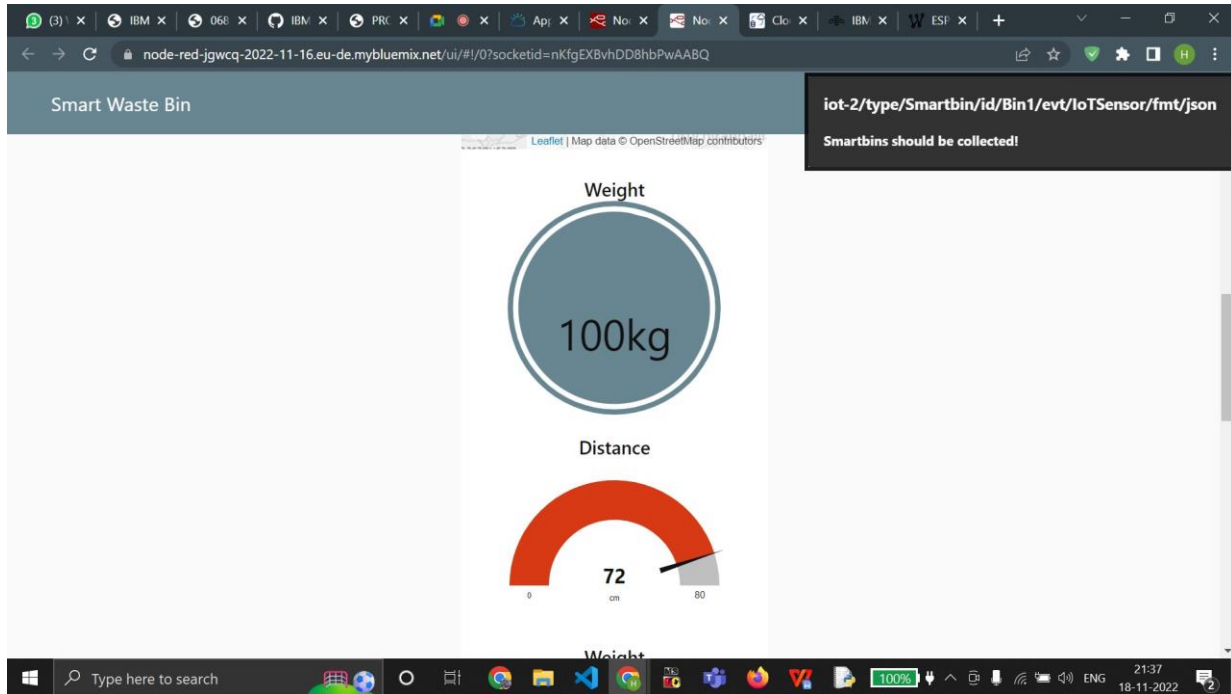
CHAPTER 9

RESULTS

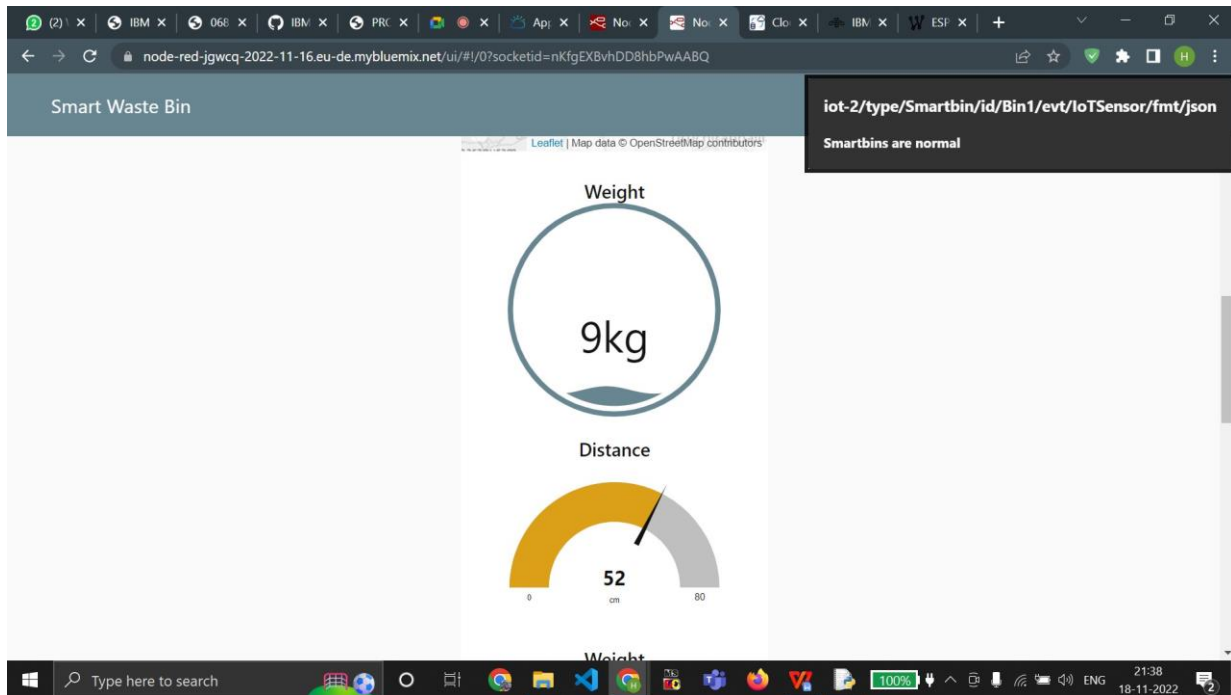
9.1WEB APP MAP



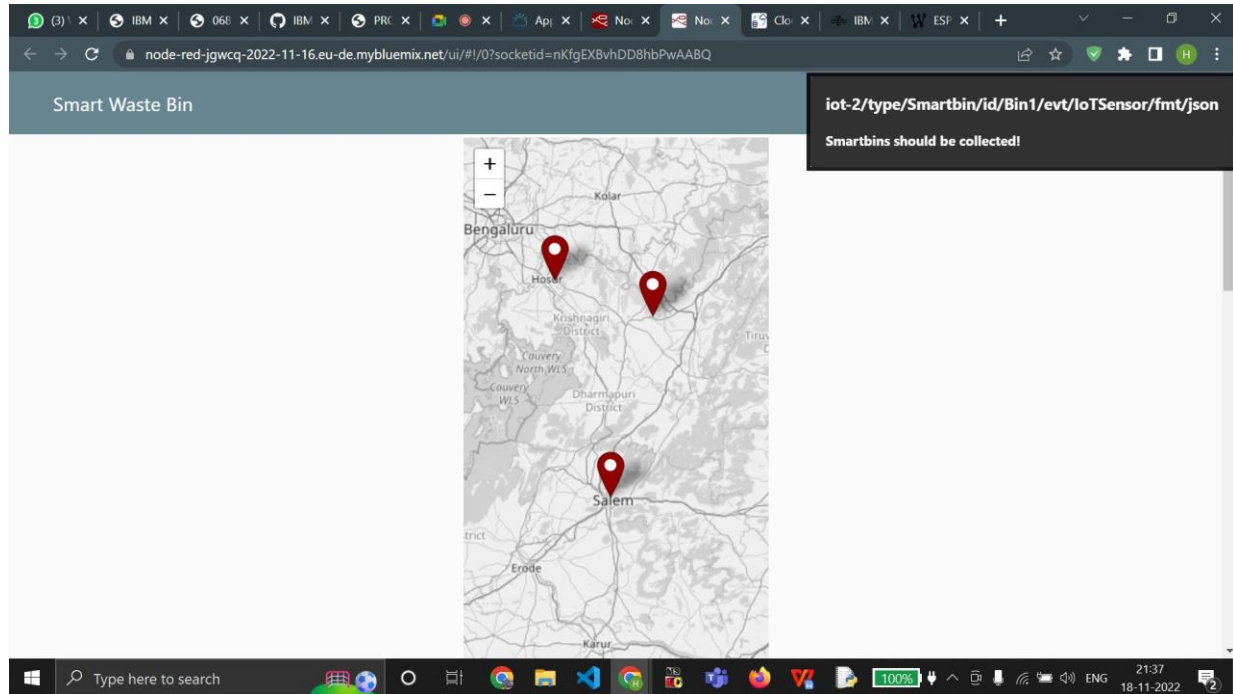
SMART BIN WHEN IT SHOULD BE COLLECTED:



SMART BIN WHEN IT IS NORMAL:



SMART BIN LOCATION:



10. ADVANTAGES AND DISADVANTAGES

Advantages of Smart Waste Management

Following are the benefits or advantages of Smart Waste Management:

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

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

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

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

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

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

Disadvantages of Smart Waste Management

Following are the drawbacks or disadvantages of Smart Waste Management:

System requires more number of waste bins for separate waste collection as per population in the city. This results into high initial cost due to expensive smart dustbins compare to other methods.

Sensor nodes used in the dustbins have limited memory size.

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

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

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

11. CONCLUSION

The cloud based system for waste collection in smart cities.

The development system provides improved database for garbage collection time and quantity of garbage collection at each location.

By implementing this project, we will avoid overflowing of garbage from the container in residential area which is previously either loaded manually or with the help of loaders in traditional trucks.

Development of application for city administration municipality staff.

12. FUTURE SCOPE

Future of Solid Waste Disposal & Management in India

With increasing population, urbanization and expanding economic activities, Solid waste disposal and management is a challenge in India. Here are some statistics which shows the solid waste management issues in India:-

According to the Central Pollution Control Board of India, the per capita generation of waste has increased from 0.26 kg/day to 0.85 kg/day. Close to 90% of waste is disposed of without proper treatment causing environmental pollution.

Total of approximately 143,449 MT of municipal waste is generated daily. However, only 35,062 tons of waste is treated.

13. APPENDIX

SOURCE CODE:

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

#Provide your IBM Watson Device Credentials
organization = "owxp6u"
deviceType = "Smartbin"
deviceId = "Bin1"
authMethod = "token"
authToken= "12345678910"

# Initialize GPIO
def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status=="lighton":
        print ("led is on")
    else :
        print ("led is off")
try:
    deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod,
"auth-token": authToken}
    deviceCli = ibmiotf.device.Client(deviceOptions)
    #.....
except Exception as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting"
10 times
deviceCli.connect()

while True:
    #Get Sensor Data from DHT11
    time.sleep(5)
    ultrasensor=random.randint(0,80)
```

```

capacity=random.randint(0,100)
lat=round(random.uniform(12.03,13.05),6)
lon=round(random.uniform(80.80,85.90),6)
data = { 'ultrasonicsensor' : ultrasensor, 'capacity': capacity, 'lat':lat, 'lon':lon}
#print data
def myOnPublishCallback():
    print ("Published ultrasonicsensor = %s Cm" % ultrasensor, "capacity= %s kg" %
capacity,"lat:%s"%lat,"lon:%s"%lon)

    success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
on_publish=myOnPublishCallback)
    if not success:
        print("Not connected to IoT")
    time.sleep(1)
    deviceCli.commandCallback = myCommandCallback

# Disconnect the device and application from the cloud
deviceCli.disconnect()

```

GITHUB LINK:

<https://github.com/IBM-EPBL/IBM-Project-54993-1663328851>