

**SMART WASTE MANAGEMENT SYSTEM FOR METROPOLITEN CITIES**

**A PROJECT REPORT**

**Submitted by**

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## INDEX

S. No.	Title	
1	<b>Introduction</b> 1.1 Project Overview 1.2 Purpose	
2	<b>Literature Survey</b> 2.1 Existing Problem 2.2 References 2.3 Problem Statement Definition	
3	<b>Ideation and Proposed Solution</b> 3.1 Empathy Map Canvas 3.2 Ideation & Brainstorming 3.3 Proposed Solution 3.4 Problem Solution fit	
4	<b>Requirement Analysis</b> 4.1 Functional requirements 4.2 Non-Functional requirements	
5	<b>Project Design</b> 5.1 Data Flow Diagrams 5.2 Solution & Technical Architecture 5.3 User Stories	
6	<b>Project Planning and Scheduling</b> 6.1 Sprint Planning & Estimation 6.2 Sprint Delivery Schedule	
7	<b>Coding and Solution</b> 7.1 Feature 1 7.2 Feature 2 7.3 Feature 3	

8	<b>Testing</b> 8.1 Test Cases 8.2 User Acceptance Testing	
9	<b>Results</b> 9.1 Performance Metrics	
10	<b>Advantages and Disadvantages</b>	
11	<b>Conclusion</b>	
12	<b>Future Works</b>	
13	<b>Appendix</b> 13.1 Source Code 13.2 Project Links	

## **CHAPTER 1: INTRODUCTION**

### **1.1 Project Overview**

Smart waste management is an innovative approach to handling and collecting waste. Based on IoT (Internet of Things) technology, smart waste management provides data on waste generation patterns and behaviour.

Our Smart waste management solution uses sensors placed in garbage bins to measure fill levels and notifies city collection services when bins are ready to be emptied. There are load and ultrasonic sensors placed to continuously monitor the bins. This data is sent to the cloud(via a microcontroller that is connected to Wi-Fi) where it is stored after which it is processed further. When the levels exceed a certain limit,a notification is sent to the garbage collector via a web application.

Over time, historical data collected by sensors can be used to identify fill patterns, optimize driver routes and schedules, and reduce operational costs. The cost of these sensors is steadily decreasing, making IoT waste bins more feasible to implement and more attractive.

### **1.2 Purpose**

In proposed system, smart waste dustbins will be located in several areas of city are connectedto Internet wirelessly, they equipped with ultrasonic

sensors which collect the data about level of collected waste in smart waste dustbin. The weight of the garbage is measured using load cell. Then smart waste dustbin sends this information to central web portal using Wi-Fi module. If the smart waste dustbin is filled up to its threshold value then the message is displayed and the responsible authorities take proper action. We can view location of every bin in the application using GPS module.

## **CHAPTER 2: LITERATURE SURVEY**

### **2.1 Existing Problem**

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 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 problems such as pollution, diseases and has adverse effects on the hygiene of living beings.

## 2.2 References

Title	Author and Publications	Description
Smart Recycle Bin System based on Wi-Fi and IoT	Noor Salah, Rabee M. Hagem & International Journal of Computer Applications (0975-8887).	The proposed system in this paper can be deployed in general purpose dustbins places and at public places. The statuses of the bins can be monitored remotely over web browser. SMS alerts can be sent to the waste collector vehicle to respective location to collect garbage.

CLOUD BASED SMART WASTE MANAGEMENT FOR SMART CITY OF DAVANAGERE	NANDINI D C, K M SHAM SUNDAR & International Research Journal of Engineering and Technology (IRJET)	The goal here is to develop automatic waste bin and make use of cloud computing paradigm to evolve a more mechanism.
Solid Waste Management in Smart Cities using IoT	Praneetha Surapaneni, Maganti Symala, Lakshmana Phaneendra Maguluri & International Journal of Pure and Applied Mathematics.	The coordinated arrangement of RFID, GPRS and GPS makes the waste bin identification and customer information accumulation framework efficient. The sensor detects if any person is there near
Smart Solid Waste Management in New Capital City Amaravathi	G. Kalyan Chakravarthi, D. Satish Chandra, SS. Asadi & International Journal of Recent Technology and Engineering (IJRTE).	Presently Indian city's struggling with the solid waste management to get rid of things by using IoT. The truck is attached with GPS tracking system. Once the bins were full then we send the signal to the truck via mobile or computer.

IoT BASED SMART WASTE MANAGEMENT SYSTEM:IN CITY	Miss: Sana Bagban,Mr: Hemant Tirmare & International Journal of Advance Research in Science and Engineering.	The Internet technologiesenhanced by the use of theInternet Protocol (IP) wireless sensors enable the Internet of Things (IoT) paradigm. IoT can be used to provide way for smart waste management.
SMART WASTE MANAGEMENT SYSTEM	Sanjiban Chakraborty, Aniket Mehta, Shaheen Sheikh, Ashmita Kumari Jha, Dr. CR Manjunath & Journal of Emerging Technologies and Innovative Research (JETIR).	Garbage collecting vehicles can be tracked using the GPS module and the RFID tags. The RFID tags on the vehicle and dustbins read and transmit the signal of the status to the cloud. And from the cloud, the data will be shared to the user's app and the admin dashboard.
Smart Waste Management: Garbage Monitoring Using Iot	Mrs Sarmila SS, Siva Kumar V, Kumaur P K & SSRG International Journal of Computer Science and Engineering (SSRG-IJCSE).	The smart dustbins are connected to the internet to get the real time information of the smart dustbins. Sensor based waste collection bins is used to identify status of waste bins if it is empty or fille



## **2.3 Problem Statement Definition**

Waste bins are part of all life. Poor waste management contributes to climate change, air pollution and it leads in foul smell and unhygienic condition. Most of the world's waste is dumped in landfill. Waste bins are overflowing due to improper waste collection and dumping process. So waste disposal workers, children and nearby residents are at greater risk. Also quality of air, water and land in this region is getting affected. Improper handling of waste can cause skin irritation and other diseases. Smart bin technology enables to save the time, cost and man power. Also the spread of disease can be prevented using a smart bin and it saves the environment from toxic effects.

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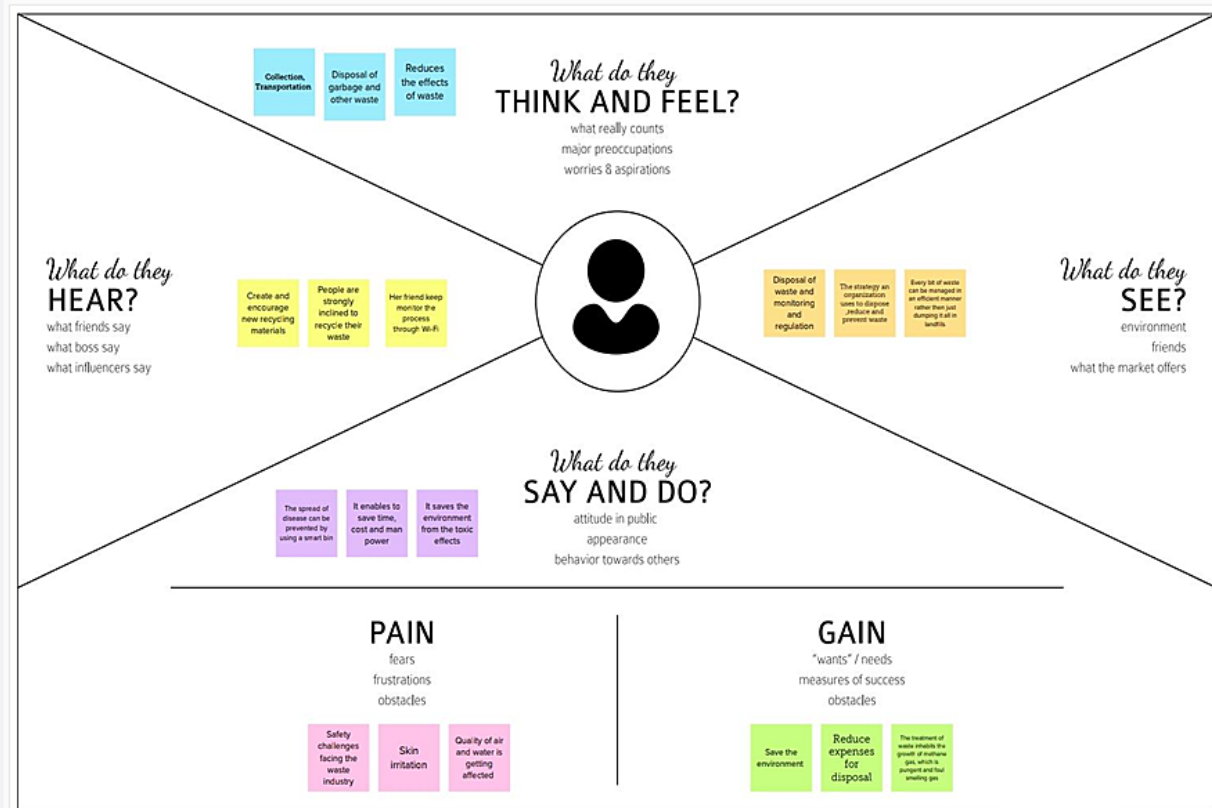
## **CHAPTER 3:**

### **IDEATION & PROPOSED SOLUTION**

#### **3.1 Empathy Map Canvas**

1

Build empathy and keep your focus on the user by putting yourself in their shoes.



## 3.2 Ideation & Brainstorming

### 3.2.1 Brainstorm by team members

# JOTHIKA S

Smart sensors  
monitor fill levels  
in waste  
containers

A Wi-Fi module  
connected to an  
access point will  
be used for  
sending data to  
ThingSpeak

Smart sensors  
gather data on  
waste generation  
patterns and send  
this information to  
the cloud.

GPS enabled  
to track the  
location

Waste collectors can  
use the smart waste  
management  
software to optimize  
their collection  
routes.

GSM 900 modem  
is used to send  
waste level data  
collected by  
microcontroller

water resistance  
sensor solution for  
IoT applications.

The software  
algorithms  
automatically  
setup the optimum  
pick-up routes.

The microcontroller is  
ample for taking up  
data from sensors and  
sending them to the  
internet through a  
network interface.

## KIRUBA ESTHER K

GSM 900 modem is used to send waste level data collected by microcontroller

Management of the overall collection process using IOT (Internet of Things).

The received signal indicates the waste bin status at the monitoring and controlling system.

Smart city infrastructure like capacity sensors in waste bins and wireless networks for data

It contains everything needed to support the microcontroller

simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

A breadboard is a construction base for prototyping of electronics

The ultrasonic sensor uses this information along with the time difference

A Wi-Fi module connected to an access point will be used for sending data to ThingSpeak

## PAVITHRA S

With the web application, the administrator will be able to search for dustbins

The Ultrasonic Sensor sends out a high-frequency sound pulse

The ESP8266 WiFi Module is a self-contained SOC with an integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network

Add waste level sensors to bins and dumpsters to track fill levels and optimize your company's waste collection schedule

Place solar powered trash compactors in outdoor spaces to maximize the amount of waste each bin can hold

The received signal indicates the waste bin status at the monitoring and controlling system.

GPS enabled to track the location

Arduino will be the processing unit for the embedded system at the bins

The environment is written in Java and based on Processing and other open-source software

## RAJALAKSHMI S

GPS  
enabled to  
track the  
location

Load cell are  
used to identify  
weight of the  
Trash Bins

A Wi-Fi module  
connected to an  
access point will  
be used for  
sending data to  
ThingSpeak

Ultrasonic  
technology  
ensures top  
measurement  
accuracy.

A powerful network  
that manages the  
network and trash  
bins to transmit the  
data.

IR Sensor emits  
in order to sense  
some aspects of  
the  
surroundings.

Like waste level  
sensors, weighing  
mechanisms installed  
in garbage trucks can  
help predict fill levels  
and reduce collection  
trips

The microcontroller is  
ample for taking up  
data from sensors and  
sending them to the  
internet through a  
network interface.

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

## 3.2.2 Group ideas

3

### Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. In the last 10 minutes, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

🕒 20 minutes

### Sensor

Smart sensors monitor fill levels in waste containers

Smart sensors gather data on waste generation in districts and send this information to the cloud

Water resistance sensor solution for IoT applications

Smart city infrastructure the capacity sensors in waste bins and wireless networks for data

Smart city infrastructure the capacity sensors in waste bins and wireless networks for data

IR Sensor emits in order to sense some aspects of the surroundings

### Microcontroller

The microcontroller is capable for taking an input from the sensor and sending them to the internet through a network interface

GSM 900 modem is used to send waste level data collected by microcontroller

A breadboard is a construction base for prototyping of electronics

GSM 900 modem is used to send waste level data collected by microcontroller

Arduino will be the processing unit for the embedded system at the bin

The microcontroller is capable for taking an input from the sensor and sending them to the internet through a network interface

### Wi-Fi Module

A Wi-Fi module connected to an access point will be used for sending data to ThingSpeak

Management of the cycle collection process using IoT (Internet of Things)

With the web application, the administrator will be able to search for decisions

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

A Wi-Fi module connected to an access point will be used for sending data to ThingSpeak

The environment is written in Java and based on Processing and other open source software

### Monitor the Location

GPS enabled to track the location

The received signal indicates the waste bin status at the monitoring and controlling system

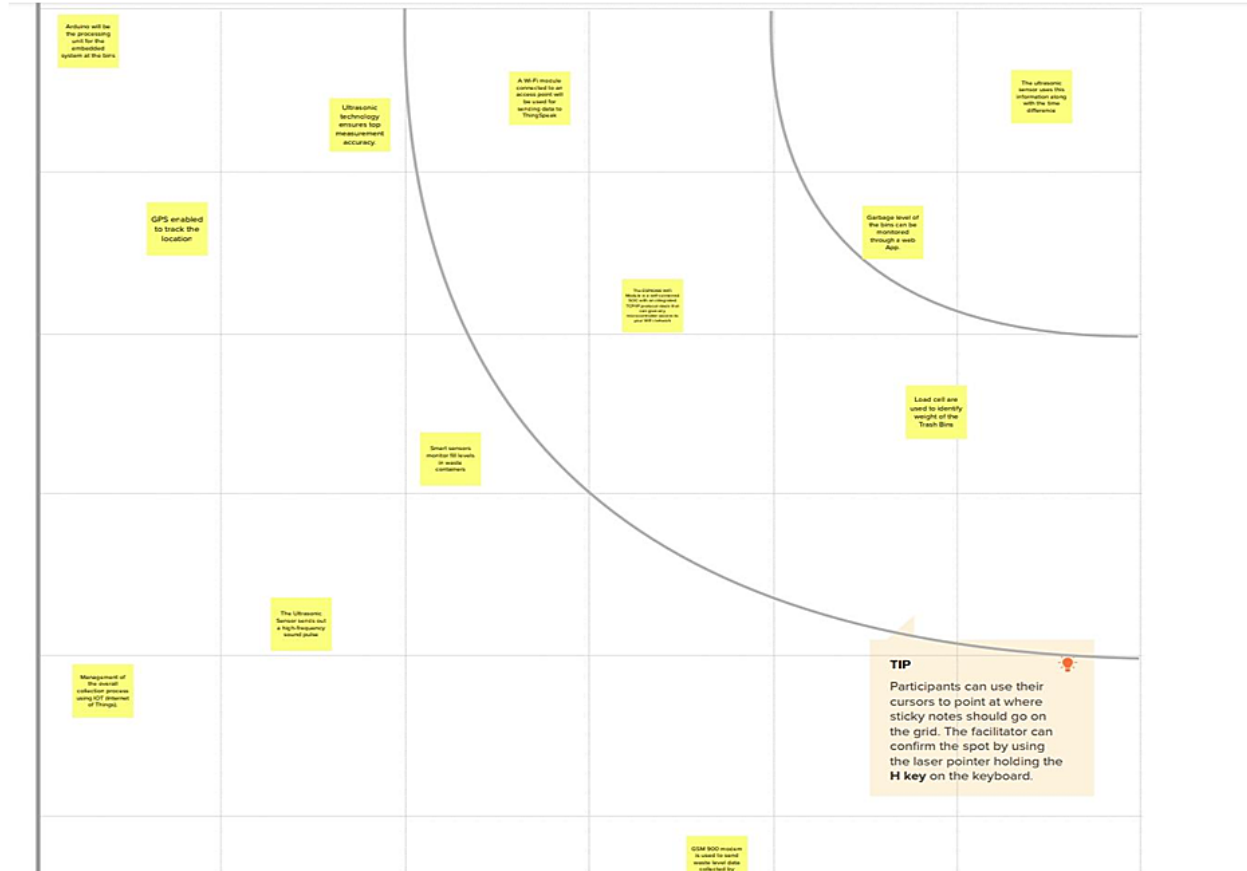
GPS enabled to track the location

Like waste level sensor, weighing mechanism installed in garbage bins can help predict the waste and reduce collection time

The received signal indicates the waste bin status at the monitoring and controlling system

GPS enabled to track the location

### 3.2.3 Prioritize



### **3.3 Proposed Solution:**

In proposed system, smart waste dustbins will be located in several areas of city are connected to Internet wirelessly,they equipped with ultrasonic sensors which collects the data about level of collected waste in smart waste dustbin. The weight of the garbage is measured using load cell. Then smart waste dustbin sends this information to central web portal using Wi-Fi module. If the smart waste dustbin is filled up to its threshold value then the message is displayed and the responsible authorities take proper action. We can view location of every bin in the application using GPS module.

### **3.4 Proposed Solution fit**

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Define CS, fit into CC	<b>1. CUSTOMER SEGMENT(S)</b> <span>CS</span> Corporation, Municipality/ Local body, Private organizations, Schools & Colleges(Educational Institutions) , Apartments and Hotels has been identified as the Stake holders.	<b>6. CUSTOMER CONSTRAINTS</b> <span>CC</span> Provide control over spread of disease and intolerable smell caused.	<b>5. AVAILABLE SOLUTIONS</b> <span>AS</span> Segregation and collection of Bio-degradable and non bio-degradable waste.  Weekly Garbage collections.  Deployed public garbage collection containers.	Explore AS, differentiate
	<b>2. JOBS-TO-BE-DONE / PROBLEMS</b> <span>J&amp;P</span> Control the breeding of insect prone disease  Control spread of Bad Odor  Eco-friendly disposal of waste	<b>9. PROBLEM ROOT CAUSE</b> <span>RC</span> Mass waste productions like Industries, food waste, Household waste, agricultural waste and others.	<b>7. BEHAVIOUR</b> <span>BE</span> Smart monitoring and keep track of the waste disposal rate and amount.  Place for Experiment.	
Identify strong TR & EM	<b>3. TRIGGERS</b> <span>TR</span> A major inconvenience that is encountered everyday in public locations.	<b>10. YOUR SOLUTION</b> <span>SL</span> Disposal of waste at regular interval.  Keep track on the waste production and disposal rate.	<b>8.CHANNELS of BEHAVIOUR</b> <span>CH</span> 8.1.Online Get the levels of waste in bins and action to be done for it.  8.2. Offline Collectors as made to collect the garbage form the respective locations.	Identify strong TR & EM
	<b>4. EMOTIONS: BEFORE / AFTER</b> <span>EM</span> Frustration and spoils mood when ever the smell reaches the sensitive nose.  Calm and peaceful environment.			

## CHAPTER 4: REQUIRMENT ANALYSIS

### 4.1 Functional Requirements

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
1	Detailed bin inventory.	All monitored bins and stands can be seen on the map, and you can visit them at any time via the Street View feature from Google. Bins or stands are visible on the map as green, orange or red circles. You can see bin details in the Dashboard – capacity, waste type, last measurement, GPS location and collection schedule or pick recognition.
2	Real time bin monitoring.	<p>The Dashboard displays real-time data on fill-levels of bins monitored by smart sensors. In addition to the % 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.</p> <p>With real-time data and predictions, you can eliminate the overflowing bins and stop collecting half-empty ones.</p>

3	Plan waste collection routes.	<p>We help you identify bins that drive up your collection costs. The tool calculates a rating for each bin in terms of collection costs.</p> <p>The tool considers the average distance depo-bin-discharge in the area. The tool assigns bin a rating(1-10) and calculates distance from depo-bin discharge.</p>
4	Adjust bin distribution.	<p>Ensure the most optimal distribution of bins.</p> <p>Identify areas with either dense or sparse bin distribution. Make sure all trash types are represented within a stand. Based on the historical data, you can adjust bin capacity or location where necessary.</p>
5	Eliminate inefficient picks.	<p>Eliminate the collection of half-empty bins.</p> <p>The sensors recognize picks. By using real-time data on fill-levels and pick recognition, we can show you how full the bins you collect are. The report shows how full the bin was when picked. You immediately see any inefficient picks below 80% full.</p>

## 4.2 Non-functional Requirements

NFR No.	Non-Functional Requirement	Description
1	Usability	IoT device verifies that usability is a special and important perspective to analyze user requirements, which can further improve the design quality. 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.
2	Security	Use a reusable bottles. Use reusable grocery bags. Purchase wisely and recycle. Avoid single use food and drink containers.
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.

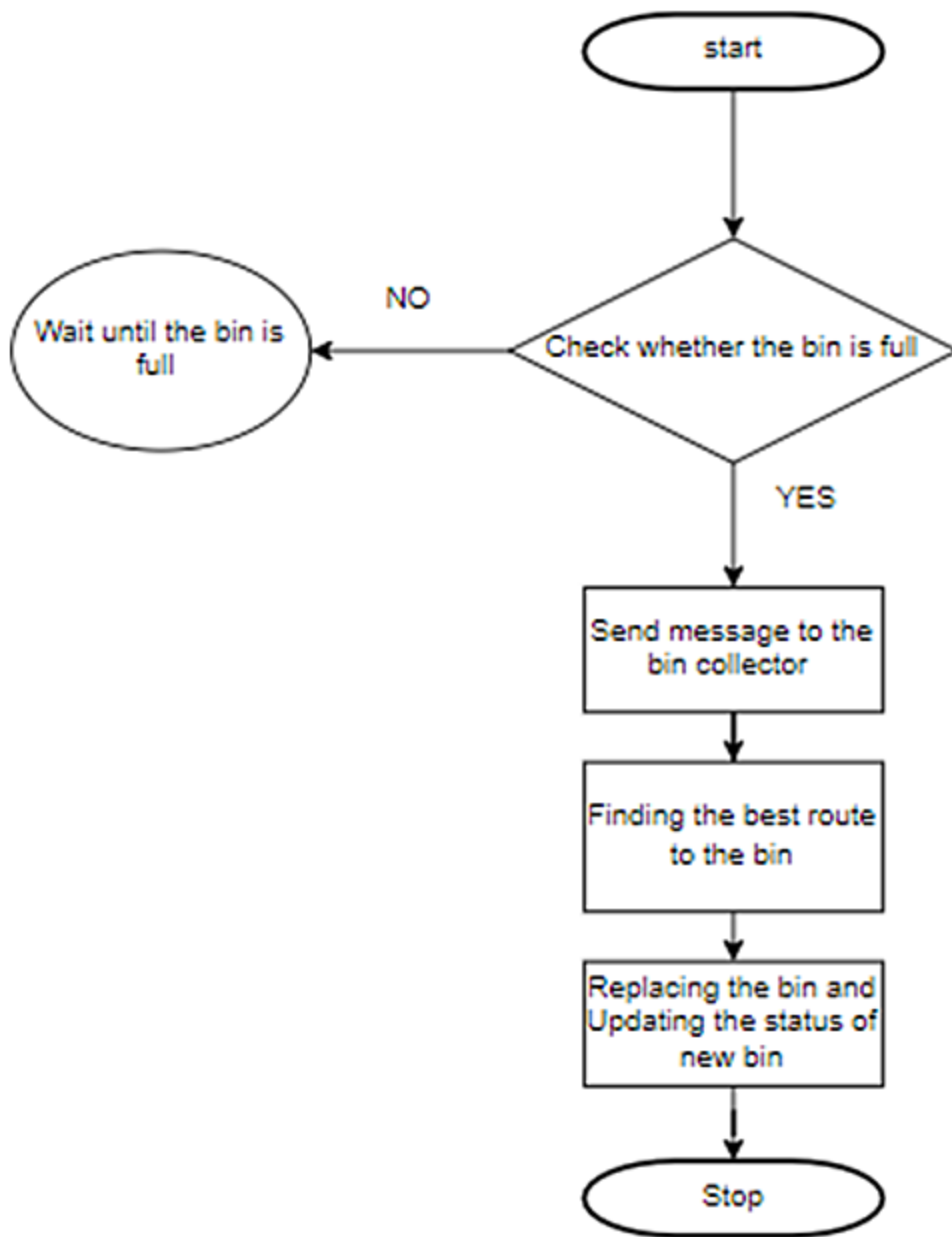
4	Performance	<p>The Smart Sensors use ultrasound technology to measure the fill levels (along with other data) in bins several times a day. Using a variety of IoT networks (NB-IoT, GPRS), the sensors send the data to Sensoneo's Smart Waste Management Software System, a powerful cloud-based platform, for data-driven daily operations, available also as a waste management app. 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%.</p>

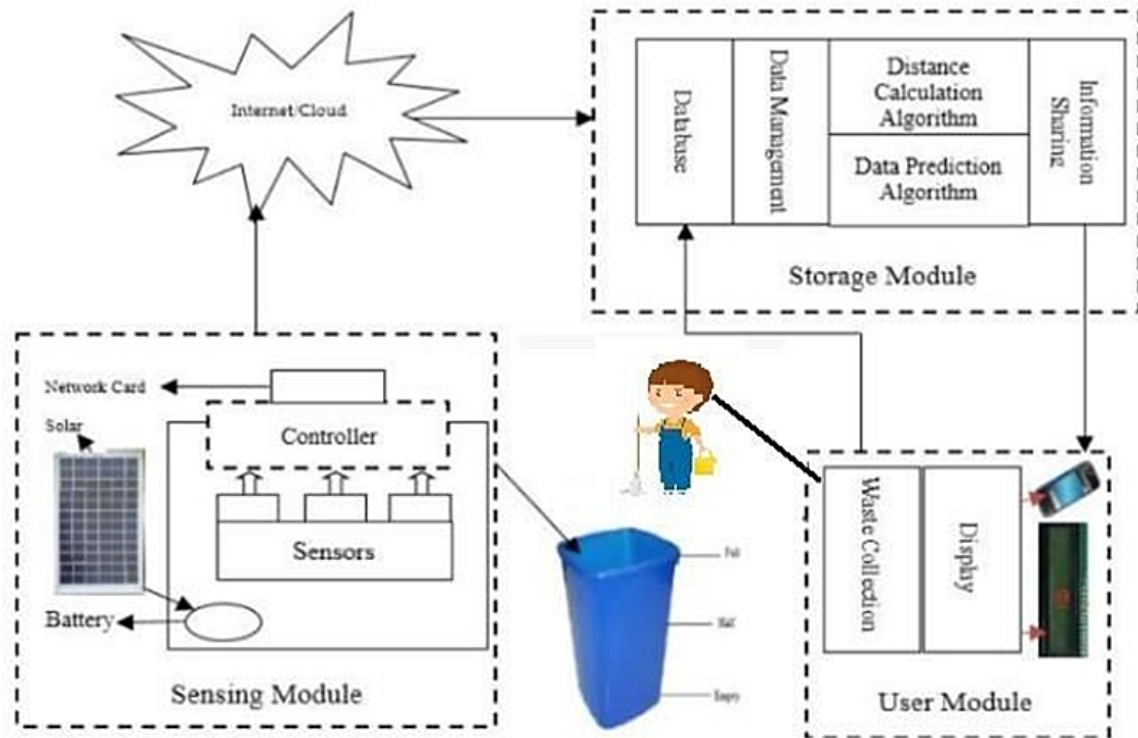
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## CHAPTER 5: PROJECT DESIGN

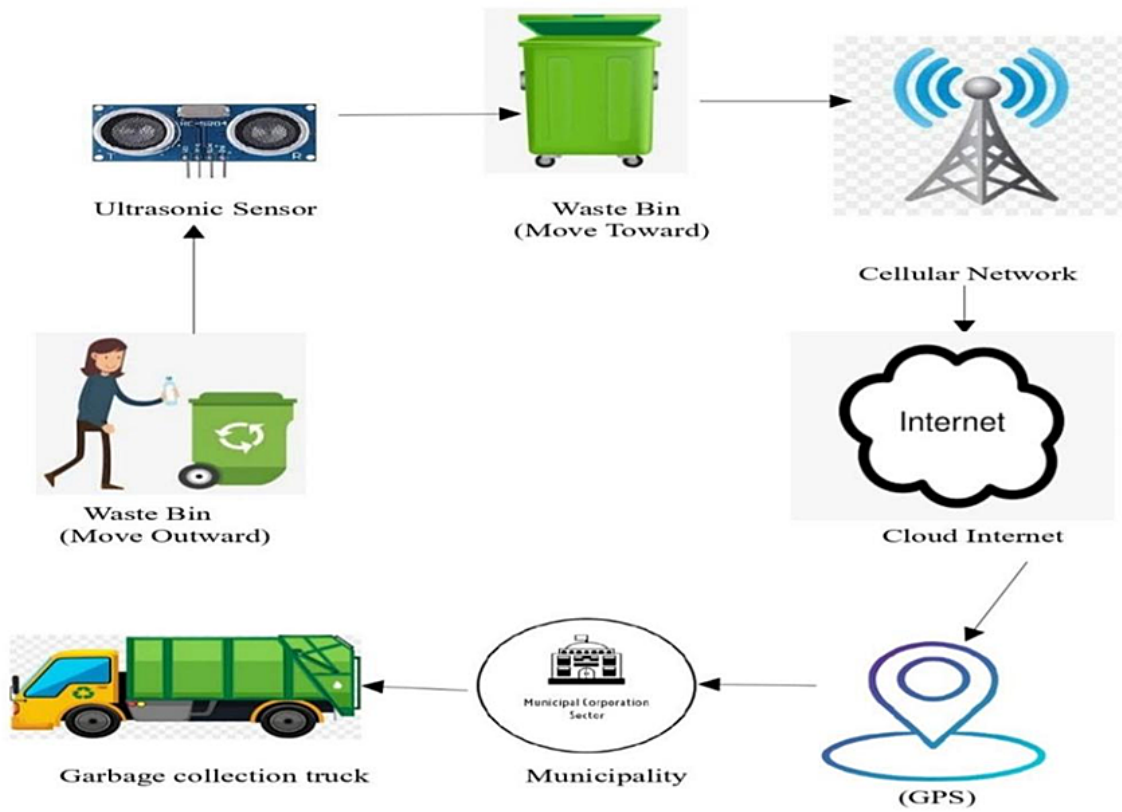
### 5.1 Data Flow Diagram:

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 requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.





## 5.2 Solution and Technical Architecture:



## 5.3 User Stories



User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria
Customer (Mobile user)	Login	USN-1	Can access his or her account to access site with the given credentials.	Admin can access the account / dashboard
Admin	Admin	USN-2	Monitor the user/customer and other participants in the process of garbage disposal/collection.	Authorized User
Garbage Collector	Login	USN – 3	Updates the status of the garbage bins once visited.	Registered by admin and authorized
Truck Driver	Login	USN-4	As user, they are directed to the work assigned to them in site and take the given route.	Admin can register and route can be dynamically re-routed
Organization Head	Login	USN-5	Has the privilege to monitor over the sectors and customers under their control and division.	Admin verified and authorized user from the organization

## CHAPTER 6: PROJECT PLANNING & SCHEDULING

### 6.1 Sprint Planning & Estimation:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	