**PROJECT REPORT**

**SMART WASTE MANAGEMENT SYSTEM**

**FOR METROPOLITIAN CITIES**

***Submitted by:***

**PNT2022TMID20896**

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1. **INTRODUCTION**
   1. **PROJECT OVERVIEW:**

Waste being generated is constantly increasing to form a global crisis. Even though we implement a more sustainable and greener environment, we still fail to meet our expectations. Collaborating technology support with a vision of social, economic and environmental sustainability is the best solution to solve such a crisis. The smart bin system implements a thorough system check and battery level monitoring. Battery level can be low. Multiple sensors attached to the bin indicate threshold levels. An alert message is sent to the garbage collectors when garbage overﬂows. Once the waste bin is emptied, an information update is sent to the municipality and server is updated. Bins are eﬃciently handled.

* 1. **PURPOSE:**

We implement technology to effectively create hygienic surroundings. Smart waste management is about including technology and data to create a more eﬃcient waste industry. Based on IoT (Internet of Things) technology, smart waste management aims to increase resource allocation, reduce expenses, and establish the sustainability of waste services. This plans more eﬃcient pathways for the trash collectors but also lowers the chance of the bin being full. 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. Mobile applications are used to overcome the complications in the regular waste management system. Thus, smart waste management provides us with the most optimal way for managing all the junks.

1. **LITERATURE SURVEY**
   1. **EXISTING PROBLEM:**

Waste management has become a challenge in local towns and cities across the world. Often the local area bins are overﬂowing and the municipalities are not aware of certain unhygienic conditions. This affects the residents residing in that particular area in a number of ways. Toxic elements such as Persistent Organic Pollutants (POPs) impose hazards to human’s health causing accumulation of such toxics. Contaminated groundwater also poses a great health risk, as it is often used for These pests can spread diseases through microbes (i.e., salmonella and e-coli), that in turn affects humans.

* 1. **REFERENCES:**

**PAPER 1**

**TITLE:** Smart Solid Waste Management

**AUTHOR:** Mohd Helmy Abd Wahab

**DESCRIPTION:** RFID technology is used at the time of trash disposal to identify the material to be recycled.

**PAPER 2**

**TITLE:** Smart Waste analysis

**AUTHOR:** M. Mohammad Aazam

**DESCRIPTION:** It provides the idea of sensors based waste bins, capable of notifying waste level status. An automatic waste bin and make use of cloud computing paradigm to evolve a more robust and effective smart waste management mechanism. Waste management is linked to different stakeholders, including recyclers, importers and exporters, food industry, healthcare, research, environment protection and related organizations, and tourism industry Mohammad Aazam et al proposed Cloud SWAM, in which each bin is equipped with sensors to notify its waste level.

**PAPER 3**

**TITLE:** Analysis of Load cell

**AUTHOR:** Ranjeet Kumar and Sandeep Chhabra

**DESCRIPTION:** Load Cells 4.1 General Load Cell related information A load cell is meant to measure the size of a mass but actually is a force sensor which transforms force into an electrical signal. The load cell needs the earth gravity to work. Every mass is attracted by the earth gravimetric field, that force is named “load”.

**PAPER 4**

**TITLE:** Smart Waste Management System using IOT

**AUTHOR:** Tejashree Kadu, Pawankumar Nirmal and Kartikee Kulkarni

**DESCRIPTION:** The paper is based on the concept of Automation used in waste management systems under the domain of Cleanliness and Hygiene. Dumping garbage onto the streets and in public areas is a common synopsis found in all developing countries and this mainly ends up affecting the environment and creating several unhygienic conditions. Smart net bean uses multiple technologies firstly the technology for measuring the amount of trash dumped secondly the movement of the waste and lastly sending necessary signals and connecting the user to the Wi-Fi system. Improper disposal and improper maintenance of domestic waste create issues in public health and environment pollution thus this paper attempts to provide practical solutions towards managing the waste by collaborating it with the use of IOT.

**PAPER 5**

**TITLE:** Monitoring The Smart Garbage Bin Filling Status

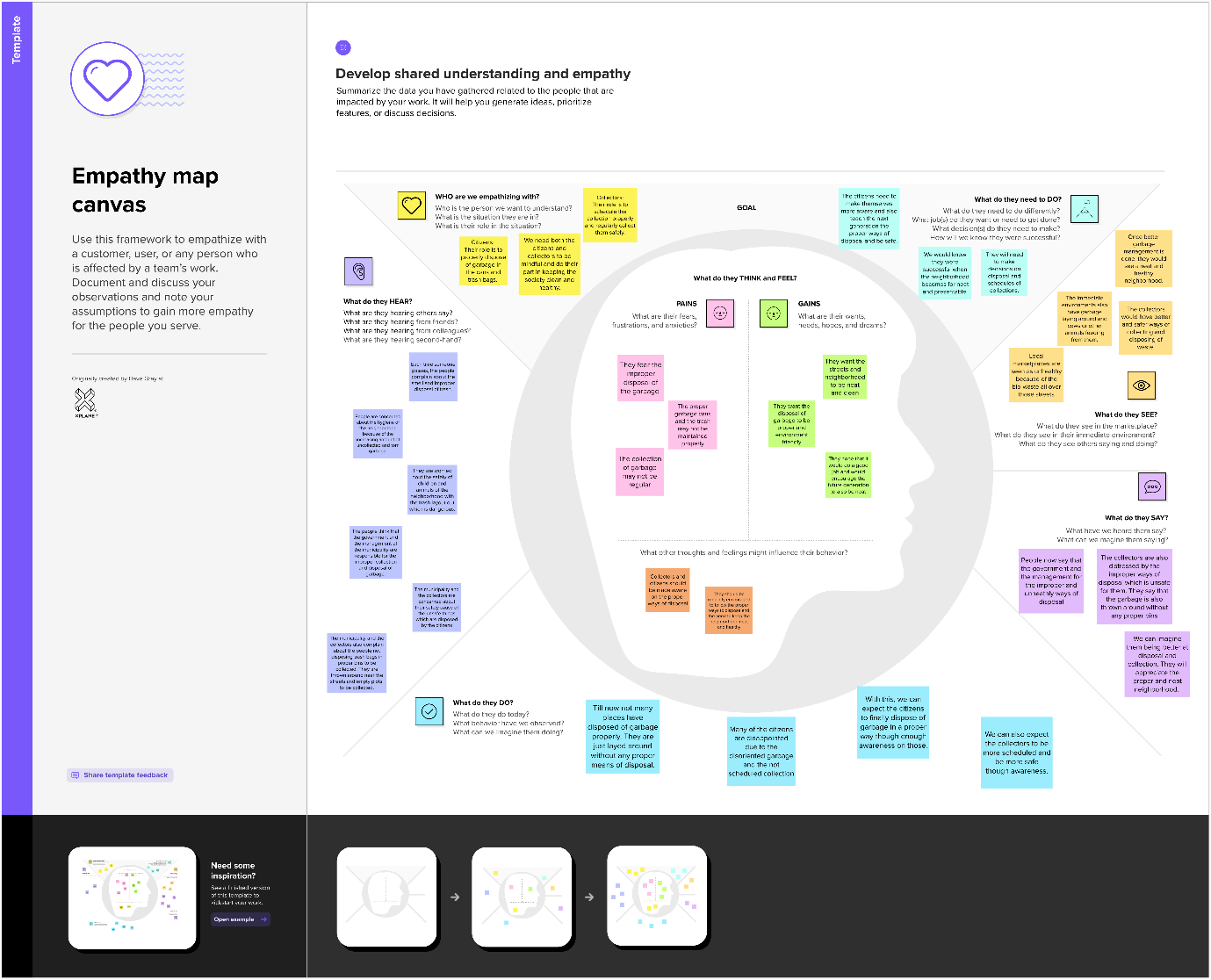
**AUTHOR:** Manoj Kumar, K. S. Parimala and N. Aruna Jyothi

**DESCRIPTION:** Garbage bins play a vital role in the waste collection process at the primary level itself. But the collected waste in the garbage bins must regularly be monitored, and from there it must be delivered to processing plants. This practice of continuous monitoring, transporting and processing contributes to the waste management. But the process of monitoring garbage bins would become difficult for the ones placed at inaccessible and remotely located sites. If such situations were prevailing continuously then the waste deposited in the bins will be increasing than to the accommodative levels resulting in spillover. Hence, there is a need for continuous monitoring of the garbage bins. In this paper, ‘Smart Garbage Bin’ (SGB) enabled with ‘Internet of Things’ (IoT) is developed. SGB’s generally embedded with the ultrasonic sensors used for sensing the garbage levels, information and communication devices that help in networking, interconnection, and data transfer.

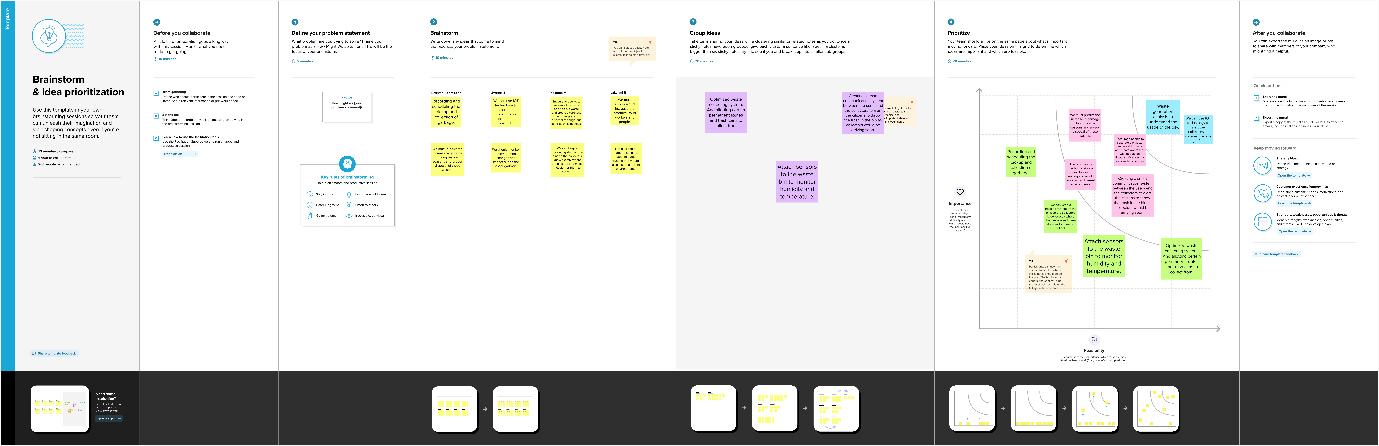
* 1. **PROBLEM STATEMENT DEFINITION:**



1. **IDEATION & PROPOSED SOLUTION**
   1. **EMPATHY MAP CANVAS:**



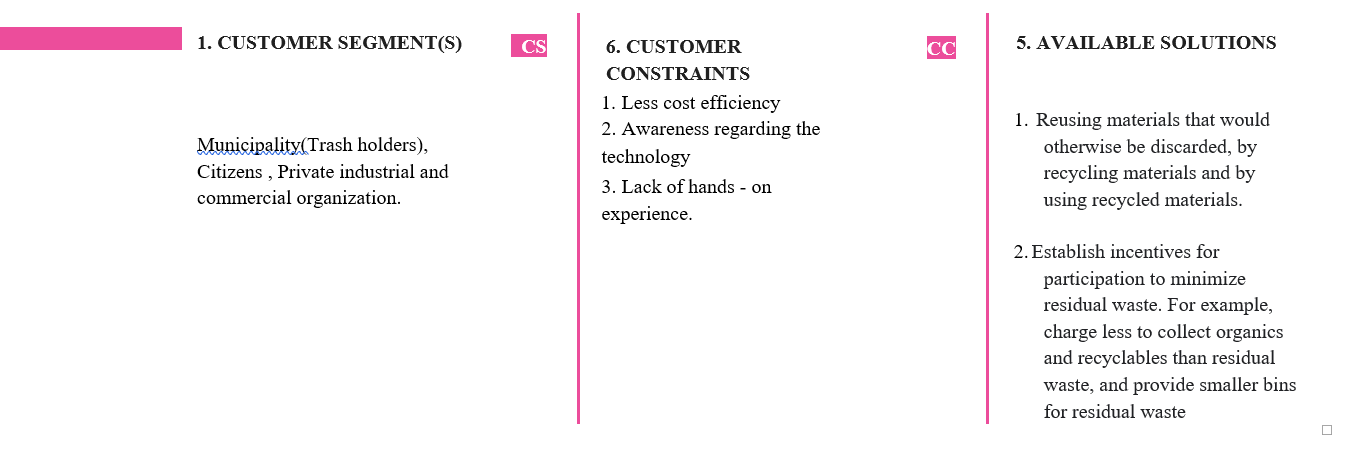
* 1. **IDEATION & BRAINSTORMING:**

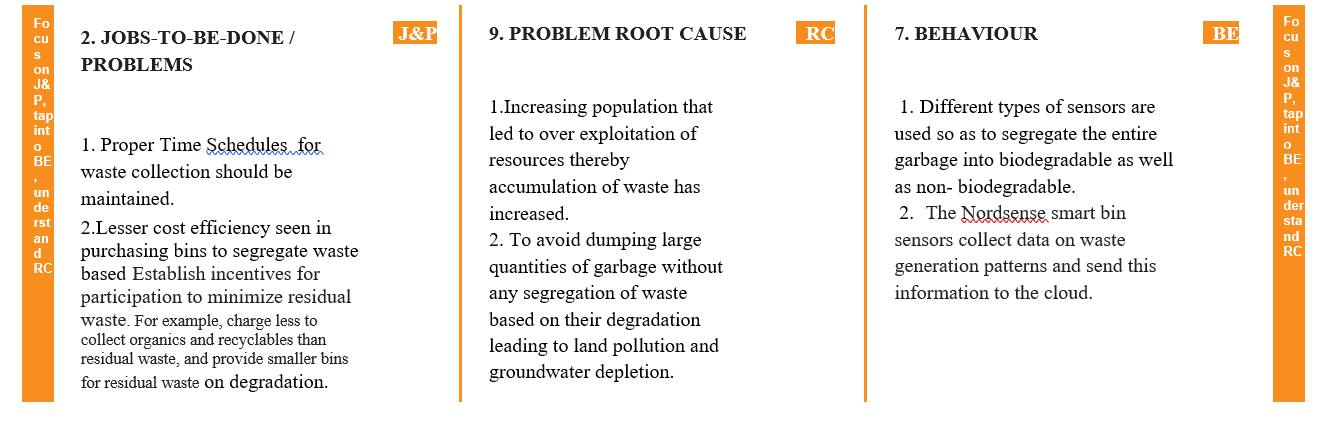


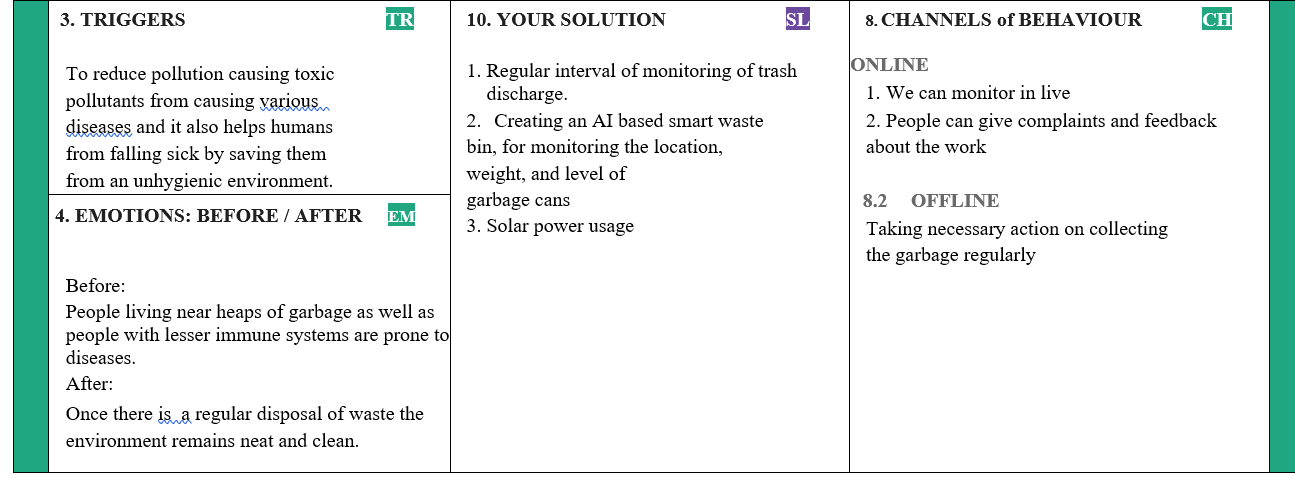
* 1. **PROPOSED SOLUTION:**

|  |  |  |
| --- | --- | --- |
| **S.No.** | **Parameter** | **Description** |
|  | Problem Statement (Problem to be solved) | This project deals with the waste management of the cities where there is no proper way of disposal. This enables the proper collection of trash. This can also be used to create awareness among citizens and collectors on the proper way of disposal and the safe way to dispose. |
|  | Idea / Solution description | The proposed system would be able to automate the solid waste monitoring process and management of the overall collection process using IOT (Internet of Things).  Collectors would be able to know when the bin is full, by placing the circuit at the waste bin, which alerts them about the bin being full.  The user will also be able to know the location of the bin. |
|  | Novelty / Uniqueness | When the bin is full, the system would send an alert though message that a particular bin is full and to collect it. We can also use a solar cell for alternate power supply. |
|  | Social Impact / Customer Satisfaction | By having a proper way of disposal of garbage, this will reduce the risk of diseases, the safety of children playing around, and would also improve the quality of air. This would also keep the neighbourhood clean and would also keep the animals safe. |
|  | Business Model (Revenue Model) | Waste Management generates revenue through the provision of various waste management and disposal services and recycling solutions to residential, commercial, industrial, and municipal clients. |
|  | Scalability of the Solution | The proposed system uses sensor and communication technologies where waste data is collected from the smart bin, in real-time, and then transmitted to an online platform where citizens and collectors can access and check the availability of the compartments scattered around a city. |

* 1. **PROBLEM SOLUTION FIT**







1. **REQUIREMENT ANALYSIS**
   1. **FUNCTIONAL REQUIREMENTS:**

|  |  |  |
| --- | --- | --- |
| **FR No.** | **Functional Requirement (Epic)** | **Sub Requirement (Story / Sub-Task)** |
| FR-1 | Bin Inventory Expense | This is the expensive architecture to build as the bins are made up with sensors and other costly devices, so it requires more security settings as it requires more cost  if we need to rebuild it. |
| FR-2 | Bin Monitoring | The Dashboard displays real-time data on fill-levels of bins monitored by smart sensors. In addition to the Percentage (%) of fill-level, based on the historical data, the tool predicts when the bin will become full, one of the functionalities that are not included even in the best waste management software.. Sensors recognize picks as well; so you can check when the bin was last collected. With real-time data and predictions, you can eliminate the overflowing bins and stop collecting half-  empty ones. |
| FR-3 | Waste Collection pathways | The project automates waste collection pathway planning by predicting the bin fill levels, after it reaches the full capacity of the bin it is ready to respond and schedule the waste collection  To identify inconsistencies planned pathways and executed pathways are compared. |
| FR-4 | Essentiality | The IOT device must send data to the Smart city waste management team in order to check the level of the dustbin space and the area location where it currently moves , it must send indication level time to time for filling of the waste products ,the localized dustbin may vary from small dustbin to bigger truck as the IOT  devices may eligible for both of them |
| FR-5 | Bin distribution | Most optimal bin distribution is ensured , dense or sparse bin distribution areas are identified and all trash types are represented within a stand.  Bin capacity or location can be adjusted based on historical data whenever necessary. |
| FR-6 | Result | The garbage bin consist of IOT devices at the top and bottom of the garbage bin which helps to analyze the weight and the amount of space in the dustbin which helps the worker and the waste management to acquire date of waste products dropped by people at individual location in order to maintain an collect and cover a vast  area of the city with the report givin by the garbage bins. |

* 1. **NON FUNCTIONAL REQUIREMENTS**

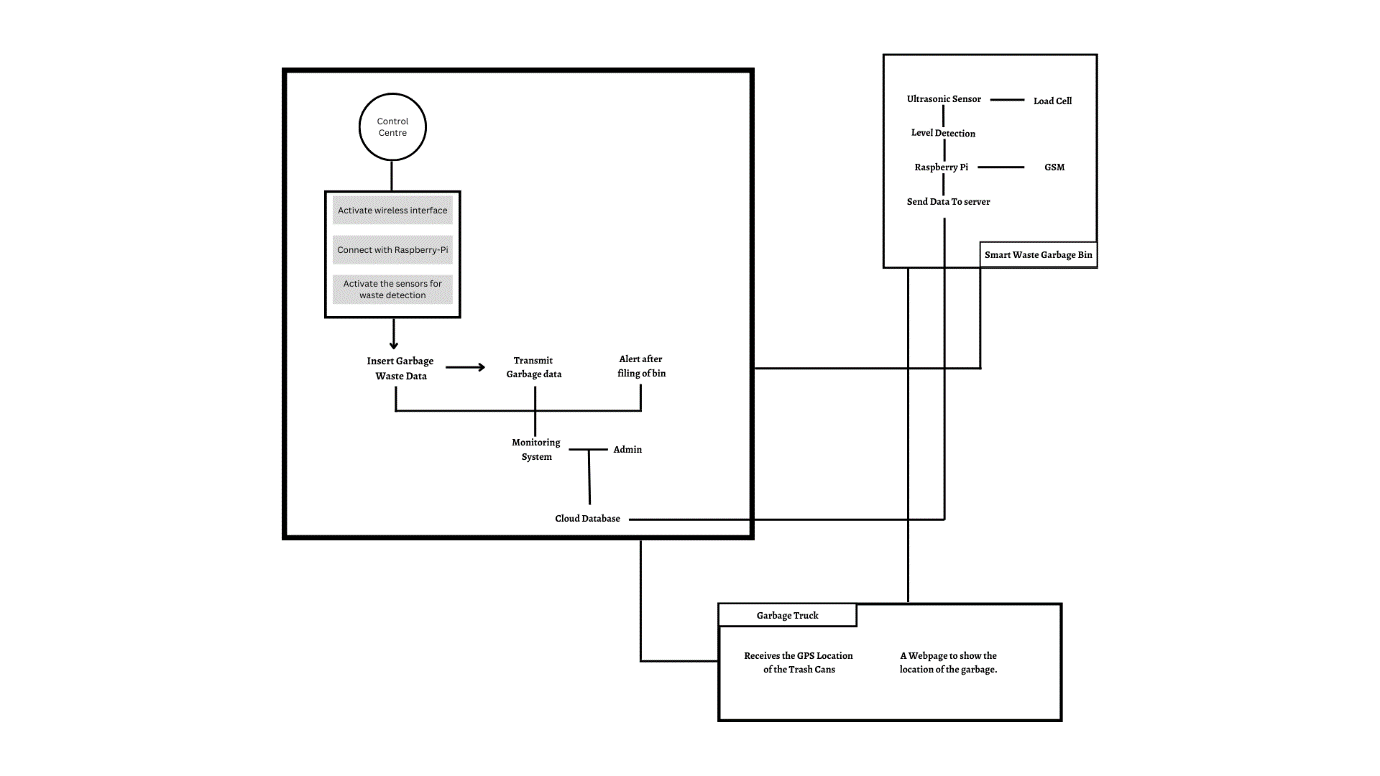
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| --- | --- | --- |
| **FR No.** | **Non-Functional Requirement** | **Description** |
| NFR-1 | **Usability** | This project helps in efficient and easy collection and disposal of waste; it also helps in keeping the environment clean and hygienic. Thus, preventing us  from deadly diseases |
| NFR-2 | **Security** | Without any channel crash the security need to be more particular as this is totally depend upon cloud service. This ensures level of assurance in data collection processing and data collection |
| NFR-3 | **Reliability** | Smart waste management is also about creating better working conditions for waste collectors and drivers. Instead of driving the same collection routes and servicing empty bins, waste collectors will spend  their time more efficiently, taking care of bins that need servicing. |
| NFR-4 | **Performance** | Ultra sound technology is used by smart sensors to measure the fill levels in bins several times a day. The sensor sends the data to sensor smart waste management system data-driven daily operations with the help of variety of IOT networks. To monitor the performance and encounter the queries customers are provided with data-driven and  decision making prototypes. |
| NFR-5 | **Availability** | Accessible through 24/7 by user and authorizer with  proper internet connectivity |
| NFR-6 | **Scalability** | As we are able to monitor the garbage 24/7 using smart waste bin it reduces the number of bins inside  town thus it is cost effective and scalable |

1. **PROJECT DESIGN**
   1. **DATA-FLOW DIAGRAM:**

A Data Flow Diagram (DFD) is a traditional way to visualize the information flows within a system. A neat and clear DFD can depict a good amount of the system requirements graphically. It can be manual, automated, or a combination of both. It shows how information enters and leaves the system, what changes the information and where information is stored. The purpose of a DFD is to show the scope and boundaries of a system as a whole. It may be used as a communications tool between a systems analyst and any person who plays a part in the system that acts as the starting point for redesigning a system.

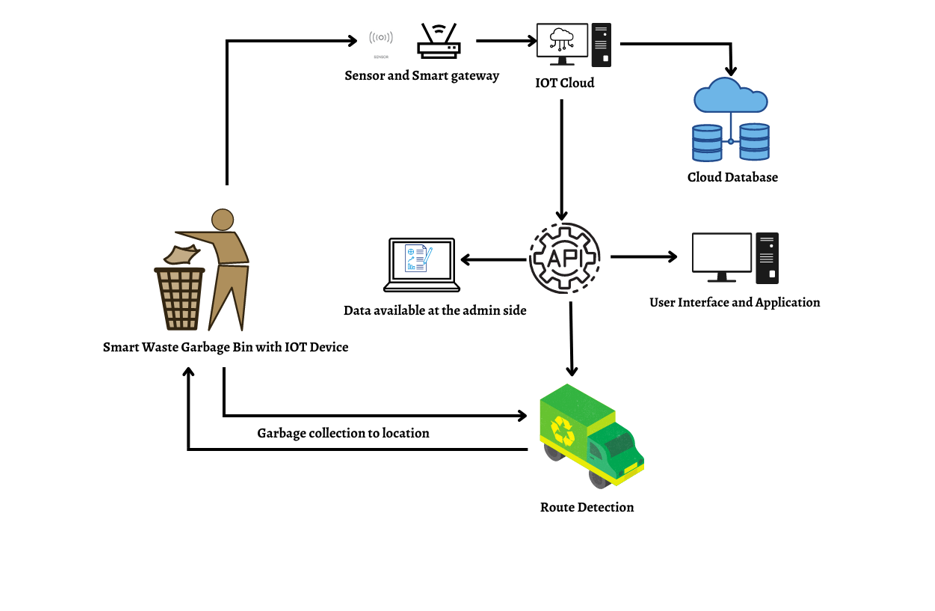
It is usually beginning with a context diagram as level 0 of the DFD diagram, a simple representation of the whole system. To elaborate further from that, we drill down to a level 1 diagram with lower-level functions decomposed from the major functions of the system. This could continue to evolve to become a level 2 diagram when further analysis is required. Progression to levels 3, 4 and so on is possible but anything beyond level 3 is not very common. Please bear in mind that the level of detail for decomposing a particular function depending on the complexity that function.

**Data flow diagram:**

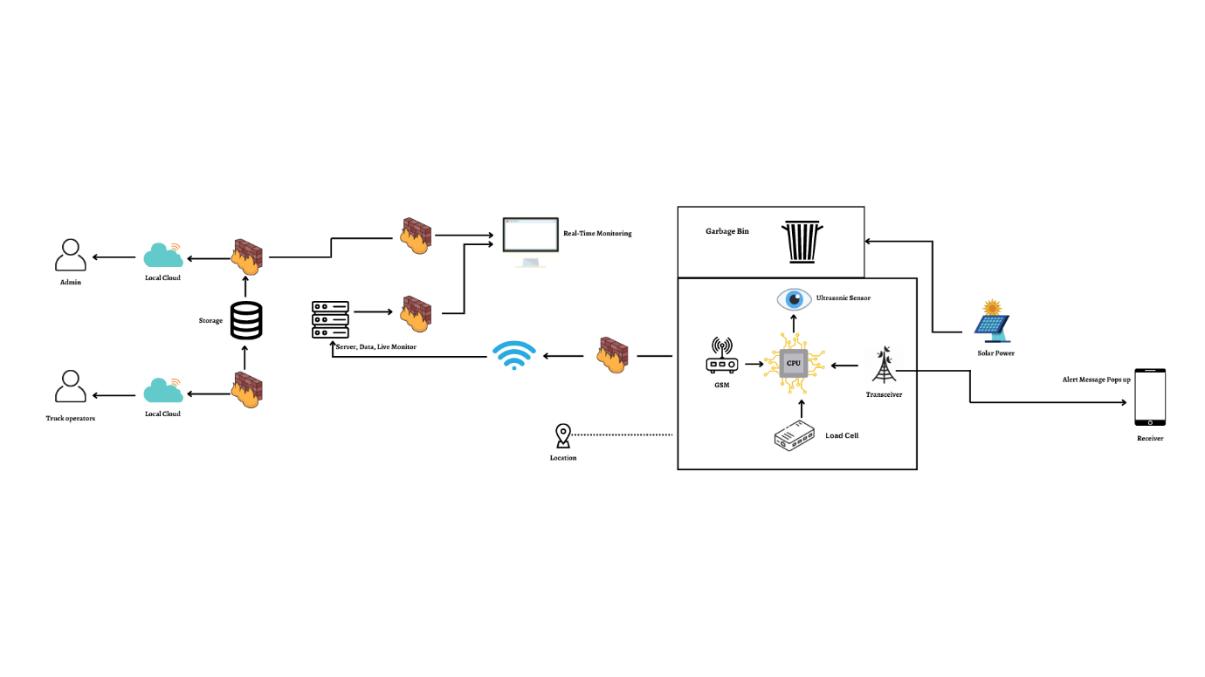


* 1. **SOLUTION AND TECHNOLOGY ARCHITECTURE:**

**Solution architecture:**



**Technical architecture:**



**TABLE-1:- Components & technologies**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No.** | **Component** | **Description** | **Technology** |
| 1. | User Interface | Web Portal | HTML, CSS, NodeRed, Javascript. |
| 2. | Application  Logic-1 | To calculate the level of trash through the ultrasonic sensor and activate alert message with python script. | Ulrasonic Sensor/ Python |
| 3. | Application Logic-2 | To calculate the weight of garbage and activate alert message with python script. | Load cell/ Python |
| 4. | Application Logic -3 | Get the location of trash. | GSM/GPS |
| 5. | Cloud Database | Database service though cloud | IBM DB2, IBM Cloudant |
| 6. | File Storage | Storing of files | Github, Local File system |
| 7. | External API-1 | Setting up of hosting services. | Firebase |
| 8. | Ultrasonic Sensor | To throw alert message when garbage is full | Distance recognition model |
| 9. | Infrastructure | Deployment of application and web portal | Localhost, Web Portal |

**TABLE-2:- Application Characteristics**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No.** | **Characteristics** | **Description** | **Technology** |
| 1. | Open-Source Frameworks | Node Red, Python, IBM Simulator. | IoT |
| 2. | Security Implementations | Raspberry Pi is connected to the internet and  is used to broadcast live data, further  security measures are recommended and use  the UFW (uncomplicated Firewall). | IoT |
| 3. | Scalable Architecture | Raspberry Pi: Specifications  Soc: rspi ZERO W  CPU:32-bit computer with a 1GHz AR Mv6  RAM: 512MB Networking: Wi-Fi  Bluetooth: Bluetooth 5.0, Bluetooth Low  Energy (BLE).  Storage: MicroSD  GPIO: 40-pin GPIO header, populated  Ports: micro-HDMI 2.0, 3.5mm analogue audio- video jack, 2x USB 2.0, 2x USB 3.0, Ethernet Dimensions: 88mm x 58mm x 19.5mm, 46g | IoT |
| 4. | Availability | These smart bins use to send an alert message when the bin gets full. | IoT |
| 5. | Performance | Number of requests: RPI manages to execute 129- 139 read requests per second.  Use of Cache:512mb Use of CDN’s:Real time | IoT |

* 1. **USER STORIES:**

| **User Type** | **Functional Requirement (Epic)** | **User Story Number** | **User Story / Task** | **Acceptance criteria** | **Priority** | **Release** |
| --- | --- | --- | --- | --- | --- | --- |
| Admin | Login | USN-1 | Manages the Operators i.e., Collectors and other users.  Also Monitors the garbage bin levels and monitors. | Can Manage a webpage. | High | Sprint-3 |
| Truck Driver | Login | USN-2 | Follow the route given by the system to collect trash. | Can drive safely and properly. | Medium | Sprint-2 |
| Garbage collector | Login | USN-3 | Collect the trash and load it into the truck safely and without any harm done to the garbage as well as themselves. | Can Collect the trash and put them into the truck. And also be punctual and safe while doing so. | High | Sprint-2 |
| Municipality | Login | USN-4 | Has to check the progress on the application and make sure there are no issues. Should also make people aware of the safe and proper ways to dispose trash. | Keep check on the progress. | Medium | Sprint-1 |

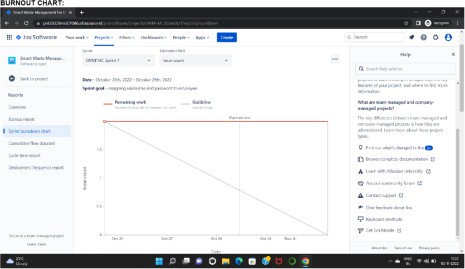
1. **PROJECT PLANNING & SCHEDULING**
   1. **SPRINT PLANNING & ESTIMATION:**

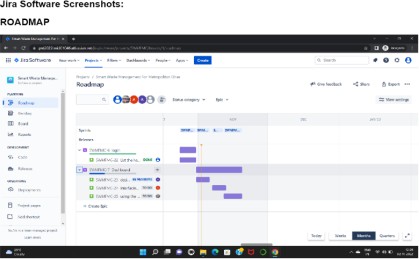
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| --- | --- | --- | --- | --- | --- | --- |
| **Sprint** | **Functional**  **Requirement (Epic)** | **User Story**  **Number** | **User Story / Task** | **Story Points** | **Priority** | **Team**  **Members** |
| Sprint-1 | Registration | USN-1 | As a user, I will register for the application by entering my E-mail ID, password, and  confirming my password | 15 | High | Lakshmi R |
| Sprint-1 | Log-in | USN-2 | As a Co-Admin I will control the waste level by monitoring them via real time web portal. Once the filling happens i will notify the trash truck with location of bin with Bin-ID | 10 | High | Reshma Srikrishnan |
| Sprint-2 | Dashboard | USN-3 | As a Truck driver, i will follow Co-Admin instruction to reach the filling bin and short  routes. | 20 | Low | Swetha S |
| Sprint-3 | Dashboard | USN-4 | As a Local garbage collector i will collect all the waste garbage load it in the garbage truck and  deliver it to the land fills | 20 | Medium | Kalpana M |
| Sprint-4 | Dashboard | USN-5 | As a Municipality officer i will make sure everything is planned and proceeding in a good way without any issues. | 15 | High | Reshma Srikrishnan |

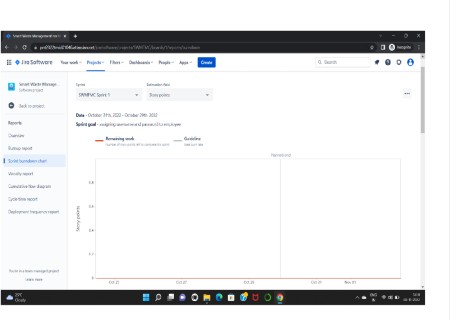
* 1. **SPRINT DELIVERY SCHEDULE:**

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| --- | --- | --- | --- | --- | --- | --- |
| **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 |
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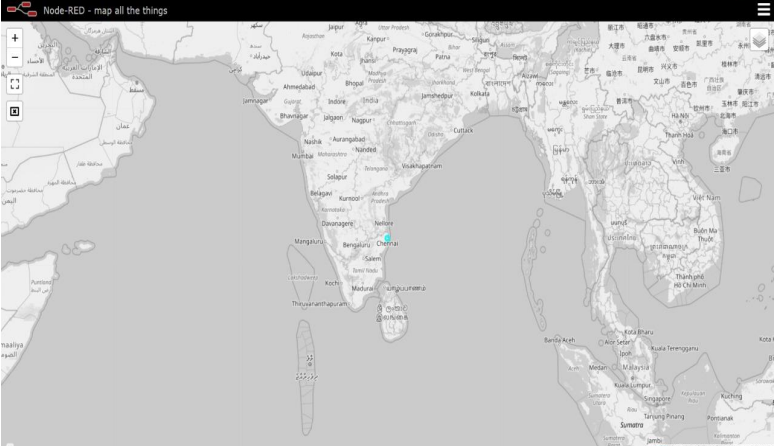
* 1. **REPORTS FROM JIRA:**







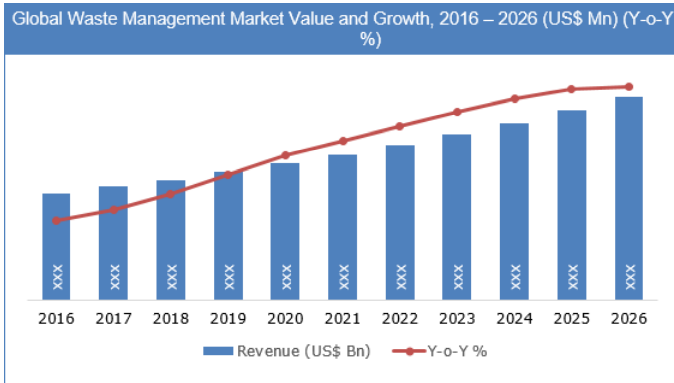
1. **CODING & SOLUTIONING:**
   1. **FEATURE-1: LOCATION TRACKER:**

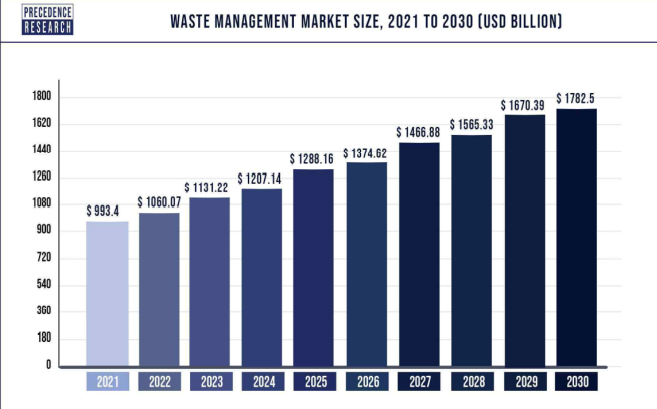


* 1. **FEATURE-2: LIVE UPDATES:**



1. **RESULTS**
   1. **PERFORMANCE METRICS:**





1. **ADVANTAGES AND DISADVANTAGES:**

**Advantages:**

* Reduction in collection cost.
* Neater neighborhood
* Safer waste disposal
* Reduced overflows

**Disadvantages:**

* We would need a lot more garbage bins a according to the average disposal of garbage in the cities.
* The initial cost is a bit expensive.

1. **CONCLUSION:**

A smart waste management system is much more effective than the current traditional system in use. We focus on providing a solution to the overflowing garbage and unsafe methods of disposal. We are focused on reducing the human intervention and creating a trash-free, healthy environment. This approach can be used in cities, towns, etc. They are used to have a proper schedule and to avoid overflowing of garbage.

1. **FUTURE SCOPE:**

* Having an analytics to predict the amount and type of waste that is collected during festive seasons, so the electronic requirements can be safe from damage and also avoid fire accidents.
* Improving the server and graphics of application.
* We can see this being implemented in the near future for the betterment of the environment.

1. **APPENDIX**

**SOURCE CODE:**

import requests

import json

import ibmiotf.application

import ibmiot.device

import timeimport

random import sys

#watson device

Org= “y4u8dp”

Devtype= “BIN1”

DevId= “BIN1ID”

Authmeth= “token”

Authtoken= “123456789”

def myCommandCallback(cmd):

global a

print(“Command received:%s” %cmd.data[“command”])

control = cmd.data[“Command”]

print(control)

try:

devOp= {“Org”:Org, “Type”: Devtype, “ID”:DevId, “authmethod”: Authmeth, “Authtoken”: Authtoken}

Devcli= ibmiotf.device.Client(deviceOptions)

except Exception as e:

print("caught exception connecting device %s" %str(e))

sys.exit()

Devcli.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 = '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 :' ' 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 '

def myOnPublishCallback(lat=10.678991, long=78.177731):

print("Gandigramam, Karur")

print("published distance = %s " % distance, "loadcell:%s " % loadcell, "lon = %s " % long, "lat = %s" % lat)

print(load)

print(dist)

print(warn)

time.sleep(10)

success = devCli.publishEvent("IoTSensor", "json", warn, qos=0,on\_publish=myOnPublishCallback)

success = devCli.publishEvent

("IoTSensor", "json", data, qos=0, on\_publish= myOnPublishCallback)

if not success:

print("not connected to ibmiot")

time.sleep(30)

devCli.commandCallback = myCommandCallback

**Github:-** <https://github.com/IBM-EPBL/IBM-Project-6725-1658835078>