PROJECT REPORT

Team ID : PNT2022TMID51732

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1.INTRODUCTION:

1.1 Project Overview:

The waste collection process is a critical aspect for the service providers. The traditional way of manually monitoring the wastes in waste bins is a complex, cumbersome process and utilizes more human effort, time and cost which is not compatible with the present-day technologies. Irregular management of waste typically domestic waste, industrial waste and environmental waste is a root cause for many of the human problems such as pollution, diseases and has adverse effects on the hygiene of living beings. In order to overcome all these problems, we are proposing the idea of smart waste management system which helps in auto-management of waste without human interaction in order to maintain a clean environment.

1.2 Purpose:

Smart waste management is an idea where we can control lots of problems which disturbs the society in pollution and diseases. The waste management has to be done instantly else it leads to irregular management which will have adverse effect on nature. The Smart waste management is compatible mainly with concept of smart cities. The main objectives of our proposed system are as follows:

- Monitoring the waste management.
- Providing a smart technology for waste system.
- Avoiding human intervention.

- Reducing human time and effort
- Resulting in healthy and waste ridden environment.

This project falls under the category of embedded systems and Node red applications.

2.LITERATURE SURVEY:

2.1 Existing problem:

- Manual systems in which employees clear the dumpsters periodically
- No systematic approach towards clearing the dumpsters
- Unclear about the status of a particular location
- Employees are unaware of the need for a particular location
- Very less effective in cleaning city

2.2 References:

S.NO	TITLE	AUTHOR & YEAR	DESCRIPTION
1.	Smart Waste using Management WSN and IOT	Sivasankari, Bhanu Shri, Y. BevishJinila 2017	In this paper, they use Wireless Sensor Networks and IOT. The garbage bins are deployed with sensors and are networked together using WSN. The sensors deployed in the garbage bins collect the data for every determined interval. Once the threshold is reached, it raises a request to the GCA (garbage collector agent). This agent collects the requests of all the filled vehicles and communicates using the IoT framework.

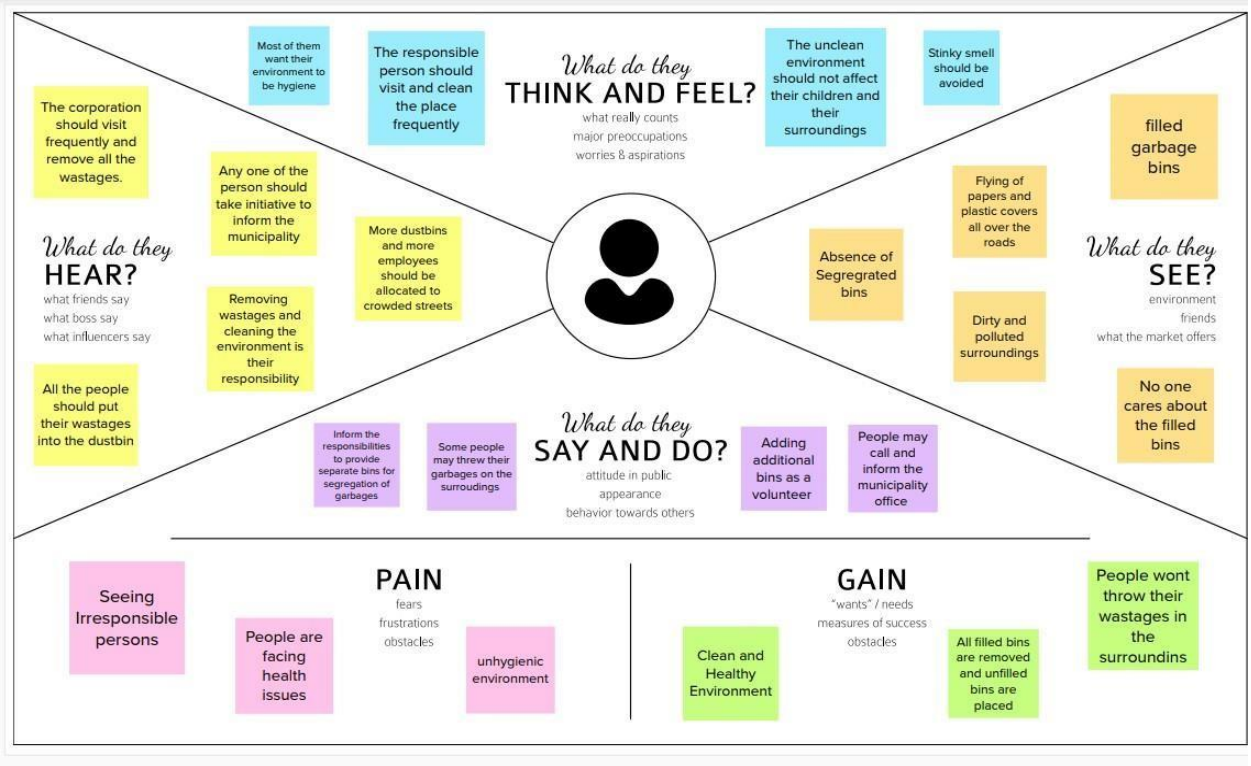
2.	Smart Waste Management System using IOT	Tejashree Kadus, PawankumarNirmal, Kartikee Kulkarni 2020	In this paper, they use an Arduino board interfaced with a load sensor, an IR sensor, and a Wi-Fi module instead of a PIR sensor and an ultrasonic sensor. In addition to electrical components,they use mechanical components like the load sensing plate and shredder to crash the trash and then measure the load.
3.	Smart Waste Management System	Bindushree, Manasa, Sanjana Rao, Vidhya Shree, Gowra PS 2021	In this paper, they use sensors, which include an IR sensor for detecting the presence of any waste and a soil moisture sensor to detect whether the waste is dry or wet. The emphasis is primarily on waste segregation, followed by analysis via the website.

2.3 **Problem Statement Definition:**

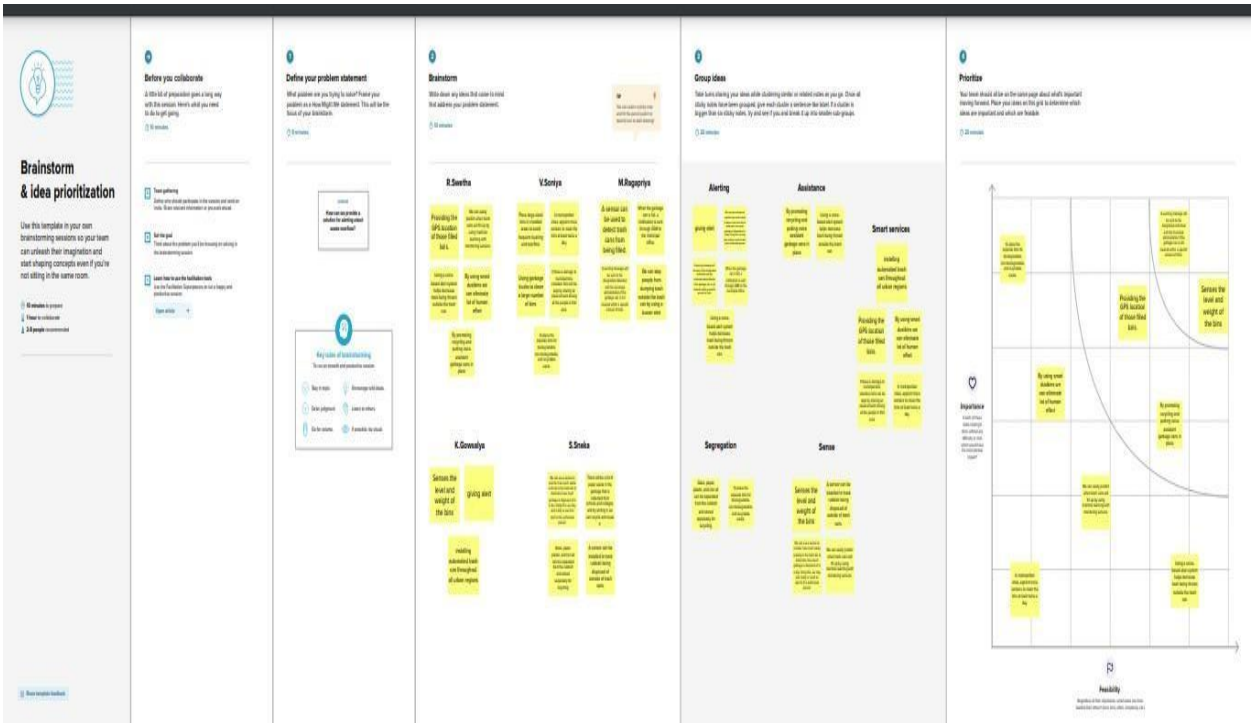
Problem Statement	**I am (customer)**	**I am trying to**	**But**	**Because**	**Which makes me feel**
PS-1	Employee in private limited company	Eliminate the scenario of the overflowing of waste	The bins are always filled	I live in a metropolitan city, where there is always a crowd.	Worried
PS-2	Authority in municipal corporation	Be alerted when the garbage bins are filled and needs to know the location of those filled bins	Do not currently have those facilities	There is no resource to analyze the level of bins	Frustrated

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)	How can the trash bins in metropolitan cities be easily notified and cleaned in an efficient manner?
2.	Idea / Solution description	The level and weight of the trash bins are analysed via a web app and that data is generated using sensors. If those bins are filled, then alert the authorities and send the GPS location of those bins to the responsible persons.
3.	Novelty / Uniqueness	Without involving human activities, the trash bins are sensed, analysed, and notified to the responsible person automatically.
4.	Social Impact / Customer Satisfaction	1.Clean cities & Healthy environment 2.Dust free & pollution less environment
5.	Business Model (Revenue Model)	Offering software as a service model to the government and creating revenue from it
6.	Scalability of the Solution	Finally, the filled trash cans can be easily managed from small towns to large metropolitan cities.

3.4 Problem Solution fit:

CUSTOMER SEGMENTS	CUSTOMER CONSTRAINTS	AVAILABLE SOLUTIONS
Municipality Authorities Public people	1. No cash 2. Network connection 3. Budget 4. Available devices	The bins are cleaned two or three days once in a random manner.
JOBS TO BE DONE / PROBLEMS To detect the level and weight of bins. To send the GPS location of bins to authorities and to notify them whenever the bins are filled.	**PROBLEM ROOT CAUSE** The garbage bins are not cleaned frequently	**BEHAVIOUR** Simply installing sensored IoT bins and analysing them via a website
TRIGGERS Seeing the filled bins, polluted environment, and diseases caused by unhygienic conditions	**YOUR SOLUTION** The level and weight of the trash bins are analysed via a web app and that data is generated using sensors. If those bins are filled, then alert the authorities and send the GPS location of those bins to the responsible persons.	**CHANNELS OF BEHAVIOUR** Online: Analyses the level and weight of bins via website Offline: Installing the sensored Iot bins. Sending the municipal employees after receiving notifications to clean the bins.
EMOTIONS: BEFORE/AFTER Before: They feel frustrated while crossing those bins, and they feel sad when their children are affected by diseases due to pollution. After: Feel good while seeing a dust free environment.		

4.REQUIREMENT ANALYSIS:

4.1 Functional requirement:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Real time bin monitoring.	The dashboard shows statistics on the amount of fill in the bins as it is tracked by smart sensors. The application also forecasts when the bin will fill up based on past data in addition to the percentage of fill level, which is one of the features that even the finest waste management software lacks. As picks are also recognised by the sensors, you can determine when the bin was last emptied. You can get rid of the overflowing bins and stop collecting half-empty ones using real-time data and forecasts.
FR-2	Eliminate inefficient picks.	Get rid of the collection of half-empty trash cans. Picks are recognised by sensors. We can demonstrate to you how full the bins you collect are using real-time data on fill levels and pick recognition.
FR-3	Plan waste collection routes.	Route planning for trash pickup is semi-automated using the tool. You are prepared to act and arrange for garbage collection based on the levels of bin fill that are now present and forecasts of approaching capacity. To find any discrepancies, compare the planned and actual paths.
FR-4	Adjust bin distribution.	Ensure the best possible bin distribution. Determine which regions have a dense or sparse distribution of bins. Ensure that each form of waste has a representative. You can make any required adjustments to bin position or capacity based on past data.
FR-5	Expensive bins.	We assist you in locating containers that increase collection prices. The tool determines a collection rating for each bin. The tool takes the local average deposal rate into account. The tool determines the distance from depo-bin discharge and rates bins (1–10).

FR-6	Detailed bin inventory.	On the map, you can see every monitored bin and stand, and you can use Google Street View at any time to visit them. On the map, bins or stands appear as green, orange, or red circles. The dashboard displays information about each bin, including its capacity, trash kind, most recent measurement, GPS position, and pick-up schedule.

4.2 Non-Functional Requirements:

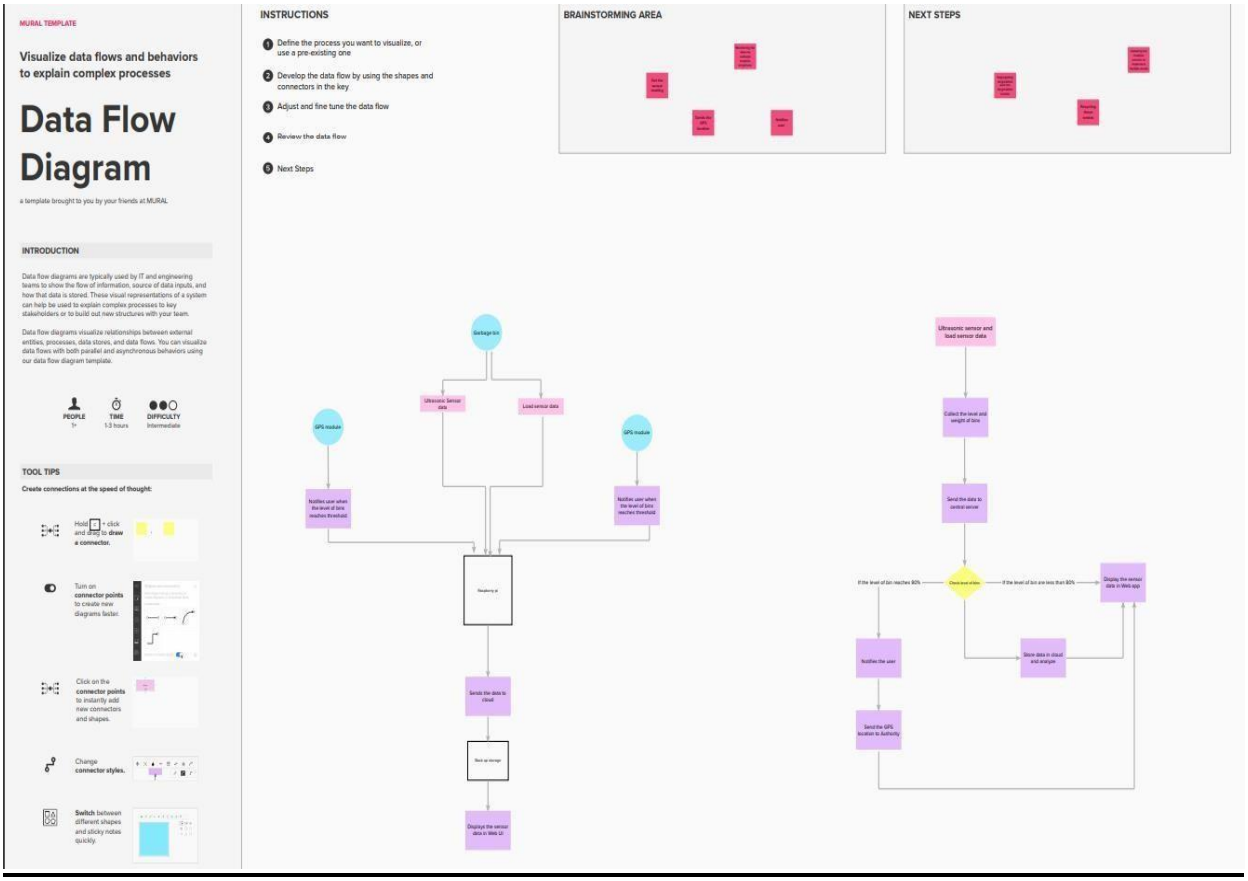
Following are the non-functional requirements of the proposed solution**.**

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	According to IoT devices, usability is a unique and significant perspective for examining user needs, which may further improve design quality. Analysing how well people interact with a product may help designers better understand customers' prospective demands for waste management, behaviour, and experience in the design process when user experience is at the centre.
NFR-2	**Security**	Utilize recyclable bottles. Utilize reusable shopping bags. Spend responsibly and recycle. Eat and drink from limited-use containers.
NFR-3	**Reliability**	Creating improved working conditions for garbage collectors and drivers is another aspect of smart waste management. Waste collectors will use their time more effectively by attending to bins that require service rather than travelling the same collection routes and servicing empty bins.

NFR-4	**Performance**	The smart sensors assess the fill levels in bins (along with other data) numerous times each day using ultrasonic technology. The sensors feed data to Senone's Smart Waste Management Software System, a robust cloud-based platform with datadriven daily operations and a waste management app, using a variety of IoT networks (NB-IoT, GPRS). As a consequence, customers receive datadriven decision-making services, and garbage collection routes, frequency, and truck loads are optimized, resulting in at least a 30% decrease in route length.
NFR-5	**Availability**	By creating and implementing robust hardware and gorgeous software, we enable cities, companies, and nations to manage garbage more intelligently.
NFR-6	**Scalability**	Using smart trash bins allows us to scale up and monitor the rubbish more efficiently, while also reducing the number of bins needed in towns and cities.

5. PROJECT DESIGN:

5.1 Data flow diagram:



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 requirements 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 collected in your bins into actionable insights to help you improve your waste services.

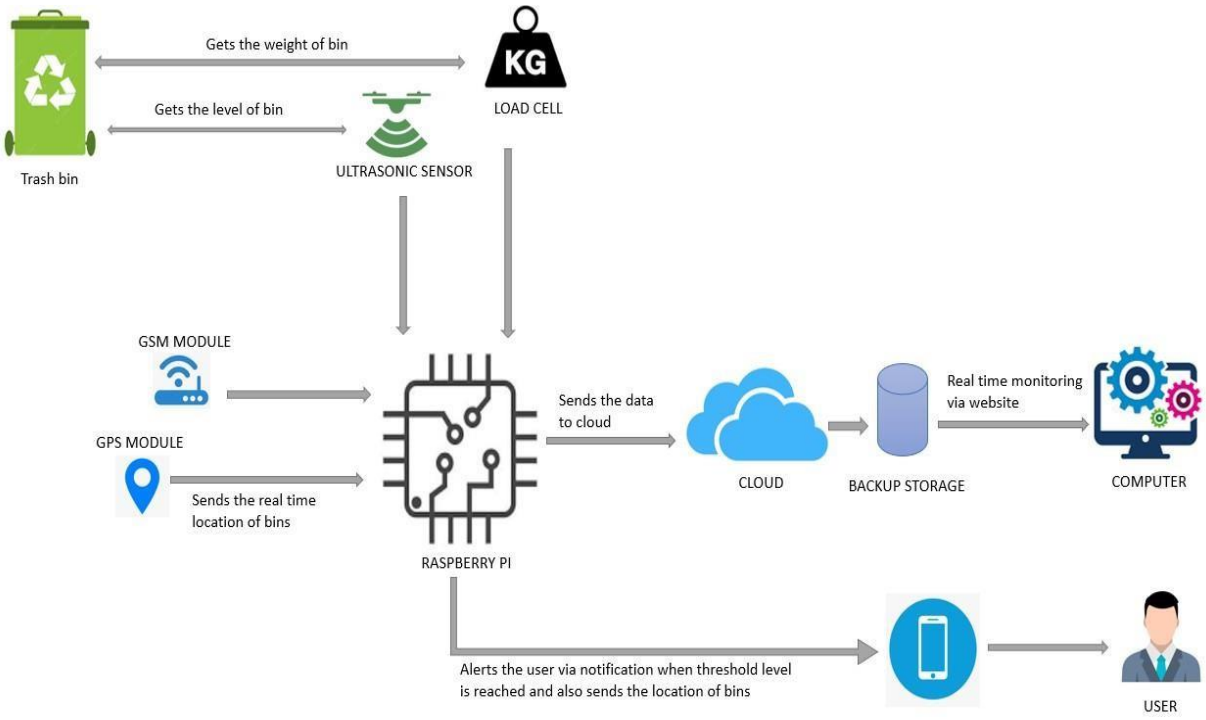
You can receive data on metrics such as:

- The first email alert sent by the system is sent when the garbage bin is empty or has a very low garbage level.
- The second SMS notification sent by the system indicates that the bin is at least 90% 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

5.2 Solution & Technical Architecture:

S. No	Component	Description	Technology
1.	Raspberry pi	Control the overall devices and sensors	Python
2.	Ultrasonic Sensor	Senses the level of bins	Sensing technology used
3.	Load sensor	Senses the weight of bins	Sensing technology used
4.	GSM module	Establishes communication between mobile device and GSM	Mobile Communication Technology used
5.	GPS Module	Sends location of bins	Global positioning technology used
6.	Cloud Database	Database Service on Cloud	IBM Cloudant
7.	Web UI	Displays the data	Node Red
8.	IOT platform	Manages an IOT ecosystem	IBM Watson IOT platform


Gets the weight of bin
KG
LOAD CELL
Gets the level of bin
Trash bin
ULTRASONIC SENSOR
GSM MODULE
GPS MODULE
Sends the real time
location of bins
RASPBERRY PI
Sends the data
to cloud
CLOUD
BACKUP STORAGE
Real time monitoring
via website
COMPUTER
Alerts the user via notification when threshold level
is reached and also sends the location of bins
USER

5.3 User Stories:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin	Login	USN-1	As a user, I will give user id and password for all the workers and manage them	I can manage web account / dashboard	Medium	Sprint-2
Co admin	Login	USN-2	As a co-admin, I will monitor garbage level. If the garbage bins are filled, I will post the location and garbage ID to the trash truck	I can manage garbage monitoring	High	Sprint-1
Truck Driver	Login	USN-3	As a truck driver, I will follow the route sent by Co-admin to reach the filled garbage.	I can drive to reach the garbage- filled bins in the shortest possible route given.	Medium	Sprint-2
Local Garbage collector	Login	USN-4	As a waste collector, I will collect all the trash from garbage and load it into garbage trucks and send it to the landfill.	I will collect the trash and have it tracked and sent off.	Medium	Sprint-2
Municipality	Login	USN-5	As a municipal authority, I will check that the process is happening in a disciplined manner without any issues.	I can keep all of these processes running smoothly.	High	Sprint-1

6. PROJECT PLANNING AND SCHEDULING:

6.1 Sprint Planning and Scheduling:

TITLE	DESCRIPTION	DATE

Literature Survey & Information Gathering	Literature survey on the selected project & gathering information by referring the, technical papers, research publications etc.	23.09.2022
Prepare Empathy Map	Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements	15.09.2022
Ideation	List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.	24.09.2022
Proposed Solution	Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	25.09.2022
Problem Solution Fit	Prepare problem - solution fit document.	16.10.2022
Solution Architecture	Prepare solution architecture document.	16.10.2022
Customer Journey	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).	26.10.2022
Functional Requirement	Prepare the functional requirement document.	
Data Flow Diagrams	Draw the data flow diagrams and submit for review	23.10.2022
Technology Architecture	Prepare the technology architecture diagram	23.10.2022
Prepare Milestone & Activity List	Prepare the milestones & activity list of the project.	29.10.2022
Project Development - Delivery of Sprint-1, 2, 3 & 4	Develop & submit the developed code by testing it	In progress

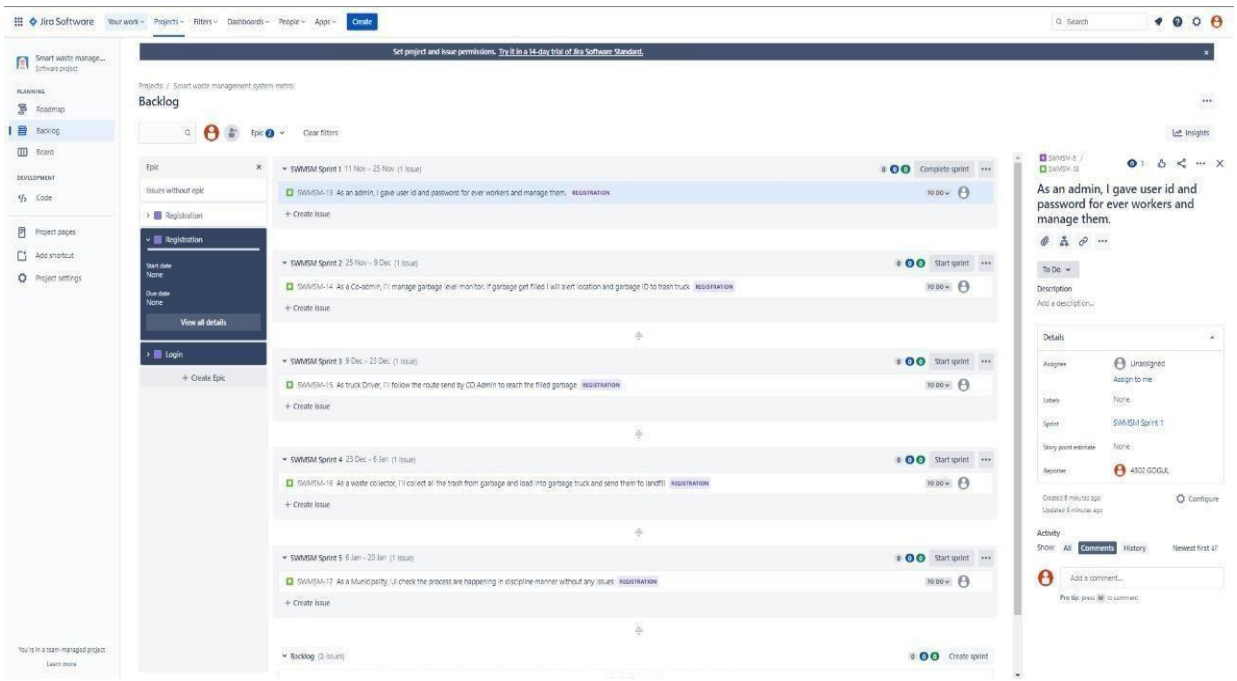
6.2 Sprint Delivery Schedule:

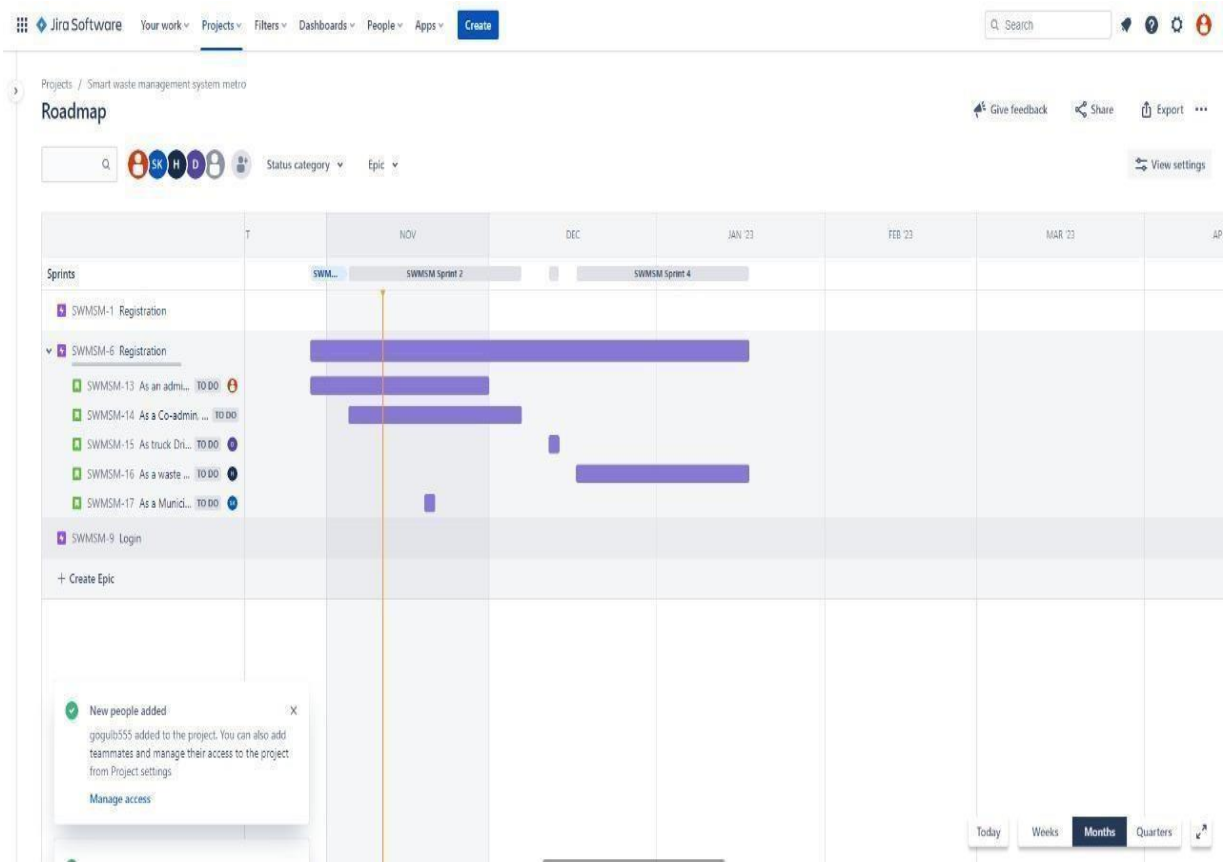
Sprint-1	Login	USN-1	As a user, I will give user id and password for all the workers and manage them	10	High	J. R. Jenisha Rani
Sprint-1	Login	USN-2	As a co-admin, I will monitor garbage level. If the garbage bins are filled, I will	10	High	R. Jeya rathina Mathimitha
Sprint	**Functional Requirement (Epic)**	**User Story Number**	**User Story / Task**	**Story Points**	**Priority**	**Team Members**
			post the location and garbage ID to the trash truck			
Sprint-2	Dashboard	USN-3	As a truck driver, I will follow the route sent by Co-admin to reach the filled garbage.	20	Low	G. Abitha
Sprint-3	Dashboard	USN-4	As a waste collector, I will collect all the trash from garbage and load it into garbage trucks and send it to the landfill.	20	Medium	R. S. Athira
Sprint-4	Dashboard	USN-5	As a municipal authority, I will check that the process is happening in a disciplined manner without any issues.	20	High	C. Christal Showmiya

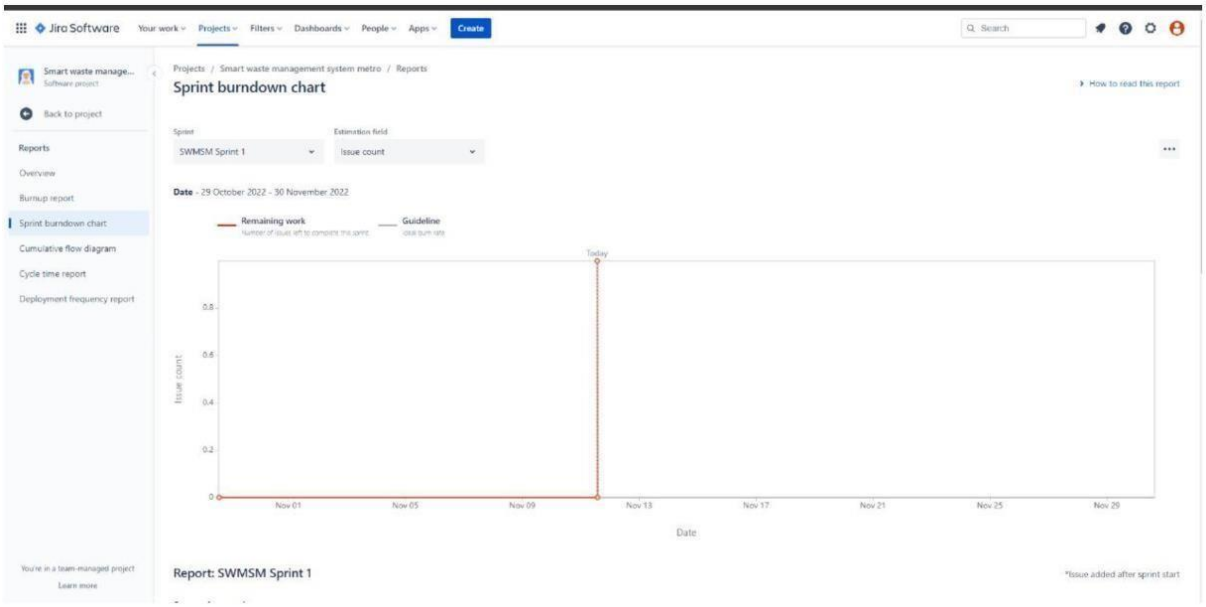
Sprint	**Functional Requirement (Epic)**	**User Story Number**	**User Story / Task**	**Story Points**	**Priority**	**Team Members**

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

6.3 Reports :

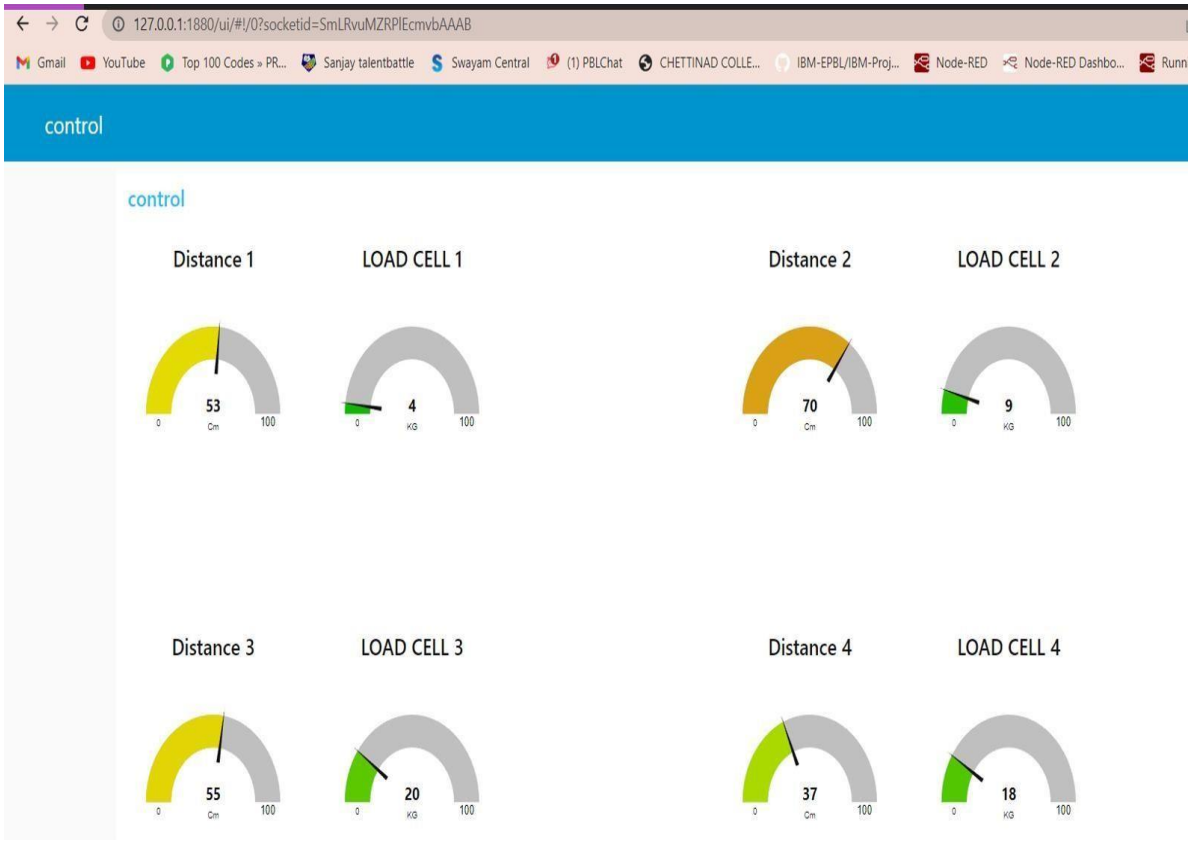






7. CODING AND SOLUTIONING:

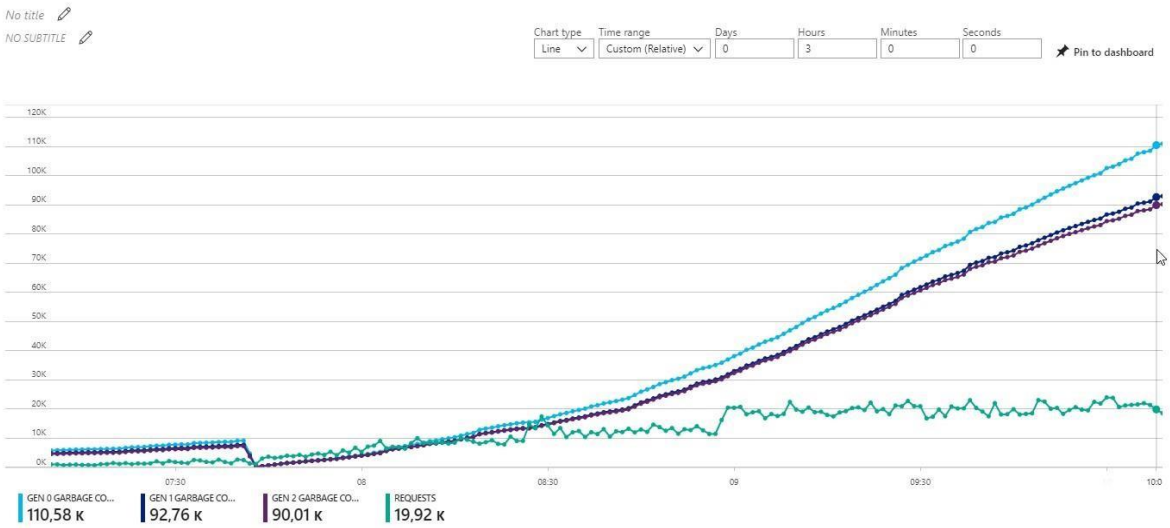
7.1 Feature 1: Web UI showing Level and Load of bin

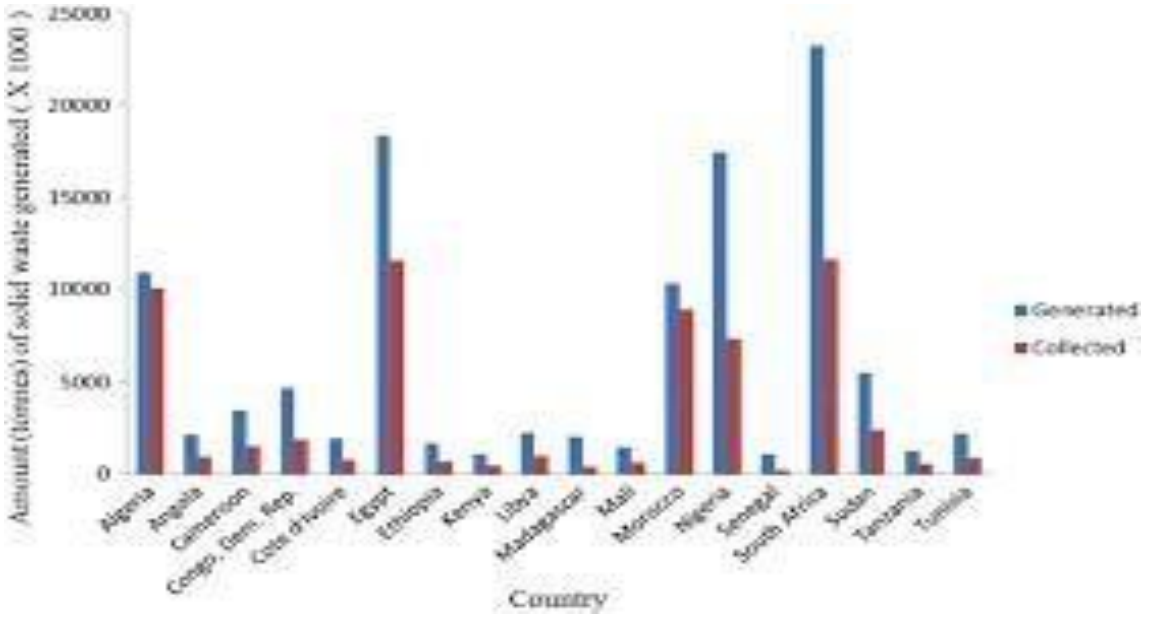


7.2 <u>Feature2:</u> Alert send to email when level and load of bin reaches threshold value 90% along with latitude and longitude

8.RESULTS:

8.1 Performance Metrics:





9. ADVANTAGES & DISADVANTAGES:

ADVANTAGES:

- Provides the real-time level and load of bins as well as the location.
- Reduction of CO2 gas.
- Provides a hygienic environment by preventing the overflow of waste.

DISADVANTAGES:

- System requires a greater 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.

10. CONCLUSION:

Monitoring the fullness of bins through the use of sensors, it is possible to achieve a more efficient system than the current existing. Our idea of "Smart waste management system", mainly concentrates on Monitoring the waste management, providing a smart technology for waste system, avoiding human intervention, reducing human time and effort and which results in healthy and waste ridden environment. The proposed idea can be implemented for smart cities where the residents would be busy enough with their hectic schedule and wouldn't have enough time for managing waste. The bins can be implemented in a city if desired where there would be a large bin that can have the capacity to accumulate the waste of solid type for a single apartment. The cost could be distributed among the residents leading to cheaper service provision.

11. FUTURE SCOPE:

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

- In case there are more dustbins, we can also make separate dustbins for dry waste and wet waste.
- The proposed solution is flexible. And decoupled with respect to the determination of optimal number of bins and vehicles, or to the algorithm that defines the best route for vehicles.

11. APPENDIX:

Source code: import time import

random import sys import

requests import

json import

ibmiotf.application import

ibmiotf.device # watson

device details

organization = "3w5ire" devicType

= "Dustbin" deviceId =

"DustbinID" authMethod=

"token" authToken=

"987654321"

#generate random values for random variables (Distance and load) 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,"authmethod":authMethod,"auth-token":authToken} 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" with value integer value into the cloud as a type of
event for every 10 seconds deviceCli.connect() while True:     lat= 10.9368     lon= 78.1366
location= "Puliyur karur"
   Distance= random.randint(1,75)     Loadcell= random.randint(0,20)     data=
{'dist':Distance,'load':Loadcell,'Latitude':lat,'Longitude':lon,'Location':location}     if
Loadcell<5 and Loadcell>0:
        load="20%"     elif
Loadcell<10 and Loadcell>5:
        load="40%"     elif Loadcell<15
and Loadcell>10:
        load="60%"     elif Loadcell<18
and Loadcell>15:
        load="80%"     elif Loadcell<20
and Loadcell>18:         load="90%"
   else:
        load="100%"      if
Distance<7 and Distance>1:
        level="90%"     elif
Distance<15 and Distance>7:
        level="80%"     elif
Distance<30 and Distance>15:
        level="60%"     elif
Distance<45 and Distance>30:
        level="40%"     elif
Distance<60 and Distance>45:
```

```
        level="20%"     elif
Distance<75 and Distance>60:
        level="10%"
else:
        level="0%"     if level=="90%"
or load=="90%":
          warn = 'alert:"Dustbin is almost filled in latitude:10.9368 and longitude:78.1366 Puliyur
karur'     def myOnPublishCallback(latitude=10.9368,longitude=78.1366):
        print("Puliyur,Karur,Tamilnadu")
        print("published Level of bin = %s " %level,"Load = %s " %load, "Latitude = %s "
%latitude,"Longitude = %s " %longitude)
        print(load)
print(level)
print(warn)
time.sleep(10)
success=deviceCli.publish
Event
("IoTSensor","json",warn,
qos=0,on_publish=
myOnPublishCallback)

    success=deviceCli.publishEvent ("IoTSensor","json",data,qos=0,on_publish=
myOnPublishCallback)
    if not success:         print("not connected to ibmiot")
time.sleep(20)
deviceCli.commandCallback=myCommandCallback
#disconnect the device deviceCli.disconnect()
```

GitHub Link:

https://github.com/IBM-EPBL/IBM-Project-29509-1660126439

Video Demo Link:

https://youtu.be/4eVj03J2w44