PROJECT REPORT

1. INTRODUCTION

1.1 Project Overview

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

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

OBJECTIVES

The key research objectives are as follows:

The proposed system would be able to automate the solid waste monitoring process and management of the overall collection process using IOT (Internet of Things).

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

In the proposed system, whenever the waste bin gets filled this is acknowledged by placing the circuit at the waste bin, which transmits it to the receiver at the desired place in the area or spot.

In the proposed system, the received signal indicates tmonitoring and controlling system.

1.2 Purpose

Gain knowledge of Watson IOT Platform.

Connecting IOT devices to the Watson IOT platform and exchanging the sensor data.

Gain knowledge on cloudant DB.

Gain knowledge of geofence.

Creating a web Application through which the user interacts with the device.

2.LITERATURE SURVEY

2.1 Excisting Problem

There are significant safety challenges facing the waste/recycling industry. They include chemical exposure, combustible dust explosions, machine guarding hazards, and exposure to powerful equipmentwith moving parts.

2.2 Reference

a. Ackerman, F., 2000: Waste Management and Climate Change. Local Environment,5(2), pp. 223-229.

b. Austrian Federal Government, 2001: Third National Climate Report of the Austrian Federal Government. Vienna, Austria.

c. Barlaz, M., 1998: Carbon storage during biodegradation of municipal solid waste components in laboratory-scale landfills. Global Biogeochemical Cycles, 12(2), pp. 373-380.

d. Barlaz, M., R. Green, J. Chanton, R.D. Goldsmith, and G. Hater, 2004: Evaluation of a biologically-active cover for mitigation of landfill gas emissions. Environmental Science and Technology, 38(18), pp. 4891-4899.

e. Bates, J. and A. Haworth, 2001: Economic evaluation of emission reductions of methane in the waste sector in the EU: Bottom-up analysis. Final Report to DG Environment, European Commission by Ecofys Energy and Environment, by AEA Technology Environment and National Technical University of Athens as part of Economic Evaluation of Sectoral Emission Reduction Objective for Climate Change, 73 pp.

f. Beck-Friis, B.G. 2001: Emissions of ammonia, N_2O, and CH_4 during composting of

organic household waste. PhD Thesis, Swedish University of Agricultural Sciences, Uppsala, 331 pp.

2.3 Problem Statement Document

Ram is a Doctor.Who has the problem that his area is fully dumpedwith waste especially near his house.Who needs to lead ahealthylife, because he doesn't want that to affect him or his family.

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, butin some countries especially the developing ones the carelessattitude of peopletowards maintaining clean surroundings, along with this many issues such as no stringent laws for using the biodegradable materials, no proper environpolicies, 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 impacton the health and environment.

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

The waste is a great hassle for our health and the environment it has many effects which are dreadful. Trash is breeding ground for bacteria, insects, flies these flies are the same that roam aroundthe eatable and drop the off springs.thus they increasethe risk with food poisoning,

typhoid,gastroentetritis, salmonella, the insects cause malaria dengue etc, beside these flies and insects other animals that prosper from the trash are the rats and thestray dogs spreadingdiseases.

Today big cities around the world are facing a common problem, problem,managing the city waste effectively without making city unclean. Today'swaste management systems involve a large number of employees being appointed to attend a certain number of waste bins this is done every day periodically. This leads to a veryinefficient and uncleansystem in which some wastebinswill be overflowing some wastebins might not be even half full. This is caused by variation in population density in the city or some other random factor this makes it impossible to determine whichpart needs immediate attention. Here a waste management system is introduced in which each wastebins is embedded in a monitoring system that will notify the corresponding personalif the wastebins is full.

This smart garbage dustbin is a very innovative system which will help to keep the cities clean. This system monitorsthe garbage bins and informsabout the level of garbagecollected in the garbage bins. For this the system uses ultrasonic sensors placed over the bins to detect the garbage level and compareit with the garbage bins depth. The overflowing of the garbage bins is very common in many cities, but this will impact our society and our surroundings. It will damagethe environment day by day to cause the manytypes of pollution along with to create many diseases for human and other animals also. We proposed smart dustbin system which will monitor and alert when the garbage level crossesthe threshold level of the garbage bin. This processwill be carried out with the help of sensors. Now days in most cities there are many dustbins which are in bad conditions. The garbage in a dustbin are all overflowed of the dustbin. Many people are throwing garbage on that dustbin which are already full or overflowed. Due to this unclean of garbage bins pollution is increases which are bad for the environment. This creates a very bad look of the city which is a way to support to the air pollution and to some harmful diseases which are easily spreadable. For this we have to develop an automatic dustbinwhich will detectthe garbage is dry or wet then separate the garbage and informs aboutthe level of garbage collected in the garbage bin to a person in the garbage collecting vehicle and by

using vendingmachine coins comes out the smart dustbin.This system helps to cityclean and green.

The idea of smart garbage bins and systemshave been in discussion for quite a long time. The technologies used at disposal to develop this smart system have also evolved, Internet of Things (IoT). Each idea seems to be similar but is slightly different at its core and our proposed work is no exception from the same.After the IoT field,finding its hold in our lives, this is our original plan for designing a smart garbagecollection system whichhas provision for citizen participation and analysis of data for better decision making. At hardware level,the smart systemis a garbage bin with ultrasonic sensor,a micro-controller and Wi-Fi module for transmission of data.

The worldwideimplementation of Internet of Things is possible with a Cloudcentric vision.This work exploits the future possibilities, key technologies and application that are likely to drive IoT research. But a strong foundation to our work is provided, where the basics and applications of Arduino board is explained. It is quite interesting as it implements a GAYT (Get As You Throw) systemconcept as a way to encourage recycling among citizens. As we would discuss further, the citizen participation part of our system is quite influenced by their work.

Although there are many research work on smart bins and intelligent waste management systems, here we have critically analyzed and summarized around twenty research works and projects addressing this issue. It is observed that most the the recent works uses Arduino Uno as their platform. Most of the works have the same working principle that their system based on IoT monitors the level of waste in the dustbin using the ultrasonic sensors installed in it. The sensed information is transmitted through RF signals to the PIC controller which in turn forwards the data to the centralserver. The data recorded can be checkedon the webpage in the receiver's LCD that is connected to the server.For waste collection when the waste level in the dustbin gets beyond the limit buzzer alarm is used. With this the authority gets aware and the message is sent to the driver of the dump truck and the further actions are taken. The entire system is cost effectiveas less number of equipment and resources are required. In other applications, loT based

sensor system is applied to detect the volume of trash. The GPS (GlobalPositioning system) system is used to identifythe location of these smartbins. This location information is communicated to the waste management department through GSM (Global System for Mobile Communications) on smartphones. Using the Google Maps the locationof the dustbin can be found.We have designed this kit to convert the normal dust hins to smart dust bin. It is implemented with real time systems to monitor the fill level and weight of the smart dustbins whether it is full or not. In this system the information of all smart dustbins can be accessed from anywhere and at any time by the authorized person he/she can take a decision accordingly.By implementing this proposed system, the cost reduction, resource optimization, effective usage of smart dust bins can be done. This system indirectly reducing traffic in the city. In major cities,the garbage collection vehicle has to visit the area everydaytwice or thrice depends on the population of the particular area and sometimes these dustbins may not be full.

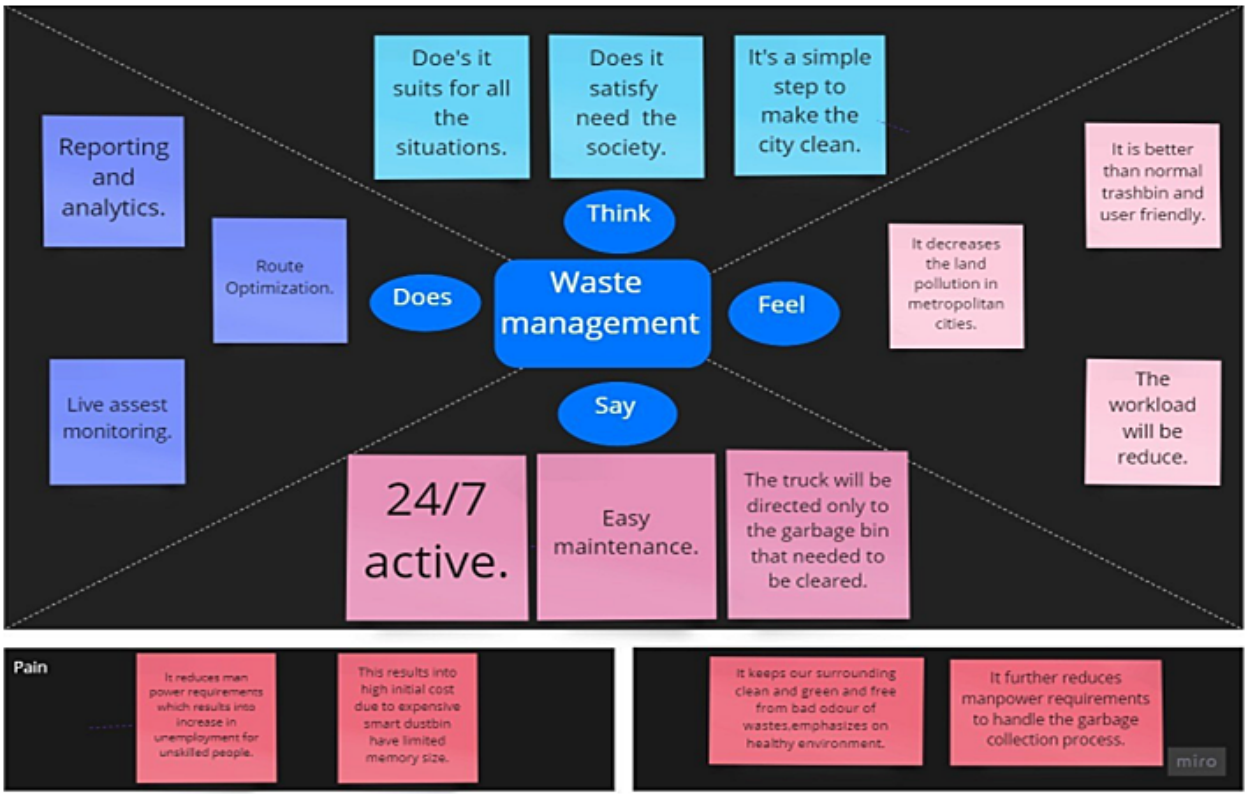
Our system will inform the status of each and every dustbin in real time so that the concern authoritycan send the garbage collection vehicle only when the dustbinis full.

This assures the collection of garbage soon when the garbage level reaches its maximum level. The system will thus provide accurate reports, increasing the efficiency of the system. The real-time monitoring of the garbage level with the help of sensors andwireless communication will reduce the total number of trips required of GCV and thus,will reducethe total expenditure associated with the garbage collection. Thus, the dustbinswill be cleared as and when filled, giving way to cleaner city, better infrastructure and increased hygiene.

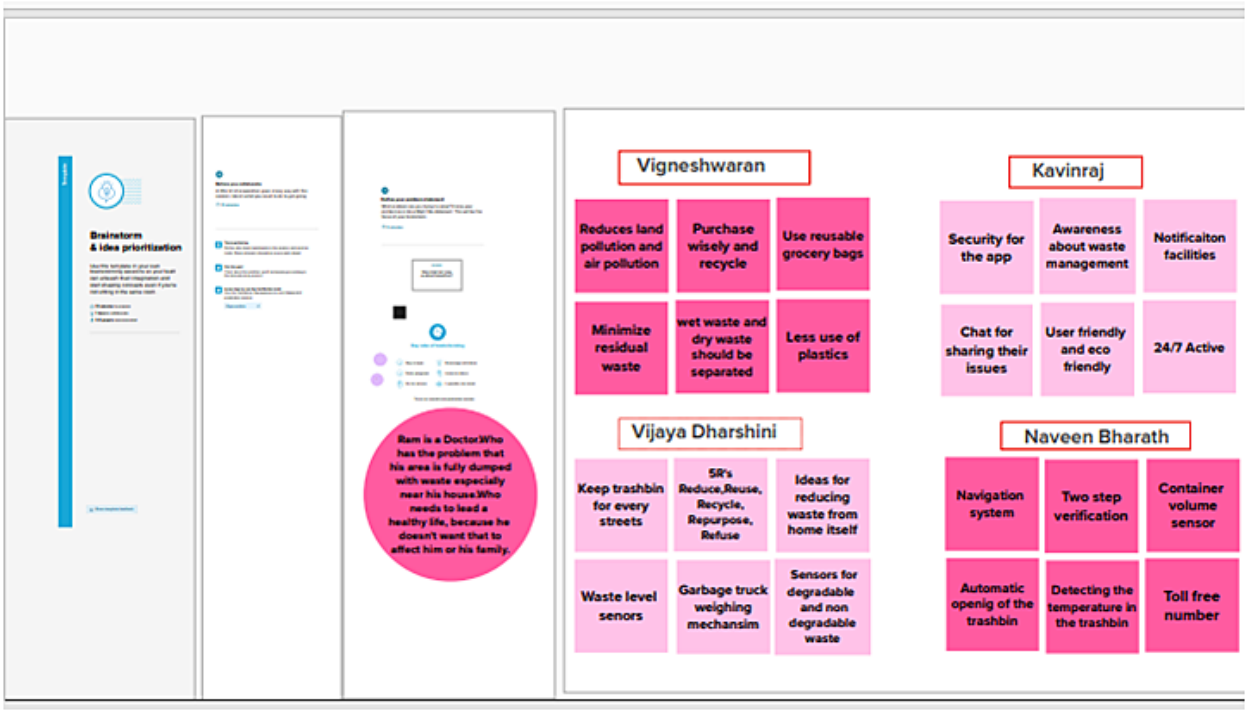
Clean Earth, GreenEarth

3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation and Brainstorming

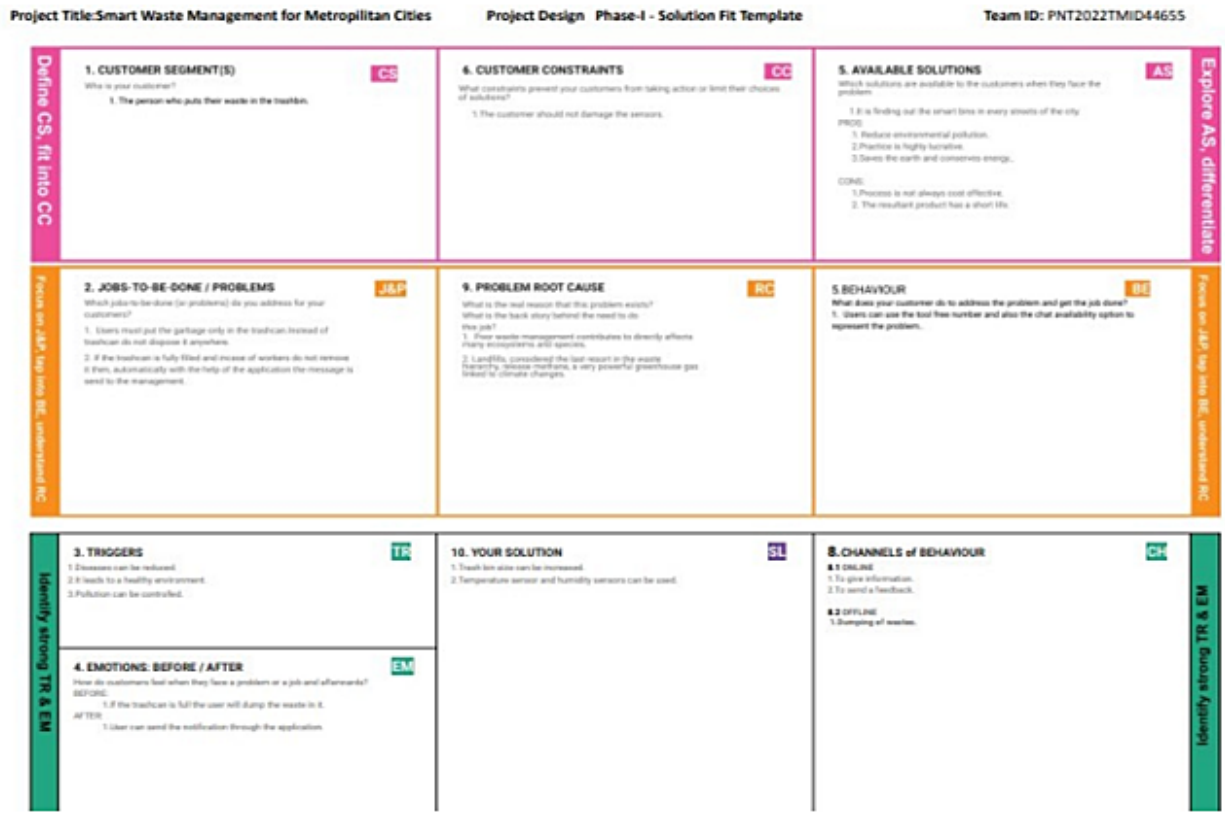


3.3 Proposed Solution

SI.No.	Parameter	Description
1.	Problem Statement (Problem to besolved)	Due to lack of proper systems for disposal and collections,wastes and garbage's end up in the roads and surroundings.With the existing methods of collecting and disposal it is near impossible to manage such amount of waste in the futureas around 30% of waste end up on the roads and public places due to ineffective disposing and collecting methods.In addition, to motivate and influence peopleto follow properwaste disposal methods.
2.	Idea / Solution description	Design a smart waste collection system that allows people to segregate the various types of solid waste they want to dispose and the municipal authorities to efficiently collect thesame.
3.	Novelty / Uniqueness	Fixing sensors for noticing temperature andhumidity of the trashcan.
4. .	Social Impact / CustomerSatisfaction	The fusion sensors, identification technology, and interact connectivity will lead to auniquely smartdisposal trash bin.
5.	Business Model(Revenue Model)	Waste management generates revenue throughthe provision of various wastemanagement and disposal services and recycling solutions, to residential, commercial, industrial, andmunicipal clients. The company derives its revenue in the formof various fees associated with its service offerings.

6.	Scalability of the Solution	By using this method the collection of waste in the city becomes more easier.It helps in reducing air pollution, trafficflow, man power, time and money.This project can add an edge to the cities aimingto get smart and people-friendly.

3.4 Problem Solution Fit



4.REQUIREMENT ANALYSIS

4.1 Functional Requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Detailed bininventory.	All monitored bins and stands can be seen on the map, and you can visit them at any time via the Street View feature from Google. Bins or stands are visible on the map as green, orange or red circles. You can see bin details in the Dashboard – capacity, waste type, last measurement, GPS location and collection schedule or pickrecognition.
FR-2	Real timebin monitoring.	The Dashboard displays real-time data on fill-levels of bins monitored by smart sensors. In addition to the % of fill-level, based on the historical data, the tool predicts when the bin will become full, one of the functionalities thatare not included even in the best wastemanagement software.. Sensors recognize picks as well; so you can check when the bin was last collected. With real-time data and predictions, you can eliminate the overflowing bins and stopcollecting half-empty ones.
FR-3	Expensive bins.	We help you identify bins that drive up your collection costs. The tool calculates a rating for each bin in terms of collection costs.The tool considers the average distance depo-bindischarge in the area. The tool assigns bin a rating(1-10) and calculates distance from depo- bin discharge.

FR-4	Adjust bin distribution.	Ensure the most optimaldistribution of bins.Identify areas witheither dense or sparsebin distribution. Make sure all trash types are represented within a stand. Based on the historical data, you can adjust bincapacity or location wherenecessary.
FR-5	Eliminate unefficient picks.	Eliminate the collection of half-empty bins. The sensors recognize picks. By using real-time data on fill-levels and pick recognition, we can show you how full the bins you collect . The report shows how full the bin was when picked. You immediately see any inefficient picks below 80% full.
FR-6	Plan waste collection routes.	The tool semi-automates wastecollection route planning. Based on current bin fill-levels and predictions of reaching full capacity, you are ready to respond and schedule waste collection. You can compare plannedvs. executed routesto identify any inconsistencies.

4.2 Non-functional Requirements:

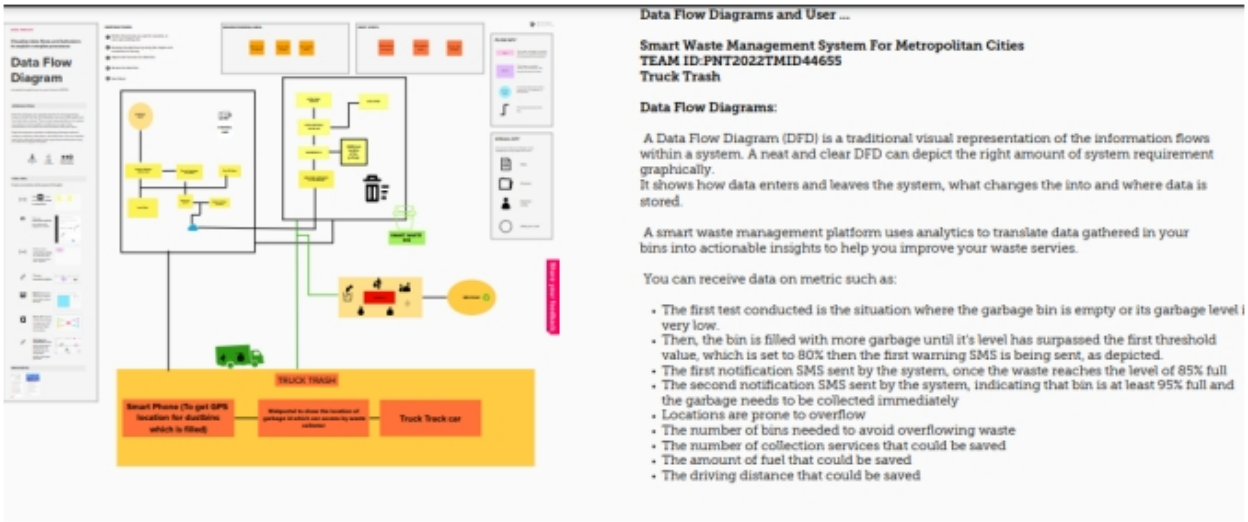
Following are the non-functional requirements of proposedsolution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	IoT deviceverifies that usability is a specialand important perspective to analyze user requirements, which can further improvethe design quality.In the design process with user experience as the core, the analysis of users' productusability can indeedhelp designers better understand users' potential needsin waste management, behavior and experience.
NFR-2	**Security**	Use a reusable bottles Use reusable grocery bags Purchase wiselyand recycle Avoid singleuse food and drink containers.
NFR-3	**Reliability**	Smart wastemanagement is alsoabout creating better working conditions for waste collectors and drivers. Insteadof driving the same collection routes and servicing empty bins, waste collectors will spend their time more efficiently, taking care of bins that need servicing.

NFR-4	**Performance**	The SmartSensors use ultrasound technology to measure the fill levels (along with other data) in bins several timesa day. Using a varietyof IoT networks ((NB-IoT,GPRS), the sensors send the data to Sensoneo's Smart Waste Management Software System, a powerful cloud-based platform, for datadriven daily operations, available also as a wastemanagement app. Customers are hence provided data-driven decision making, and optimization of waste collection routes,frequencies, and vehicleloads resulting in route reduction by atleast 30%.
NFR-5	**Availability**	By developing & deploying resilient hardware and beautiful software we empower cities, businesses, andcountries to managewaste smarter.
NFR-6	**Scalability**	Using smart waste bins reduce the number of binsinside town , cities coz we able to monitorthe garbage 24/7 more cost effect and scalability when we movesto smarter.

5.PROJECT DESIGN

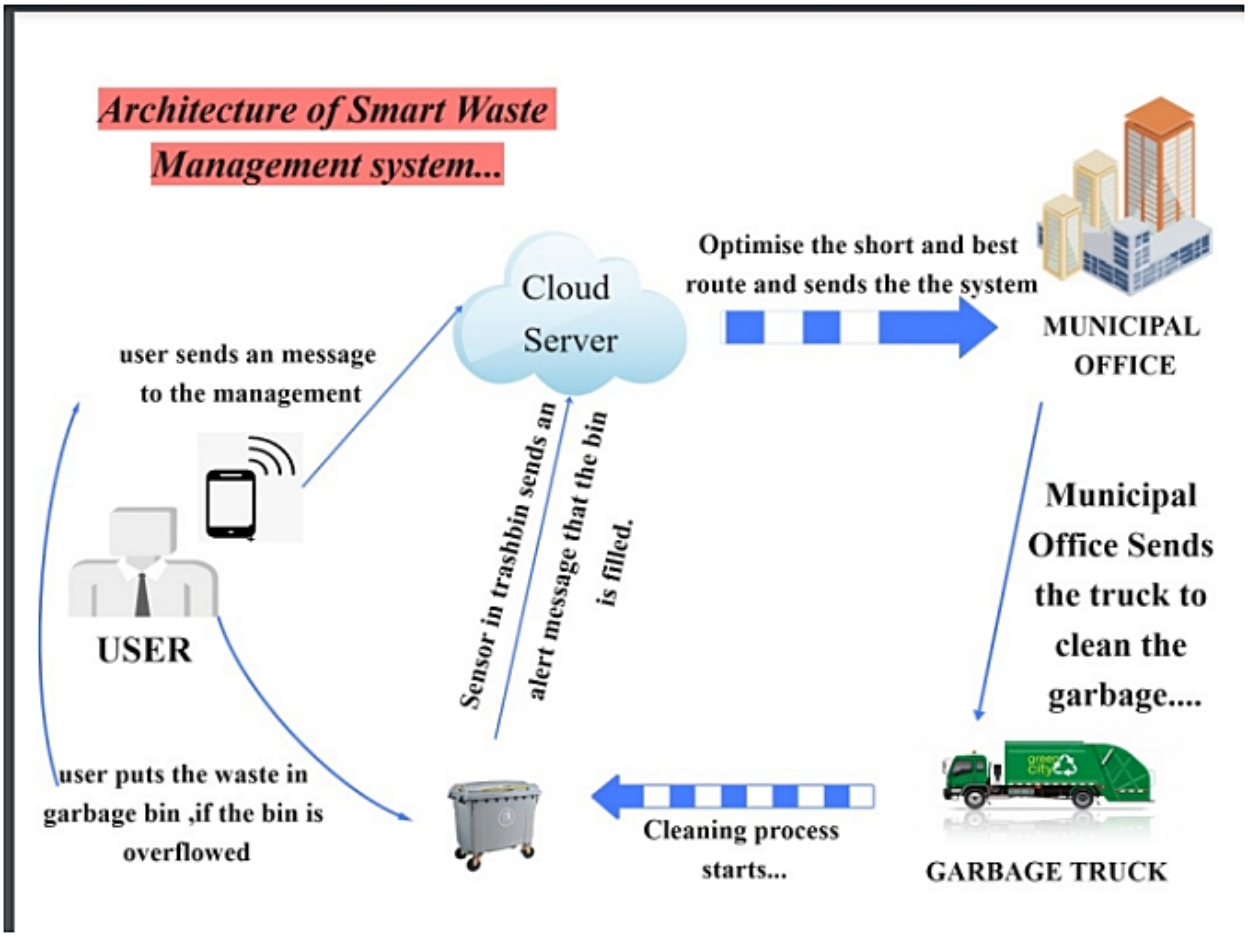
5.1 Data Flow Diagram



User Type	Functional Requirement (EPIC)	User Story Number	User Story / Task	Acceptance Criteria	priority	Release
Admin(who manage web server)	Login	USN-1	As an Admin, i gave user id and passwords for ever workers and manage them.	I an manage web account/ dashboard	Medium	Sprint-2
Co Admin	Login	USN-1	As a Co Admin, I'll manage garbage level monitor .if garbage get filling alert i will post location and garbage id to trash truck	I can manage garbage monitoring	High	Sprint-1
Truck Driver	Login	USN-3	As Truck Driver, I'll follow the route send by Co Admin to reach the filled garbage	I can drive to reach the garbage filled route in shortest route given	Medium	Sprint-2
Local Garbage Collator	Login	USN-4	As a Waste Collator, I'll collect all the trash from garbage and load into garbage truck and send them to landfill	I an collect trash and pulled to truk and send off	Medium	sprint-2

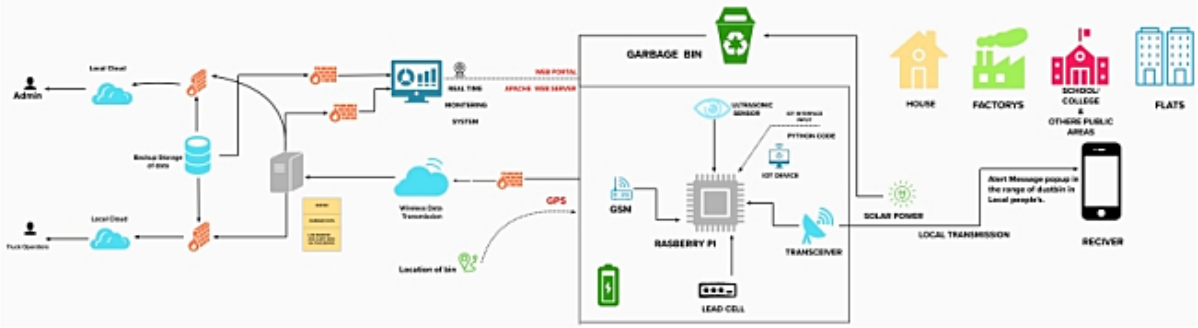
Munlipality	Login	USN-5	As a Municipality, I'll check the process are happening in discipline manner without any issues	I an manage all these process going good	HIGH	Sprint-1

5.2 Solution & Technical Architecture

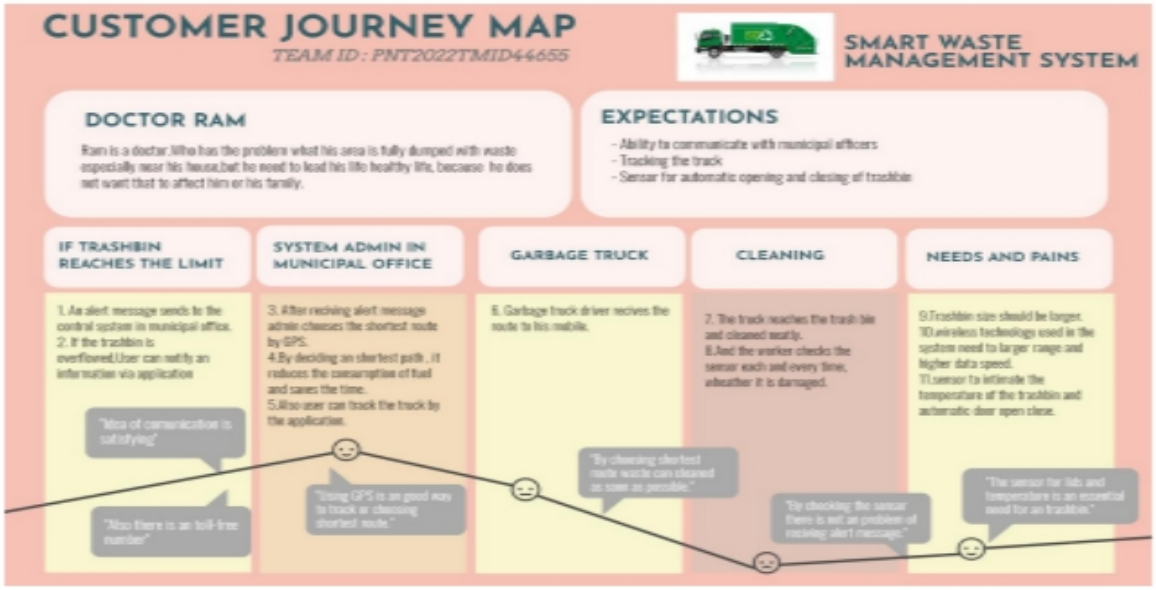


TECHNOLOGY ARCHITETURE OF SMART WASTE MANAGEMENT SYSTEM IN METROCITIES USING IOT ....

TEAM ID:PNT2022TMID44655



5.3 User Stories



6.PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

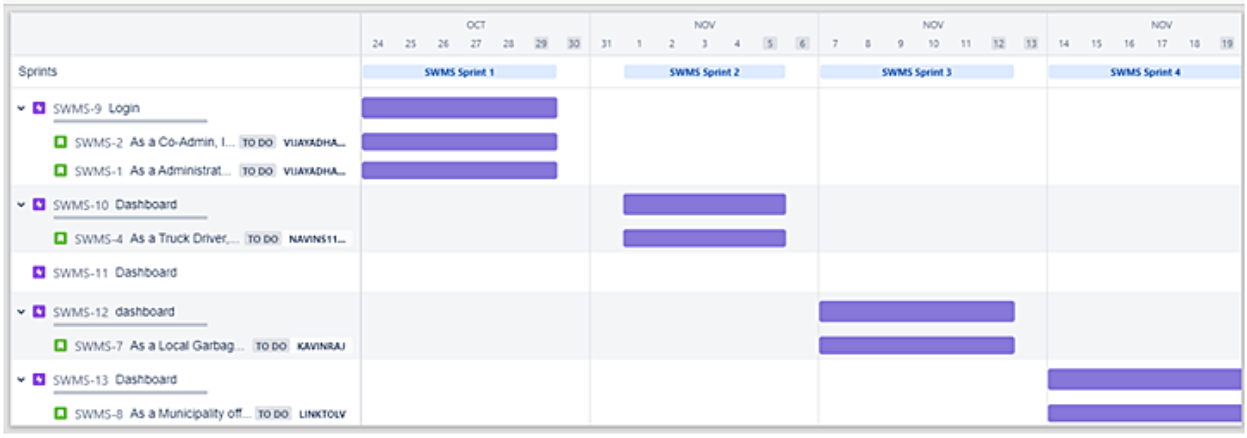
Use the below template to create product backlog and sprint schedule.

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As a Administrator, I need to give user id and passcode for every workers over there in municipality	10	High	Vijayadharshini
Sprint-1	Login	USN-2	As a Co-Admin, I'll control the waste level by monitoring them vai real time web portal. Once the filling happens, I'll notify trash truck with location of bin with bin ID	10	High	Vijayadharshini
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	Low	Naveen Bharath
Sprint-3	Dashboard	USN-4	As a Local Garbage Collector, I'II gather all the waste from the garbage, load it onto a garbage truck, and deliver it to Landfills	20	Medium	Kavinraj
Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	High	Vigneshwaran

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date(Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date(Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Oct 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Oct 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Oct 2022

6.3 Reports from JIRA

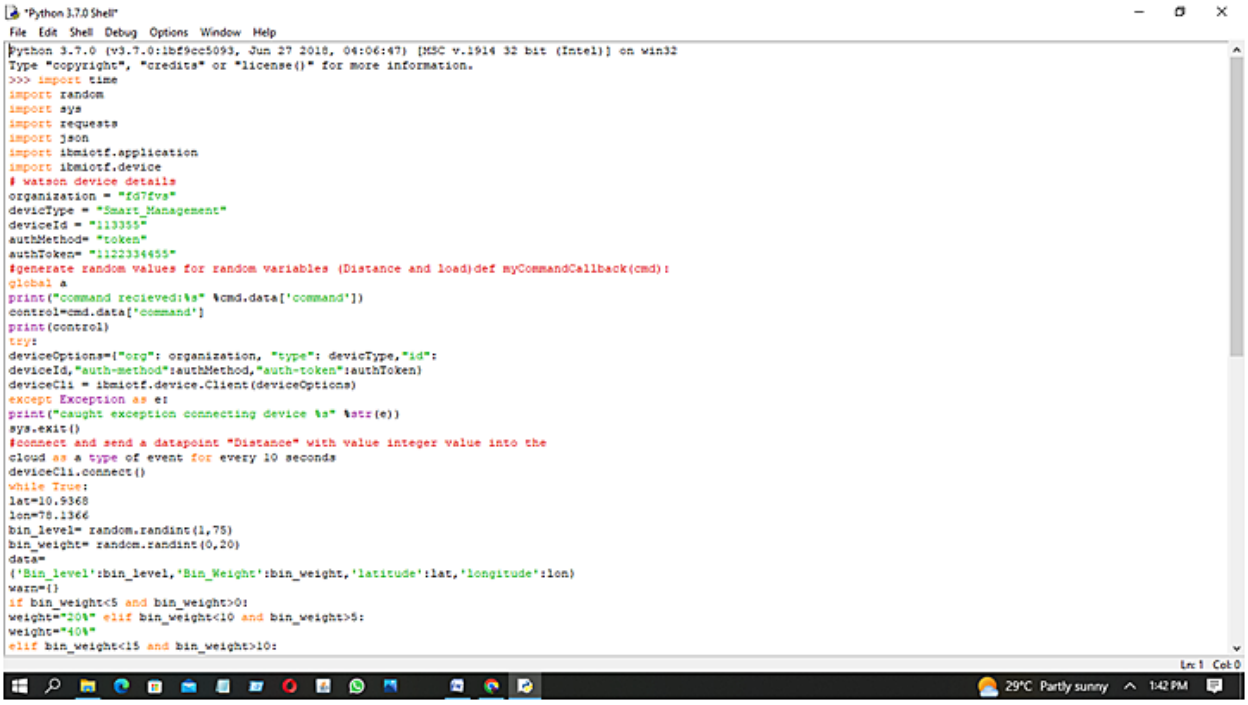


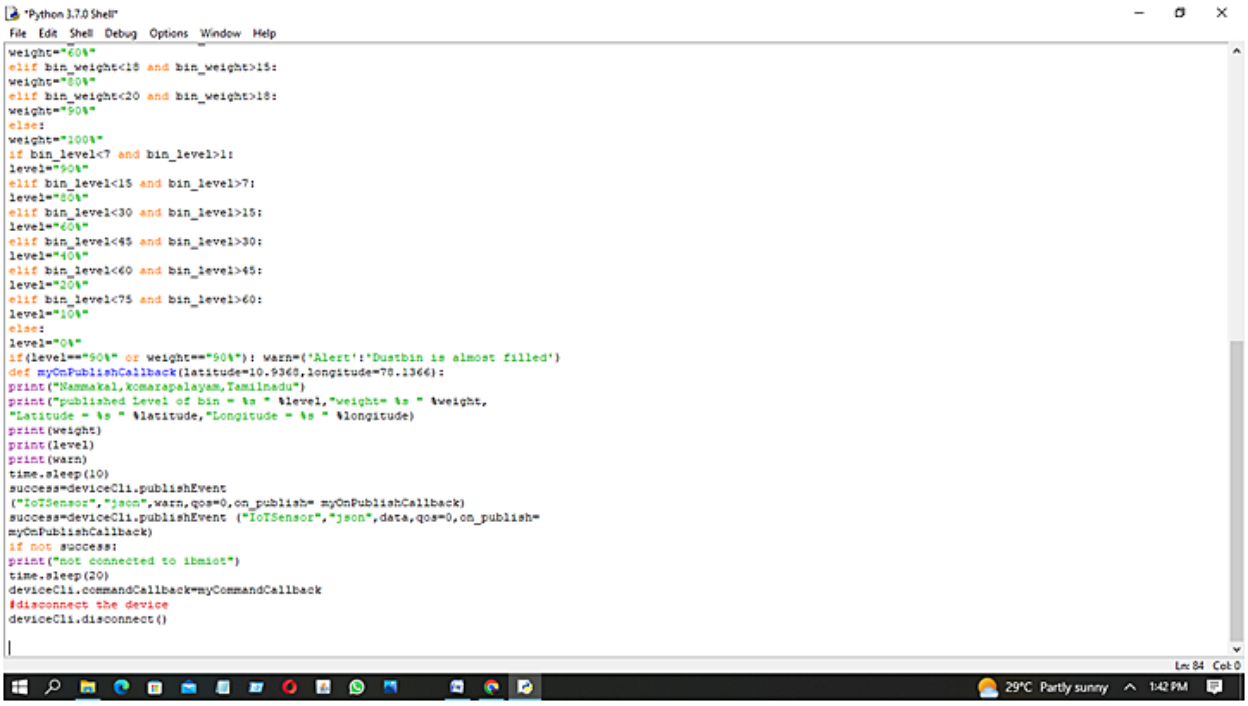
7.CODING & SOLUTIONING

(Explain the features added in the project along with code)

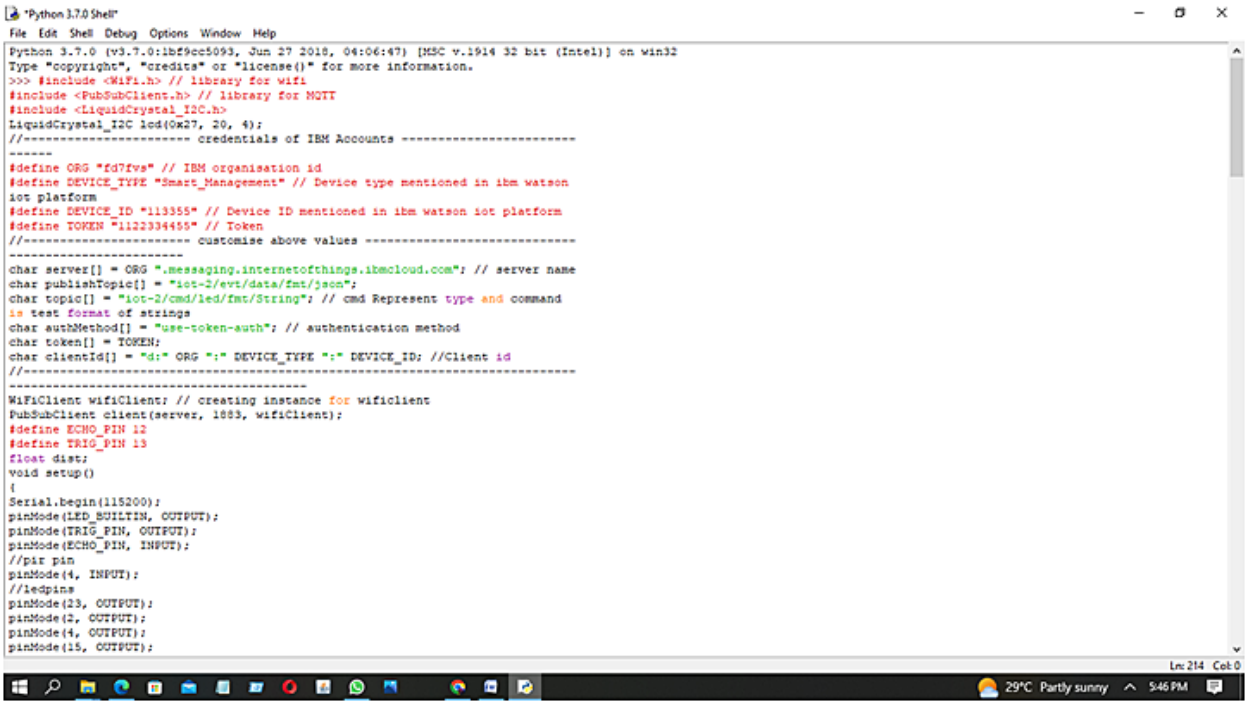
7.1 Feature 1

Python Script

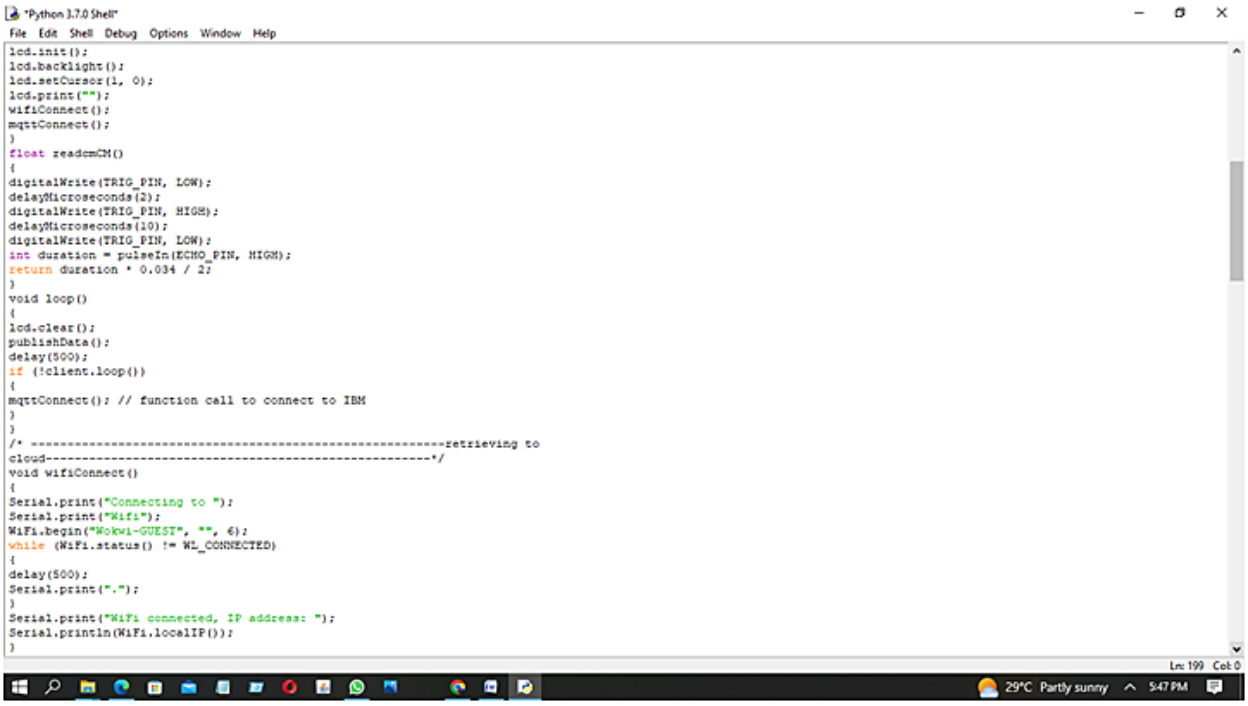


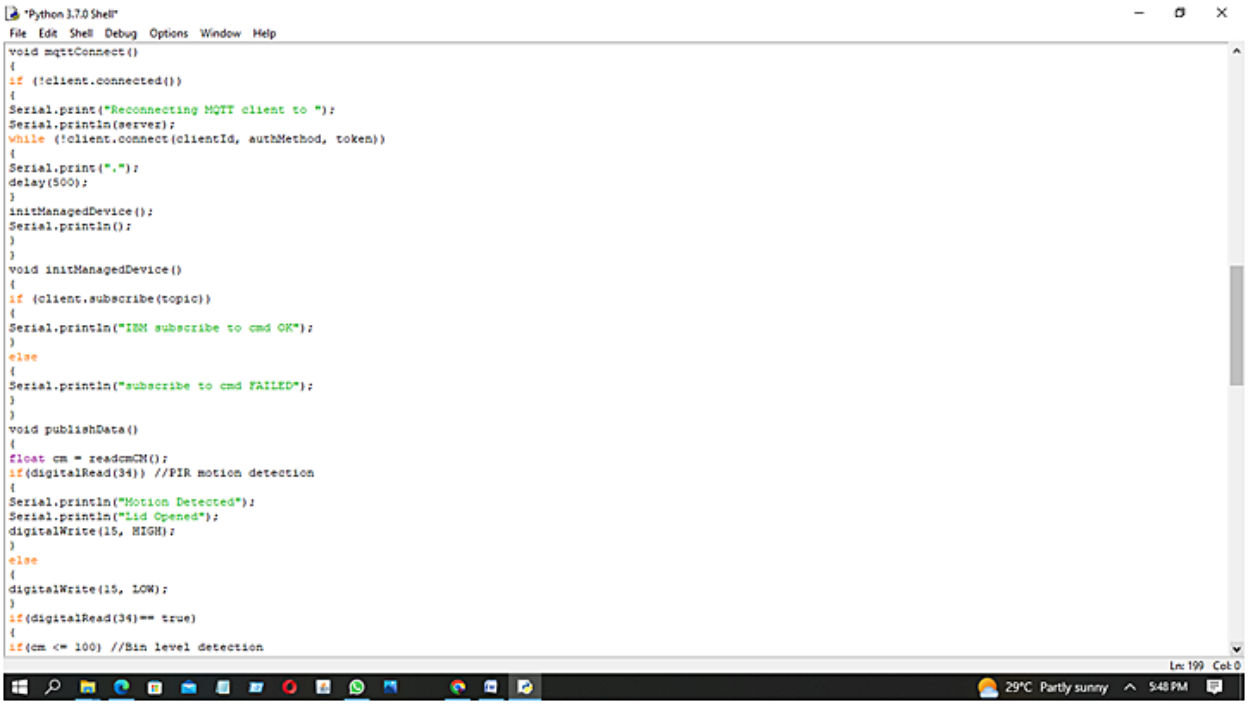

Python 3.7.0 Shell
File Edit Shell Debug Options Window Help
weight="60%"
elif bin_weight<18 and bin_weight>15:
weight="80%"
elif bin_weight<20 and bin_weight>18:
weight="90%"
else:
weight="100%"
if bin_level<7 and bin_level>1:
level="90%"
elif bin_level<15 and bin_level>7:
level="80%"
elif bin_level<30 and bin_level>15:
level="60%"
elif bin_level<45 and bin_level>30:
level="40%"
elif bin_level<60 and bin_level>45:
level="20%"
elif bin_level<75 and bin_level>60:
level="10%"
else:
level="0%"
if(level=="90%" or weight=="90%"): warn={'Alert':'Dustbin is almost filled'}
def myOnPublishCallback(latitude=10.9360,longitude=78.1366):
print("Nammakal,Komarapalayam,Tamilnadu")
print("published Level of bin = %s " %level,"weight= %s " %weight,
"Latitude = %s " %latitude,"Longitude = %s " %longitude)
print(weight)
print(level)
print(warn)
time.sleep(10)
success=deviceCli.publishEvent
("IoTSensor","json",warn,qos=0,on_publish= myOnPublishCallback)
success=deviceCli.publishEvent ("IoTSensor","json",data,qos=0,on_publish=
myOnPublishCallback)
if not success:
print("not connected to ibmiot")
time.sleep(20)
deviceCli.commandCallback=myCommandCallback
#disconnect the device
deviceCli.disconnect()
Ln: 84 Col: 0
29°C Partly sunny
1:42 PM

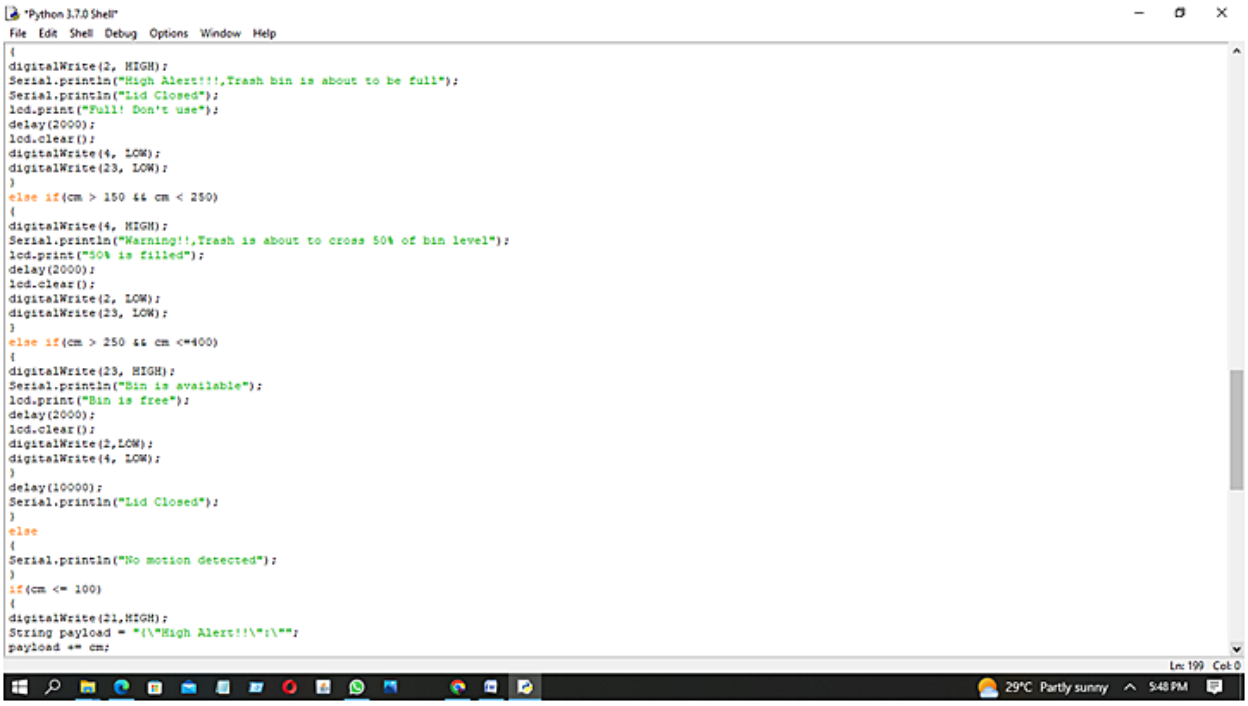
7.2 Feature 2

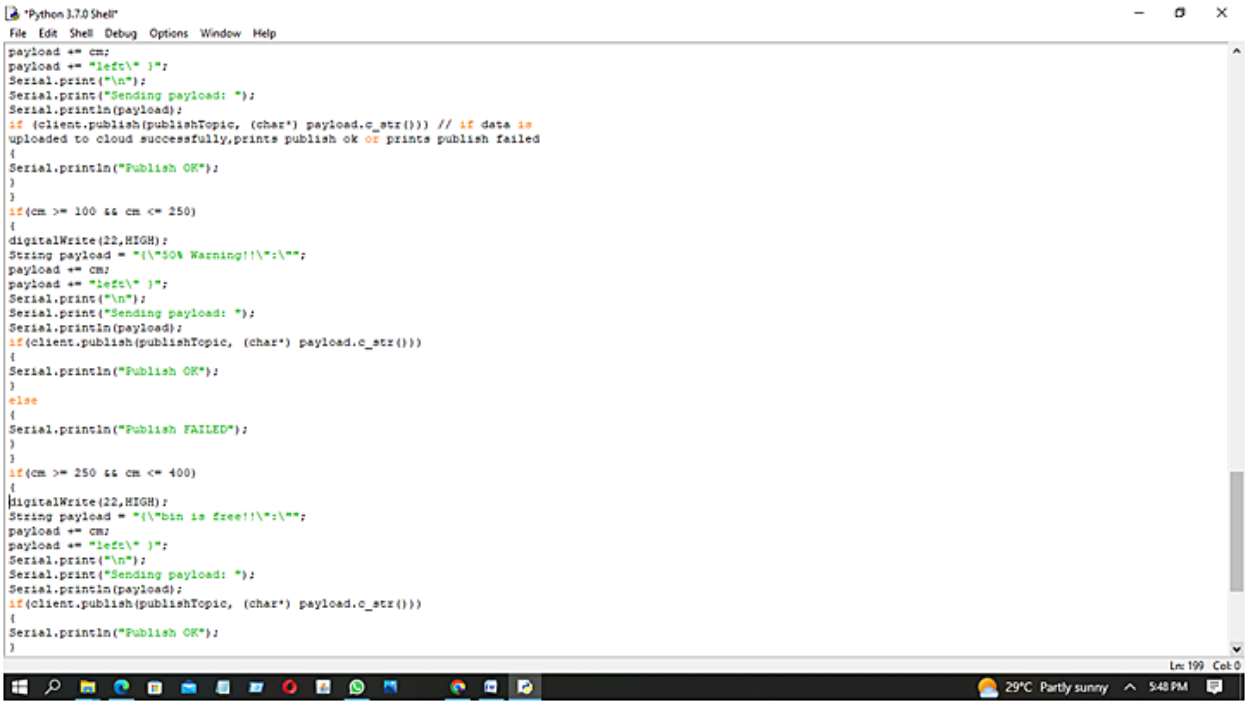

Python 3.7.0 Shell
File Edit Shell Debug Options Window Help
Python 3.7.0 (v3.7.0:1bf9cc5093, Jun 27 2018, 04:06:47) [MSC v.1914 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> #include <WiFi.h> // library for wifi
#include <PubSubClient.h> // library for MQTT
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 20, 4);
//---------------------- credentials of IBM Accounts ------------------------
------
#define ORG "fd7fvs" // IBM organisation id
#define DEVICE_TYPE "Smart_Management" // Device type mentioned in ibm watson
iot platform
#define DEVICE_ID "113355" // Device ID mentioned in ibm watson iot platform
#define TOKEN "1122334455" // Token
//---------------------- customise above values ----------------------------
----
char server[] = ORG ".messaging.internetofthings.ibmcloud.com"; // server name
char publishTopic[] = "iot-2/evt/data/fmt/json";
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
//---

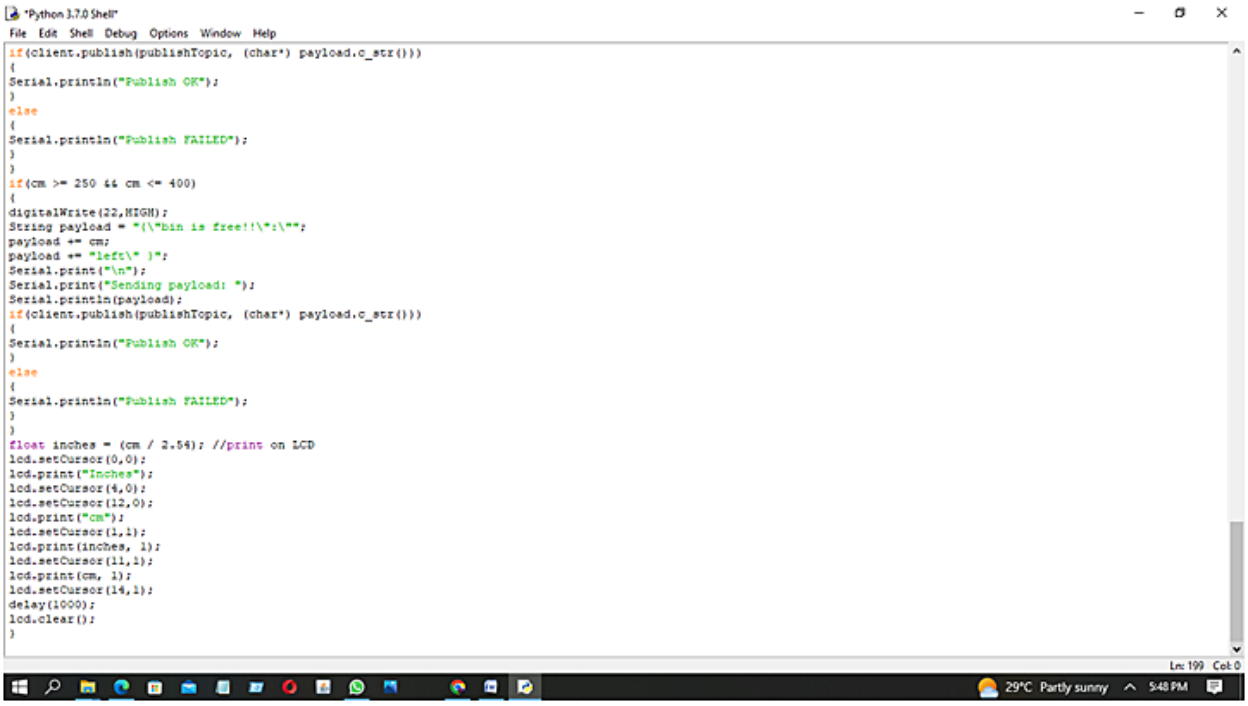
WiFiClient wifiClient; // creating instance for wificlient
PubSubClient client(server, 1883, wifiClient);
#define ECHO_PIN 12
#define TRIG_PIN 13
float dist;
void setup()
{
Serial.begin(115200);
pinMode(LED_BUILTIN, OUTPUT);
pinMode(TRIG_PIN, OUTPUT);
pinMode(ECHO_PIN, INPUT);
//pir pin
pinMode(4, INPUT);
//ledpins
pinMode(23, OUTPUT);
pinMode(2, OUTPUT);
pinMode(4, OUTPUT);
pinMode(15, OUTPUT);
Ln: 214 Col: 0
29°C Partly sunny
5:46 PM


Python 3.7.0 Shell
File Edit Shell Debug Options Window Help
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());
}
Ln: 199 Col: 0
29°C Partly sunny
5:47 PM


Python 3.7.0 Shell
File Edit Shell Debug Options Window Help
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);
}
else
{
digitalWrite(15, LOW);
}
if(digitalRead(34)== true)
{
if(cm <= 100) //Bin level detection
Ln: 199 Col: 0
29°C Partly sunny
5:48 PM

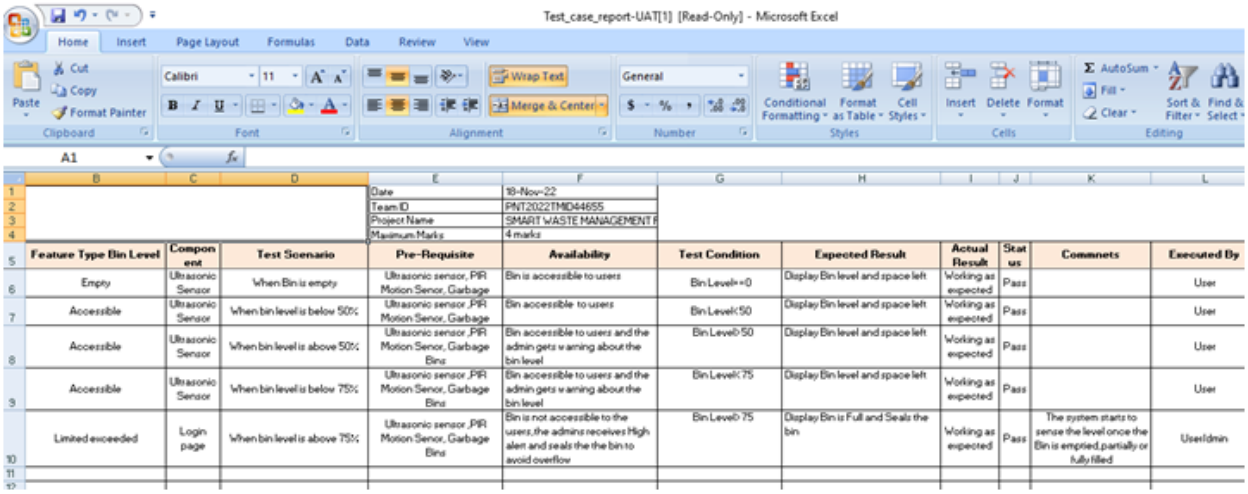

Python 3.7.0 Shell
File Edit Shell Debug Options Window Help
{
digitalWrite(2, HIGH);
Serial.println("High Alert!!!,Trash bin is about to be full");
Serial.println("Lid Closed");
lcd.print("Full! Don't use");
delay(2000);
lcd.clear();
digitalWrite(4, LOW);
digitalWrite(23, LOW);
}
else if(cm > 150 && cm < 250)
{
digitalWrite(4, HIGH);
Serial.println("Warning!!,Trash is about to cross 50% of bin level");
lcd.print("50% is filled");
delay(2000);
lcd.clear();
digitalWrite(2, LOW);
digitalWrite(23, LOW);
}
else if(cm > 250 && cm <=400)
{
digitalWrite(23, HIGH);
Serial.println("Bin is available");
lcd.print("Bin is free");
delay(2000);
lcd.clear();
digitalWrite(2,LOW);
digitalWrite(4, LOW);
}
delay(10000);
Serial.println("Lid Closed");
}
else
{
Serial.println("No motion detected");
}
if(cm <= 100)
{
digitalWrite(21,HIGH);
String payload = "{\"High Alert!!\":\"";
payload += cm;
Ln: 199 Col: 0
29°C Partly sunny
5:48 PM


Python 3.7.0 Shell
File Edit Shell Debug Options Window Help
payload += cm;
payload += "left\" }";
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 or prints publish failed
{
Serial.println("Publish OK");
}
}
if(cm >= 100 && cm <= 250)
{
digitalWrite(22,HIGH);
String payload = "{\"50% Warning!!\":\"";
payload += cm;
payload += "left\" }";
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");
}
}
if(cm >= 250 && cm <= 400)
{
digitalWrite(22,HIGH);
String payload = "{\"bin is free!!\":\"";
payload += cm;
payload += "left\" }";
Serial.print("\n");
Serial.print("Sending payload: ");
Serial.println(payload);
if(client.publish(publishTopic, (char*) payload.c_str()))
{
Serial.println("Publish OK");
}
Ln: 199 Col: 0
29°C Partly sunny
5:48 PM


Python 3.7.0 Shell
File Edit Shell Debug Options Window Help
if(client.publish(publishTopic, (char*) payload.c_str()))
{
Serial.println("Publish OK");
}
else
{
Serial.println("Publish FAILED");
}
}
if(cm >= 250 && cm <= 400)
{
digitalWrite(22,HIGH);
String payload = "{\"bin is free!!\":\"";
payload += cm;
payload += "left\" }";
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");
}
}
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();
}
Ln: 199 Col: 0
29°C Partly sunny
5:48 PM

8. TESTING

8.1 Test Case



				Date	18-Nov-22						
				Team ID	PNT2022TMID44655						
				Project Name	SMART WASTE MANAGEMENT F						
				Maximum Marks	4 marks						
Feature Type Bin Level	Component	Test Scenario	Pre-Requisite	Availability	Test Condition	Expected Result	Actual Result	Status	Commnets	Executed By	
Empty	Ultrasonic Sensor	When Bin is empty	Ultrasonic sensor, PIR Motion Senor, Garbage Bins	Bin is accessible to users	Bin Level=<0	Display Bin level and space left	Working as expected	Pass		User	
Accessible	Ultrasonic Sensor	When bin level is below 50%	Ultrasonic sensor, PIR Motion Senor, Garbage Bins	Bin accessible to users	Bin Level<50	Display Bin level and space left	Working as expected	Pass		User	
Accessible	Ultrasonic Sensor	When bin level is above 50%	Ultrasonic sensor, PIR Motion Senor, Garbage Bins	Bin accessible to users and the admin gets warning about the bin level	Bin Level>50	Display Bin level and space left	Working as expected	Pass		User	
Accessible	Ultrasonic Sensor	When bin level is below 75%	Ultrasonic sensor, PIR Motion Senor, Garbage Bins	Bin accessible to users and the admin gets warning about the bin level	Bin Level<75	Display Bin level and space left	Working as expected	Pass		User	
Limited exceeded	Login page	When bin level is above 75%	Ultrasonic sensor, PIR Motion Senor, Garbage Bins	Bin is not accessible to the users,the admins receives High alert and seals the the bin to avoid overflow	Bin Level> 75	Display 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 filled	User/Idmin	

8.2 User Acceptance Testing

Acceptance Testing
UAT Execution & Report Submission

Date	17 November 2022
Team ID	PNT2022TMID44655
Project Name	SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES - IOT

1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the [ProductName] 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	6	4	2	2	14
Duplicate	1	0	4	0	5
External	2	3	0	1	6
Fixed	5	2	6	8	21
Not Reproduced	0	0	2	0	2
Skipped	0	0	0	0	0
Won't Fix	0	0	0	0	0
Totals	11	1	6	7	25

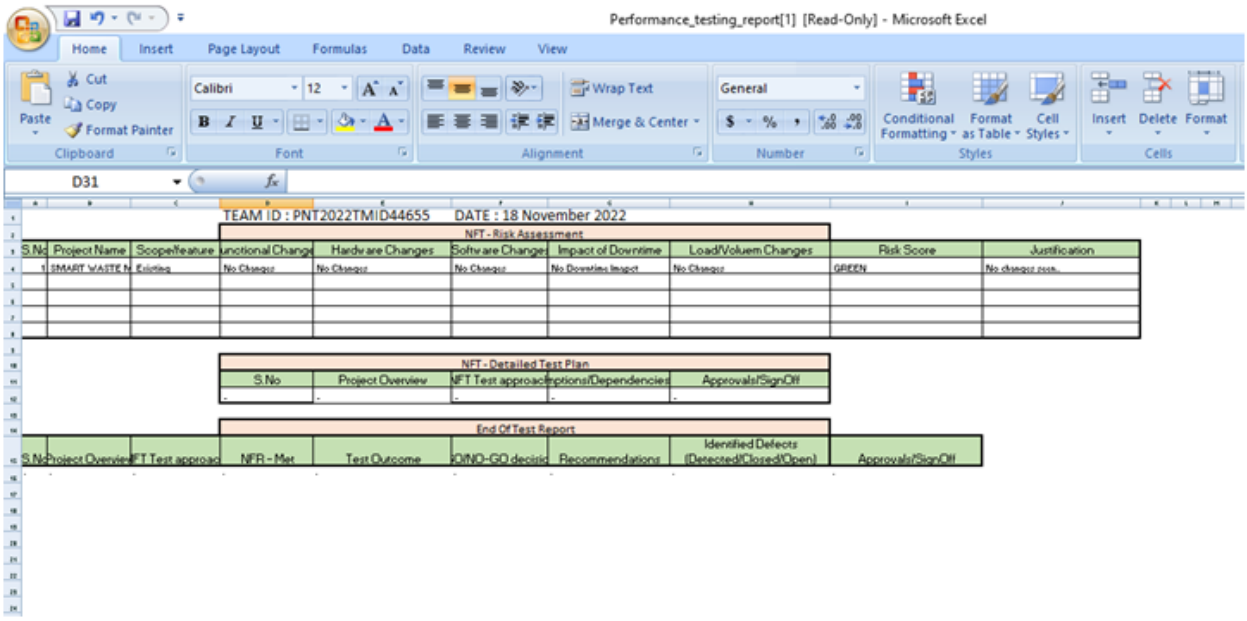
3. Test Case Analysis

This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	6	0	0	6
Client Application	20	0	0	20
Security	3	0	0	3
Outsource Shipping	8	0	0	8
Exception Reporting	5	0	0	5
Final Report Output	2	0	0	2
Version Control	4	0	0	4

9. RESULTS

9.1 Performance Metrics



10. ADVANTAGES & DISADVANTAGES

Benefits or 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.

Drawbacks or 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 trainining has to be provided to the people involved in the smart waste management system.

11. CONCLUSION

We have implemented real time waste management system by using smart dustbin to check the fill level of smart dustbin whether the dustbin are full or not. In this system the information of all smart dustbins can be accessed from anywhere and anytime by the concern person and he can take decision accordingly. By implementing this process system the cost reduction, resource optimization effective use of the smart dustbin can be done.

“Refuse what you do not need; Refuse what you do not need; Reduce what you do need; Reuse what you consume; Recycle what you cannot refuse, reduce, or reuse; and rot(compost) the rest”

12. FUTURE SCOPE

à“Global Smart Waste Management System Market Size, Status and Forecast 2025” report provides the newest industry data and industry future trends, allowing you to identify the products and end users driving Revenue growth and profitability. The industry report lists the leading competitors and provides the insights strategic industry Analysis of the key factors influencing the market.

Global Smart Waste Management System Market Overview:

à The report spread across 94 pages is an overview of the Global Smart Waste Management System Market Size, Status and Forecast 2025. The Global Smart Waste Management System Market is projected to grow at a healthy growth rate from 2018 to 2025 according to new research. The study focuses on market trends, leading players, supply chain trends, technological innovations, key developments, and future strategies.

àThe Global Smart Waste Management System Market is expected to grow at an impressive Compound Annual Growth Rate (CAGR) from 2018 to 2025. The major forces driving the Smart Waste Management System Market include a rise in smart city initiatives across different regions and stringent regulations and compliance requirements for environment protection & waste management. Recently, integration of Internet of Things (IoT) across different verticals is providing good opportunities for the growth of the Smart Waste Management System Market by providing real-time intelligence, thus, leading the organizations to shift towards deployment of smart solutions.

àAnalytics and Reporting Solutions provide Advanced Analytics and help in managing data generated by the sensors. It is expected to hold the largest share of the Smart Waste

Management System Market by solution. The solution includes components such as advanced analytics, data management, and dashboards & platforms. The huge flow of data and the need for environment protection are the major driving forces for the growth of analytics and reporting solutions in the Smart Waste Management System Market.

13. APPENDIX

Source Code

```
#Installing necessary

libraries import wiotp.sdk.device

import time

import random

import requests

import math

#Configuration details for connecting python script to IBM Watson IOT Platform

myConfig = {

"identity": {

"orgId": "fd7fvs",

"typeId": "Smart_Management",

"deviceId":"113355"

},

"auth": {

"token": "1122334455"

} }

def myCommandCallback(cmd):
```

```
 print("Message received from IBM IoT Platform: %s" % cmd.data['command']) m=cmd.data['command']

#Connecting the client to ibm watson iot platform

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

 client.connect()

 #Generate Random values for latitude, longitude in a circular distribution from the current location and

 #alert the garbage collector to go to the particular location where the bin level and bin weight exceeds the threshold

while True:

latitude=random.uniform(27.2046,125.25)

longitude=random.uniform(77.4977,100.15)

 binlevel=random.randint(10,100)

 binweight = random.randint(50,1500)

if binweight>=1000 and binlevel>80: myData={'latitude':latitude,

 'longitude':longitude,'binlevel':binlevel, 'binweight':binweight}

client.publishEvent(eventId="status", msgFormat="json", data=myData, qos= 0, onPublish=None)

##print("Published data Successfully: %s", myData)

print("BIN IS FULL..TIME TO EMPTY IT!!!!\n",myData)

client.commandCallback = myCommandCallback

 time.sleep(2)

 #break

 else :

 print("BIN IS IN NORMAL LEVEL...")

 time.sleep(2)
```

```
#Disconnect the client connection

client.disconnect()
```

GitHub & Project Demo Link

https://github.com/IBM-EPBL/IBM-Project-44513-1660724981

https://drive.google.com/file/d/1oxTuf36TO8Ni7t4Y5ozHtfsuQtZyNJxw/view?usp=drivesdk