K. L. N. COLLEGE OF ENGINEERING

(An Autonomous institution, affiliated to Anna University, Chennai)

ELECTRONICS AND COMMUNICATION ENGINEERING

Smart Waste Management System for Metropolitan Cities

INTERNET-OF-THINGS DOMAIN

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BONAFIDE CERTIFICATE

Certified that this project report "**SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES**" is the bonafide work of

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ABSTRACT

Day by day the population is rapidly growing and the economic broadening of the country, there is a very vast growth of the waste of management also. There is no actual right way of its solution or proper chain system to track and monitor the waste and disposal system. Cities are getting smart nowadays, but waste is not. Regardless of all the cities, the dustbins and waste are not getting tracked, sometimes the garbage in the bins gets to above the point, where it overflow outside the garbage pail and open out in whole areas and causes so many health issues to the citizens. The prototype schema which we are trying to address the waste management issues with several solutions like by using the smart bins which will indicate the level of the garbage inside the bins and will alert the admin to pick the garbage from the particular region to take action accordingly. In this system, it provides an effective solution to the waste management problem. This will minimize the frequent checking of garbage pail and keep the environment more hygienic and it aims to optimise waste collection and reduce fuel consumption.

LIST OF TABLES:

LIST OF FIGURES:

CHAPTER – 1

1. INTRODUCTION

1.1. PROJECT OVEREVIEW:

With increasing population and also changes in lifestyle municipal solid waste generation is increasing significantly. Hence waste management is a challenge in urban cities. The overall waste management involves three main types of entities; they are people who generate waste, waste collectors/city admin, stakeholders. Most of the waste isof organic matter, comprising 44.4%.These data of contents in the waste management is sent to stakeholder using cloud and also in order to have a complete waste management mechanism, and it is very important to have a smart way of notifying the quantity of eachtype of waste and involves the stakeholders effectively.

1.2. PURPOSE:

So a proper waste management system is necessary to avoid spreading some deadly diseases. Managing the smart bins by monitoring the status of it and accordingly taking the decision. This waste is further picked up by the municipal corporations to finally dump it in dumping areas and landfills. But due to lack of resources, ineffective groundwork, some waste is not collected which poses serious health hazard to the surrounding environment. Proper cleaning intervals may provide a solution to this problem. But keeping a track of the status of the bin manually is a very difficult job. These dustbins are interfaced with raspberry pi based system with ultrasonic sensors. Where the ultrasonic sensor detects the level of the dust in dustbin and sends the signals to raspberry pi the same signal are encoded and send to the application and it is received. The data has been received, analyzed and processed in the database, which displays the status of the Garbage in the dustbin on the application of authoritized person mobile. The concerned authority get alert about dustbin is full and informs person whoever is responsible for collecting garbage from the particular areas. The garbage trucks collect the garbage from the completely full dustbin and dispose it.

CHAPTER – 2

2. LITERATURE SURVEY:

2.1. EXISTING PROBLEM:

Seven reports were reviewed in detail for the literature review, with the majority of these providing some evidence to support the theory that the introduction of waste collections is associated with a reduction in waste arising. The following text should be reviewed with consideration given to the fact that these studies were not specifically designed to assess the impact of waste collections on at source food waste reduction. Therefore, evidence is taken from these reports to be used in different context from that in which it was collected. Overall the reports demonstrate that while there is some evidence to support the theory that implementing a waste collection can lead to an overall reduction in collected waste, there is currently no significant evidence to demonstrate to what extent this is due to prevention at source as opposed to diversion to home composting. A number of the reports support the need for further research in this area.

2.2. REFERENCES:

1) J. A. Nathanson, “Solid-waste management | Britannica.com.”

2) L. A. Manaf, M. A. A. Samah, and N. I. M. Zukki, “Municipal solid waste management in Malaysia: Practices and challenges,” Waste Manag., vol. 29, no. 11, pp. 2902–2906, Nov. 2009.

3) S. Sharmin and S. T. Al-Amin, “A Cloud-based Dynamic Waste Management System for Smart Cities,” in Proceedings of the 7th Annual Symposium on Computing for Development - ACM DEV ’16, 2016, pp. 1–4.

4) B. R. Balakrishnan Ramesh Babu, A. K. Anand Kuber Parande, and C.A. Chiya Ahmed Basha, “Electrical and electronic waste: a global environmental problem,” Waste Manag. Res., vol. 25, no. 4, pp. 307–318, Aug. 2007.

5) K. Kawai and L. T. M. Huong, “Key parameters for behavior related to source separation of household organic waste: A case study in Hanoi, Vietnam,” Waste Manag. Res., vol. 35, no. 3, pp. 246–252, Mar. 2017.

2.3. PROBLEM STATEMENT DEFINITION:

In the present day scenario, many times we see that the garbage bins or Dust bin are placed at public places in the cities are overflowing due to increase in the waste every day. It creates unhygienic condition for the people and creates bad smell around the surroundings this leads in spreading some deadly diseases & human illness, to avoid such a situation we are planning to design “Smart Waste Management System using IoT”. In this proposed System there are multiple dustbins located throughout 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 full. 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.

CHAPTER – 3

3. IDEATION & PROPOSED SOLUTION:

3.1. EMPATHY MAP CANVAS:

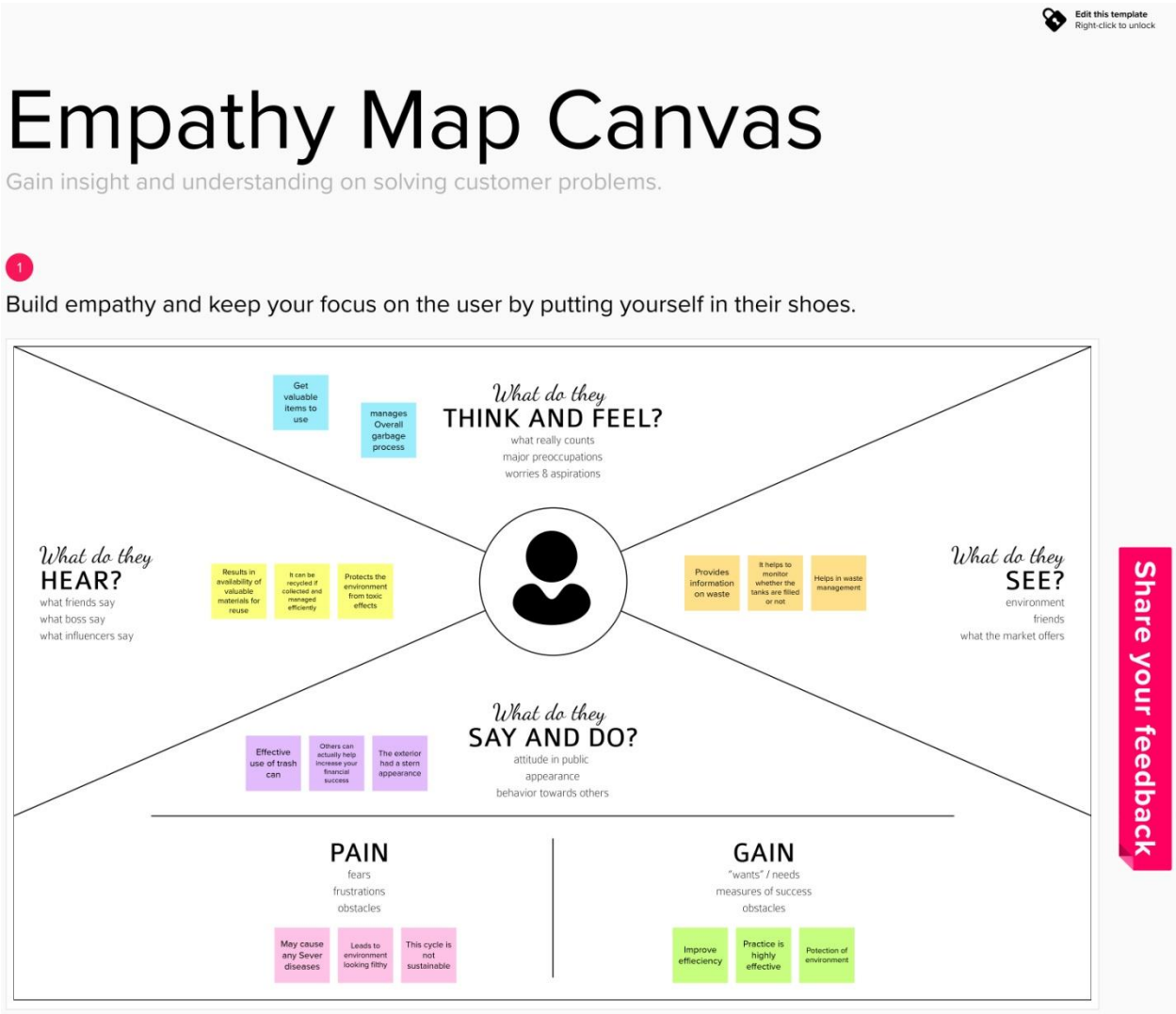


Figure – 3.1

3.2. IDEATION & BRAINSTORMING:

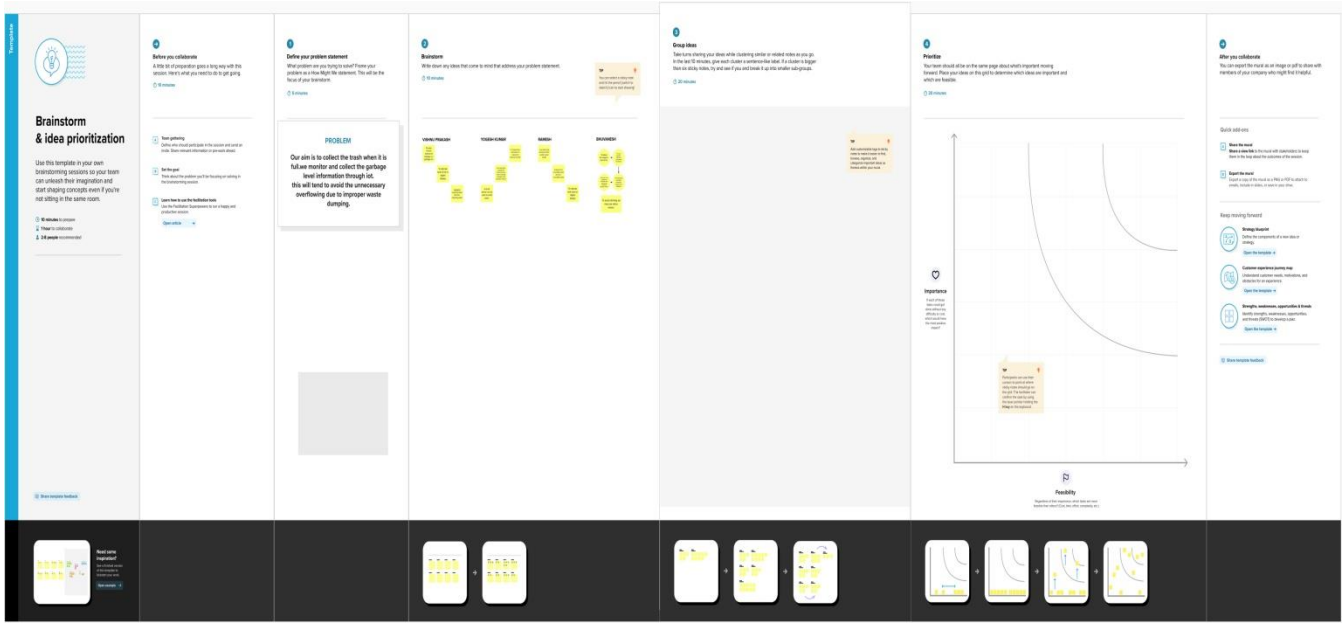


Figure – 3.2

3.3. PROPOSED SOLUTION:

S.NO.	PARAMETER	DESCRIPTION
1.	Problem Statement (Problem to be solved)	To find a solution for waste management system in metropolitan cities. • The manual monitoring of wastes in waste bins is a cumbersome process and utilizes more human effort, time and cost. • Irregular disposal of wastes causing trouble to people. • Foul smell around the place with uncollected wastes or garbage.
2.	Idea / Solution description	To create smart waste management system using Internet Of Things. • Creating an app, there by the corporation of a particular locality inside a metropolitan city can check the garbage bins whether they are filled or not. • This process is achieved by using an ultrasonic sensor to know the levels of garbage bin through cloud connection.
3.	Novelty / Uniqueness	Managing the wastages in metropolitan cities accurately. • To reduce the human-effort and difficulty in monitoring the garbage bins. • Unlike the conventional methods for collecting garbage bins, this method tells us to use the transport only in required places.
4.	Social Impact / Customer Satisfaction	It reduces the pollution and makes an healthy environment.

		• People can experience a clean environment. • Reduces the human effort involving inthe garbage disposal process. • This idea will be very much beneficial for a city corporation for monitoring the cleanliness of various parts of the city.
5.	Business Model (Revenue Model)	Disposal of waste in a smart way for the company purpose. • This project aims to support the municipal corporations. • Provide a clean environment. • This reduces a huge fuel cost to the city corporations by reducing the unwanted transport expenses to unnecessary places.
6.	Scalability of the Solution	Track the level of level of garbage in each area to find the amount of waste in metropolitan cities. • There is no need of new establishment of things. • Already present garbage bins are modified slightly. • It can be updated to automated garbage collection through vehicles.

3.4. PROBLEM SOLUTION FIT:

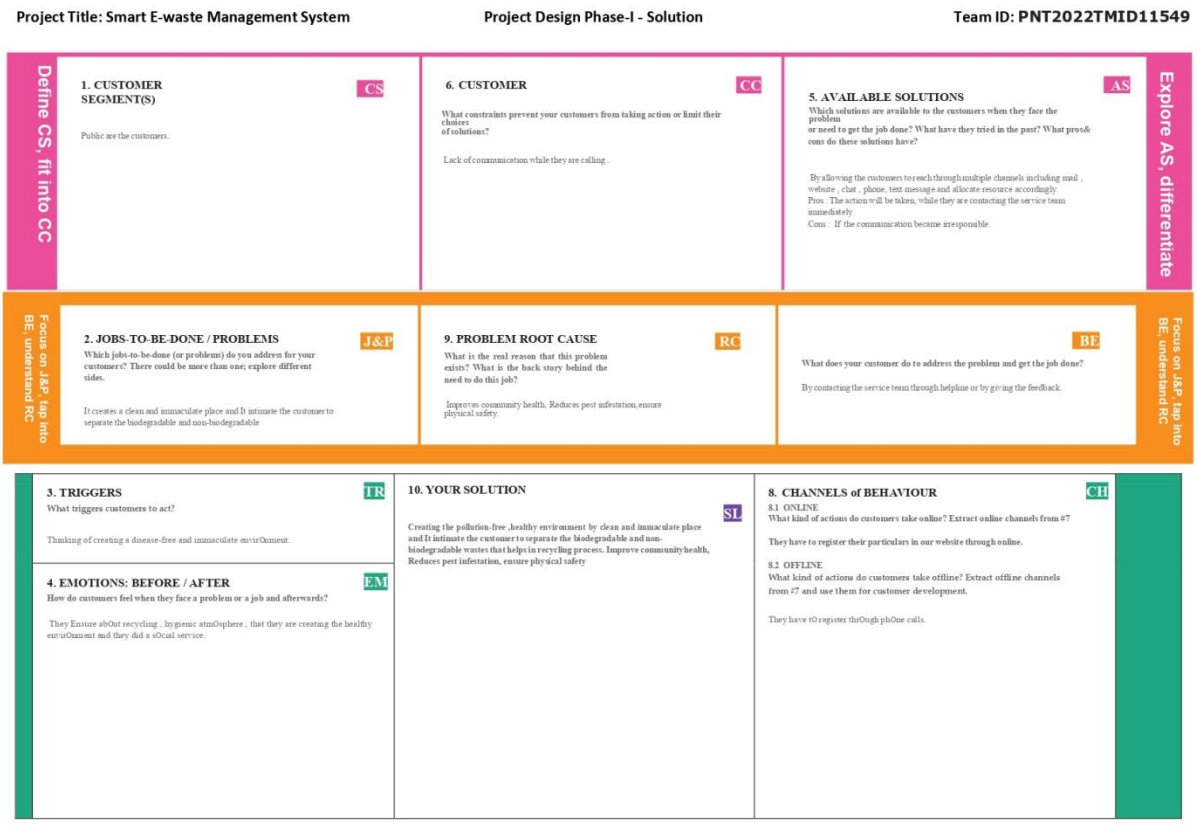


Figure – 3.3

CHAPTER – 4

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-Track)
FR-1	Detailed Explanation of bin	You can see bin details in the Dashboard – capacity, waste type, last measurement, GPS location and collection schedule.
FR-2	Monitoring using real time examples	Displays real-time data on fill-levels of bins monitored by smart sensors. With real-time data and predictions, you can eliminate the overflowing bins and stop collecting half-empty ones
FR-3	Cost of bins	It helps to identify bins that drive up your collection costs. The tool calculates a rating for each bin in terms of collection costs.
FR-4	Adjusting level of garbage	Identify areas with either dense or sparse bin distribution. Make sure all trash types are represented within a stand.
FR-5	Eliminate unsufficient garbage	Eliminate the collection of half-empty bins. By using real-time data on fill-levels and pick recognition, we can show you how full the bins you collect are.
FR-6	Planning for waste collection	The tool semi-automates waste collection route planning. Based on current bin fill-levels and predictions of reaching full capacity, you are ready to respond and schedule waste collection.

4.2. NON- FUNCTIONAL REQUIREMENTS:

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

NFR NO.	NON-FUNCTIONAL REQUIREMENT	DESCRIPTION
NFR-1	**Usability**	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**	Use a reusable garbage Purchase wisely and recycle Avoid single use food and drink containers
NFR-3	**Reliability**	Smart waste management is also about creating better working conditions for waste collectors and drivers.
NFR-4	**Performance**	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 data driven daily operations, available also as a waste management app.
NFR-5	**Availability**	Another purpose of this project is to make the proposed waste management system as cheap as possible. By developing & deploying resilient hardware and beautiful software we empower cities, businesses, and countries to manage waste smarter.
NFR-6	**Scalability**	By using smart waste bins, we able to monitor the garbage frequently and number of bins will be reduced.

CHAPTER – 5

5. PROJECT DESIGN:

5.1. DATA FLOW DIAGRAMS:

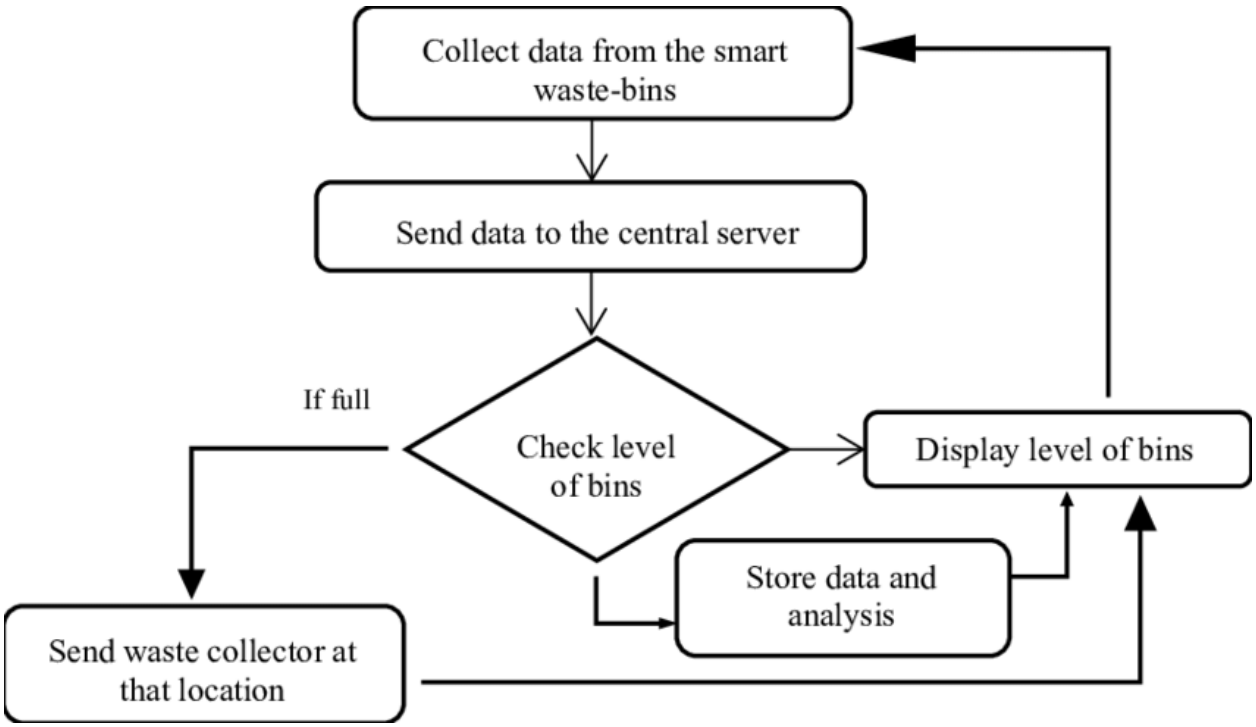


Figure – 5.1

5.2. SOLUTION & TECHNICAL ARCHITECTURE:

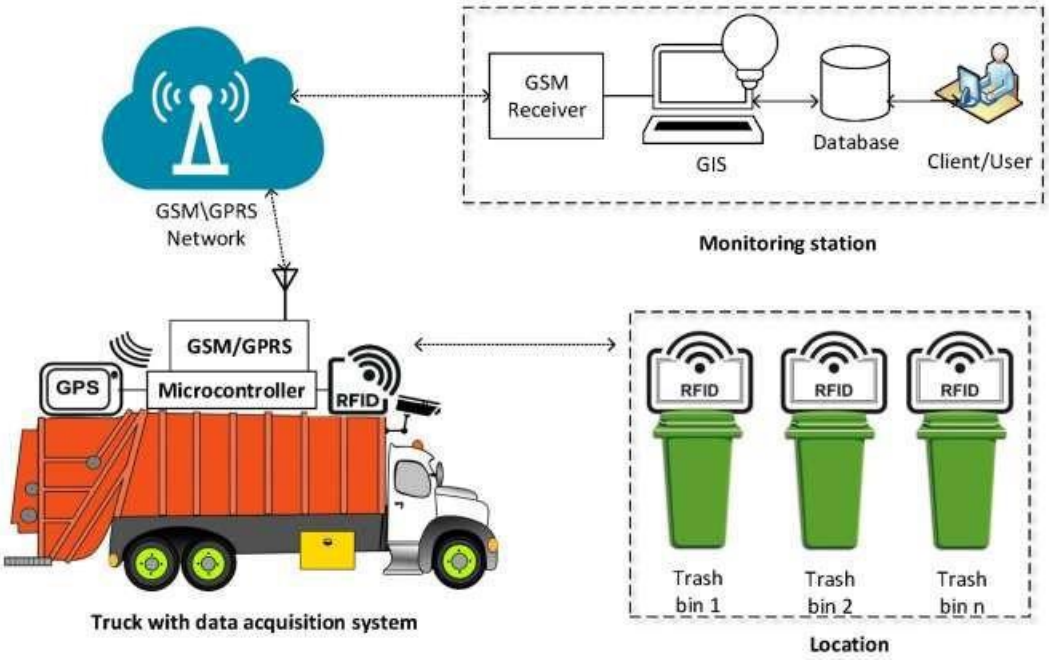


Figure – 5.2

5.3. USER STORIES:

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

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance Criteria	Priority	Release
Admin	Login	USN – 1	Admin gives a user id and password for each and every worker and helps to manage.	I can access my account / dashboard.	Medium	Sprint - 2
Assistant Admin	Login	USN – 2	They help us to monitor the garbage level once it is filled alert message will be thrown with location.	I can manage and monitor the garbage level	High	Sprint – 1
Driver	Login	USN – 3	They will follow the location where the garbage is filled and collect them in the truck.	I can drive to reach the garbage where it is filled using location and collect them.	Medium	Sprint – 2
Garbage Collector	Login	USN – 4	It will collect the trash and load it into the garbage truck and send to landfill.	I can collect the trash and load them in truck.	Medium	Sprint – 2
Government Municipality	Login	USN – 5	It will check the process without involving any issues.	I can manage the process smoothly.	High	Sprint - 1

CHAPTER – 6

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 Administrator, I need to give user id and pass code for ever workers over there in Municipality.	10	High	Bhuvanesh
Sprint – 1	Login	USN – 2	As Co-Admin, I'll control the waste level by monitoring them real time web portal. I'll notify trash truck with location of bin with bin ID.	10	High	Yogesh Kumar
Sprint – 2	Dashboard	USN – 3	As Truck Driver, I'll follow Admin's Instruction to reach the filling bin in short roots and save time.	20	Low	Ramesh
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	Vishnu Prakash
Sprint - 4	Dashboard	USN – 5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems.	20	High	Bhuvanesh

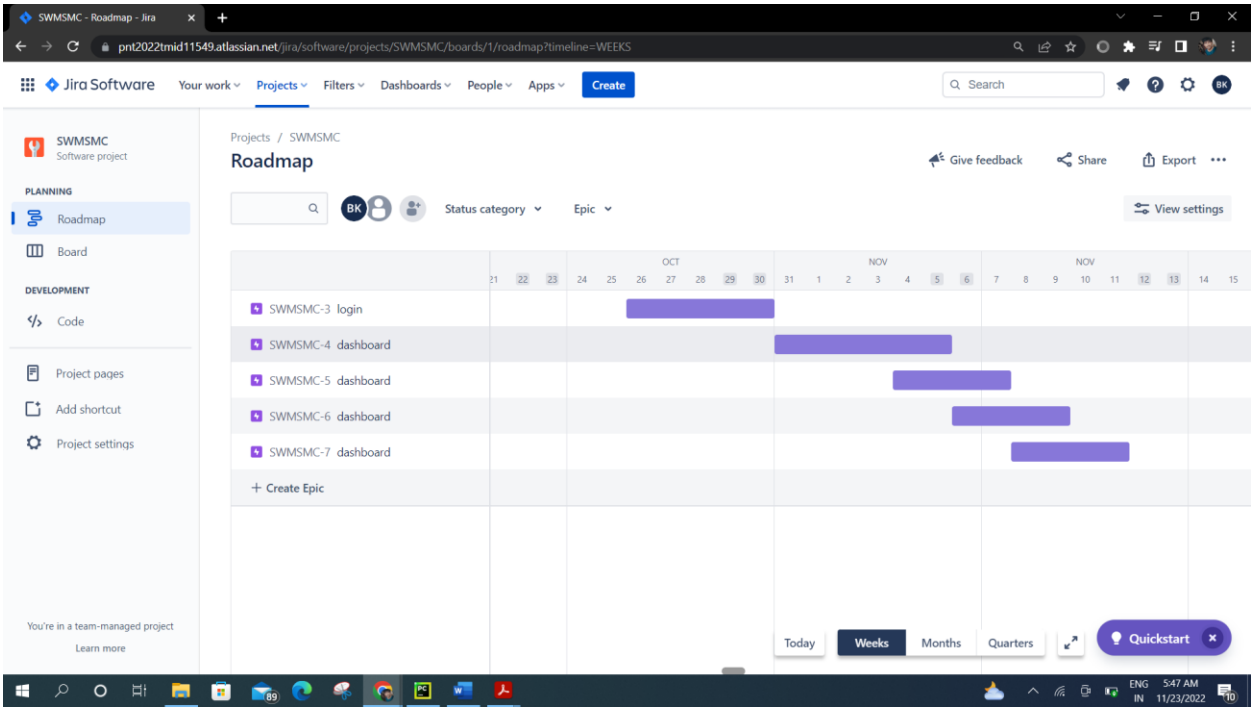
SPRINT	TOTAL STORY POINTS	DURATION	SPRINT START DATE	SPRINT END DATE (PLANNED)	STORY POINTS COMPLETED (AS ON PLANNED END DATE)	SPRINT RELEASE DATE (ACTUTAL)
Sprint – 1	20	6 DAYS	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint – 2	20	6 DAYS	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint – 3	20	6 DAYS	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint – 4	20	6 DAYS	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.2. SPRINT DELIVERY SCHEDULE:

TITLE	DESCRIPTION	DATE
Literature Survey & Information Gathering	Literature survey on the selected project & gathering information by referring the, technical papers, research publications etc.	28 SEPTEMBER 2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements.	24 SEPTEMBER 2022
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & Importance.	25 SEPTEMBER 2022
Proposed Solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	23 SEPTEMBER 2022
Problem Solution Fit	Prepare problem - solution fit document.	30 SEPTEMBER 2022
Solution Architecture	Prepare solution	28 SEPTEMBER 2022

	Architecture document.	
Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application.	20 OCTOBER 2022
Functional Requirement	Prepare the functional requirement document.	8 OCTOBER 2022
Data Flow Diagrams	Draw the data flow diagrams and submit for review.	9 OCTOBER 2022
Technology Architecture	Prepare the technology Architecture diagram	10 OCTOBER 2022
Prepare Milestone & Activity List	Prepare the milestones &activity list of the project.	22 OCTOBER 2022
Project Development - Delivery of Sprint - 1, 2, 3 &4	Develop & submit the developed code by testing it.	14 OCTOBER 2022

6.3. JIRA SOFTWARE:



CHAPTER – 7

7. CODING & SOLUTIONING:

7.1. PYTHON CODE:

```
import wiotp.sdk.device
import time
from geopy.geocoders import Nominatim
import random

myConfig = {
 "identity": {
 "orgId": "zal46w",
 "typeId": "NodeMCU",
 "deviceId":"12345"},
 "auth": {
 "token": "1234567890"
 }
}
id= [0]
geoloc=Nominatim(user_agent="geoapiExercises")

def init():
```

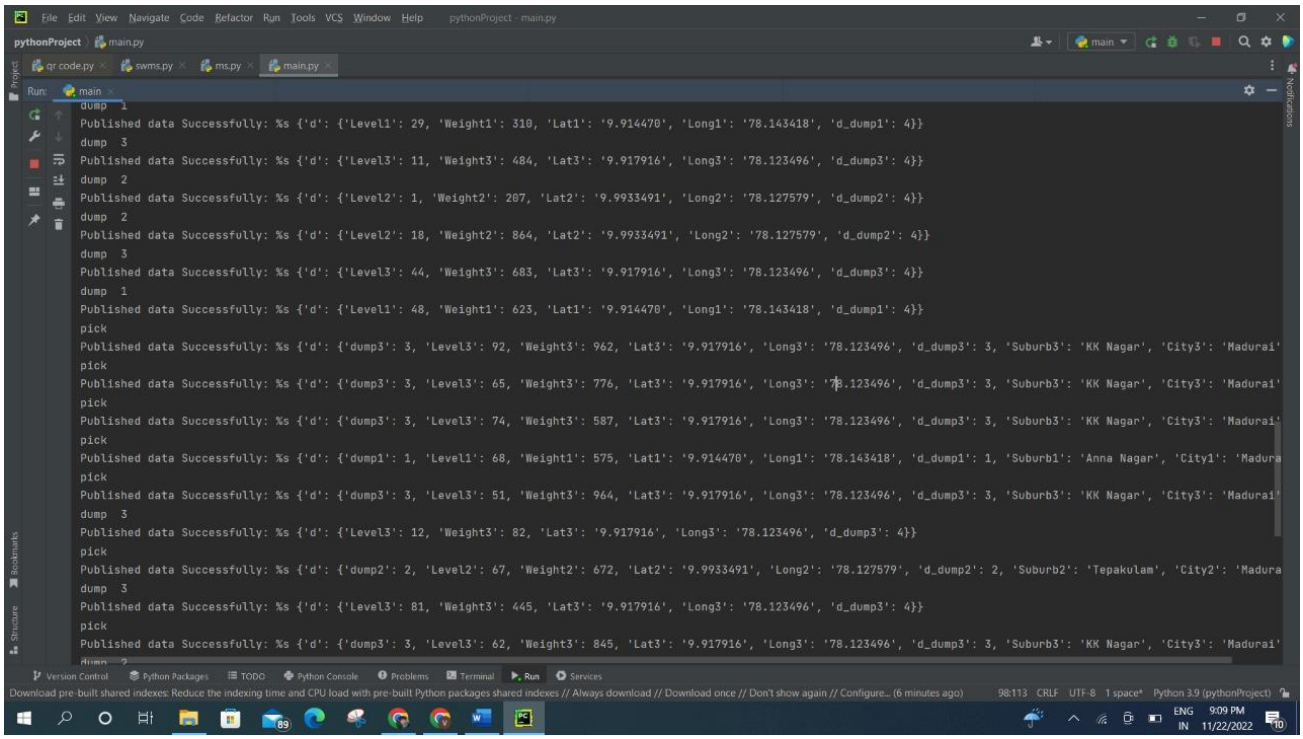
```
 lat, long = "9.914470", "78.143418"

 lat1, long1 = "9.9933491", "78.127579"

 lat2, long2 = "9.917916", "78.123496"

 location = geoloc.reverse(lat + "," + long)

 addr = location.raw['address']

 suburb = addr.get('suburb', '')

 city = addr.get('city', '')

 mydata = {'p': {'suburb1': suburb+", "+city, 'suburb2': "Tepakulam, "+city,
'suburb3': "KK Nagar,
"+city,'g_lat1':lat,'g_long1':long,'g_lat2':lat1,'g_long2':long1,'g_lat3':lat2,'g_long3':
long2}}

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


def dumpster_1():

 lat, long = "9.914470", "78.143418"

 location = geoloc.reverse(lat + "," + long)

 addr = location.raw['address']

 suburb = addr.get('suburb', '')

 city = addr.get('city', '')

 level = random.randint(1,100)

 weight = random.randint(1,1000)

 mydata = {'d': {'Level1': level, 'Weight1': weight, 'Lat1': lat, 'Long1':
long,'d_dump1':4}}
```

```
 if (level > 50 and weight > 500):
  mydata = {
   'd': {'dump1': dumpid, 'Level1': level, 'Weight1': weight, 'Lat1': lat, 'Long1': long,
'd_dump1':1,'Suburb1': suburb, 'City1': city}}
  client.publishEvent(eventId="status", msgFormat="json", data=mydata, qos=0,
onPublish=None)
  print("pick")
  time.sleep(2)
 else:
  client.publishEvent(eventId="status", msgFormat="json", data=mydata, qos=0,
onPublish=None)
  print("dump ", dumpid)
 print("Published data Successfully: %s", mydata)


def dumpster_2():
 lat, long = "9.9933491", "78.127579"
 location = geoloc.reverse(lat + "," + long)
 addr = location.raw['address']
 suburb = "Tepakulam"
 city = addr.get('city', '')
 level = random.randint(1,100)
 weight = random.randint(1,1000)
 mydata = {'d': {'Level2': level, 'Weight2': weight, 'Lat2': lat, 'Long2':
long,'d_dump2':4}}
```

```
 if (level > 50 and weight > 500):
  mydata = {
   'd': {'dump2': dumpid, 'Level2': level, 'Weight2': weight, 'Lat2': lat, 'Long2': long,'d_dump2':2,'Suburb2': suburb, 'City2': city}}
  client.publishEvent(eventId="status", msgFormat="json", data=mydata, qos=0, onPublish=None)
  print("pick")
  time.sleep(2)
 else:
  client.publishEvent(eventId="status", msgFormat="json", data=mydata, qos=0, onPublish=None)
  print("dump ", dumpid)
 print("Published data Successfully: %s", mydata)


def dumpster_3():
 lat, long = "9.917916", "78.123496"
 location = geoloc.reverse(lat + "," + long)
 addr = location.raw['address']
 suburb = "KK Nagar"
 city = addr.get('city', '')
 level = random.randint(1,100)
 weight = random.randint(1,1000)
 mydata = {'d': {'Level3': level, 'Weight3': weight, 'Lat3': lat, 'Long3': long,'d_dump3':4}}
```

```
 if (level > 50 and weight > 500):
  mydata = {
   'd': {'dump3': dumpid, 'Level3': level, 'Weight3': weight, 'Lat3': lat, 'Long3': long,'d_dump3':3,'Suburb3': suburb, 'City3': city}}
  client.publishEvent(eventId="status", msgFormat="json", data=mydata, qos=0, onPublish=None)
  print("pick")
  time.sleep(2)
 else:
  client.publishEvent(eventId="status", msgFormat="json", data=mydata, qos=0, onPublish=None)
  print("dump ", dumpid)
 print("Published data Successfully: %s", mydata)



def myCommandCallback(cmd):
 print("Message received from IBM IoT Platform: %s" % cmd.data['command'])
 m=cmd.data['command']
client = wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None)
client.connect()
while True:
 dumpid = random.randint(1,3)
 init()
 if dumpid == 1:
```

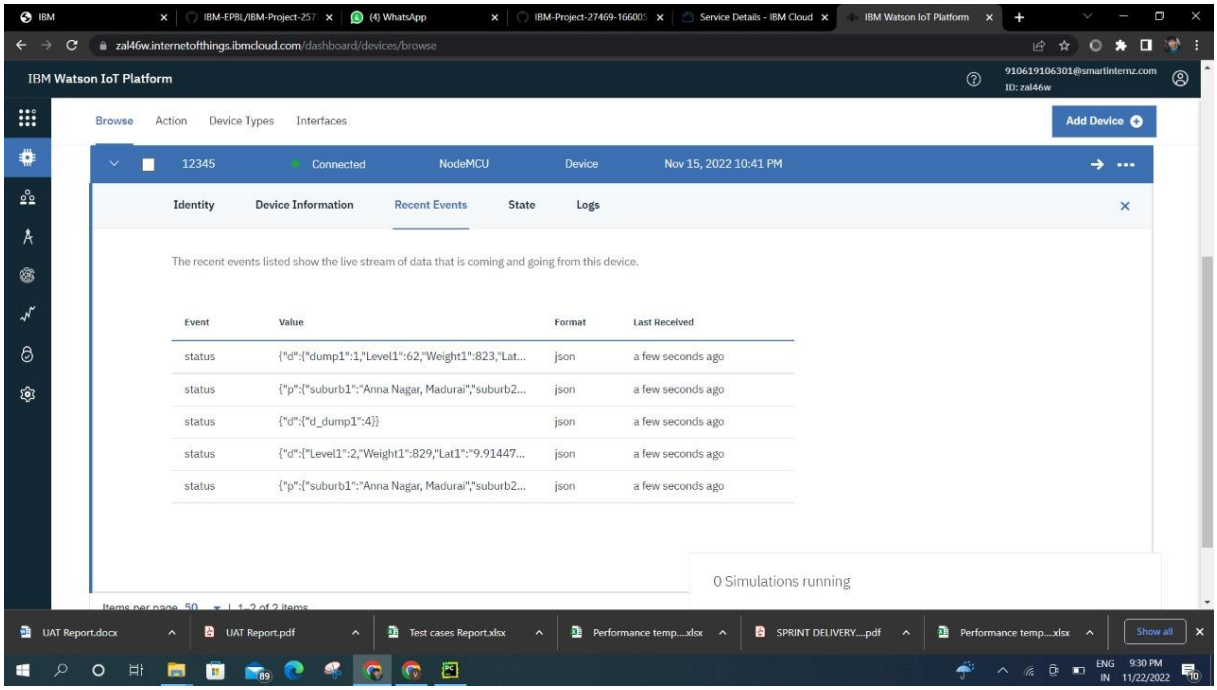
```
 dumpster_1()
elif dumpid == 2:
 dumpster_2()
elif dumpid==3:
 dumpster_3()


mydata = {'d': {'d_dump1': 4}}
 client.publishEvent(eventId="status", msgFormat="json", data=mydata, qos=0,
onPublish=None)


 client.commandCallback = myCommandCallback
 time.sleep(2)
client.disconnect()
```

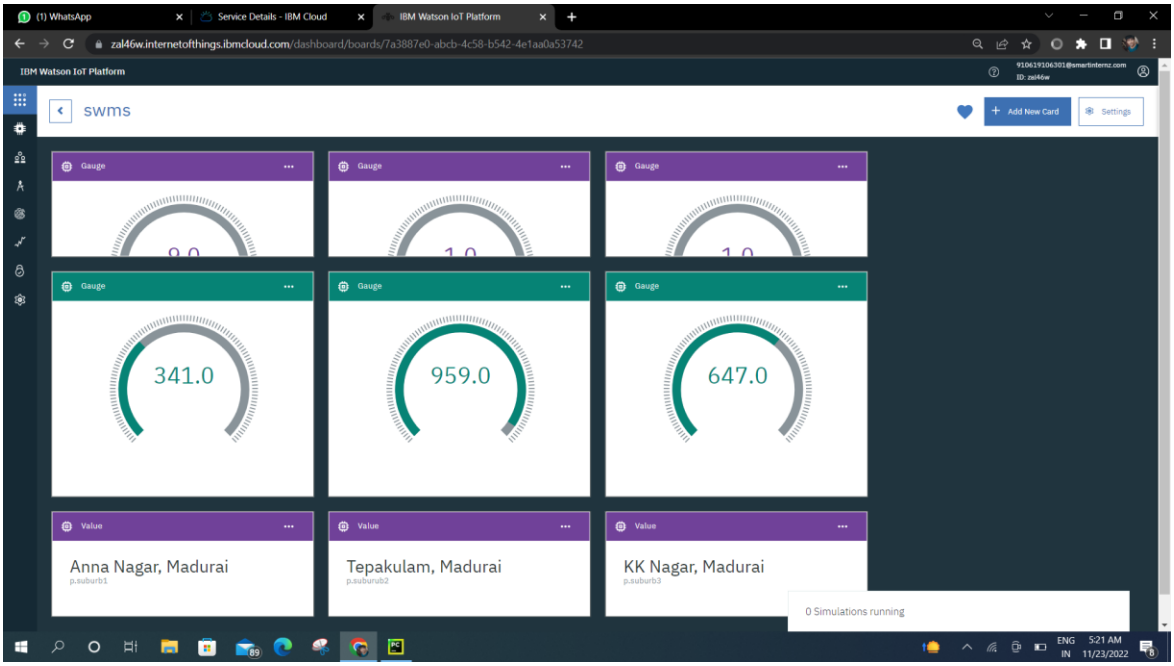


CHAPTER – 8

8. TESTING:

8.1. TEST CASES:





8.2. USER ACCEPTANCE TESTING:

Date	**10 November 2022**
Team ID	**PNT2022TMID11549**
Project Name	**Smart Waste Management System for Metropolitan Cities – IOT**
Maximum Marks	**4 Marks**

1. PURPOSE OF DOCUMENT

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

2. DEFECT ANALYSIS:

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

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

Totals	24	14	13	26	78

3. TEST CASE ANALYSIS:

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

Section	Total Cases	Not Tested	Fail	Pass
Python installation	7	0	0	7
Launch IBM Watson	45	0	5	40
IBM Watson and python integration	2	0	0	2
Install Node red	13	0	7	6
Interconnecting IBM Watson and Node red	19	0	10	9
Web UI dashboard	14	0	0	14
MIT app design	30	1	4	25
To View the Values in mobile Application	20	0	7	13
Totals	150	1	33	116

CHAPTER – 9

9.1. RESULTS:

We have implemented real time waste management system by using smart dustbins to check the fill level of smart dustbins whether the dustbin are full or not. In this system the information of all smart dustbins can be accessed from anywhere and anytime by the concern person and he/she can take a decision accordingly.

CHAPTER – 10

ADVANTAGES:

- ✓ Real time information on the fill level of the dustbin.
- ✓ Deployment of dustbin based on the actual needs.
- ✓ Cost Reduction and resource optimization.
- ✓ Improves Environment quality.
- ✓ Fewer smells.
- ✓ Cleaner cities.
- ✓ Intelligent management of the server.
- ✓ Effective usage of dustbins.

DISADVANTAGES:

- ✓ Time consuming and less effective: trucks go and empty containers whether they are full or not.
- ✓ High costs.
- ✓ Unhygienic Environment and look of the city.
- ✓ Bad smell spreads and may cause illness to human beings.

CHAPTER – 11

CONCLUSION:

Due to the absence of sustainable waste management technology, the current waste disposal situation is likely to worsen. This work presents an enhanced solution to the problem of waste management by the littering of the garbage bins once they are full. Littering of the environment and the health hazards are minimized as timely disposal of the wastes is ensured as the system automatically sends a message alert to the garbage collector or the management authority once the bin is full thereby ensuring that the bin is made empty to avoid dumping of refuse on the floor.

CHAPTER – 12

FUTURE SCOPE:

We can make separate dustbins for dry waste and wet waste . There are many birds and animals like dog, cat roaming around so we can add a cage to protect the dustbin from them. The key motivation is in achieving efficiency in the waste management sector at the national level. Issues in the waste management Waste truck drivers need a navigation system and reporting problem system. Citizens want to have better service, lower cost and having easily accessible reports. Inorder to maintain a clean and hygienic environment in the area around us, we are using the technology for the better garbage monitoring system. In big institutions or a city under a municipal corporation where there are extensive quantities of garbage bins deployed and workers are kept specifically for this task, the antiquated technique for physically hunting down filled garbage bins is wasteful and does not run well with the technological era we are in. Routine checks for cleaning the garbage bins which depend on time crevices are wasteful in light of the fact that a dustbin may get filled early or may get tampered and might require prompt consideration or there might not be any need of a routine check for a drawn out stretch of time. Likewise, to save fuel and time and make the entire process more effective and convenient, the workers

going on routine check should know the shortest route consisting of all the filled garbage bins.

CHAPTER – 13

GITHUB: https://github.com/IBM-EPBL/IBM-Project-25779-1659973172

PROJECT DEMO LINK:
https://www.youtube.com/watch?v=tIOvJeuCM9o&feature=youtu.be