SMART WASTE MANAGEMENT FOR METROPOLITAN CITIES

INTRODUCTION:

Garbage is made up of non-renewable resources used daily to meet our needs then throw away. As increase in consumption of paper, clothing, bottles, and product packaging increases, the generation of garbage also increases significantly. The form and type of solid waste depends on a number of factors which include the living standard and life style of the inhabitants of the region and the natural resources found in the region. There are two categories of Urban waste namely, organic and inorganic. Decomposed products which are poorly managed or uncontrolled can and often times lead to contamination of air, water and soil resources . One of the challenges a developing country faces due to rapid increase in population is proper solid waste management. A typical example is the garbage bins seen around which appear overfull to the point of spilling out, leading to environmental pollution. The effect of this is increase in the number of diseases because it gives room for insects to breed. Solid waste requires systematic management the content, origin or hazard potential notwithstanding as this will ensure environmental best practices and living standard. Because solid waste management forms a very critical aspect of our environmental hygiene, it is therefore necessary to incorporate it into environmental planning . The advances in computers have led to the birth of new innovations and opportunities like the Internet of Things where things that are connected to the internet can also be controlled and interacted with via the internet. 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 main drive of solid waste management is the reduction and elimination of adverse effect of waste materials on human health and environment leading to improvement in quality of life. In this work, an intelligent solid waste monitoring system is developed using Internet of Things (IoT) and cloud computing technologies. This is a recent innovation as cloud computing has been applied in other areas like . Ultrasonic sensors are employed to detect the fill level of solid waste in each of the containers. The data obtained by the sensor is then transmitted to an IoT cloud platform, using a Wi-Fi communication link. For each designated fill level, the system sends appropriate notification message to alert relevant authorities and concerned citizen(s) for necessary action. Also, the fill level is monitored on in real-time

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.

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 :

2.1. Literature Review on cities those have adopted smart city concept

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.

2.2 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.

2.3 References :

S.NO	PAPER	AUTHOR	YEAR	METHOD AND ALGORITM

1.	Smart City Governance in Developing Countries	SY Tan, A Taeihagh	January 2020	The idea is based on smart city for developing cleanliness. The review found that technology-enabled smart cities in developing countries can only be realized when concurrent socioeconomic, human, legal, and regulatory reforms are instituted. Governments need to step up their efforts to fulfil the basic infrastructure needs of citizens, raise more revenue, construct clear regulatory

				frameworks to mitigate the technological risks involved, develop human capital, ensure digital inclusivity, and promote environmental sustainability. A supportive ecosystem that encourages citizen participation, nurtures start-ups, and promotes public–private partnerships needs to be created to realise their smart city vision.
2	The future of waste management in smart and sustainable cities	Behzad Esmaeilian, BenWang, KemperLewis FabioDuarte, CarloRatti, Sara Behdad	November 2018	The potential of smart cities and connected communities in facilitating waste management efforts. waste management system is proposed, where three interconnected elements are

				discussed:1. an infrastructure for proper collection of product lifecycle data to facilitate full visibility throughout the entire lifespan of a product,2. a set of new business models relied on product lifecycle data to prevent waste generation, and 3.an intelligent sensor-based infrastructure for proper upstream waste separation and on-time collection. The proposed framework highlights the value of product lifecycle data in reducing waste and enhancing waste recovery and the need for connecting waste management practices to the whole product life-cycle. An

				example of the use of tracking and data sharing technologies for investigating the waste management issues has been discussed..
3	Real-time smart garbage bin mechanism for solid waste management in smart cities	Dominic Abuga, N S Raghava	December 2021	This paper focuses on a real-time smart garbage bin mechanism for solid waste management in smart cities. The mechanism proposed accesses real-time information of any smart garbage bin deployed across the city and helps to resolve the problem of waste overflow from garbage bins and keep the smart cities clean. Fuzzy logic is applied in the strategic deployment of smart garbage bins across the smart cities. The

				system is

				implemented on Net-logo which is widely used in multi-agent modelling environments. The significant advantage of the system is its novelty in real-time decision-making and real-time monitoring using the fuzzy logic process.
4	Smart Waste Management under Smart City Mission	Priyanka Mokale	October 2019	Smart waste management helps to reduce the waste, create waste to energy source also it helps to keep the environment clean and neat. Its main way to show the difference between small-town waste management and Metropolitan cities challenges and how to manage it and then gave the recommendation

				for solid waste

				management improvement.
5	Iot based solid waste management solution	Kellow Pardini, Joel J. P. C. Rodrigues, Sergei Kozlov, Neeraj kumar	December 2018	A review analysis of waste management models available in the literature is performed in detail in this paper. Then, a deep review is undertaken of the related literature based on IoT infrastructure for efficient handling of waste generated in urban scenarios, focusing on the interaction among concessionaires and waste generators (citizens) from the perspective of a shorter collection time with reduced costs, as well as citizenship promotion. An IoT-based reference model

				is described, and a comparison analysis of the available solutions is presented, with the goal to highlight the most relevant approaches and identify open research issues on the topic
6	Smart waste management using IOT	V.Pavan sankeerth,V.Santhosh Markandeva,E.sriRanga&v.Bhavana	November 2019	It is seen that a large portion of the trash across the roadside are over loaded because the waste is not gathered intermittently. In this technique the bins are equipped with ultrasonic sensors to measure the garbage level and sends this data to a server using micro controller with Wi-Fi technology over internet. The server monitors the garbage

				bins that are

				spread across the city at multiple locations. The system notifies the garbage truck driver when the garbage has to be removed based on the garbage level of the bin. The server sends SMS to the assigned mobile number which provides a route to the driver based on all the data collected from bins. This system makes waste management in metropolitan cities more efficient.

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.

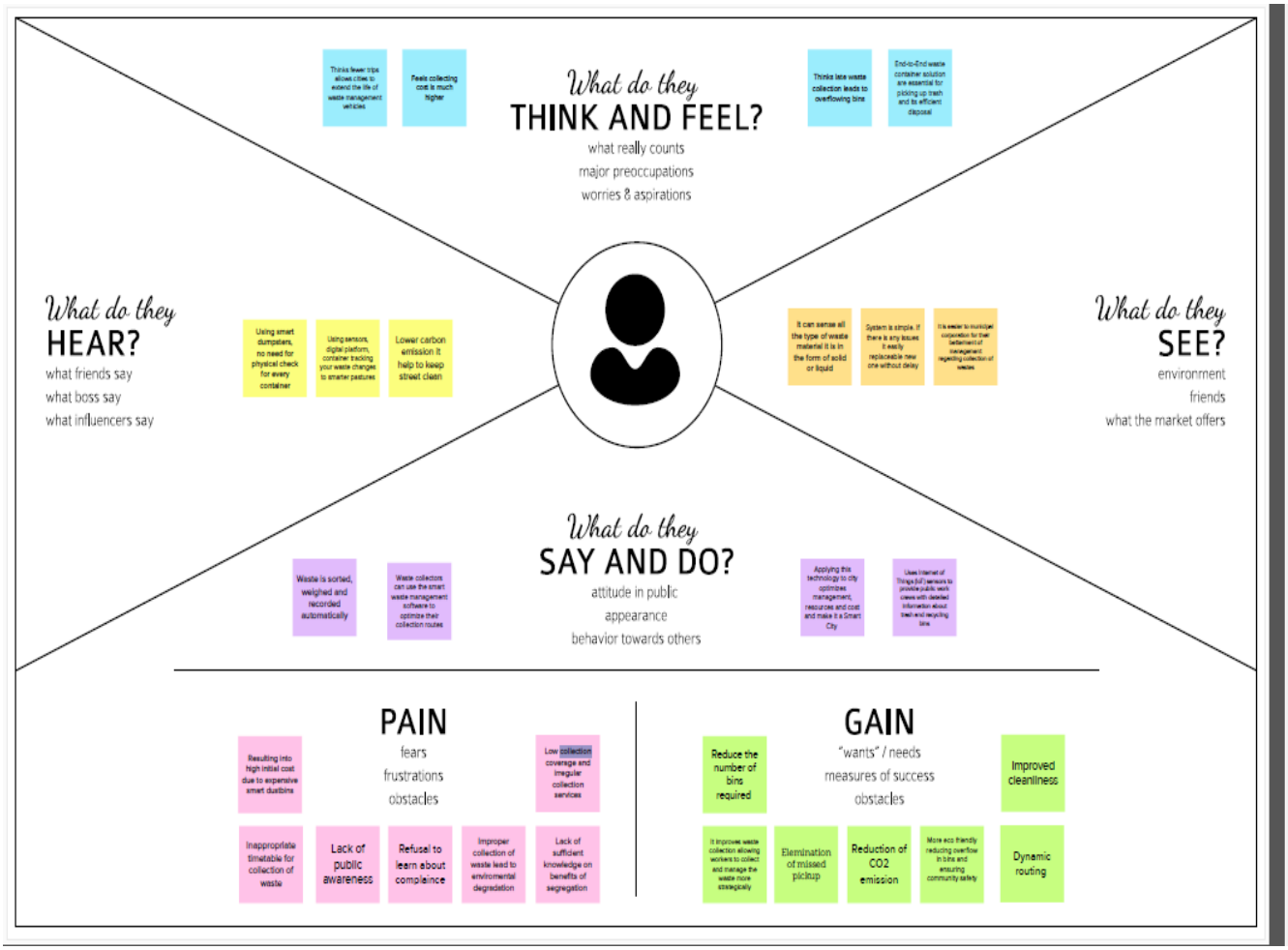
3. IDEATION & PROPOSED SOLUTION:

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.

- 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.
- Smart waste management makes it possible to plan more efficient routes for the trash collectors.
- A monitoring technology that collects and tracks real time data.
- Smarter working for route optimization.

3.3 Proposed Solution :

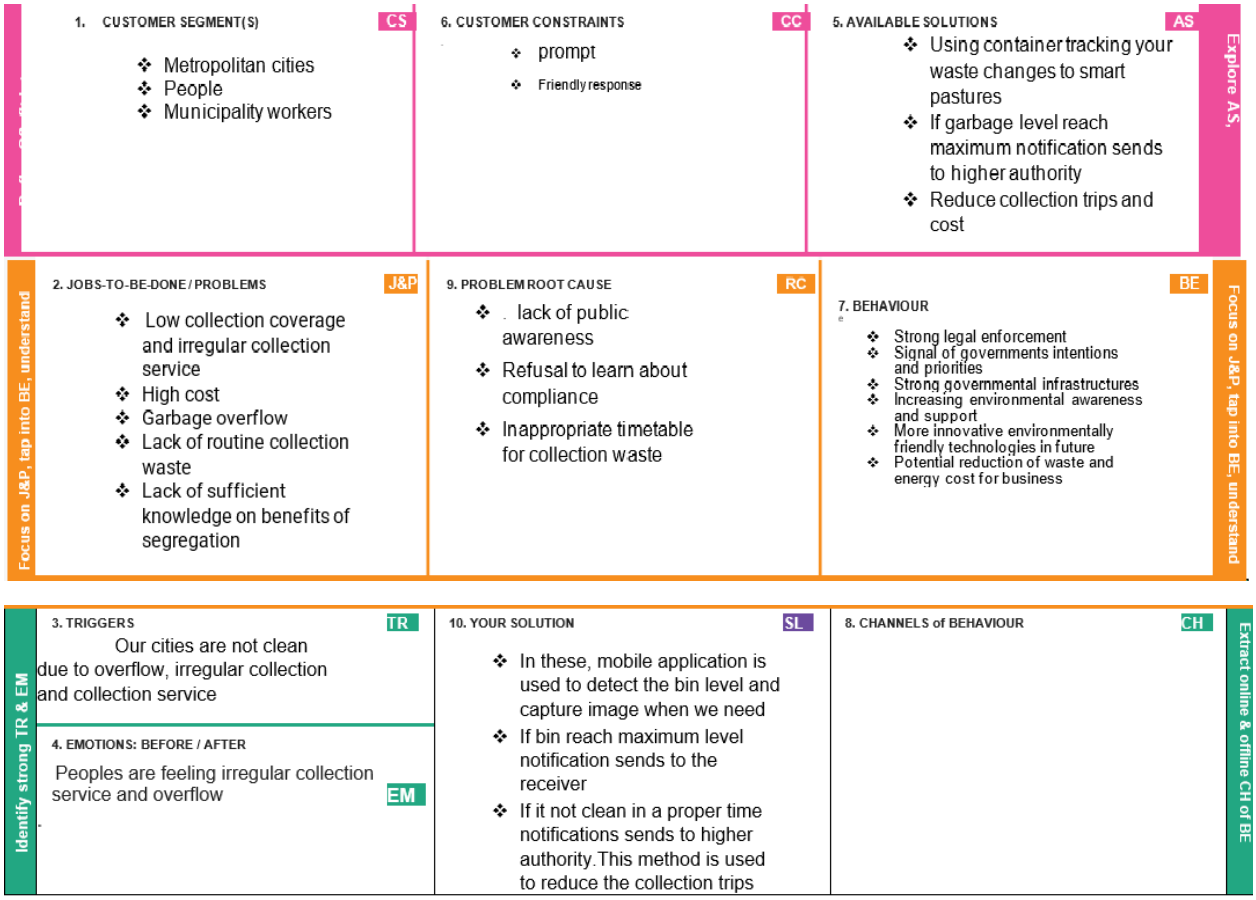
Proposed Solution means the technical solution to be provided by the Implementation agency in response to the requirements and the objectives of the Project

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	▪ Inadequate communal containers for sorting waste, lack of routine collection of waste and inadequate resources for the sanitation unit to efficiency collect the waste generated ▪ Irregular collection service and collection coverage ▪ High costGarbage overflow ▪ Lack of sufficient knowledge on benefits of segregation
2.	Idea / Solution description	▪ Elimination of missed pickups ▪ If garbage level reach maximum, notification sends to higher authority ▪ Citizens easily access information about the public waste using mobile application ▪ Large size dustbins are used to reduce collection trips and cost ▪ Using container tracking your waste changes to smart pastures ▪ Mobile application is used to detect the bin level and capture image when we need ▪ In our system if dustbin is relocated to another location, it will automatically registered with the server with new location

		▪ Garbage bins are separated by biodegradable and non-bio degradable
3.	Novelty / Uniqueness	▪ End to end waste container solution is essential for picking up trash and its efficient disposal ▪ Easy way to track and detect the solution
		▪ If bin is not clean the notification sends to higher authority ▪ Waste is sorted, weighted and recorded automatically
4.	Social Impact / Customer Satisfaction	▪ Reduction of co2 emission ▪ Improved cleanliness ▪ More eco-friendly reducing overflow in bins and ensuring community safety ▪ Keeps the environment clean and fresh ▪ Reduce environmental pollution
5.	Business Model (Revenue Model)	▪ Reduce cost ▪ It is easier to municipal corporation for their betterment of management of regarding collection of wastes ▪ Saving worker's time ▪ It improves employee efficiency ▪ Low workers need
6.	Scalability of the Solution	▪ Rating of 10 ▪ Users -9 ▪ Product -9

3.4 Problem Solution fit :

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



4. REQUIREMENT ANALYSIS :

4.1 Functional requirement:

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Real time monitoring	In this , a 24*7 monitoring system is designed for monitoring dumpsters.
FR-2	Sensor	Sensor is used for measuring the level of waste in the dumpster.it can sense all type of waste material it is in the form of solid or liquid.
FR-3	Smart bin	If bin reached maximum level the notification sends to the admin.The admin will post the location and garbage id to the truck driver. Then

		the truck driver reaches the destination and pickup the trash in a proper time. When used this idea it eliminates the missed pickups.
FR-4	Mobile application	Citizens easily access information about the public waste using mobile application. It is used to detect the bin level and capture image when we need. If bin reach maximum level notification sends to the receiver. if it not cleans in a proper time notification sends to higher authority.
FR-5	Server	If dustbins are relocated to another location, it will automatically register with new server with new location.
FR-6	Truck	Waste collectors can use the smart waste management software to optimized their collection routes.it is essential for picking up trash and its efficient disposal.it reduce the trips.

Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	The system should be user friendly to make it efficient. Easy way to track and detect the solution
NFR-2	Security	User name and password Backup facility Privileges

		Safety requirement for admins to protect the user from eye problem
NFR-3	Reliability	Error free operation Easy to access Easier way to improve cleanliness
NFR-4	Performance	The system should be performed as desired user. More eco-friendly reducing overflow in bins and ensuring community safety
NFR-5	Availability	The system should able to run all times.it is easier to municipal corporation for their better management of regarding collection of wastes.
NFR-6	Scalability	Ratings Users: 99% Product:90% Public : 99%

5. PROJECT DESIGN :

5.1 Data Flow Diagrams :

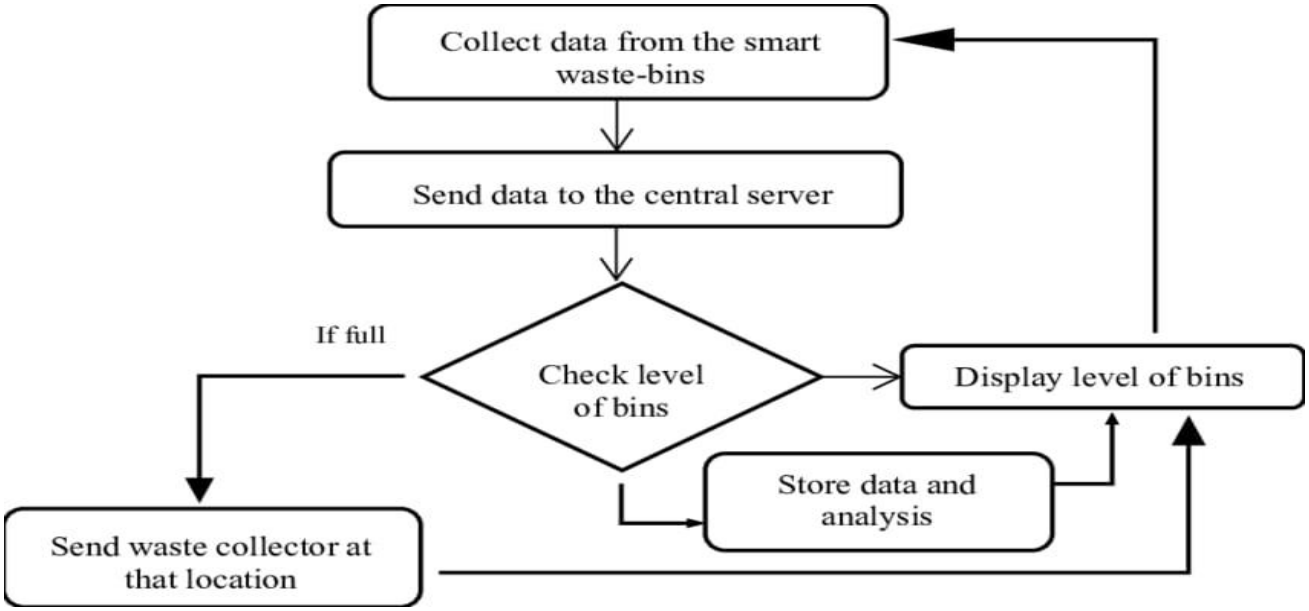
A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

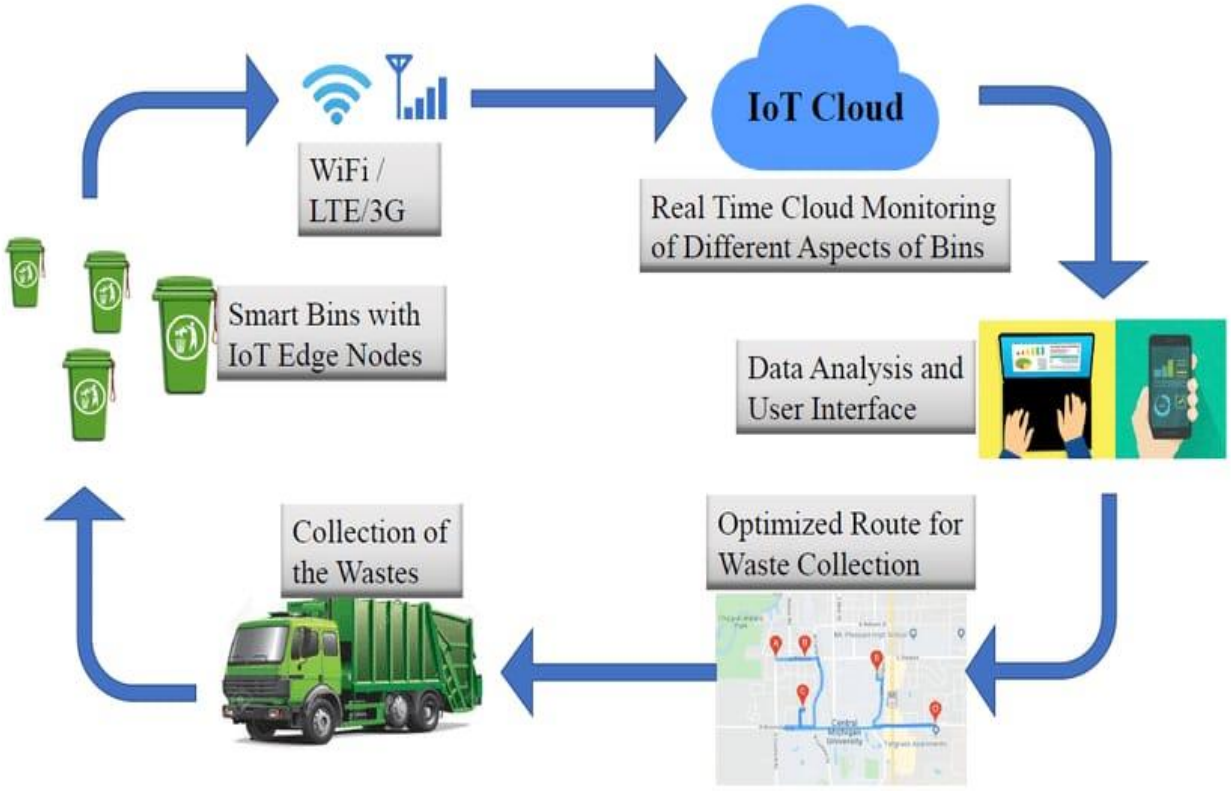
Smart waste management system for metropolitan cities:

- It is a platform uses analytics to translate the data gather in your bin into actionable insights to help to improve our smart city
- The first test conducted is the situation garbage bin empty or full
- Then, the bin is filled 70% it gives the notification the admin.
- When it reaches 90%it gives SMS its full the garbage needs to collect immediately. The admin will post the location and garbage id to the truck driver. Then the truck driver reaches the destination and pick up the trash in a proper time. When used this idea it eliminates the missed pickups.

- The number of bins avoided
- The number of collection services that could be saved
- Driving distance could be saved
- Fuel is saved
- If it not cleared properly the notifications sends to higher authority

Data flow diagram :





USER STORIES :

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin (manage web server)	Login	USN-1	As an admin, I gave user id and password for ever workers manage them.	I can manage the server	Medium	Sprint-1
Co admin	Login	USN-2	As a Co admin. I will manage the garbage level monitor. If garbage fill alert I will post location, garbage id to the truck driver.	I can manage the process	High	Sprint-1

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Truck driver	Login	USN-3	A s a truck driver, I will follow the routes send by co admin to reach the filled garbage	I can manage the travel through the route in proper manner	Medium	Sprint-2
Local garbage collector	Login	USN-4	As a waste collector, I will collect all the waste from garbage and load into the garbage truck and send them into land fill.	I can collect the waste and kept in a truck and send off	Medium	Sprint-1
Municipality	Login	USN-5	As a municipality I will check the process are going good manner without any issues.	I can manage all these processes going good manner	High	Sprint-1

5.2 Solution & Technical Architecture :

Garbage level detection in bins.

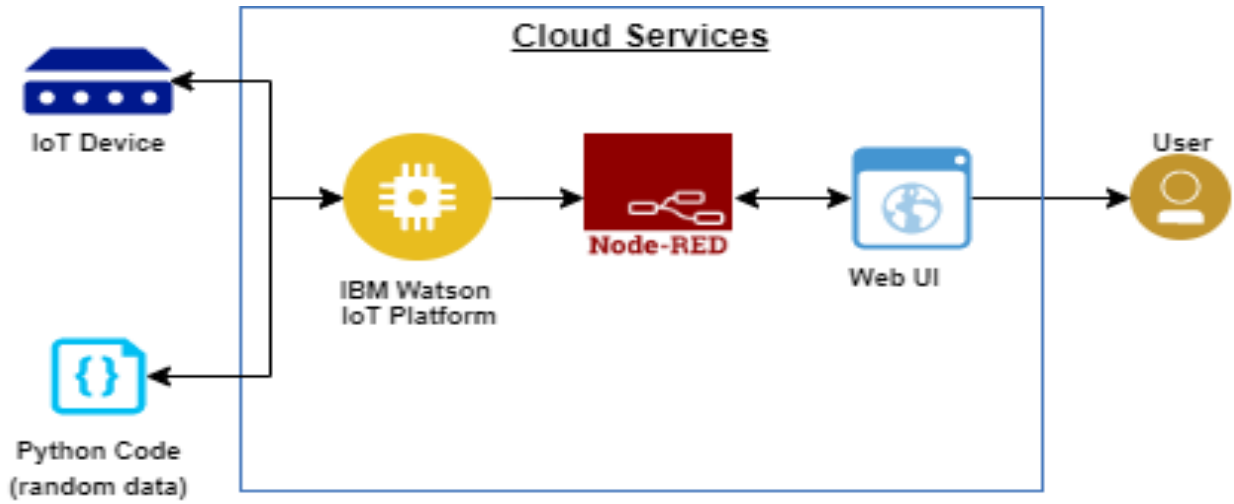
Getting the weight of the garbage in the bin.

Alerts the authorized person to empty the bin whenever the bins are full.

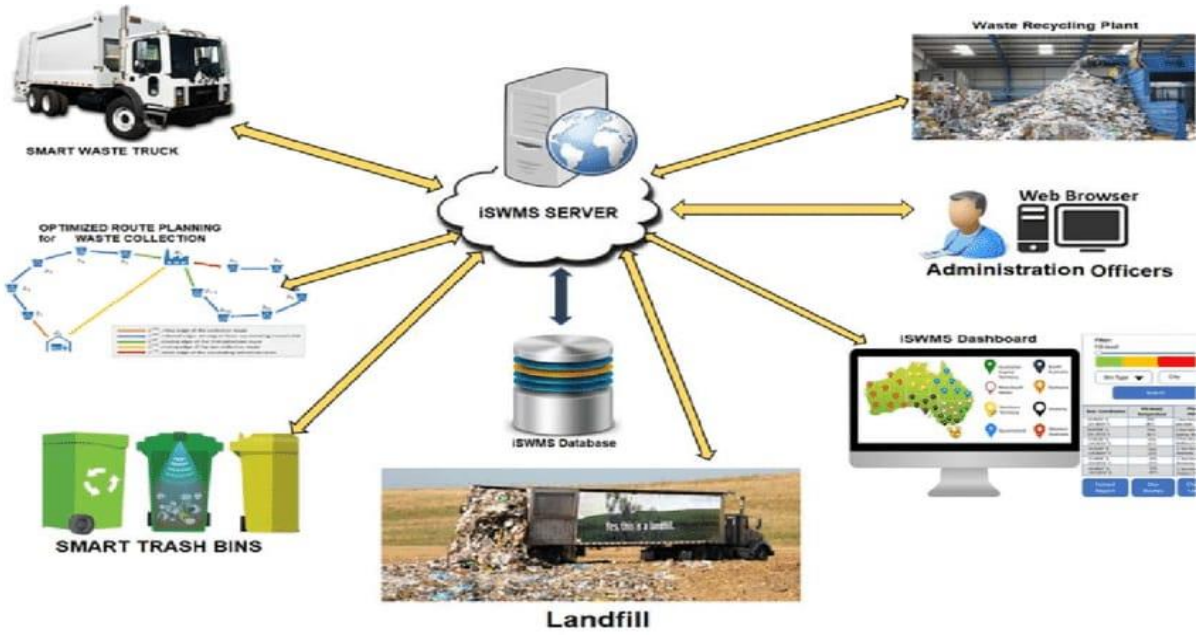
Garbage level of the bins can be monitored through a web App.

We can view the location of every bin in the web application by sending GPS location from the device.

Architecture Design :


Cloud Services
IoT Device
IBM Watson
IoT Platform
Node-RED
Web UI
User
Python Code
(random data)


WiFi / LTE/3G
IoT Cloud
Real Time Cloud Monitoring of Different Aspects of Bins
Smart Bins with IoT Edge Nodes
Data Analysis and User Interface
Optimized Route for Waste Collection
Collection of the Wastes



6. PROJECT PLANNING & SCHEDULING :

6.1 Sprint Planning & Estimation :

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As an admin, I need to create id and password for ever workers to maintain the platform in secure manner.	2	High	Rajalakshmi. K, Kurinjimalar.V
Sprint-1	Dashboard	USN-2	As a co admin, monitoring the real time garbage level. If it reaches maximum level, I will give alert message to the truck driver with a bin id and location. If it	1	High	Brindha devi. K Jayanthan. M

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
			Overflows the notification sends to higher authority.			
Sprint-2	Dashboard	USN-3	As a truck driver, I will follow the co admin message and track location in shortest route and save the fuel and time.	2	Low	Naveen. N Arputha raja. S
Sprint-1	Dashboard	USN-4	As a garbage collector, I will load the waste in a truck and deliver to a landfill	2	Medium	Naveen. N Jayanthan.M
Sprint-1	Dashboard	USN-5	As a coperation officer, I will monitor everything as a process is going without any issues.	1	High	Arputha raja S Rajalakshmi. K

Project Tracker, Velocity & Burndown Chart: (4 Marks)

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	5 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

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	13SEPTEMBER 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	It is used to identify the current state and desired states by this problem statement.	24 SEPTEMBER 2022
Proposed Solution	In this proposed Solution, it includes novelty, feasibility, business model, social impact and scalability of solution	24 SEPTEMBER 2022
Problem Solution Fit	In this, the point validating that the base problem resulting in a idea exists and the solution solves the problem.	2 OCTOBER 2022
Solution Architecture	Solution Architecture	13 OCTOBER 2022
Customer Journey	To Understand User Interactions and experiences with application	10 OCTOBER2022
Functional Requirement	Prepare functional Requirement	17 OCTOBER2022
Data flow Diagrams	Data flow diagram	17 OCTOBER 2022
Technology Architecture	Technology Architecture diagram	21 OCTOBER 2022
Project Development- Delivery of sprint 1,2,3 &4	Develop and submit the developed code by testing it	24 OCTOBER 2022 – 19 NOVEMBER 2022

7. CODING & SOLUTIONING :

7.1 Feature 1:

```
import requests

import json

import ibmiotf.application

import ibmiotf.device

import time

import random
```

```
import sys


organization = "kvnnui"
deviceType="swm"
deviceId="1234"
authMethod="token"
authToken="987654321"



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:
```

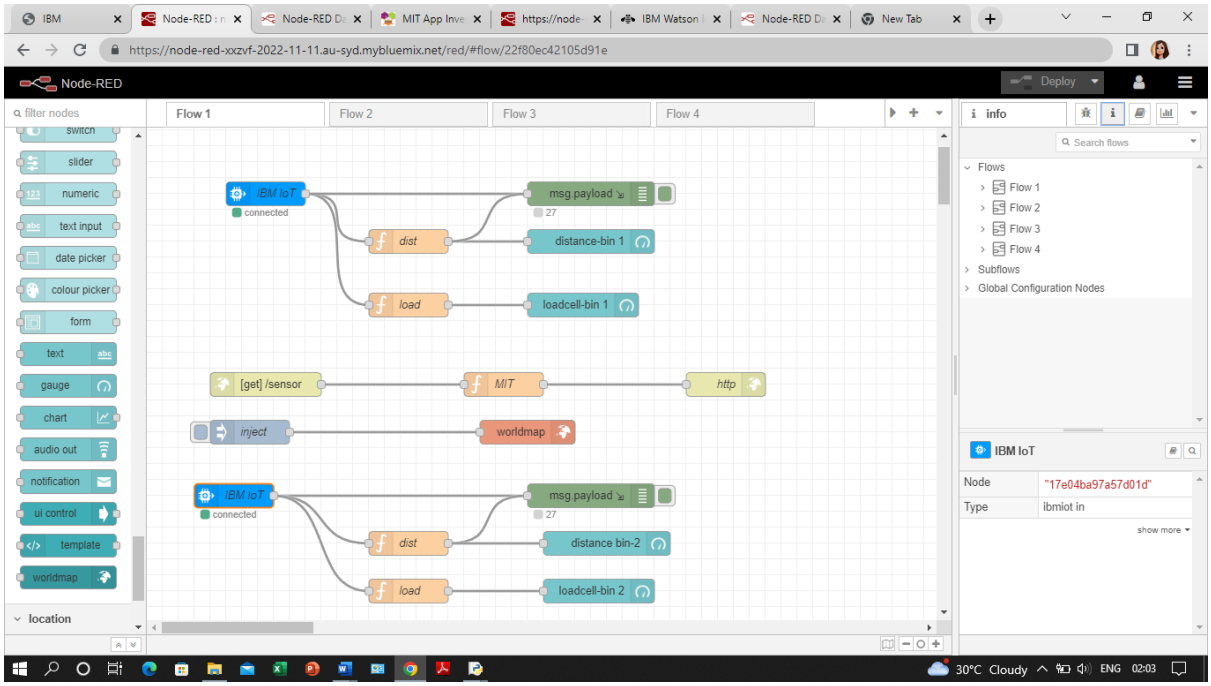
```
distance= random.randint(10,70)
loadcell= random.randint(5,15)
data= {'dist':distance,'load':loadcell}

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 %'
```

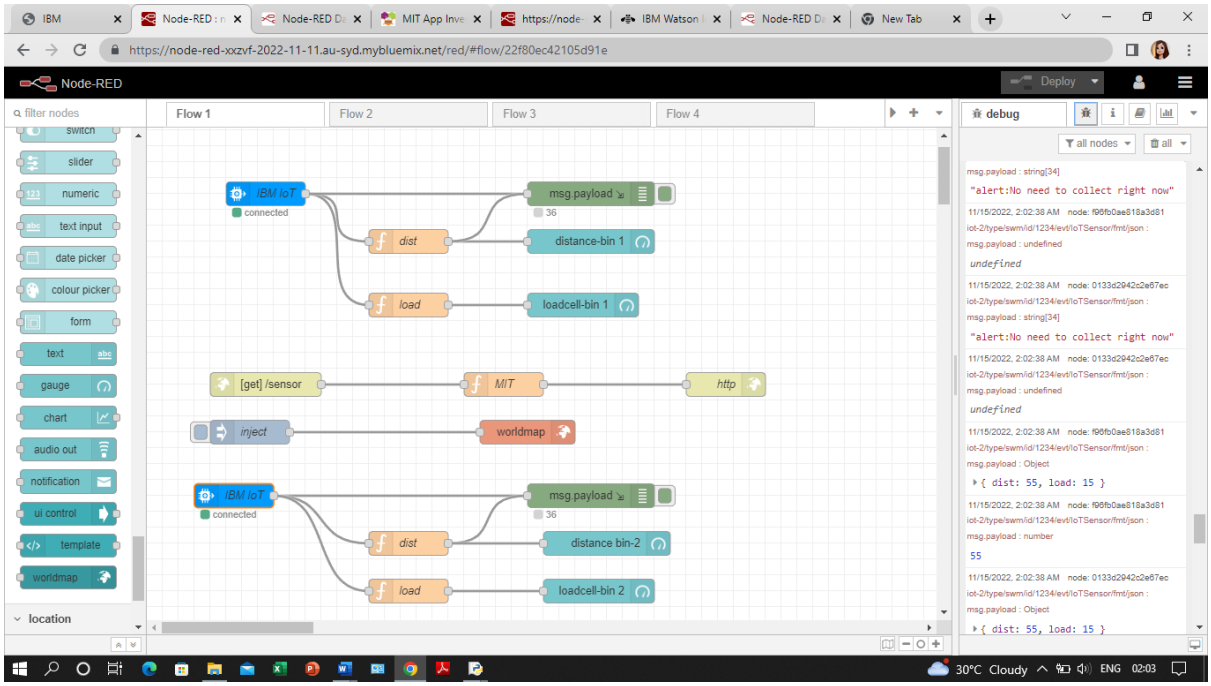
```
    if load == "90 %" or distance == "90 %":
        warn = 'alert:' ' Warning: Trash poundage getting high, Time to collect'

    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

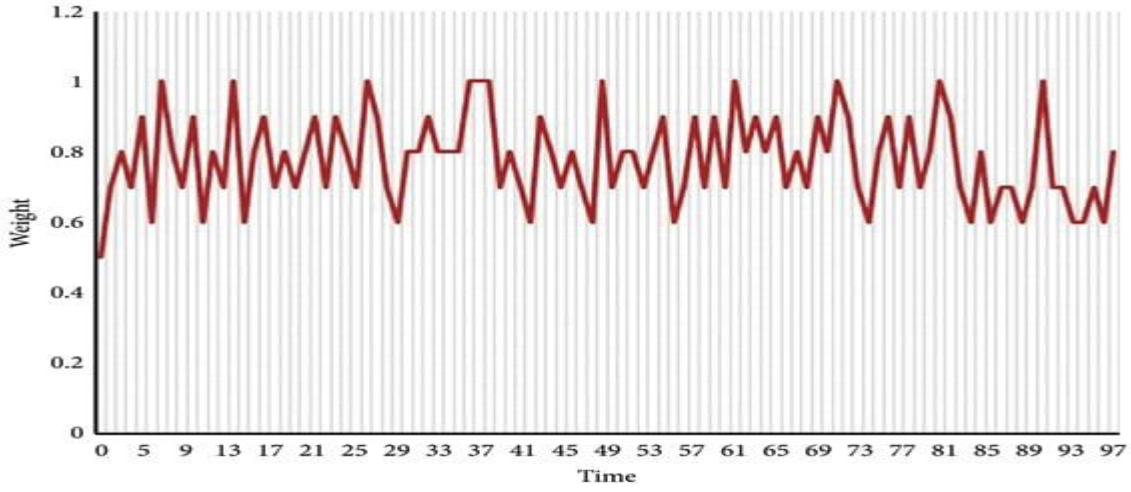
Test case ID	Feature Type- Bin Level	Component	Test Case Scenario	Pre-Requisite	Availability	Test Condition	Expected Result	Actual Result	AccessBy
Test case1	Empty	Ultrasonic Sensor	When Binis empty	Ultrasoncic sensor PIR Motion	Sensor Garbage Bins	Bin Level == 0	Displays Bin level and space left	Working as expected	User
Test case2	Accessible	Ultrasonic Sensor	When bin level is below50 %	Ultrasonic sensor , PIR Motion Sensor , , Garbage Bins	,bin is accessibleto user	Bin Level < 50	Displays Bin level and space left	Working as expected	User
Test case3	Accessible	Ultrasonic Sensor	When bin level is above 50	Ultrasonic sensor , PIR Motion Sensor , , Garbage Bins	Bin is accessibleto users and the admin gets warning about the bin level	Bin level >50	Displays bin level space left	Working as expected	User
Test case4	Accessible	Ultrasonic sensor	When bin level is below75%	Ultrasonic sensor , PIR Motion Sensor , , Garbage Bins	Bin is accessibleto 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	Accessible	Limit exceedUltrasonic sensor	When bin level is Above	Ultrasoncic sensor , PIR Motion	Bin is not accessible To the	Bin level>75	Display bin level And	Working as expected	User

			75%	Sensor , , Garbage Bins	users,the admin receives high alert and seals the bin to avoid overflow		space 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.

PERFORMANCE METRICS:



10. ADVANTAGES & DISADVANTAGES :

ADVANTAGES:

- 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.

DISADVANTAGE :

- 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:

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.

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.

APPENDIX :

SOURCE CODE:

Code:

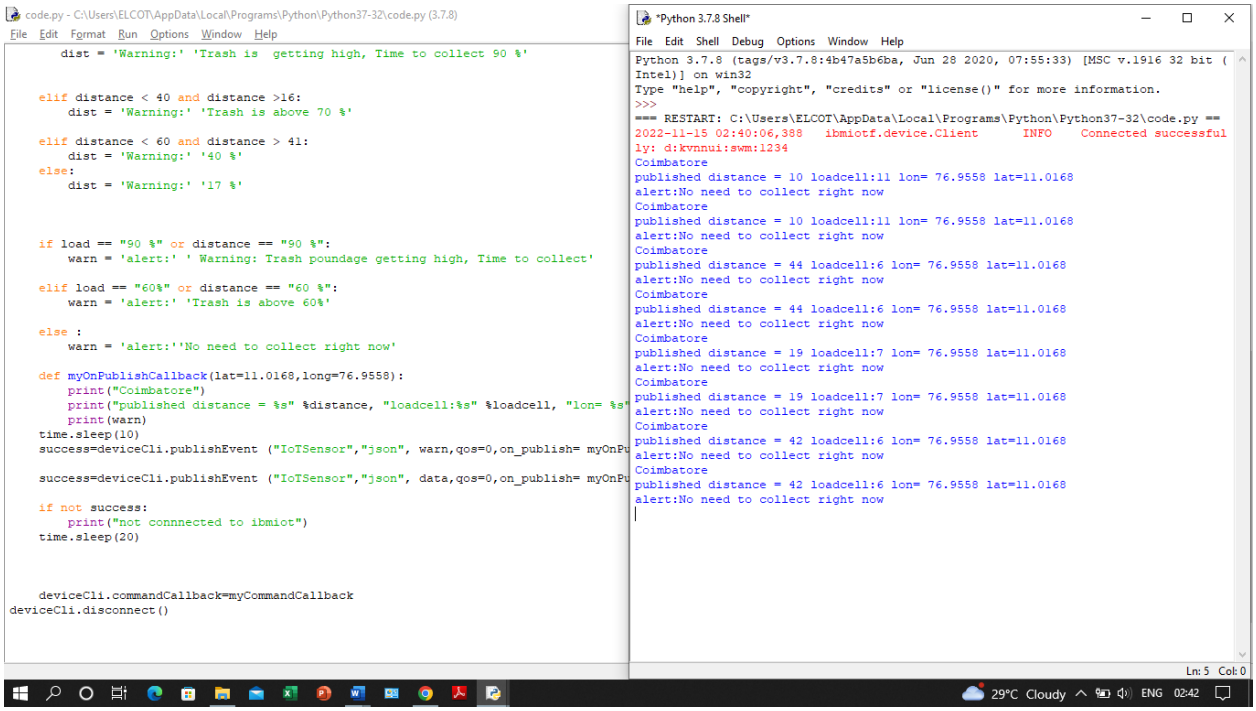
```
import requests
import json
import ibmiotf.application
import ibmiotf.device
import time
import random
import sys



organization = "kvnnui"
deviceType="swm"
deviceId="1234"
authMethod="token"
authToken="987654321"



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-14911-1659591796

Video link :

https://drive.google.com/file/d/1w0jacKE7gboCd6Zon4zXMag7Tipn8KMN/view?usp=share_link