PROJECT REPORT

PROJECT TITLE: SMART WASTE MANAGEMENT IN METROPOLITAN CITIES.

TEAM ID: PNT2022TMID42565

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1. INTRODUCTION:

In the recent decades, Urbanization has increased tremendously. At the same phase there is an increase in waste production. Waste management has been a crucial issue to be considered.

The main part in cleanliness is the garbage collection system that has to be smarter. In addition to this the people need easy accessibility to the garbage disposing points and garbage collection process has to be efficient in terms of time and cost in terms of fuel. In the present situation, the Garbage collection in the Indian cities is mostly manual where all the workers need to go to location where garbage is dropped by the citizens, and they need to collect it with some equipment. This system is not automated till now. The smart cities in India are developing with the fast rate in many respects such as smart homes, connectivity with world by roads, rails and airways, use of information technology etc. However, there is need to improve the garbage collection and disposal in smart cities. The present paper discusses the various issues with existing garbage collection systems and the novel approach to improve the garbage collection using Automated Robotic Dustbin

This project is a way to achieve this good cause. In this paper, smart bin is built on a microcontroller based platform Arduino Uno board which is interfaced with GSM modem and Ultrasonic sensor. Ultrasonic sensor is placed at the top of the dustbin which will measure the stature of the dustbin. The threshold stature is set as 10cm. Arduino will be programmed in such a way that when the dustbin is being filled, the remaining height from the threshold height will be displayed. Once the garbage reaches the threshold level ultrasonic sensor will trigger the GSM

modem which will continuously alert the required authority until the garbage in the dustbin is squashed.

Once the dustbin is squashed, people can reuse the dustbin. At regular intervals dustbin will be squashed. Once these smart bins are implemented on a large scale, by replacing our traditional bins present today, waste can be managed efficiently as it avoids unnecessary lumping of wastes on roadside. Foul smell from these rotten wastes that remain untreated for a long time, dueto negligence of authorities and carelessness of public may lead to long term problems.Breeding of insects and mosquitoes can create nuisance around promoting unclean environment. This may even cause dreadful diseases.

1.1. Project Overview :

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. In the case of the proposed solid waste management system, the bins are connected to the internet to relay real-time information of the status of the bin. The rapid growth in population in recent years has led to more waste disposals, necessitating the need for a proper waste management system to

avoid unhygienic living conditions. Implementation of the system translates to the bin being interfaced with microcontroller-based system with ultrasonic sensors and a Wi-Fi module. The data which would be sent from the bins would be received, analysed and processed in the cloud that displays the level of the garbage in the bin on a graph in its web page. The data obtained by the sensor is then transmitted to an IoT cloud platform, using a Wi-Fi communication link.

1.2. Purpose:

Smart waste management is about using technology and data to create a more efficient waste industry. Based on IoT (Internet of Things) technology, smart waste management aims to optimize resource allocation, reduce running costs, and increase the sustainability of waste services. Smart waste management is characterized by the usage 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. The purpose to reduce the dangerous effects of such waste on the environment and human health. A big part of waste management deals with municipal solid waste, which is created by industrial, commercial, and household activity. Waste management reduces the effect of waste on the environment, health, and so on. It can also help reuse or recycle resources, such as; paper, cans, glass, and so on. There is various type of waste management that include the disposal of solid, liquid, gaseous, or hazardous substances. Waste management is an important element of environmental protection. Its purpose is to

provide hygienic, efficient and economic solid waste storage, collection, transportation and treatment or disposal of waste without polluting the atmosphere, soil or water system.

2. LITERATURE SURVEY:

Researches have shown that smart waste management adoption has been an open area for identifying major barriers that hinder its adoption. The below section comprises list of studies that highlight the benefits of adopting smart city concept including smart waste management around the world.

2.1. Existing problem:

Improper disposal of municipal Solid Waste (MSW) can create unsanitary conditions and these conditions in turn can lead to pollution of the environment and outbreaks of vector borne diseases- that is, diseases spread by rodents and insects. The task of solid –waste management present complex technical challenges. They also pose a wide variety of administrative, economic and social problems that must be managed and solved.

2.2. References:

TITLE : Smart Dustbin Management Using IOT and Blynk Application
YEAR : 2021
AUTHORS : F. Annie Lincy,T. Sasikala,
DESCRIPTION : At present, population rate in the main cities has increased tremendously. This has increased the production of waste. The management of

huge volume of waste has become more difficult and challenging. The public dustbins are overflowing and have become nobody's concern. Due to the lack of responsibility of the corporation people, the overflowing garbage wastes have created unhygienic surroundings and foul smell. So, to overcome this issue, smart dustbin is designed. This smart dustbin is built on Arduino Uno board and is interfaced with GSM, GPRS and sensors. The sensors are used to check the threshold level of the dustbin. The threshold levels are already set. If the garbage hits the mentioned threshold level, continuous alert is sent to the respective authority until the garbage is recovered and the externally fixed LED is changed into red color. Once, the garbage from the bin cleared the LED changes to green color. This alert system is triggered by the sensors to the GSM modem. A time limit (say 24 hours) is given to respective authority, where if he/she fails the duty, the alert to the higher authority is sent. By this facility, the higher authority will be able to take action on the irresponsible workers. Features like maps are used to locate the dustbins which make the authority to reach the location easily. Connectivity among the dustbins are given to establish communication among the bins and provides smart system. Thus, the implementation of smart dustbins will create a hygienic society and will make the management of waste easy. The negligence of authorities and the public may be reduced. A clean and disease free environment can be created.

TITLE : IOT Based Smart Dustbin Monitoring With Tracking System Using ATMega 2560 Microcontroller

YEAR : 2019

AUTHORS : Mohammad Abbas Hussain,Kvs Nikhil,Koppuravuri Yaswanth Pavan Kalyan,

DESCRIPTION : India is rapidly developing country in the world. As a growing economy it is important to manage its waste. In India on an average 64 million tons of detritus is produced which ranks 5th in global scenario. Now a days in many localities garbage is thrown arbitrary and roads are seen with full of litter. These unplanned things causes many problems sometimes it may cause hazardous diseases. It necessitates a management system that will curb this issue and has a complete observation on the detritus. The intention towards this paper mainly focused on the monitoring and tracking of garbage present in our ambience. In addition to that the data is sent into IOT based cloud platform for real time monitoring. After reaching the end value of garbage in the dustbin the alerts are sent directly to the municipal corporation through GSM module. If any fire occurs in the dustbin, it will get alert through buzzer.

TITLE : Smart Waste Collection Monitoring System using IoT

YEAR : 2021

AUTHORS : Saurabh Pargaien,Amrita Verma Pargaien,Dikendra Verma,Vatsala Sah,Neeraj Pandey,Neetika Tripathi,

DESCRIPTION : Timely cleaning of dustbin is a big challenge and if left unaddressed, it may pose several health risks by making the place unhygienic. Current system for the waste management in local areas of small and highly populated cities is sluggish which leads to a lot of garbage strewn all over the city. The rate of generation of waste is so high that if the garbage collector doesn't visit

a place for a couple of days it creates the conditions adverse. In covid-19 pandemic situation, it was very important to monitor and decompose medical waste properly. The handling of normal home garbage was also challenging due to lockdown. In this situation automatic monitoring and controlling of garbage using IOT can play a significance role in garbage management. This paper proposes a smart and fast approach for waste management by creating a network of smart dustbins equipped with sensors and microcontrollers in a city which is monitored by a central control unit to speed up the process in an intelligent and smart way thereby eliminating such hazardous conditions caused by the current sluggish system. The proposed system also takes into account the issue of improper internet connectivity.

TITLE : IoT enabled dustbins

YEAR : 2017

AUTHORS : Sahil Mirchandani,Sagar Wadhwa,Preeti Wadhwa,Richard Joseph,

DESCRIPTION : Nowadays, waste management is one of the problems on which million of dollars are spent worldwide. the key issue in waste management is waste collection and sorting. Also, one of the issues in the waste management is that the garbage bin at public places gets overflowed in advance before the commencement of the next cleaning process. This, in turn, leads to various hazards such as bad odor & ugliness to that place which may be the root cause for the spread of various diseases. To tackle this problem, we propose the IOT enabled dustbins in this paper. these bins, use RFID tags for tracking of the wastes linked with a web-based online system and according to the weight of waste added, host server calculates the points and updates in the database of virtual wallet. Also, it measures the

fullness of the dustbins and updates the status of each dustbin on the municipal server. It notifies them when the dustbin is full and provides the shortest route to empty all the dustbins based on the capacity of the municipal waste loading vehicles. The Capacity of trucks is calculated and updated each time according to the number of dustbins serviced by the trucks, as soon as it completes a route assigned to it. Furthermore, the user is assisted in material waste classification through our application and also the smart bin knows its content and can report back to the rest of the recycling chain about its contents. Our system, target two crucial problems, cost efficiency in waste sorting and waste collection processes.

TITLE : Design of a Convolutional Neural Network Based Smart Waste Disposal System

YEAR : 2019

AUTHORS : Md. Samiul Haque Sunny,Debopriya Roy Dipta,Shifat Hossain,Hossain Mansur Resalat Faruque,Eklas Hossain,

DESCRIPTION : In recent times, waste management problem has become a crucial challenge for Bangladesh, which is having a detrimental impact on the environment. This paper presents the proposition of designing a smart dustbin similar to an Automated Teller Machine (ATM) along with an intelligent embedded system, which has been dubbed as Automated Teller Dustbin (ATD). An efficient convolutional neural network (CNN) based image classifier is developed, which is able to detect and recognize any object regarded as garbage by analyzing training features. Additionally, it can also count the number of labeled objects and assign a price value to each object. The waste brought by any individual to the ATD will

readily be recognized by the image classifier and the recycle value, which has been assigned for that object can be withdrawn by that individual. Therefore, a direct exchange of waste and its equivalent price is possible, which will incentivize people to use our proposed smart dustbin. After the installation cost, the operation and maintenance cost can be gained by recycling the garbage in it. A pre-trained CNN-based model ALexNet has been utilized to train and test the model with a dataset of 20 images for each of the 10 categorized vehicles. The Capacity of trucks is calculated and updated each time according to the number of dustbins serviced by the trucks, as soon as it completes a route assigned to it. Furthermore, the user is assisted in material waste classification through our application and also the smart bin knows its content and can report back to the rest of the recycling chain about its contents. Our system, target two crucial problems, cost efficiency in waste sorting and waste collection processes.

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2.3. Problem Statement Definition :

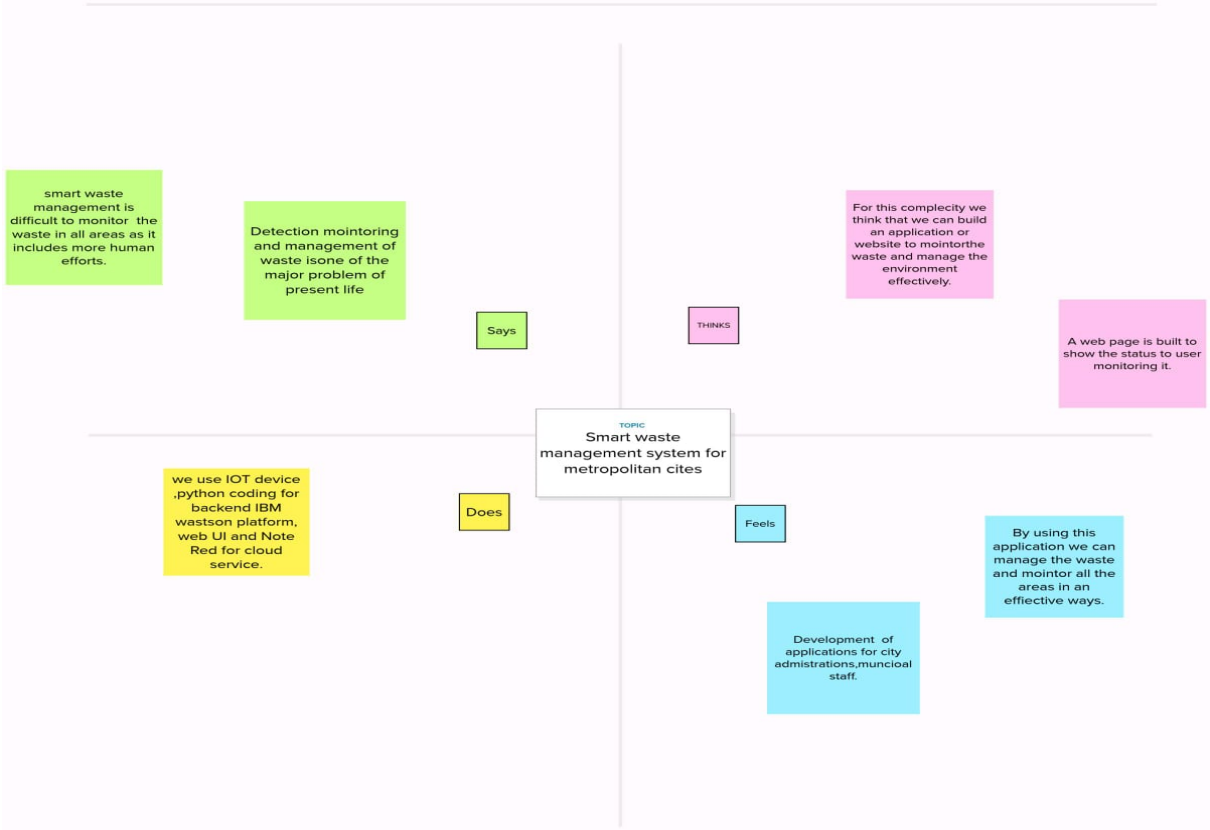
Design a smart waste collection system that allows citizens to segregate the various types of solid waste they want to dispose and the municipal authorities to efficiently collect the same. It was noted that inadequate communal containers for storing waste, lack of routine collection of waste and inadequate resources for the sanitation unit to effectively collect the waste generated are some of the problems uncounted in terms of waste management.

3. IDEATION & PROPOSED SOLUTION:

Ideation is the process where you generate ideas and solutions through sessions such as Sketching, Prototyping, Brainstorming, Brainwriting, Worst Possible Idea, and a wealth of other ideation techniques. Ideation is also the third stage in the Design Thinking process Ideation is the creative process of generating new ideas, which can be accomplished through a variety of ideation techniques, such as brainstorming and prototyping. If done right, ideation is what helps founders and executives determine the right problem to solve and how to solve it.

3.1. Empathy Map Canvas :

An empathy map is a collaborative tool teams can use to gain a deeper insight into their customers. Much like a user persona, an empathy map can represent a group of users, such as a customer segment



3.2. Ideation & Brainstorming :

Ideation is often closely related to the practice of brainstorming, a specific technique that is utilized to generate new ideas. A principal difference between ideation and brainstorming is that ideation is commonly more thought of as being an individual pursuit, while brainstorming is almost always a group activity.

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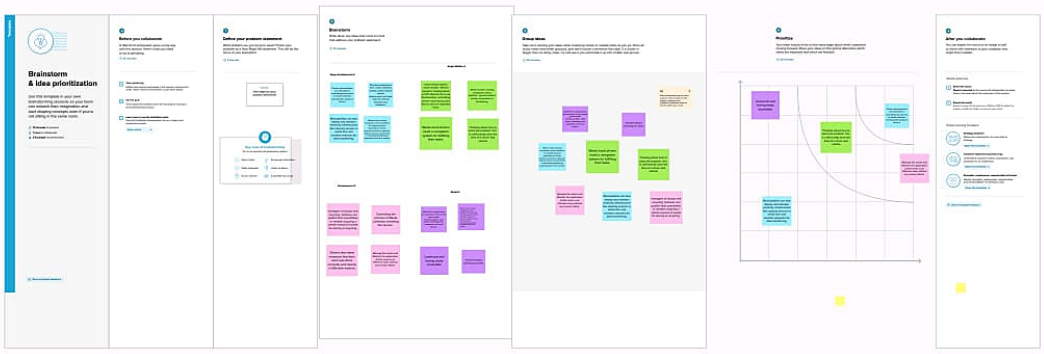
It improves waste collection allowing workers to collect and manage the waste more strategically. Everyday the controller receives the update about the filled level of dustbins. Higher authorities receives notification after overflowing indication is sensed.

PROJECT REPORT



3.3. Proposed Solution:

Proposed Solution means the technical solution to be provided by the Implementation agency in response to the requirements and the objectives of the Project.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To Smart Waste Management System For metropolitan cities. Many cities in India are being expanded as smart cities. In such a way ,Waste Management is the big challenge in India. Researchers are working in so many ways. The following factors are Causing the problem. Growth of population density and existing congested infrastructure .The highly populated metropolitan cities generate tons of waste everyday . It makes unhygienic condition for the general population and makes awful smell around environment .This finally spreads some fatal infections and human ailment.
2.	Idea/Solutiondescription	To solution in classification and real time data monitoring, architecture of the waste management system based on deep learning ,the proposed model renders an astute way to sort digestible and indigesitible . Waste using a convotional nerural network.IOT enables control of real time data from anywhere. The devices are wireless. The bin level with the existing GPS location. The significant advantage of the system is to collect waste material.
3.	Novelty/Uniqueness	The smart waste management System such as Smart bins , sensors,source areas, and vehicles. System work dynamically with respect to smart bins, collection vehicle, and routes.
4.	SocialImpact/ CustomerSatisfaction	The neat and clean surrounding .Smart transport System,smart grid,smart environment,and smart Thing.The Smart Waste Management is top priority in any smart city as directly affects the lifestyle,healthcare and environment.
5.	Business	User-Citizen

	Model(RevenueModel)	Waste collectors-waste collection company Drivers Dispatcher Janitor Waste trucks owning company Authorities Government City administration Municipality Waste department Waste disposal Waste disposal organization Waste storage
6.	Scalability of the Solution	Efficient and effective Functioning, Cleaner Environs, Better health issues, Pollution free and stinking free environs.

3.4. Problem Solution Fit:

This occurs when you have evidence that customers care about certain jobs, pains, and gains.

In this problem solution there are multiple dustbins located through the city or the campus, these dustbins are provided with low cost embedded device which helps in tracking the level of the garbage bins and an unique ID will be provided for every dustbin in the city so that it is easy to identify which garbage bin is fill. When the level reaches the threshold limit, the device will transmit the level along with the unique ID provided. These details can be accessed by the concern authorities from their place with the help of internet and an immediate action can be made to clean the dustbins.

4. REQUIREMENT ANALYSIS:

4.1 FUNCTIONAL REQUIREMENT:

Following are the functional requirements of the proposed solution:

FR No	Functional Requirement	Sub Requirement
FR-1	Detailed bin Inventory	* By using Street view Features from google we can visit and see all monitored Trash cans and stands which can be seen on the map. *You can see bin details in the Dashboard – capacity, waste type, last measurement, GPS location and collection schedule or pick recognition.

FR-2	Bin Monitoring	*The Dashboard shows the actual data on fill-levels of bins monitored by Sensors. *Sensors recognize picks as well; so you can check when the bin was last collected. *With real-time data and predictions, you can eliminate the overflowing bins and stop collecting half-empty ones
FR-3	Expensive bins	We help you identify bins that drive up your collection costs. The tool calculates a rating for each bin in terms of collection costs. The tool considers the average distance bin discharge in the area. The tool assigns bin a rating (1-10) and calculates distance from bin discharge.
FR-4	Adjusted bin distributions	Ensure the most optimal distribution of bins. Identify areas with either dense or sparse bin distribution. Make sure all trash types are represented within a stand. Based on the historical data, you can adjust bin capacity or location where necessary
FR-5	Eliminate unefficient picks	*It eleiminates the half empty bins by recognizing from sensor *Monitored by Raspberry Pi camera with 12 MP and high resolution of upto 1080p is used. *By using real-time data on fill-levels and pick recognition, we can show you how full the bins you collect are.

4.2. Non-functional Requirements:

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

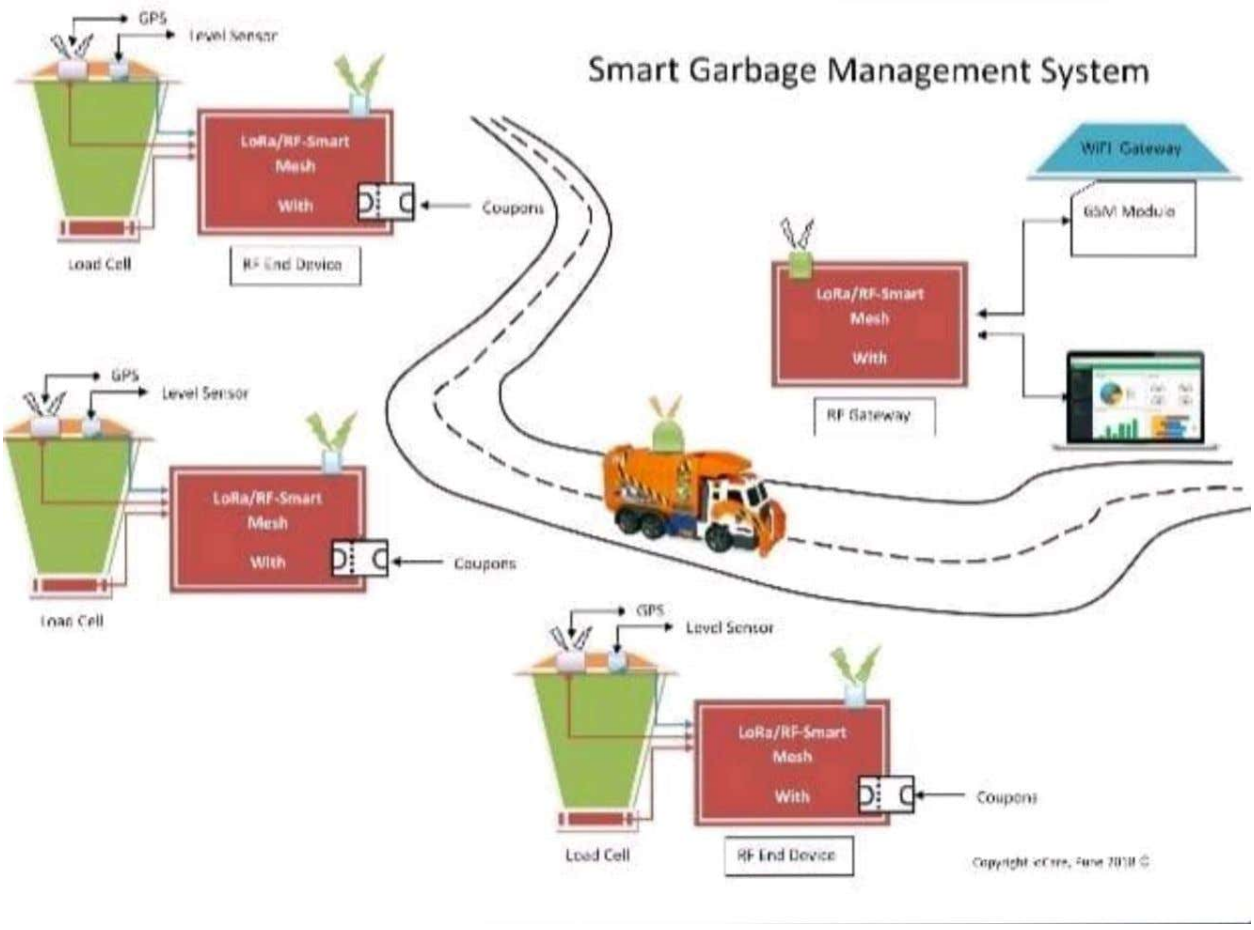
FR No	Non-Functional Requirement	Description
NFR-1	Usability	IoT device verifies that usability is a special and important perspective to analyze user requirements, which can further improve the design quality. In the design process with user experience as the core, the analysis of users'

		product usability can indeed help designers better understand users' potential needs in waste management, behavior and experience.
NFR-2	Security	1. Use a reusable bottles 2. Use reusable grocery bags 3. Compost it 4. Purchase wisely and recycle 5. Avoid using use and throw food and drink containers.
NFR-3	Reliability	Smart waste management is also about creating better working conditions for waste collectors and drivers. Instead of driving the same collection routes and servicing empty bins, waste collectors will spend their time more efficiently, taking care of bins that need ervicing.
NFR-4	Performance	The Smart Sensors use ultrasound technology to measure the fill levels (along with other data) in bins several times a day. Using a variety of IoT networks (NB-IoT,GPRS), the sensors send the data to Sensoneo's Smart Waste Management Software System, a powerful cloud-based platform, for datadriven daily operations, available also as a waste management app. Customers are hence provided data-driven decision making, and optimization of waste collection routes, frequencies, and vehicle loads resulting in route reduction by at least 30%
NFR-5	Availability	By developing & deploying resilient hardware and beautiful software we empower cities, businesses, and countries to manage waste smarter.
NFR-6	Scalability	Using smart waste bins reduce the number of bins inside town and cities because we are able to monitor the garbage 24/7 more cost effectively and scalability is high

5. PROJECT DESIGN

5.1 DATA FLOW DIAGRAMS

1. The user should register himself in the web application and this user database will be stored in IBM cloudant through Node-Red.
2. Here we use IOT's such as level sensor and GPS location(Global Positioning System).
3. The IOTdevices to the waston IOT platform exchanges the sensor data.
4. Sensors to integrate use random values as a sensor data.
5. Data is integrate to garbage levels detected to bin.
6. The GPS coordinates garbage bin will be sent IOT platform.
7. The location of bin values along with viewed in web application.
8. Web application through interaction with user/admin device.
9. User/admin receives the notification message about garbage levels



Reference: https://www.ibm.com/case-studies/greenq-[td https://greenq.gq/wp-content/uploads/2018/01/GreenQ- Case –Study-herzliya.pdF

5.2. SOLUTION & TECHNICAL ARCHITECTURE:

IOT device:

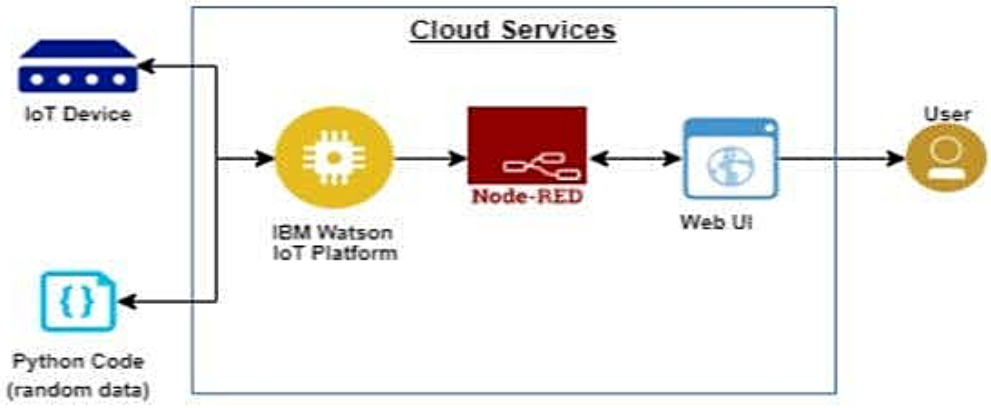
IOT devices are hardware devices, such as sensors, gadgets, appliances and other machines that collect and exchange data over the Internet.

GPS coordinates of the garbage bin values will be sent to the IBM IOT platform Location of the Bin along with bin status can be viewed in the Web Application.

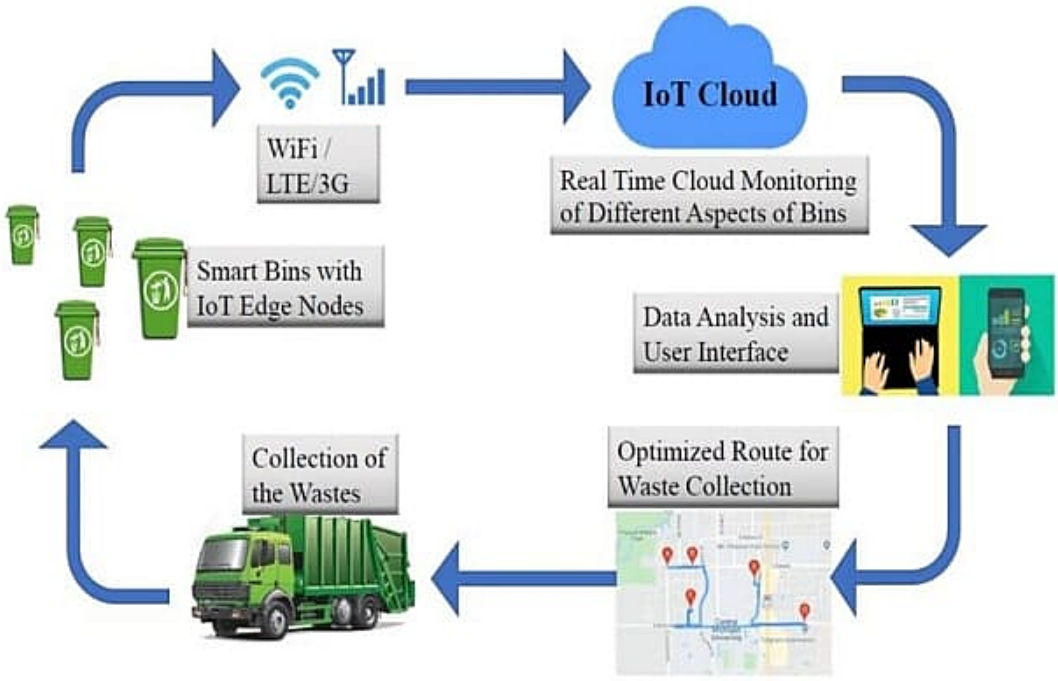
$ Notifies the admin if the bin value crosses the threshold value.

To accomplish this, we have to complete all the activities and tasks listed below:

$ Create and configure IBM Cloud Services
$ Create IBM Watson IoT Platform
$ Create a device & configure the IBM IoT Platform
$ Create Node-RED service
$ Create a database in Cloudant DB to store location data
$ Develop a web Application using Node-RED Service
$ Develop the web application using Node-RED.
$ Develop a python script to publish the location details to the IBM IoT platform



TECHNICAL ARCHITECTURE



5.3. USER STORIES:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user, web user)	Registration	USN-1	As a user, I can register for the application by entering my name,phone number, password, and confirming my password.	I can access my account / dashboard.	High	Sprint - 1
		USN-2	As a user, I will receive a pop-up message that I registered for the application.	I can click ok and can access my account	High	Sprint - 1
Administrator, Care Executive	Registration	USN-1	As a user, I can register for the application by entering my name,phone number, password, and confirming my	I can access my account / dashboard.	High	Sprint - 1

			password.			
		USN-2	As a user, I will receive a pop-up message that I registered for the application.	I can click ok and can access my account	High	Sprint - 1
	Login	USN-3	As a user, I can log into the application by entering phone number& password.	I can login with my phone number and passwor	High	Sprint - 1
	Dashboard	USN-4	As a user, I can register for the application through Internet.	I can register & access the dashboard with Internet Login	Low	Sprint - 2
		USN-5	As a user, I can register for the application through phone number.	I can confirm all my details.	Medium	Sprint - 1
	Order Details	USN-6	As a user, I visit the particular GPS location and collect the trash.	Make sure that the process is completed.	High	Sprint - 2

6. PROJECT PLANNING &SCHEDULING

6.1. SPRINT PLANNING & ESTIMATION:

*Product Backlog, Sprint Schedule, and Estimation

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, password, and confirming my password.	2	High	Balaji N
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	Alagu Esakkiammal N
Sprint-2		USN-3	As a user, I can register for the application through Facebook	2	Low	Aruleeswaran R
Sprint-1		USN-4	As a user, I can register for the application	2	Medium	Angel Melbha A

			through Gmail			
Sprint-1	Login	USN-5	As a user, I can log into the application by Entering email & password	1	High	Balaji N Aruleeswaran R

*Project Tracker, Velocity & Burndown Chart

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	29 Oct 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	49	29 Oct 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	50	29 Oct 2022

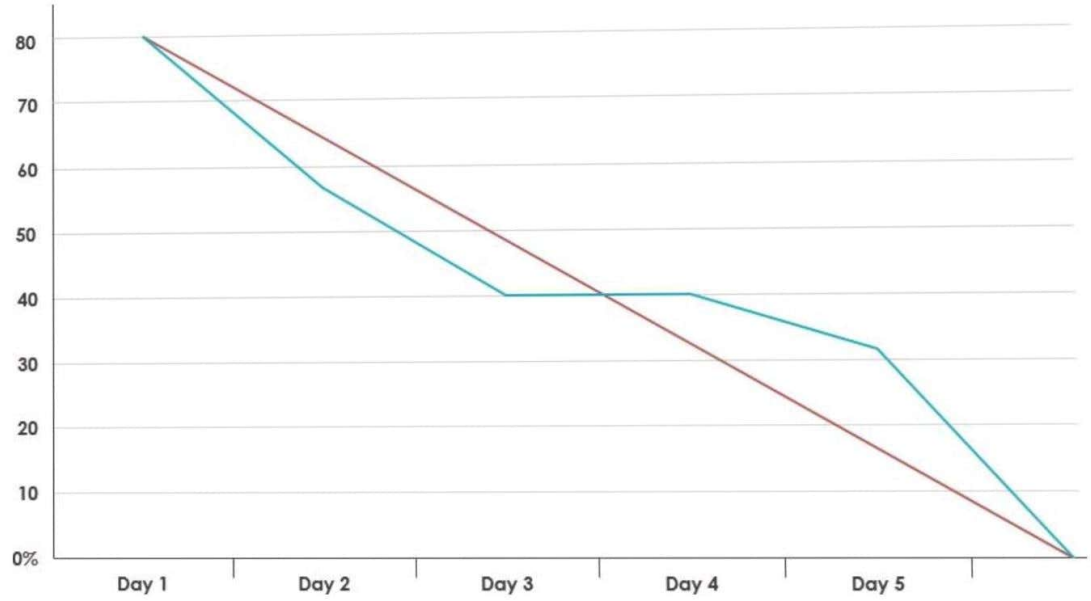
Velocity:

$$AV = \frac{\text{Sprint duration}}{\text{Velocity}}$$

$$= \frac{20}{10}$$

$$= 2.$$

Burndown Chart:



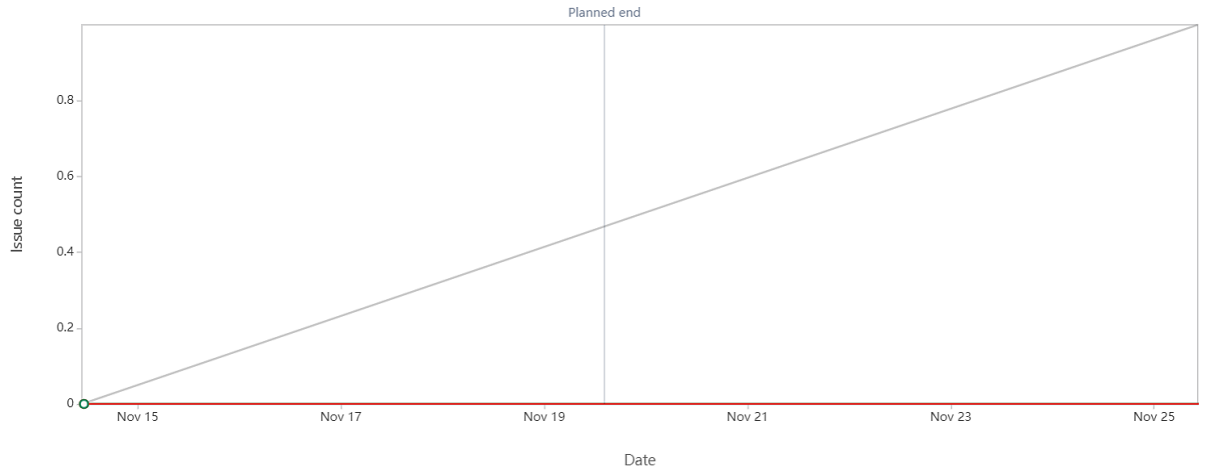
6.2. Sprint Delivery Schedule:

Title	Description	Date
Literature Survey	Gathering Information by referring the articles, technical paper and it is enumerated, describe, summarize and clarify this previous research	13 SEPTEMBER 2022
Empathy Map	It is collaborative tool teams can use to gain a deeper insight into their customers. To capture the user pain and gains And prepare the list of problem statement.	10 SEPTEMBER 2022
Brainstorm & ideation phase	Try to solve the problem with new ideas by having a discussion that includes all members of group. Prioritise a top 3 ideas based on feasibility and Importance	19 SEPTEMBER 2022
Problem statement	In this proposed Solution, it includes	24 SEPTEMBER 2022

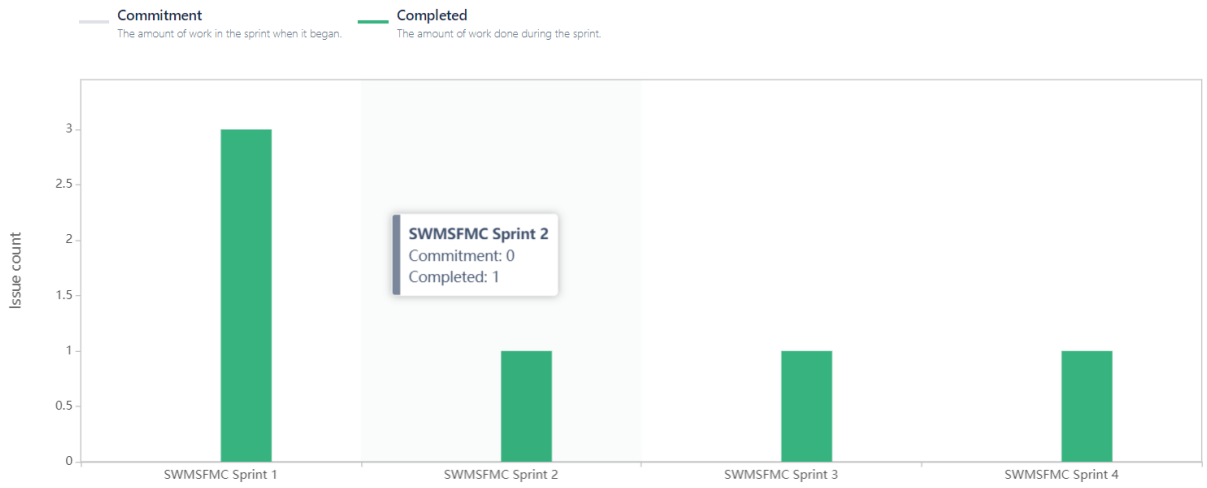
	novelty, feasibility, business model, social impact and scalability of solution	
Proposed solution	In this proposed Solution, it includes novelty, feasibility, business model, social impact and scalability of solution	03 NOVEMBER 2022
Problem Solution Fit	In this, the point validating that the base problem resulting in a idea exists and the solution solves the problem.	02 OCTOBER 2022
Solution Architecture	Solution Architecture	19 SEPTEMBER 2022
Customer Journey	To Understand User Interactions and experiences with application	10 OCTOBER 2022
Functional Requirement	Prepare functional Requirement	03 OCTOBER 2022
Data flow Diagrams	Data flow diagram	03 OCTOBER 2022
Technology Architecture	Technology Architecture diagram	03 OCTOBER 2022
Project DevelopmentDelivery of sprint 1,2,3 &4	Develop and submit the developed code by testing it	02 NOVEMBER 2022 - 19 NOVEMBER 2022

6.3. Report from JIRA:

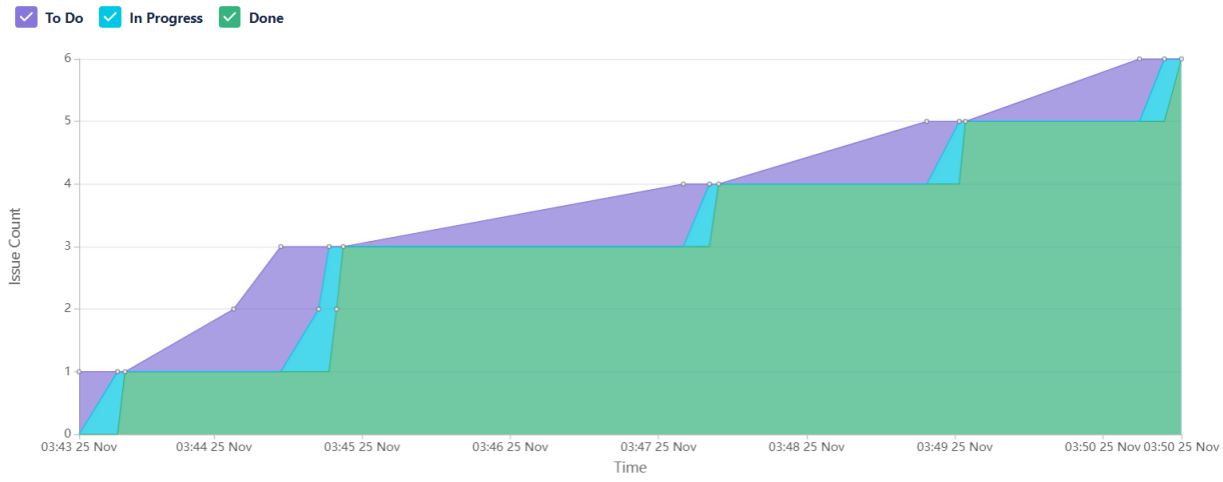
Burnup Report



Velocity Report



Cumulative Flow Diagram



7. CODING AND SOLUTIONING:

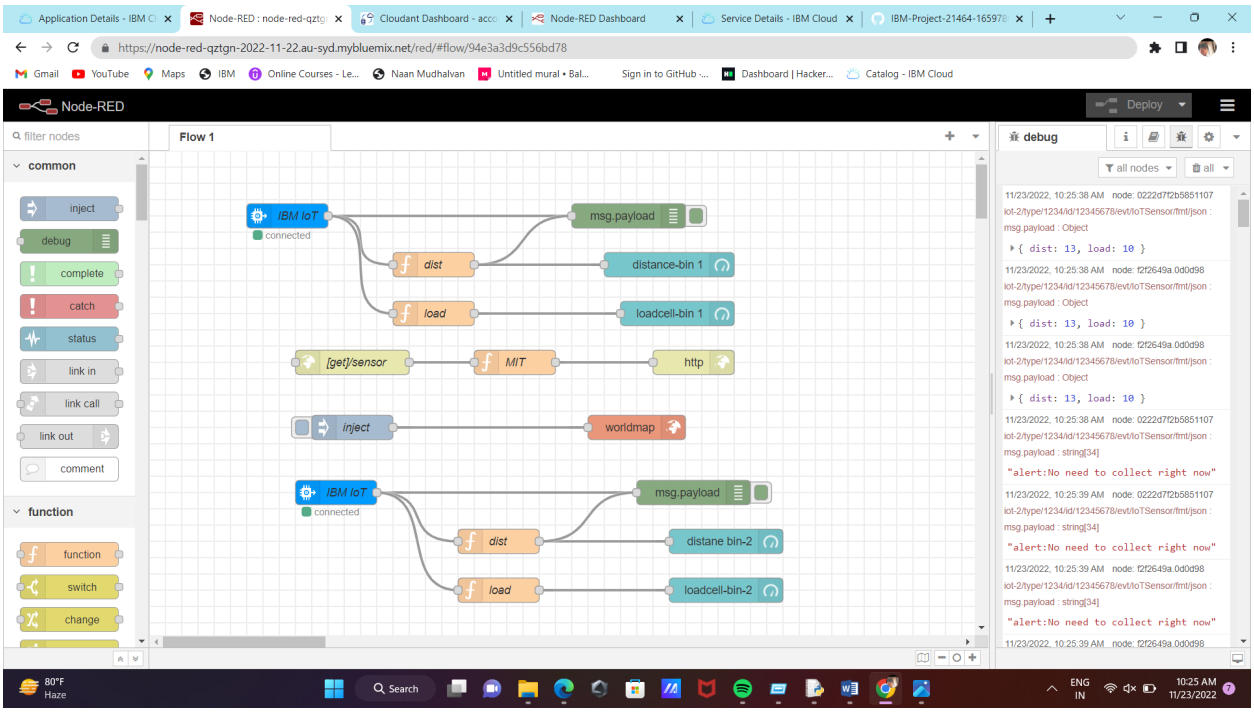
7.1. FEATURE 1:

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

import random
import sys


organization = "70icwf"
deviceType="1234"
deviceId="12345678"
authMethod="token"
authToken="S_OVsw4ICr5-Vk9A9x"



def myCommandCallback(cmd):
        global a
        print("Command received: %s" %cmd.data['command'])
        control=cmd.data['command']
        print(control)
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()
deviceCli.connect()
```

```
while True:

        distance= random.randint(10,70)
        loadcell= random.randint(5,15)
        data= {'dist':distance,'load':loadcell}

       if loadcell < 13 and loadcell > 15:
            load= "90 %"
        elif loadcell < 8 and loadcell > 12:
            load= "60 %"
        elif loadcell < 4 and loadcell > 7:
            load= "40 %"
        else:
            load = "0 %"

        if distance < 15:
           dist = 'Warning:' 'Trash is getting high, Time to collect 90 %'

        elif distance < 40 and distance >16:
             dist = 'Warning:' 'Trash is above 70 %'

        elif distance < 60 and distance > 41:
             dist = 'Warning:' '40 %'
        else:
             dist = 'Warning:' '17 %'
        if load == "90 %" or distance == "90 %":
           warn = 'alert:' ' Warning: Trash poundage getting high, Time to collect'
        elif load == "60%" or distance == "60 %":
             warn = 'alert:' 'Trash is above 60%'
       else :
             warn = 'alert:"No need to collect right now'
        def myOnPublishCallback(lat=11.0168,long=76.9558):
            print("Coimbatore")
            print("published distance = %s" %distance, "loadcell:%s" %loadcell, "lon=
%s"%long,"lat=%s" %lat)
            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 connnected to ibmiot")
    time.sleep(20)
    deviceCli.commandCallback=myCommandCallback
deviceCli.disconnect()
```

7.2. FEATURE 2:



8. TESTING:

8.1. Test Cases:

Test case ID	Feature Type Bin Level	Compnent	Test Case Scenario	PreRequisite	Availability	Test Condition	Expected Result	Actual Result	Access By
Test case 1	Empty	Ultrasonic Sensor	When Bin is empty	Ultrasonic sensor PIR Motion	Sensor Garbage Bins	Bin Level == 0	Displays Bin level and space left	Working as expected	User
Test case 2	Accessible	Ultrasonic Sensor	When bin level is below50 %	Ultrasonic sensor PIR Motion Sensor Garbage Bins	Bin is accessible to user	Bin Level < 50	Displays Bin level and space left	Working as expected	User
Test case 4	Accesible	Ultra sonic sensor	When bin level is below75%	Ultrasonic 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 space left	Working as expected	User
Test case 5	Accesible	Limit exceedUltra sonic sensor	When bin level is Above 75%	Ultrasonic sensor PIR	Bin is not accessible To	Bin level> 75	Display bin level And Space	Working as expected	User

				Motion Sensor Garbage Bins	the users,the admin receives high alert and seals the bin to avoid overflow		left		
Test case 6	Accessible	Sensor	90%	Ultrasonic sensor PIR Motion Sensor Garbage Bins	If bin is 90% above high alert is given to the user	>90	Space right	Working as expected	User

9. RESULTS:

Environmental protection – from pollution or contamination. Money generation – companies may buy recyclable materials due to their value. Additionally, the waste management industry creates employment opportunities. Safety – irresponsibly disposed of waste can harm people.

10. ADVANTAGES & DISADVANTAGES :

ADVANTAGES:

1. 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%.

2. 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.

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

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

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

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

DISADVANTAGE :

1. 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.

2. Sensor nodes used in the dustbins have limited memory size.

3. 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).

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

5. The trainining has to be provided to the people involved in the smart waste management system.

11. CONCLUSION:

Solid waste management is faced with a number of issues which include lack of throughput, inadequate solid waste data, efficiency problem, delays in collection and resistance to new technologies. Presently, waste management is a major problem for authorities who are responsible for such task because it’s a costly service and it huge-ly impacts the environment as a whole. This study introduced a smart waste monitoring system that uses several sensors and communication technologies to achieve the set task. The proposed system was achieved through the development of theoreticalmodels, layout and decision making algorithms in the course of the project.There is an enormous amount of room for the development of this project in order for it to meet commercial standards. One of my many recommendations would be that of the addition of other sensors e.g. accelerometer. The accelerometer will make the system save more energy by turning on the system to measure the bin level only when the lid is opened to dispose waste. The system would then update its current state on ThingSpeak and turn off, preventing unnecessary measurement when the bin’s level has not been altered due to dormancy. Another recommendation is the use of solar panel for power generation making its power supply autonomous Monitoring the fullness of bins through the use of sensors, it is possible to achieve a more efficient system than the current existing. But most importantly, it will help us to save our planet. Besides, recycling saves the earth by facilitating the reprocess of paper which will save millions of trees. Also, recycling saves a lot of energy because many things that we recycle can easily be converted into virgin materials. The behaviour of generating garbage is too dangerous not only for today's generation, but also for future generations. It is critical to educate people and encourage them to practise Recycle, Reuse, and Reduce instead of producing waste. Waste disposal should be a priority for municipalities and governments.

12. FUTURE SCOPE:

Though the SBM framework designed for smart cities in the context of IoT has potentials, at the same time, it has the following challenges: (i) Distribution of trash bins in the most populated areas where the amount of waste is unpredictable on daily basis (ii) Disturbance in the Internet connectivity due to various causes, that is, weather disruption or defected connection (iii) Lazy transportation: traffic jam could be a big challenge for vehicles to reach on time and collect garbage (iv) Communication between two entities and damage of batteries could be severe challenges for the system In the future, the model may be extended to an alternate and the shortest pathfinding for collecting vehicles in order to enhance transportation and remove collecting barriers. In addition, adding alternate sources for connectivity in case of power failure or weather hindrance may also be considered. Further, to facilitate the mechanism and save more energy, automated segregating TBs can be installed for dry, wet, and hazardous types of waste.

13. APPENDIX :

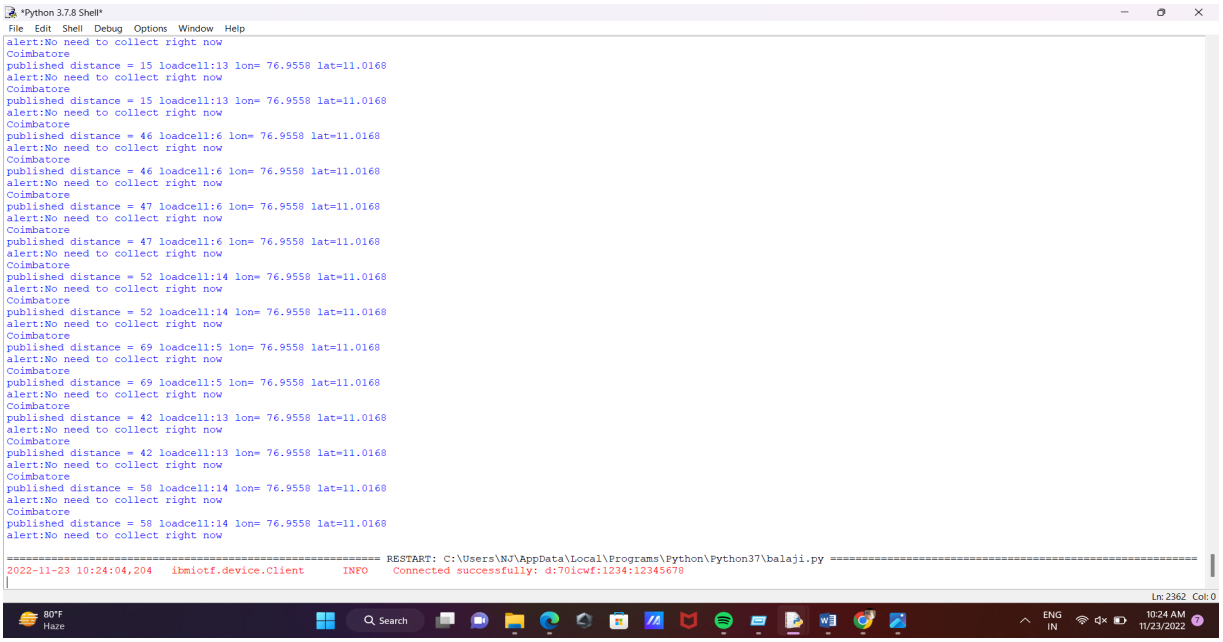
SOURCE CODE:

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

import random
import sys
```

```
organization = "70icwf"
deviceType="1234"
deviceId="12345678"
authMethod="token"
authToken="S_OVsw4ICr5-Vk9A9x"



def myCommandCallback(cmd):
        global a
        print("Command received: %s" %cmd.data['command'])
       control=cmd.data['command']
        print(control)
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()
deviceCli.connect()
while True:

        distance= random.randint(10,70)
        loadcell= random.randint(5,15)
        data= {'dist':distance,'load':loadcell}

        if loadcell < 13 and loadcell > 15:
           load= "90 %"
        elif loadcell < 8 and loadcell > 12:
           load= "60 %"
        elif loadcell < 4 and loadcell > 7:
           load= "40 %"
        else:
           load = "0 %"
```

```
        if distance < 15:
          dist = 'Warning:' 'Trash is getting high, Time to collect 90 %'

        elif distance < 40 and distance >16:
            dist = 'Warning:' 'Trash is above 70 %'

        elif distance < 60 and distance > 41:
            dist = 'Warning:' '40 %'
        else:
            dist = 'Warning:' '17 %'
        if load == "90 %" or distance == "90 %":
          warn = 'alert:' ' Warning: Trash poundage getting high, Time to collect'
        elif load == "60%" or distance == "60 %":
            warn = 'alert:' 'Trash is above 60%'
        else :
            warn = 'alert:"No need to collect right now'
        def myOnPublishCallback(lat=11.0168,long=76.9558):
            print("Coimbatore")
            print("published distance = %s" %distance, "loadcell:%s" %loadcell, "lon=
%s"%long,"lat=%s" %lat)
            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 connnected to ibmiot")
        time.sleep(20)
        deviceCli.commandCallback=myCommandCallback
deviceCli.disconnect()
```

Output:



GITHUB Link:

https://github.com/IBM-EPBL/IBM-Project-21464-1659780692

Video link :

https://youtu.be/7t0YFVMqrto