# PROJECT REPORT

SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITAN CITIES

**TEAM ID:PNT2022TMID46746**


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Team member : KABISHENA P
Team member : SARASWATHI K

# Project Report Format

## 1. INTRODUCTION

### 1.1 Project Overview:

Our waste generation is constantly growing to form a global garbage crisis. Even though we indulge in creating a more sustainable and greener, we still fail to handle our waste generation and management. Combining technology support with a vision of social, economic and environmental sustainability is the best way out of this problem. It is done in the following manner. The smart bin system undergoes a thorough system check and battery level monitoring in order to function efficiently. If the battery level is found to be low, it has to be recharged immediately, else it can proceed to the next step. The threshold level levels of the bin are indicated my multiple sensors attached to bin. If the garbage exceeds the level, then an alert message is sent to the garbage collectors as well as to the municipality or area administration. The area in which garbage is found to overflow is allocated to respective garbage collectors in the form of messages through GSM system. Once the waste bin is emptied, an information update is sent to the municipality and server is updated. This is how the waste from bins can be efficiently handled and managed using technology which in turn keeps the environment clean and healthy.

### 1.2 Purpose:

We amalgamate technology along with waste management in order to effectively create a safe and a hygienic environment. 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. 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. A good level of coordination exists between the garbage collectors and the information supplied via technology. This makes them well aware of the existing garbage level and instigate them whenever the bins reach the threshold level. They are sent with alert messages so that they can collect the garbage on time without littering the surrounding area. The fill patterns of specific containers can be identified by historical data and managed accordingly in the long term. In addition to hardware solutions, mobile applications are used to overcome the challenges in the regular waste management system, such as keeping track of the drivers while they are operating on the field. Thus, smart waste management provides us with the most optimal way of managing the waste in an efficient manner using technology

## 2. LITERATURE SURVEY:

### 2.1 Existing problem:

Waste management has become an alarming challenge in local towns and cities across the world. Often the local area bins are overflowing and the municipalities are not aware of it. This affects the residents of that particular area in numerous ways starting from bad odour to unhygienic and unsafe surroundings. Poor waste management - ranging from non-existing collection systems to ineffective disposal -causes air pollution, water and soil contamination. Open and unsanitary areas contribute to contamination of drinking water and can cause infection and transmit diseases. Toxic components such as Persistent Organic Pollutants (POPs) pose particularly significant risks to human health and the environment as they accumulate through the food chain. Animals eating contaminated plants have higher doses of contaminants than if they were directly exposed. Precipitation or surface water seeping through waste will absorb hazardous components from landfills, agricultural areas, feedlots, etc. and carry them into surface and groundwater. Contaminated groundwater also poses a great health risk, as it is often used for drinking, bathing and recreation, as well as in agricultural and industrial activities. Landfills and waste transfer stations can attract various pests (insects, rodents, gulls, etc.) that look for food from waste. These pests can spread diseases through viruses and bacteria (i.e., salmonella and e-coli), which are a risk to human health.

### 2.2 References:

**PAPER 1:**

**TITLE:** IoT Based Waste Management for Smart City

**AUTHOR NAME:** Parkash Tambare, Prabu

Venkatachalam**PUBLICATION YEAR:** 2016

**DESCRIPTION:**

In the current situation, we frequently observe that the trash cans or dust cans that are located in public spaces in cities are overflowing due to an increase in the amount of waste produced each day. We are planning to construct “IoT Based Waste Management for Smart Cities” to prevent this from happening because it makes living conditions for people unsanitary and causes unpleasant odours in the surrounding area. There are numerous trash cans scattered throughout the city or on the campus that are part of the proposed system. Each trash can is equipped with a low-cost embedded device that tracks the level of the trash cans and an individual ID that will enable it to be tracked and identified.

**PAPER 2:**

**AUTHOR NAME:** Mohammad Aazam, Marc St-Hilaire, Chung-Horng Lung, Ioannis Lambadaris

**PUBLICATION YEAR:** 2016 **DESCRIPTION:**

Each bin in the Cloud SWAM system that Mohammad Aazam et al suggested has sensors that can detect the amount of waste inside. There are separate bins for organic, plastic/paper/bottle/glass, and metal waste. This way, each form of waste is already divided, and it is known how much and what kind of waste is collected thanks to the status. Different entities and stakeholders may benefit from the accessibility of cloud-stored data in different ways. Analysis and planning can begin as soon as garbage is collected and continue through recycling and import/export-related activities. Timely garbage collection is provided via the Cloud SWAM system. A timely and effective method of waste collection improves health, hygiene, and disposal.

**PAPER 3:**

**TITLE:** Arduino Microcontroller Based Smart Dustbins for Smart Cities**AUTHOR NAME:** K. Suresh, S. Bhuvanesh and B. Krishna Devan **PUBLICATION YEAR:** 2019 **DESCRIPTION:**

In this paper, a technique for cleaning up our surroundings and environment is described. The Indian government just began work on a smart city initiative, and in order for these towns to be smarter than they already are, the garbage collection and disposal system must be improved upon. Self-Monitoring Automated Route Trash (SMART) dustbins are intended for use in smart buildings such as colleges, hospitals, and bus stops, among other places. In this study, we have employed the PIR and Ultrasonic sensors to detect human presence, the Servomotor to open the dustbin lid, and the Ultrasonic sensor to detect the level of rubbish. Signals between two trash cans are transmitted using a communication module, and the GSM module sends the message to the operator.

**PAPER 4:**

**AUTHOR NAME:** Mohd Helmy Abd Wahab, Aeslina Abdul Kadir,

Mohd Razali Tomari and Mohamad Hairol Jabbar

**PUBLICATION YEAR:** 2014

**DESCRIPTION:**

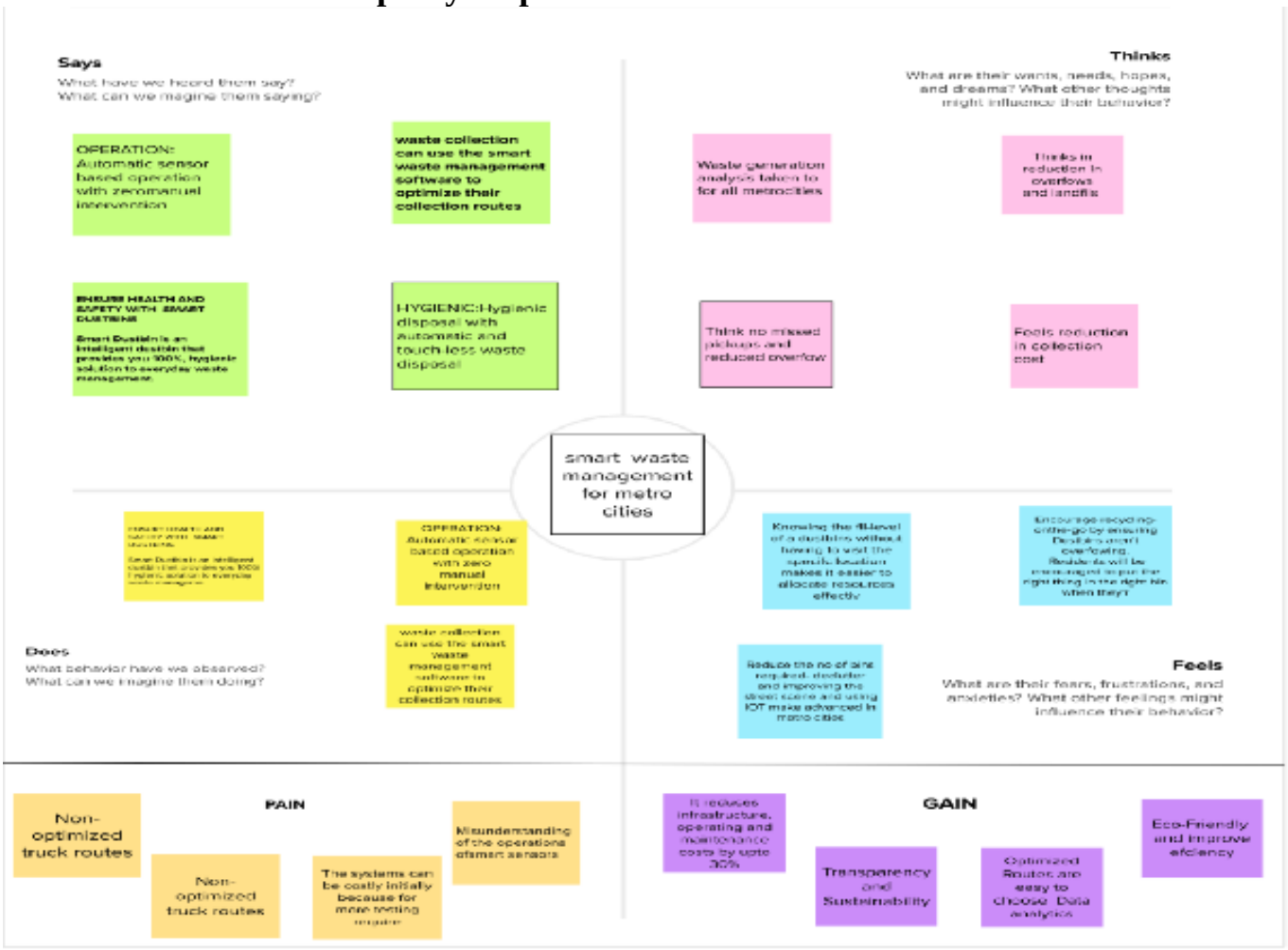
Proposed a smart recycle bin that can handle the recycling of plastic, glass, paper, and aluminium cans. It generates a 3R card after automatically determining the value of the trash thrown away. The recycle system makes it possible to accumulate points for placing waste into designated recycle bins. By allowing the points to be redeemed for goods or services, such a system promotes recycling activities. The system keeps track of information on disposal procedures, materials disposed of, user identification, and points accrued by the user. To use the recycle bin, the user must tap his card to the designated RFID reader. Doors to recycling bins are opened, and rubbish is placed one by one.

# Problem Solution fit:

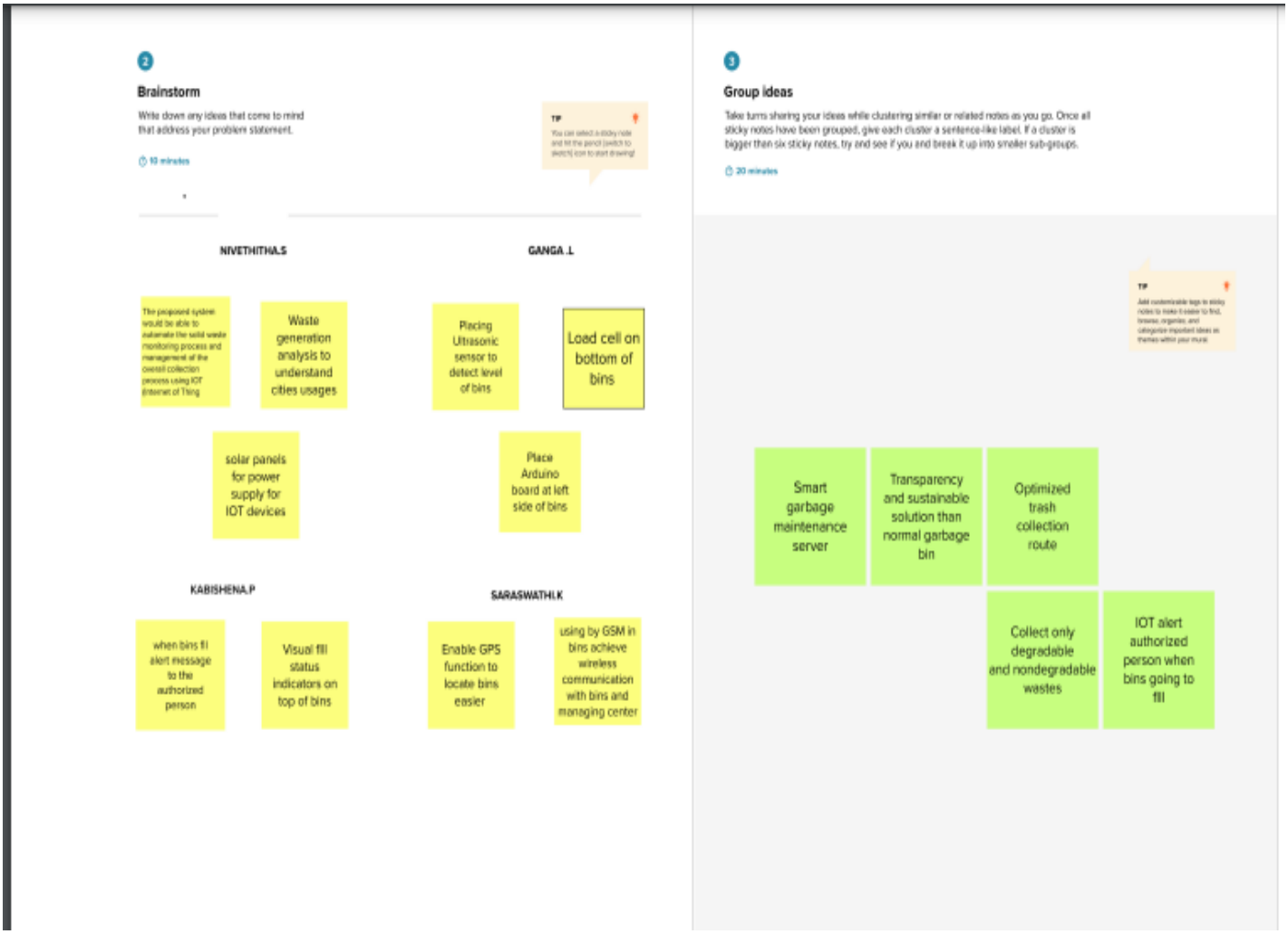
| **Problem Statement(PS)** | **I am (Customer)** | **I am trying to** | **But** | **Because** | **Which makes me feel** |
|---|---|---|---|---|---|
| PS-1 | Householder | Dispose the vegetable waste and other household waste | It increases the land pollution and contaminate ground water | To keep the surroundings clean and healthy. | Difficult |
| PS-2 | industrialist | Dispose the chemical waste and recycle for future use. | It contaminates wildlife's habitats and endangers the life of people at large. | To avoid risk for both environment and human health. | Unpleasant. |

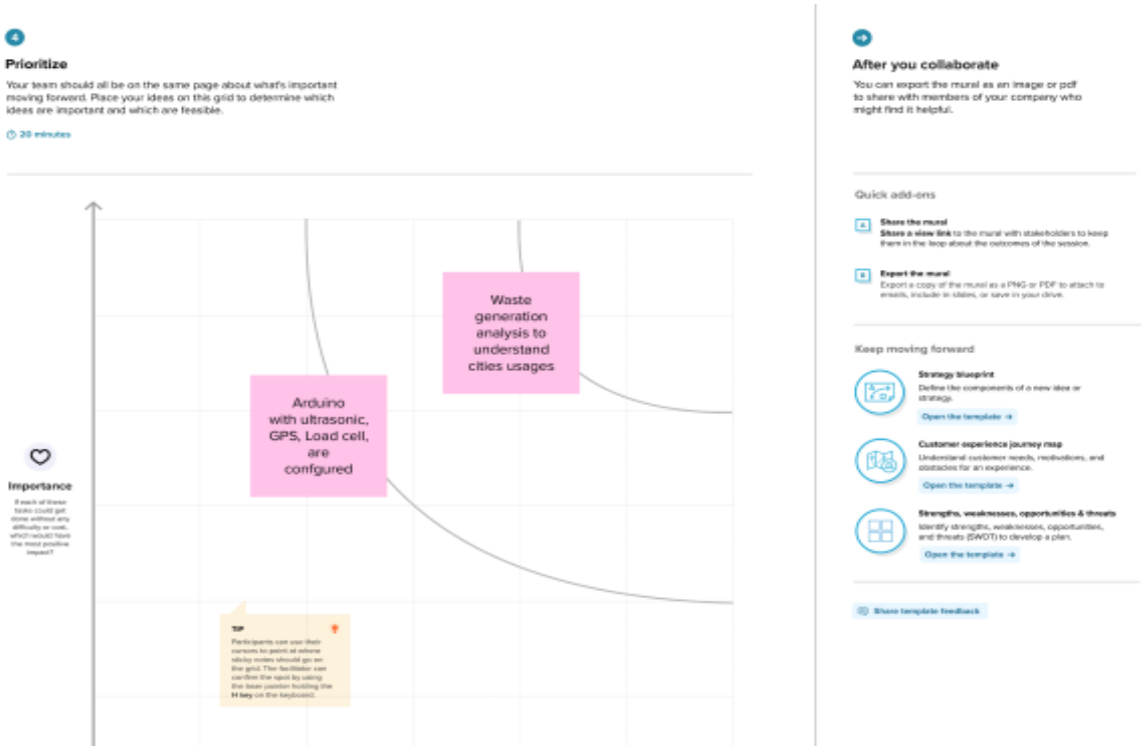
# 3. IDEATION & PROPOSED SOLUTION:

## 3.1 Empathy map canvas:



## 3.2 Ideation & Brainstorming:



### 3.3 Proposed Solution:

| S.NO | PARAMETER | DESCRIPTION |
|---|---|---|
| 1. | Problem statement (problem to be solved). | 1.To manage the waste in metropolitan cities using smart technique. |
| 2. | Idea/ sloution description. | 1.To implement a smart bin built on a microcontroller based platform ArduinoUnoboard.<br>2. which is interfaced with GSM modemand Ultrasonic sensor ,which can gives the status of the waste present in the dustbin to the municipal authority. |
| 3. | Novelty/uniqueness. | 1.Immediate Transferring of data about each bin to the control room.<br>2.Accurate indication.<br>3.Weight of the trashes are indicated. |
| 4. | Social impact/ customer satisfaction. | 1.It reduces the overflow of trashes in the bin.<br>2.It Reduces the pollution.<br>3.It provides vibrant environment<br>4.Reduces the Breeding of disease vectors (mosquito, Housefly,cockroach ,microbes, Etc.,)<br>5. Easy collection and discharging of waste by the concern authority at regular intervals. |
| 5. | Business model(revenue model). | 1.The Waste are put in the bin by the public<br>2.The bins sense the level of trash.<br>3.It provides the indication of each stage of the waste dumped by using the LED.<br>4.Once the trash completely fills the bin<br>5.Information is provided to the control room.<br>6.The trash is collected and the bin will be emptied by the corporation. |
| 6. | Scalability of the solution. | 1.Well monitoring system with accurate indication.<br>2. Reduce the waste efficiently.<br>3.Easy maintenance.<br>4.Reasonable cost. |

## 3.4 Problem solution fit:

### 3.5 Functional requirement

Following are the functional requirements of the proposed solution.

| FR No. | Functional Requirement (Epic) | Sub Requirement (Story / Sub-Task) |
|---|---|---|
| FR-1 | User Registration | Registration through Form<br>Registration through Gmail<br>Registration through LinkedIN |
| FR-2 | User Confirmation | Confirmation via Email<br>Confirmation via OTP |
| FR-3 | User waste categories. | User decay<br>User non-decay |
| FR-4 | User dustbin | User size<br>User capacity |
| FR-5 | Eliminate unefficient picks. | Eliminate the collection of half-empty bins.<br>The sensors recognize picks |
| FR-6 | Plan waste collection routes. | The tool semi-automates waste collection route planning |

## Non-functional Requirements:

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

| FR No. | Non-Functional Requirement | Description |
|---|---|---|
| NFR-1 | Usability | 1.IoT device verifies that usability is a special and important perspective to analyze user requirements,which can further improve the design quality.<br>2. 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. |
| NFR-2 | Security | 1.Use a reusable bottles<br>2. Use reusable grocery bags<br>3. Purchase wisely and recycle |

| | | |
|---|---|---|
| NFR-3 | Reliability | 1.Smart waste management is also about creating better working conditions for waste collectors and drivers.<br>2. Instead of driving the same collection routes and servicing empty bins, waste collectors will spend their time more efficiently, taking care of bins that need servicing |
| NFR-4 | Performance | 1.The Smart Sensors use ultrasound technology to measure the fill levels (along with other data) in bin several times a day.<br>2. Using a variety of IoT networks(NB IoT,GPRS), the sensors send the data to Smart Waste Management Software System, a powerful cloud-based platform,<br>for data-driven daily operations, available also as a waste management app.<br>3. 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 , cities because we able to monitor the garbage 24/7 more cost effect and scalability when we moves to smarter. |

## 4. PROJECT DESIGN:

### 4.1 **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 A smart waste management platform uses analytics to translate the data gather in your **bins into actionable insights to help you improve your waste services.** You can receive data on metric such as:

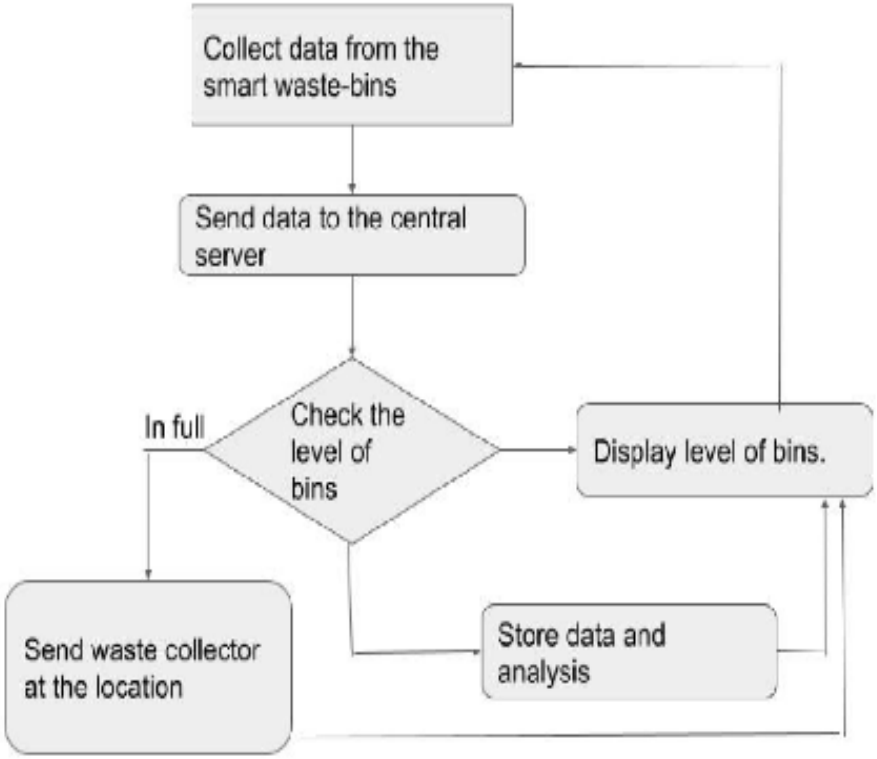
- The first test conducted is the situation where the garbage bin is empty or its garbage level is very low

- Then, the bin is filled with more garbage until its level has surpassed the first threshold **value, which is set to 80% then the first warning SMS is being sent, as depicted**
- The first notification SMS sent by the system, once the waste reaches the level of 85% full
- The second notification SMS sent by the system, indicating that bin is at least 95% full and **the garbage needs to be collected immediately**

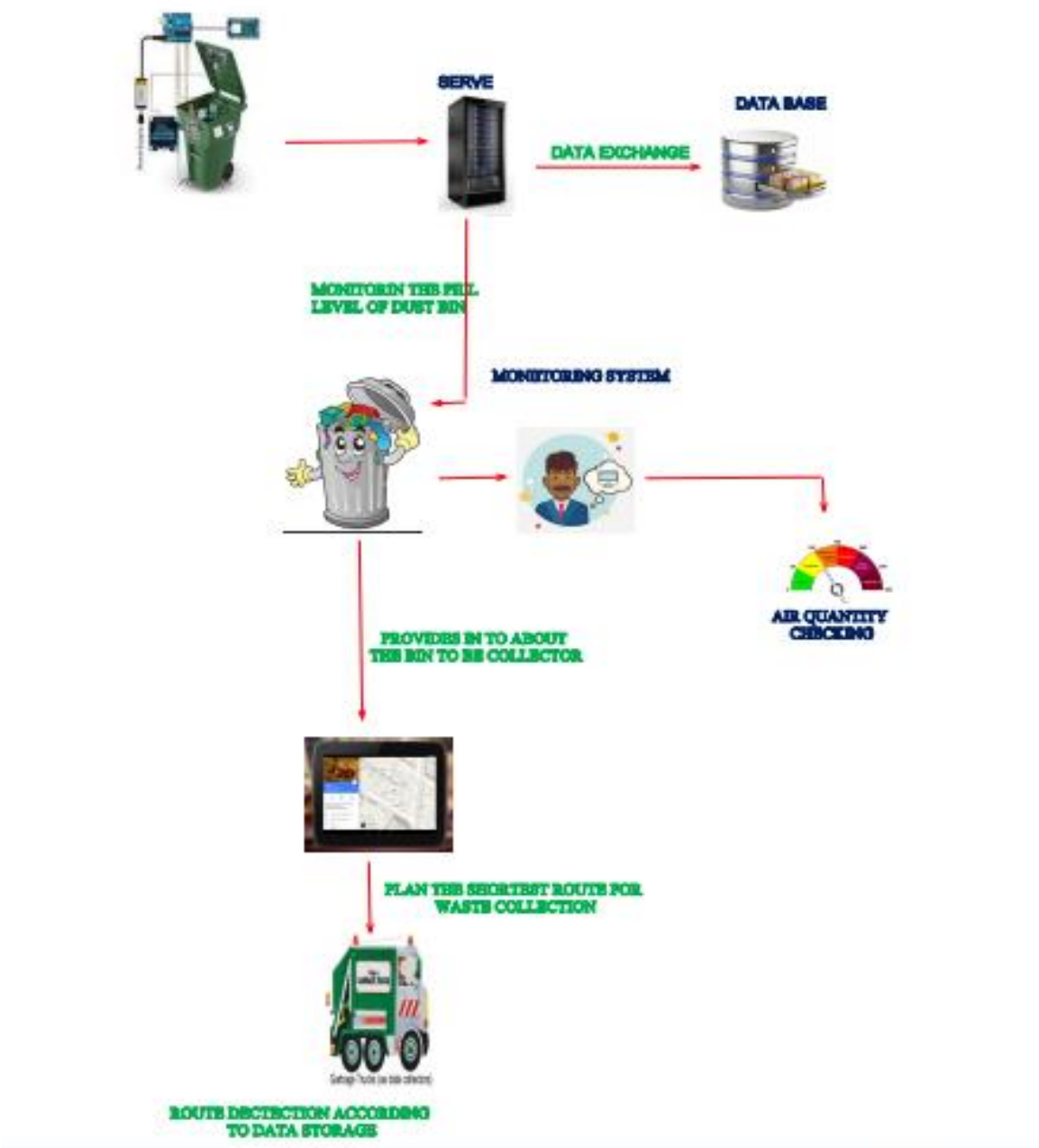
- Locations prone to overflow
- The number of bins needed to avoid overflowing waste
- The number of collection services that could be saved
- The amount of fuel that could be saved
- The driving distance that could be saved

**Data flow diagram:**

# FLOW DIAGRAM:



## 4.2 Solution & Technical Architecture:



### 4.3 Userstories:

| User type | Functional Requirement (EPIC) | User story Number | User story/Task | Acceptance criteria | priority | Release |
|---|---|---|---|---|---|---|
| Admin (who manage web server) | login | USN-1 | Ass an admin,I gave user id and pass word for ever workers and manage them. | I can manage web account/dashboard | medium | Sprint-2 |
| Co admin | login | USN-2 | ASa Co admin.I am manage garbageget filling alert I will post location and garbage id to trash truck | I can manage garbage monitoring | high | Sprint-1 |
| Truck driver | login | UNS-3 | A struck driver,I am follow the route sebd by CO admin to reach the filling garbage. | I can drive to reach the garbage filled route in pulled to | medium | Sprint-2 |
| Local garbage collector | login | UNS-4 | As a waste collector, I am collect all there trash from garbage and load into garbage truck and send them to landfillt | I can collect trach and pulled to truck and send off | High | Sprint-2 |
| municipality | login | UNS-5 | As municipality, I am check the process are happening In disciplinemanner without any any issues. | I can manage all these process going good. | High | Sprint-2 |

## 5. PROJECT PLANNING & SCHEDULING:

### 5.1 Sprint Planning & Estimation:

| PHASE | TITLE | DESCRIPTION |
|---|---|---|
| Ideation Phase | Literature Survey & Information Gathering | Literature survey on the selected project & gatheringinformation by referring the,technical papers, research publications etc. |
| | Prepare Empathy Map | Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements |
| | Ideation | List the by organizing the brainstorming session and prioritize the top 3 ideas based onthe feasibility & importance. |
| Phase-1 | Proposed Solution | Prepare the proposed solution document, which includes thenovelty, feasibility of idea, business model, social impact,scalability of solution, etc. |
| | Problem Solution Fit | Prepare problem - solution fitdocument. |
| | Solution Architecture | Prepare solution architecturedocument. |

| | | |
|---|---|---|
| Phase-2 | Customer Journey | Prepare the customer journey mapsto understand the user interactions & experiences with the application(entry to exit). |
| | Functional Requirement | Prepare the functional and Nonfunctional requirementdocument. |
| | Data Flow Diagrams | Draw the data flow diagrams andsubmit for review. |
| | Technology Architecture | Prepare the technology architecturediagram. |
| Project planning phase | Prepare Milestone & ActivityList | Prepare the milestones & activitylist of the project. |
| Project development phase | Project Development - Delivery of Sprint-1, 2, 3 & 4 | Develop & submit the developedcode by testing it. |

## 5.2 Sprint Delivery Schedule:

| Sprint | Functional Requirement (Epic) | User Story Number | User Story / Task | Story Points | Priority | Team Members |
|---|---|---|---|---|---|---|
| Sprint-1 | Login | USN-1 | 1.As a Administrator, I need to give user id and passcode for ever workers over there in municipality. 2.As a Co-Admin, I'll control the waste level by monitoring them vai real time web portal. Once the filling happens, I'll notify trash truck with location of bin with bin ID | 20 | HIGH | GANGA |
| Sprint-2 | Dashboard | USN-2 | As a Truck Driver, I'll follow Co-Admin's Instruction to reach the filling bin in short roots and save time | 20 | LOW | NIVETHITHA |
| Sprint-3 | Dashboard | USN-3 | As a Local Garbage Collector, I'll gather all the waste from the garbage, load it onto a garbage truck, and deliver it to Landfills | 20 | MEDIUM | SARASWATHI |
| Sprint-4 | Dashboard | USN-4 | As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems | 20 | HIGH | KABISHENA |

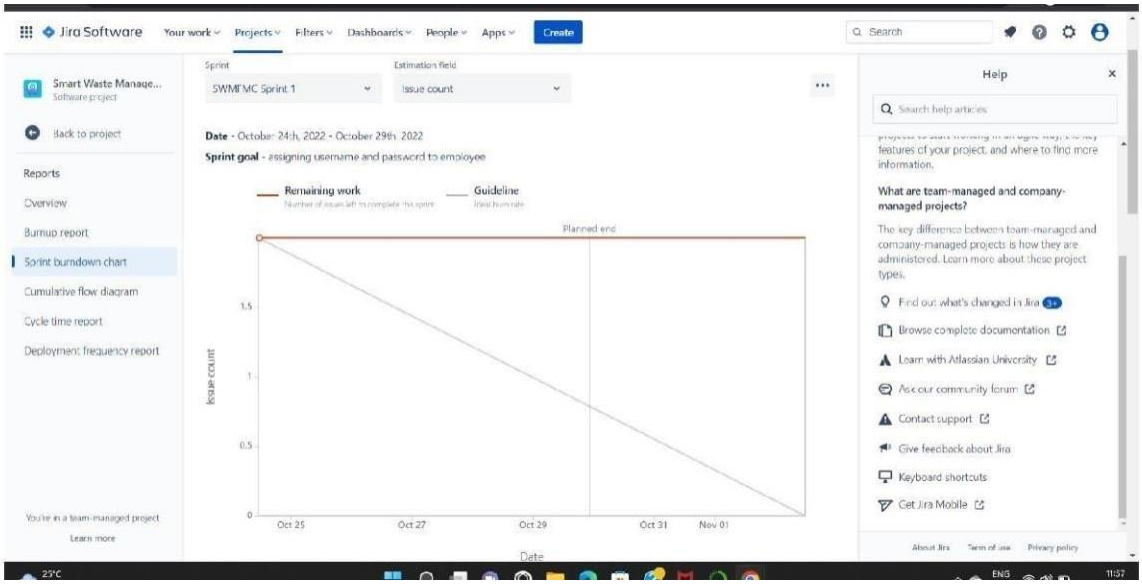
## Project Tracker, Velocity & Burndown Chart:

| Sprint | Total Story Points | Duration | Sprint StartDate | Sprint EndDate (Planned) | Story Points Completed ( Planned EndDate) | SprintRelease Date (Actual) |
|---|---|---|---|---|---|---|

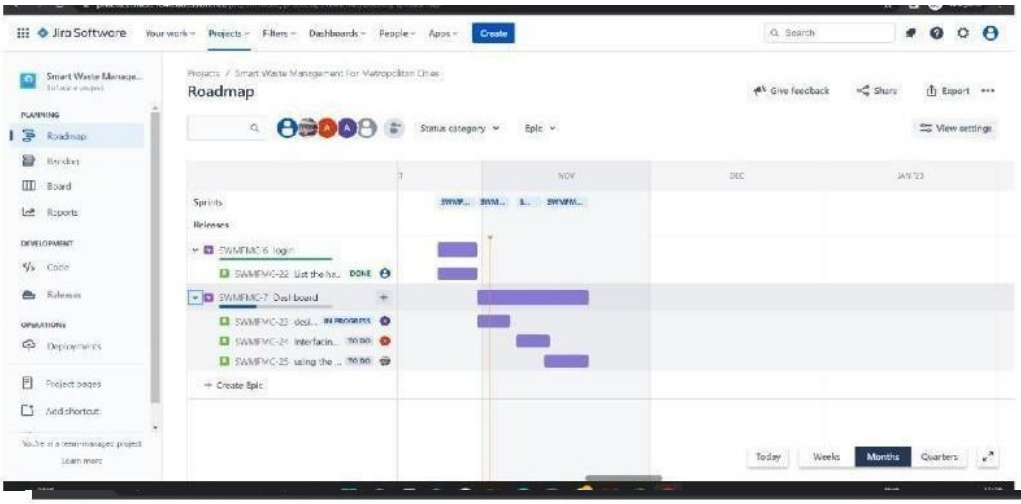
| | | | | | | |
|---|---|---|---|---|---|---|
| Sprint-1 | 20 | 6 Days | 22 Oct 2022 | 27 Oct 2022 | 20 | 06 Nov 2022 |
| Sprint-2 | 20 | 6 Days | 31 Oct 2022 | 05 Nov 2022 | 30 | 07 Nov 2022 |
| Sprint-3 | 20 | 6 Days | 07 Nov 2022 | 12 Nov 2022 | 49 | 08 Nov 2022 |
| Sprint-4 | 20 | 6 Days | 14 Nov 2022 | 19 Nov 2022 | 50 | 09 Nov 2022 |

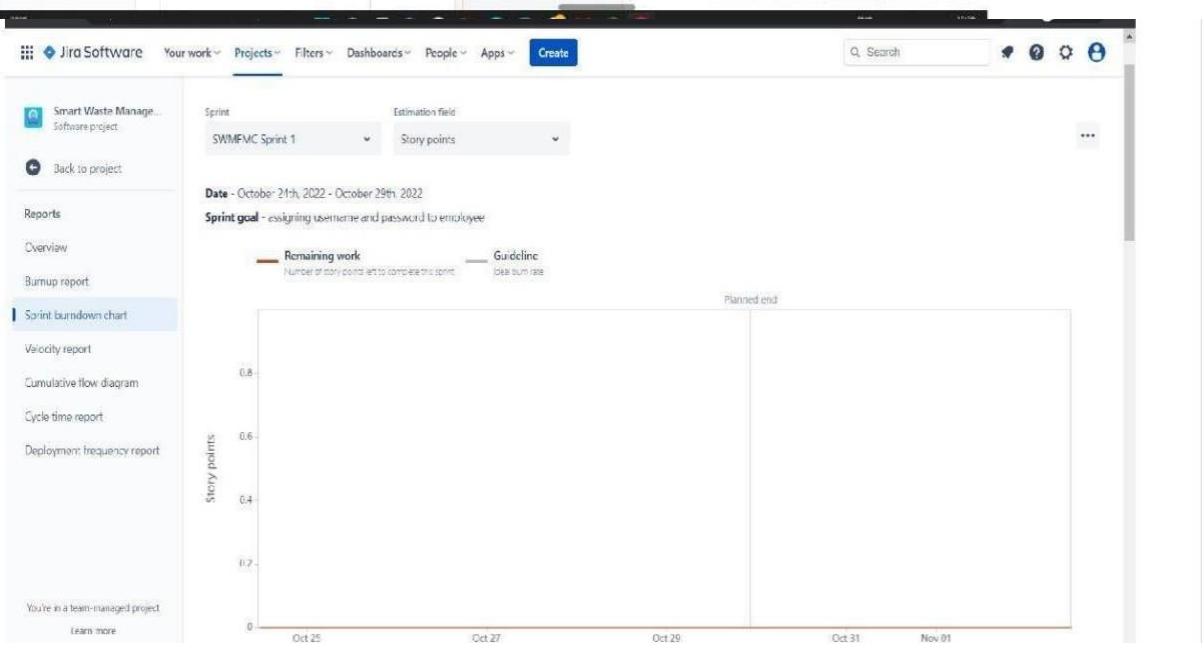
## 5.3 Reports from JIRA:

## Burnout Chart:



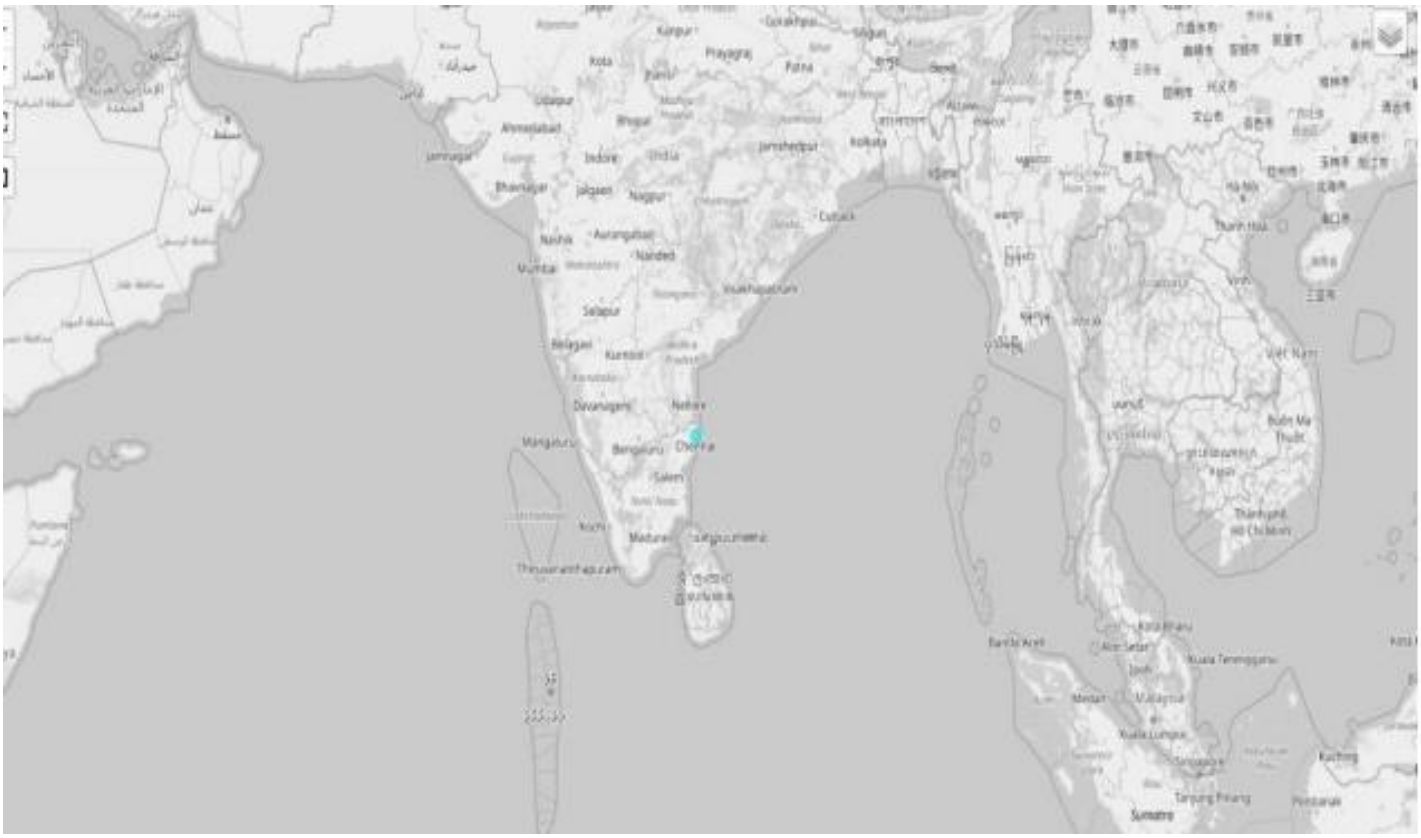

## Road map:



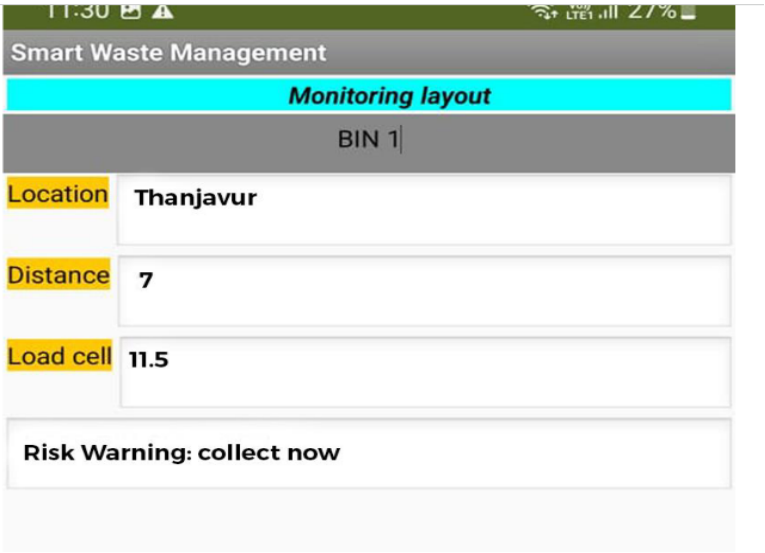



## 6. CODING & SOLUTIONING:

### 6.1 Feature 1- LOCATION TRACKER:



## 6.2 Feature 2- LIVE UPDATE ON COLLECTED DATA:




# 7.Testing:

## 7.1 Testcases:

| TEST CASE ID | FEATURE TYPE | COMPONENT | TEST SCENARIO | PREREQUISITE | STEPSTO EXECUTE | TEST DATA | EXPECTED RESULT | ACTUAL RESULT | STATUS | COMMENTS | TC FOR AUTOMATION( Y/N) | BUG ID | EXECUTED BY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOGIN PAGE_TC _001 | FUNCTIONAL | HOME PAGE | VERIFY THE USER IS ABLE TO SEE THE LOGIN/SIG N UP WEN USER CLICK ON MY ACCOUNT BUTTON | | 1.ENTER URL AND CLIK GO 2.VERIFY LOGIN/SIGN UP | https://169.51.20.4.219.30106 | L0gin page is visible | Working as expected | PASS | **Success ful** | | | KABISHENA |

### 7.2 User acceptance Testing:

1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the [ProductName] project at the time of the release to User Acceptance Testing (UAT).

2. **Defect Analysis**

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

| Resolution | Severity1 | Severity 2 | Severity 3 | Severity 4 | Subtotal |
|---|---|---|---|---|---|
| By Design | 10 | 4 | 2 | 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 | 7 |

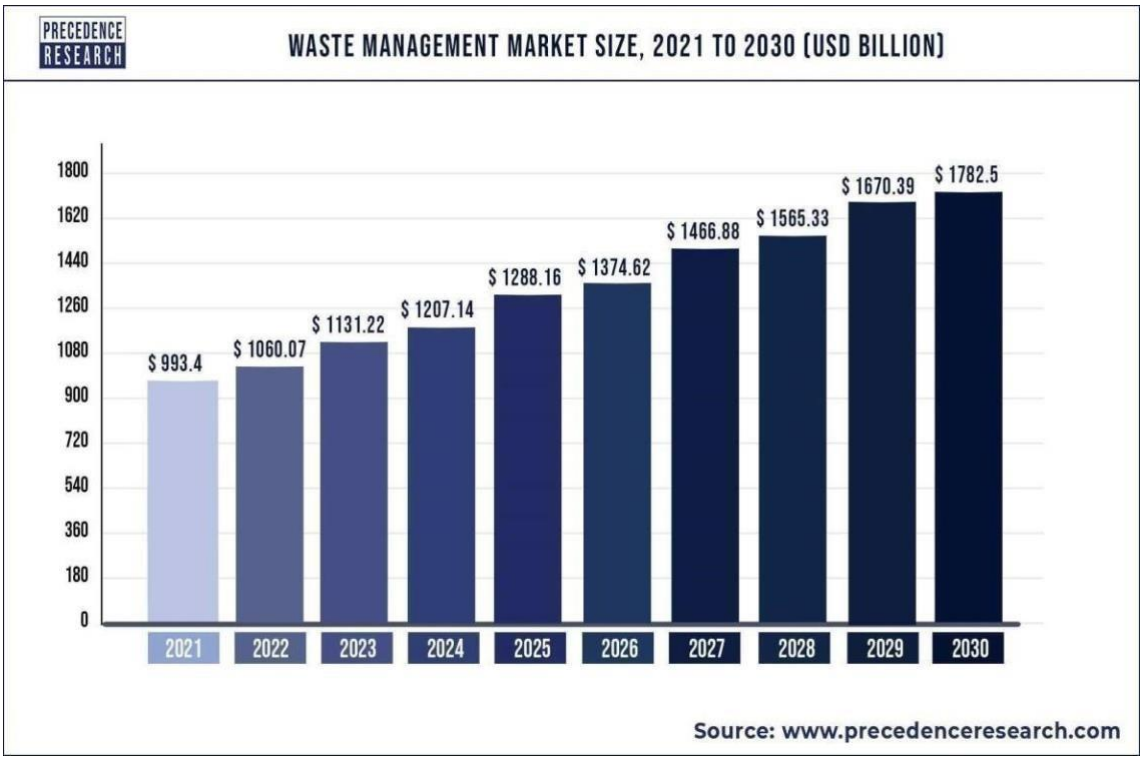
**1. Test Case**

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

| Section | Total Cases | Not Tested | Fail | Pass |
|---|---|---|---|---|
| Print Engine | 7 | 0 | 0 | 7 |
| Client Application | 51 | 0 | 0 | 51 |
| Security | 2 | 0 | 0 | 2 |
| Outsource Shipping | 3 | 0 | 0 | 3 |
| Exception Reporting | 9 | 0 | 0 | 9 |
| Final Report Output | 4 | 0 | 0 | 4 |
| Version Control | 2 | 0 | 0 | 2 |

## 9.RESULTS:

### 9.1 Performance Metrics:




## 10. ADVANTAGES & DISADVANTAGES

### ADVANTAGES:

- Reduction in Collection Cost
- No Missed Pickups
- Reduced Overflows
- Waste Generation Analysis
- CO2 Emission Reduction

### DISADVANTAGES:

- System requires a greater number of waste bins for separate waste collection as perpopulation in the city.
- This results into high initial cost due to expensive smart dustbins compare to othermethods. Sensor nodes used in the dustbins have limited memory size.

## 11. CONCLUSION:

A Smart Waste Management system that is more effective than the one in use now is achievable by using sensors to monitor the filling of bins. Our conception of a "smart waste management system" focuses on monitoring waste management, offering intelligent technology for waste systems, eliminating human intervention, minimizing human time and effort, and producing a healthy and trash-free environment. The suggested approach can be implemented in smart cities where residents have busy schedules that provide little time for garbage management. If desired, the bins might be put into place in a metropolis where a sizable container would be able to hold enough solid trash for a single unit. The price might be high.

## 12. FUTURE SCOPE:

There are several future works and improvements for the proposed system, including the following:

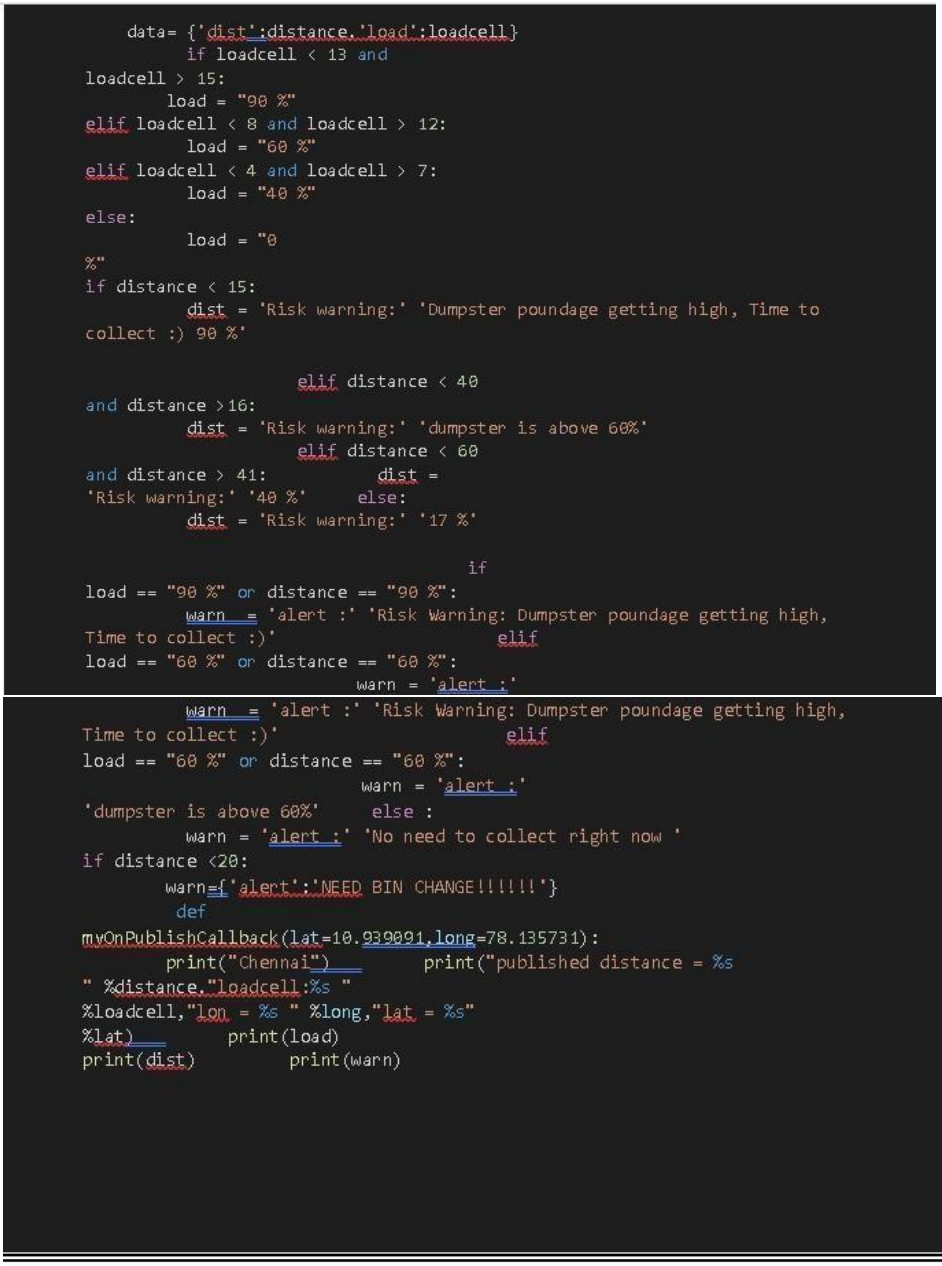
1. Change the system of user authentication and atomic lock of bins, which would aid inprotecting the bin from damage or theft.
2. The concept of green points would encourage the involvement of residents or end users, making the idea successful and aiding in the achievement of collaborative waste management efforts, thus fulfilling the idea of Swachh Bharath.
3. Having case study or data analytics on the type and times waste is collected on different days or seasons, making bin filling predictable and removing the reliance on electronic components, and fixing the coordinates.
4. Improving the Server's and Android's graphical interfaces

13. Appendix:

```
# Project : Smart Waste
Management # Team ID :
PNT2022TMID01046 import requests
import json import
ibmiotf.application import
ibmiotf.device import time import
random import sys

# watson device details
 organization          =
"ms9s4l"   devicType   =
"Project"   deviceId   =
"TMID01046" authMethod=
"token"      authToken=
"13150415"

#generate random values for randomo variables for distance and loadcell


def myCommandCallback(cmd):
    global a      print("command recieved:%s"
%cmd.data['command'])
control=cmd.data['command']     print(control)
 try:         deviceOptions={"org": organization, "type":
devicType,"id":
deviceId,"auth-method":authMethod,"auth-token":authToken}
deviceCli = ibmiotf.device.Client(deviceOptions) except
Exception as e:
```

```
deviceCli = ibmiotf.device.Client(deviceOptions) except
Exception as e:
        print("caught exception connecting device %s" %str(e))
sys.exit()

#connect and send a datapoint "distance and loadcell" with value integer
value into the cloud as a type of event for every 10 seconds
deviceCli.connect()
 while
True:
     distance=
random.randint(10,70)
loadcell= random.randint(5,15)
```

```
    time.sleep(10)


    success=deviceCli.publishEvent ("IoTSensor","json",warn,qos=0,on_publish=
myOnPublishCallback)

    success=deviceCli.publishEvent ("IoTSensor","json",data,qos=0,on_publish=
myOnPublishCallback)



    if not success:
        print("not connected to ibmiot")
    time.sleep(10)



    deviceCli.commandCallback=myCommandCallback
#disconnect the device
deviceCli.disconnect()
```



```
    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 = 'Risk warning:' 'Dumpster poundage getting high, Time to
collect :) 90 %'

                    elif distance < 40
and distance >16:
          dist = 'Risk warning:' 'dumpster is above 60%'
                    elif distance < 60
and distance > 41:          dist =
'Risk warning:' '40 %'     else:
          dist = 'Risk warning:' '17 %'

                                      if
load == "90 %" or distance == "90 %":
          warn  = 'alert :' 'Risk Warning: Dumpster poundage getting high,
Time to collect :)'                    elif
load == "60 %" or distance == "60 %":
                              warn = 'alert :'
          warn  = 'alert :' 'Risk Warning: Dumpster poundage getting high,
Time to collect :)'                    elif
load == "60 %" or distance == "60 %":
                              warn = 'alert :'
'dumpster is above 60%'     else :
          warn = 'alert :' 'No need to collect right now '
if distance <20:
        warn={'alert':'NEED BIN CHANGE!!!!!!'}
         def
myOnPublishCallback(lat=10.939091,long=78.135731):
        print("Chennai")       print("published distance = %s
" %distance,"loadcell:%s "
%loadcell,"lon = %s " %long,"lat = %s"
%lat)       print(load)
print(dist)         print(warn)
```

**GitHub Link:**

https://github.com/IBM-EPBL/IBM-Project-44357-1660724321