

**IOT BASED SMART WASTE MANAGEMENT  
SYSTEM FOR METROPOLITAN CITIES**

**Team ID:PNT2022TMID033070**

**A PROJECT REPORT**

**Submitted by**

**R.Karthika-820419205029**

**P.S. Divya Bharathi-820419205018**

**V.Nivedhitha-820419205040**

**K.A.Zennera Fathima-820419205070**

**From**

**ANJALAI AMMAL MAHALINGAM ENGINEERING COLLEGE  
KOVILVENNI.THIRUVARUR.**

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#### **1. Introduction**

##### **1.1 Project Overview**

With rapid increase in population, the issues related to sanitation with respect to garbage management are degrading immensely. It creates

unhygienic conditions for the citizens in the nearby surrounding, leading to the spread of infectious diseases and illness. To avoid this problem, IoT based “Smart Waste Management” is the best and trending solution. In the proposed system, public dustbins will be provided with embedded device which helps in real time monitoring of level of garbage in garbage bins. The data regarding the garbage levels will be used to provide optimized route for garbage collecting vans, which will reduce cost associated with fuel. The load sensors will increase efficiency of data related to garbage level and moisture sensors will be used to provide data of waste segregation in a dust bin. The analysis of ceaseless data gathered will help municipality and government authorities to improve plans related to smart waste management with the help of various system generated reports. **1.2 Purpose**

Smart waste management focuses on solving the previously mentioned solid waste management problems using sensors, intelligent monitoring systems, and mobile applications. The first smart waste management solution to make the waste collection process more efficient is sensors. Sensors can measure the fill level of the containers and provide updated information at any time and notify waste management services to empty them when they are full or almost full. These devices help optimize the best possible route containing fully filled containers and create smart schedules for drivers. The selection of the containers also minimizes the need for trash collection staff because their duties are deduced. They can also alert the waste management companies or municipalities if an undesirable incident happens such as sudden temperature rise or displacement of the container by their GPS features.

## **2. Literature survey:**

### **2.1 Existing system**

Around 80% of waste collections happen at the wrong time. Late waste collections lead to overflowing bins, unsanitary environments, citizen complaints, illegal dumping, and increased cleaning and collection costs. Early waste collections mean unnecessary carbon emissions, more traffic congestion, and higher running costs. The old way of doing waste management is highly inefficient. And in today's

ever-technological world, an innovative and data-driven approach is the only way forward.

Traditionally, municipalities and waste management companies would operate on a fixed collection route and schedule. This means that waste collection trucks would drive the same collection route and empty every single waste container – even if the waste container did not need emptying. This means high labor and fuel costs – which residents ultimately foot the bill for. This is also an unsustainable way of working - the more vehicles on the road carrying out unnecessary collections means more carbon emissions are released into our planet's atmosphere.

## **2.2 Reference**

- [1] Mohammad Aazam, Marc St-Hilaire, Chung-Horng Lung, Ioannis Lambadaris , (2016),”Cloud-based Smart Waste Management for Smart Cities”, IEEE
- [2] Dr. N. Sathish Kumar, B. Vijayalakshmi, R. Jenifer Prarthana, A .Shankar, (2016 ), “IoT Based Smart Garbage alert system using Arduino UNO “, IEEE
- [3] Belal Chowdhury, Morshed U. Chowdhury, (2007) “RFID-based Real-time Smart Waste Management System”, Australasian Telecommunication Networks and Applications Conference, December, Christchurch, New Zealand
- [4] Mohd Helmy Abd Wahab, Aeslina Abdul Kadir, Mohd Razali Tomari and Mohamad Hairol Jabbar (2014), “Smart Recycle Bin A Conceptual Approach of Smart Waste Management with Integrated Web based System“, IEEE
- [5] F achmin F olianto, Y ong Sheng Low, Wai Leong Yeow , (2015) “Smartbin: Smart Waste Management System”, Tenth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP ) Singapore, 7-9 April, IEEE
- [6] Gopal Kirshna Shyam, Sunilkumar S. Manvi, Priyanka Bharti, (2017) ” Smart Waste Management using Internet-of- Things (IoT)” Second International Conference On Computing and Communications Technologies (ICCCT’17), IEEE


- [7] Keerthana B, Sonali M Raghavendran, Kalyani S, Suja P, V.K.G.Kalaiselvi, (2017), “Internet of Bins Trash Management in India“, IEEE
- [8] Bharadwaj B, M Kumudha, Gowri Chandra N, Chaithra G, (2017) “Automation of Smart Waste Management Using IoT to Support “Swachh Bharat Abhiyan” – a practical Approach “ IEEE
- [9] Shubham Thakker, R.Narayanamoorthi, (2015), “Smart and Wireless Waste Management An innovative way to manage waste and also produce energy” 2nd International Conference on Innovations in Information Embedded and Communication Systems ICIECS’15 , IEEE
- [10] Artemios G. Voyiatzis, John Gialelis, and Dimitrios Karadimas, (2014) “Dynamic Cargo Routing on-the- Go: The Case of Urban Solid Waste Collection” 2 nd IEEE WiMob 2014 international workshop on smart city and ubiquitous computing application , IEEE



### 3.2 Brainstorm & Idea Prioritization Template

## Step-1: Team Gathering, Collaboration and Select the Problem Statement


Template



### Conducting a brainstorm

Executing a brainstorm isn't unique; holding a productive brainstorm is. Great brainstorms are ones that set the stage for fresh and generative thinking through simple guidelines and an open and collaborative environment. Use this when you're just kicking-off a new project and want to hit the ground running with big ideas that will move your team forward.

⌚ 15 minutes to prepare  
⌚ 30-60 minutes to collaborate  
👤 3-8 people recommended

 Meta

➔

**Before you collaborate**

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

⌚ 15 minutes

A

**Choose your best "How Might We" Questions**

Create 5 HMW statements before the activity to propose them to the team.

B

**Set the stage for creativity and inclusivity**

Go over the brainstorming rules and keep them in front of your team while brainstorming to encourage collaboration, optimism, and creativity.

1. **Encourage wild ideas** (If none of the ideas sound a bit ridiculous, then you are filtering yourself too much.)
2. **Defer judgement** (This can be as direct as harsh words or as subtle as a condescending tone or talking over one another.)
3. **Build on the ideas of others** ("I want to build on that idea" or the use of "yes, and...")
4. **Stay focused on the topic at hand**
5. **Have one conversation at a time**
6. **Be visual** (Draw and/or upload to show ideas, whenever possible.)
7. **Go for quantity**

C

**Interested in learning more?**

Check out the Meta Think Kit website for additional tools and resources to help your team collaborate, innovate and move ideas forward with confidence.

[Open the website ➔](#)

1

**Choose your best "How Might We" Questions**

Share the top 5 brainstorm questions that you created and let the group determine where to begin by selecting one question to move forward with based on what seems to be the most promising for idea generation in the areas you are trying to impact.

⌚ 10 minutes

**Problem Statement**

Depending on the fill level, the system sends appropriate notification messages to alert relevant authorities and concerned citizen(s) for necessary action.

**Problem Statement**

Design a smart waste collection system that allows citizens to segregate the various types of solid waste they want to dispose and the municipal authorities to efficiently collect the same. The system should be mobile app (Android based).

**Problem Statement**

Redesign the shape of solid waste in a smart town so that instead of most dumping quarters and a place a smart town is built up of the citizens. Hence a smart town is the one of the smartest of different locations after the city of the future but the best solution for the citizens to achieve the smart town.

**Problem Statement**

Nowadays, the Garbage Collecting Vehicle (GCV) collects the waste bins or bins in a town. So, the problem is how to bring all wastages on the roads. Hence, to overcome this limitation, in this paper a scheme for smart waste management.

## Step-2: Brainstorm, Idea Listing and Grouping

2

### Brainstorm solo

Have each participant begin in the "solo brainstorm space" by silently brainstorming ideas and placing them into the template. This "silent-storming" avoids group-think and creates an inclusive environment for introverts and extroverts alike. Set a time limit. Encourage people to go for quantity.

⌚ 10 minutes

Karthika R

Residential design	Easy to design	Reduce a vehicle person's carbon footprint
Reduce the number of garbage collection vehicles	Cost effective	High efficiency

Divya Bharathi P S

The community	Location convenience	Low cost
High accuracy	Light weight and modular	No need external storage

Zamara Fatima

Cost effective	Easy to design	Based on web app
Reduce to demand	Efficient system	The community

Nivethitha

Use wireless sensor	Share location information	Light weight and stable
High accuracy	Monitoring & alert	To know garbage near using sensor

3

### Brainstorm as a group

Have everyone move their ideas into the "group sharing space" within the template and have the team silently read through them. As a team, sort and group them by thematic topics or similarities. Discuss and answer any questions that arise. Encourage "yes, and..." and build on the ideas of other people along the way.

⌚ 15 minutes

TIP

You can use the Voting section tool above to focus on the strongest ideas.

Indicate a authorized person to collect waste	share the location to garbage collector	To check garbage level using sensor
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## Step-3: Idea Prioritization

4

### Decide your focus

Give each person two icons to vote which idea should your team focus on.

⌚ 5 minutes

karthika



DivyaBharathi



Zennera Fathima



Nivethitha



### After you collaborate

A brainstorm like this typically results in a handful of promising ideas that you can carry forward and act upon.

#### Quick add-ons

A

#### Cluster related ideas

Look for patterns or similarities in the standout ideas. Could any be combined together to form a stronger concept? Cluster similar ideas and label each cluster with a theme.

B

#### Vote on the most promising ideas

Narrow your focus to only the strongest few ideas by holding a **Voting Session**. Give each person 2 votes

#### Keep moving forward



#### 2x2 Prioritization matrix

Build shared understanding and make collective decisions for moving ideas forward.

[Open the template →](#)



#### Storyboarding

Show existing and/or future consumer experiences through the act of sketching.

[Open the template →](#)



#### Pre-mortem

Harness the collective experience and wisdom of the team, before the project even starts

[Open the template →](#)

## 3.3.Proposed solution

S.No.	Parameter	Description
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1.	Problem Statement (Problem to be solved)	<ol style="list-style-type: none"> <li>1. The manual monitoring of wastes in waste bins is a cumbersome process and utilises more human effort, time and cost.</li> <li>2. Irregular disposal of wastes causing trouble to people.</li> <li>3. Foul smell around the place with uncollected wastes or garbage.</li> </ol>
2.	Idea / Solution description	<ol style="list-style-type: none"> <li>1. This process is achieved by using a ultrasonic sensor to know the levels of garbage bin through cloud connection.</li> <li>2. Creating an app, there by the corporation of a particular locality inside a metropolitan city can check the garbage bins whether they are filled or not.</li> </ol>

3.	Novelty / Uniqueness	<ol style="list-style-type: none"> <li>1. Unlike the conventional methods for collecting garbage bins, this method tells us to use the transport only in required places</li> <li>2. To reduce the human-effort and difficulty in monitoring the garbage bins.</li> </ol>
4.	Social Impact / Customer Satisfaction	<ol style="list-style-type: none"> <li>1. People can experience a clean environment.</li> <li>2. Reduces the human effort involving in the garbage disposal process.</li> <li>3. This idea will be very much beneficial for a city corporation for monitoring the cleanliness of various parts of the city.</li> </ol>
5.	Business Model (Revenue Model)	<ol style="list-style-type: none"> <li>1. This reduces a huge fuel cost to the city corporations by reducing the unwanted transport expenses to unnecessary places.</li> <li>2. This project aims to support the municipal corporations.</li> <li>3. Provide a clean environment.</li> </ol>

6.	Scalability of the Solution	<ol style="list-style-type: none"> <li>1. A huge time is saved from frequent monitoring of garbage bins through human labours.</li> <li>2. It can be updated to automated garbage collection through vehicles.</li> <li>3. There is no need of new establishment of things.</li> <li>4. Already present garbage bins are modified slightly.</li> </ol>
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### **3.4 Problem solution fit:**

Define CS fit to CC	<b>1. CUSTOMER SEGMENT(S)</b> <span>CS</span> - Trashy Drivers and Workers - Metropolitan Citizens - Waste Holders	<b>6. CUSTOMER CONSTRAINTS</b> <span>CC</span> - Requires recycling and protection against chemical substance - Internet is necessary to use web app	<b>5. AVAILABLE SOLUTIONS</b> <span>AS</span> - Customer can send the message about smart wastes if any damage on the IOT device - Can collect the wastages before getting overflowing	Explore AS, differentiate
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Focus on J.S.P. sap into BE. under stand	<b>2. JOBS-TO-BE-DONE / PROBLEMS</b> <span>JP</span> - Garbages must be collected before getting filled - overflowing should be avoided	<b>9. PROBLEM ROOT CAUSE</b> <span>RC</span> - High amount of wastages created by citizens - waste management is not properly handled by management	<b>7. BEHAVIOUR</b> <span>BE</span> - Sensor sense the amount of garbage level - Send notification to the respected garbage collector	Focus on J.S.P. sap into BE. under stand
	- Insufficient applications and tools for managing wastages <span>TR</span>	- The main solution is to make a clean environment and well defined smart waste management system <span>ST</span>	<b>8.1. ONLINE</b> Advertising through social media <b>8.2. OFFLINE</b> Exploring the information about smart waste management	Identify story & EM
	<b>4. EMOTIONS: BEFORE / AFTER</b> <span>EM</span>			

## 4. Requirements

### 4.1 Functional Requirements

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Expensive bins	<ol style="list-style-type: none"> <li>As we are making up bins with sensors and other costly devices , this is somewhat expensive architecture to built.</li> <li>And so this requires more security settings as it requires more cost if we need to rebuilt it.</li> </ol>

FR-2	Implementing proper monitoring system	<ol style="list-style-type: none"> <li>1. All bins can be seen on the map, and you can visit them at any time via the Street View feature from Google. Bins are visible on the map as green, orange or red circles.</li> <li>2. You can see bin details in the Dashboard capacity, waste type, last measurement, GPS location and collection schedule or pick recognition.</li> </ol>
FR-3	Separation of different kind of wastes	<ol style="list-style-type: none"> <li>1. Separation of different kind of wastes involves people responsibility too and so, proper education needs to be provided.</li> <li>2. And bins should be implemented accordingly in each location.</li> <li>3. And especially medical wastes should be disposed in a proper manner.</li> </ol>
FR-4	Routing the pickup of trash	<ol style="list-style-type: none"> <li>1. Route planning for rubbish pickup is semi-automated using the tool.</li> <li>2. 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.</li> <li>3. To find any discrepancies, compare the planned and actual routes.</li> </ol>

FR-5	Getrid of ineffective picks	<ol style="list-style-type: none"> <li>1. Get rid of the collection of half-empty trashcans.</li> <li>2. Picks are recognised by sensors.</li> <li>3. We are able to show you how filled the bins youcollect are by utilizing real-time data on fill- levelsand pick recognition.</li> <li>4. The report details the bin's initial level ofbrimmingness.</li> <li>5. Any picksbelow 80% full thatare inefficient are seenright away.</li> </ol>
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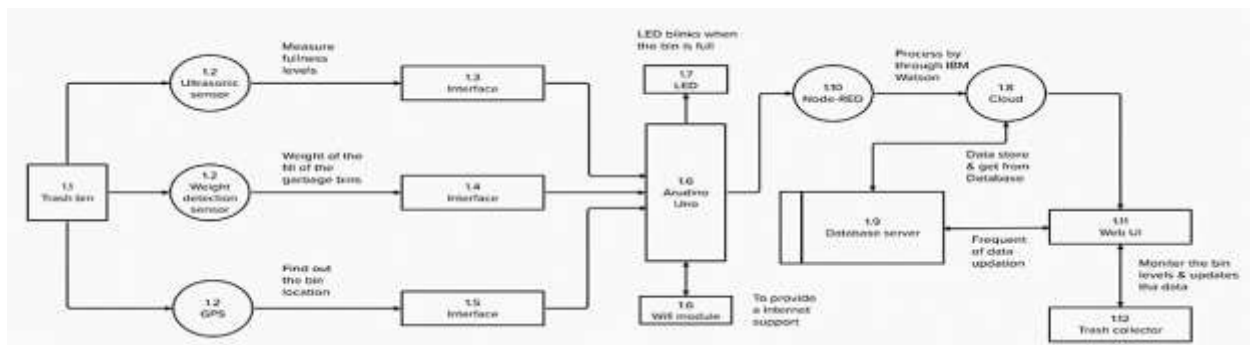
## 4.2 Non-Functional Requirements

FR No.	Non-Functional Requirement	Description
NFR-1	Usability	<ol style="list-style-type: none"> <li>1. The study of customers' product usability can help designers better understand users' possible demands in waste management, behavior, and experience during the design process, whichplaces a focuson the user experience.</li> </ol>
NFR-2	Security	<ol style="list-style-type: none"> <li>1. Security ensures the level of assurance in data collection, processing and conveying.</li> <li>2. As this is totally depend upon cloudservice we needto make security moreparticularwithout channel crash.</li> </ol>

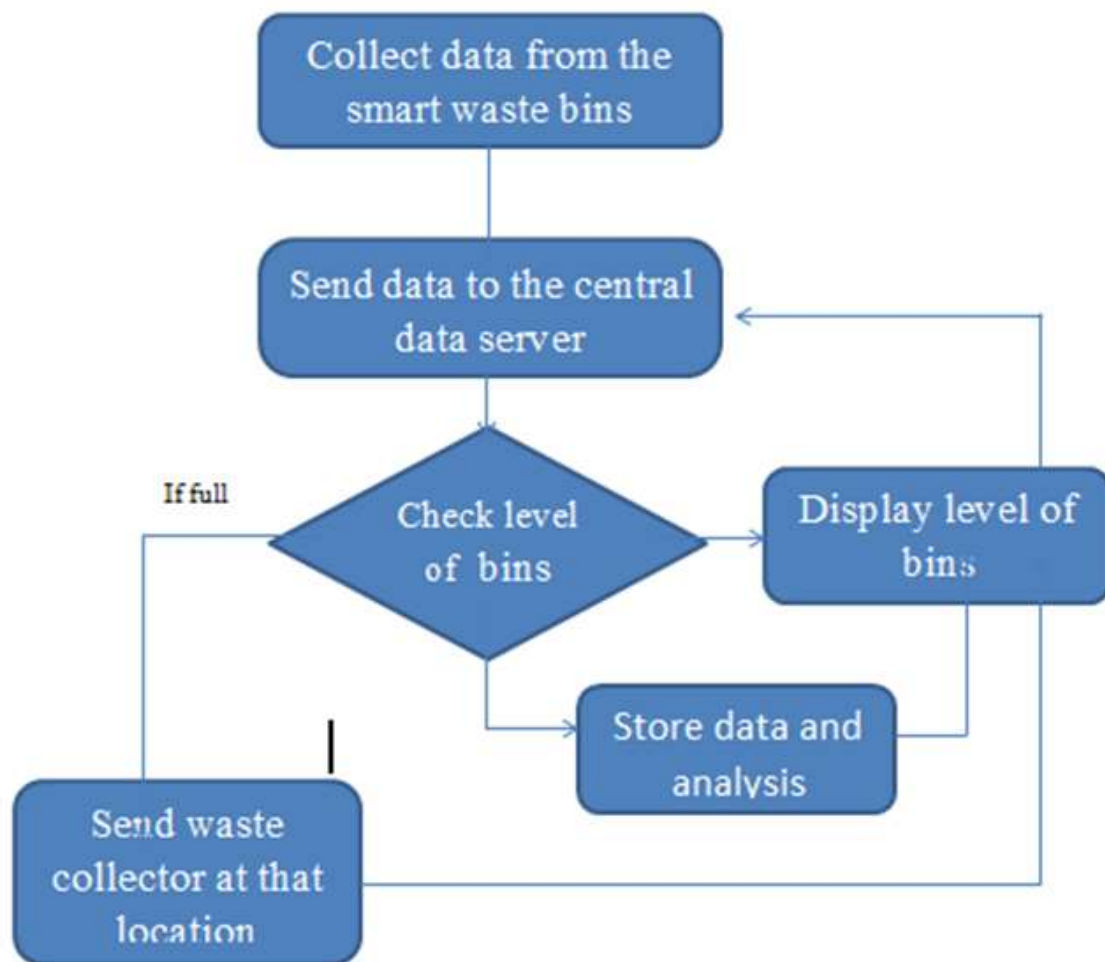
NFR-3	<b>Reliability</b>	<ol style="list-style-type: none"> <li>1. Creating better working conditions for waste collectors and drivers is another aspect of smart waste management. Waste collectors will use their time more effectively by attending to empty bins that need service rather than driving the same collection routes.</li> </ol>
NFR-4	<b>Performance</b>	<ol style="list-style-type: none"> <li>1. The system consist of sensors to measure the weightof waste and the level of wasteinside the bin.</li> <li>2. Customers are provided with required datadriven and decision making prototypes which would help uses to monitor its performance andencounter their quires.</li> </ol>
NFR-5	<b>Availability</b>	<ol style="list-style-type: none"> <li>1. By creating and implementing durable hardware and gorgeous software, we enablecities, companies, and nations to manage garbage more intelligently.</li> </ol>
NFR-6	<b>Scalability</b>	<ol style="list-style-type: none"> <li>1. We have to customize the number of bins inthe town/city which we are going to monitor 24/7 aweek and collect data.</li> <li>2. Smartwaste management aims to optimizeresource allocation, reduce running costs, and increase the sustainability of waste service.</li> <li>3. Analytics data to manage collection routes and the placement of bins moreeffectively.</li> </ol>

## 5. Project Design

### 5.1 Data Flow Diagram



## 5.2 Solution & Technical Architecture



## 5.3 User Stories



Use Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Ad admin	Web server login	USN-1	As a admin, I have my user name and password foe every worker and co-workers to manage them.	I can manage web account and direct workers.	High	Sprint-1
Co-admin	Login	USN-2	As a co-admin, I'll manage other monitoring activities like garbage level monitoring, location accuracy, garbage separation and removal of waste within a scheduled time.	I can monitor garbage bins activities.	High	Sprint-1
Customer (Web user)	User	USN-3	Here comes the customer, he/she will have access to mobile apps or login webpages to view progress of bins and to report if any query found.	He/ she has the right to make a query if any	High	Sprint-2

Cuscustomer	Worker	USN-4	The customer care executive, will try to rectify the queries from customers by contacting coadmin. If case of any critical/ emergency situation query can be conveyed to higher authority.	I can attend calls and respond people by rectifying the problem.	High	Sprint-4
tdTruck drivdriver	Worker	USN-5	Here, truck driver is a worker who has particular assignments that he has to report when and where the garbage has been picked according to the daily schedule. And should update the happenings in the given website (Webpage login).	I can update my activities on site when the given task has been completed.	Medium	Sprint-5

## 6.Project Planning and Scheduling

### 6.1 Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	UserStory Number	User Story/ Task	Story Points	Priority	Team Members
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Sprint-1	Registration	USN-1	As a Administrator, I need to give user id and passcode for ever workers over there in municipality	10	High	Nivedhitha.v
Sprint-1	Login	USN-2	As a Co-Admin, I'll control the waste level by monitoring them vai real time web portal. Oncethe filling happens, I'll notify trash truck with location of binwith bin ID	10	High	Zennera Fathima.K.A
Sprint-2	Dashboard	USN-3	As a Truck Driver, I'll follow Co-Admin's Instruction to reach the filling bin in short rootsand save time	20	Low	Karthika.R
Sprint-1	Dashboard	USN-4	As a Local Garbage Collector, I'll gather all the waste fromthe garbage, load it onto a garbage truck, and deliver it toLandfills	20	Mediu m	Karthika.R,Divya a Bharathi.P.S
Sprint-1	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	High	Divya Bharathi.P.S

## 6.2 Sprint Delivery Scheduling

<b>Sprint</b>	<b>Total StoryPoints</b>	<b>Duration</b>	<b>Sprint Start Date</b>	<b>Sprint End Date (Planned)</b>	<b>Story Points Completed (as on Planned End Date)</b>	<b>Sprint ReleaseDate (Actual)</b>
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov2022	20	05 Nov2022
Sprint-3	20	6 Days	07 Nov2022	12 Nov2022	20	12 Nov2022
Sprint-4	20	6 Days	14 Nov2022	19 Nov2022	20	19 Nov2022

## 7.Coding and Solution

```

#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 20, 4);
float cm;
float inches;
#define ECHO_PIN 12
#define TRIG_PIN 13 float dist;
void setup()
{
  Serial.begin(115200); pinMode(LED_BUILTIN, OUTPUT); pinMode(TRIG_PIN,
  OUTPUT); pinMode(ECHO_PIN, INPUT);
  //pir pin pinMode(34, INPUT);

  //ledpins
  pinMode(23, OUTPUT); pinMode(22, OUTPUT);
  pinMode(21, OUTPUT); pinMode(15, OUTPUT);

```

```

lcd.init(); lcd.backlight(); lcd.setCursor(1, 0); lcd.print("");
}
float readcmCM()
{
digitalWrite(TRIG_PIN, LOW); delayMicroseconds(2); digitalWrite(TRIG_PIN,
HIGH); delayMicroseconds(10); digitalWrite(TRIG_PIN, LOW);
int duration = pulseIn(ECHO_PIN, HIGH); return duration * 0.034 / 2;
}
void loop()
{
    if(digitalRead(34))        //pir motion detection
    {
Serial.println("Motion Detected"); Serial.println("Lid Opened"); digitalWrite(10,
HIGH); delay(10000);
Serial.println("Lid Closed");
    }
    else
    {
digitalWrite(10, LOW);
    }

    if(cm <= 100)        //Bin level detection
    {
digitalWrite(21, HIGH);
Serial.println("High Alert!!!,Trash bin is about to be full"); digitalWrite(22, LOW);
digitalWrite(23, LOW);
    }
    else if(cm > 150 && cm < 250)
    {
digitalWrite(22, HIGH);
Serial.println("Warning!!,Trash is about to cross 50% of bin level");
digitalWrite(21, LOW);
digitalWrite(23, LOW);
    }
    else if(cm > 250 && cm <=400)
    {

```

```
digitalWrite(23, HIGH); Serial.println("Bin is available"); digitalWrite(21, LOW);  
digitalWrite(22, LOW);  
}
```

```
float inches = (cm / 2.54);    //print on lcd lcd.setCursor(0,0);  
lcd.print("Inches"); lcd.setCursor(4,0); lcd.setCursor(12,0);
```

```
lcd.print("cm"); lcd.setCursor(1,1); lcd.print(inches, 1); lcd.setCursor(11,1);  
lcd.print(cm, 1); lcd.setCursor(14,1); delay(1000); lcd.clear();
```

```
}
```

Diagram.json file

```
{  
  "version": 1,  
  "author": "Uri Shaked", "editor": "wokwi", "parts": [  
    { "type": "wokwi-esp32-devkit-v1", "id": "esp", "top": 0, "left": 0, "attrs": { } },  
    {  
      "type": "wokwi-led",  
      "id": "led1",  
      "top": -43.97,  
      "left": 296.62,  
      "attrs": { "color": "limegreen" }  
    },  
    {  
      "type": "wokwi-led",  
      "id": "led2",  
      "top": 15.48,  
      "left": 299.36,  
      "attrs": { "color": "yellow" }  
    },  
    {  
      "type": "wokwi-led",  
      "id": "led3",  
      "top": 140.83,  
      "left": 302.1,  
      "attrs": { "color": "blue" }  
    },  
  ],  
}
```

```
{
  "type": "wokwi-led",
  "id": "led4",
  "top": 79.19,
  "left": 300.24,
  "attrs": { "color": "red" }
},
{
  "type": "wokwi-resistor",

  "id": "r1",
  "top": -3.9,
  "left": 224.81,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-resistor", "id": "r2",
  "top": 55.55,
  "left": 221.42,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-resistor", "id": "r3",
  "top": 179.36,
  "left": 221.1,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-resistor", "id": "r4",
  "top": 119.28,
  "left": 220.77,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-lcd1602",
  "id": "lcd1",
```

```

"top": 248.08,
"left": 161.61,
"attrs": { "pins": "i2c" }
},
{
"type": "wokwi-hc-sr04",
"id": "ultrasonic1",
"top": 13.99,
"left": -295.33,
"attrs": { "distance": "57" }
},
{
"type": "wokwi-pir-motion-sensor", "id": "pir1",
"top": -147.86,
"left": -88.23,
"attrs": {}
}
],
"connections": [
[ "esp:TX0", "$serialMonitor:RX", "", [] ],
[ "esp:RX0", "$serialMonitor:TX", "", [] ],
[ "led1:A", "r1:2", "green", [ "v0" ] ],
[ "led2:A", "r2:2", "yellow", [ "v0" ] ],
[ "led4:A", "r4:2", "red", [ "v0" ] ],
[ "led3:A", "r3:2", "blue", [ "v0" ] ],
[ "led1:C", "esp:GND.1", "black", [ "v-2.56", "h-170.98", "v116.48" ] ],
[ "led2:C", "esp:GND.1", "black", [ "v-2.24", "h-173.72", "v91.96" ] ],
[ "led4:C", "esp:GND.1", "black", [ "v-3.11", "h-174.6", "v27.59" ] ],
[ "led3:C", "esp:GND.1", "black", [ "v-1.92", "h-177.99", "v-32.18" ] ],
[ "r1:1", "esp:D23", "green", [ "v2.63", "h-71.91", "v19.92" ] ],
[ "r2:1", "esp:D22", "yellow", [ "v-1.65", "h-71.58", "v-30.65" ] ],
[ "r4:1", "esp:D21", "red", [ "v-1.01", "h-89.32", "v-64.37" ] ],
[ "r3:1", "esp:D15", "blue", [ "v0.22", "h-89.65", "v-53.64" ] ],
[ "lcd1:GND", "esp:GND.1", "black", [ "h-26.5", "v-129.82" ] ],
[ "lcd1:VCC", "esp:3V3", "red", [ "h-44.89", "v-131.65" ] ],

```

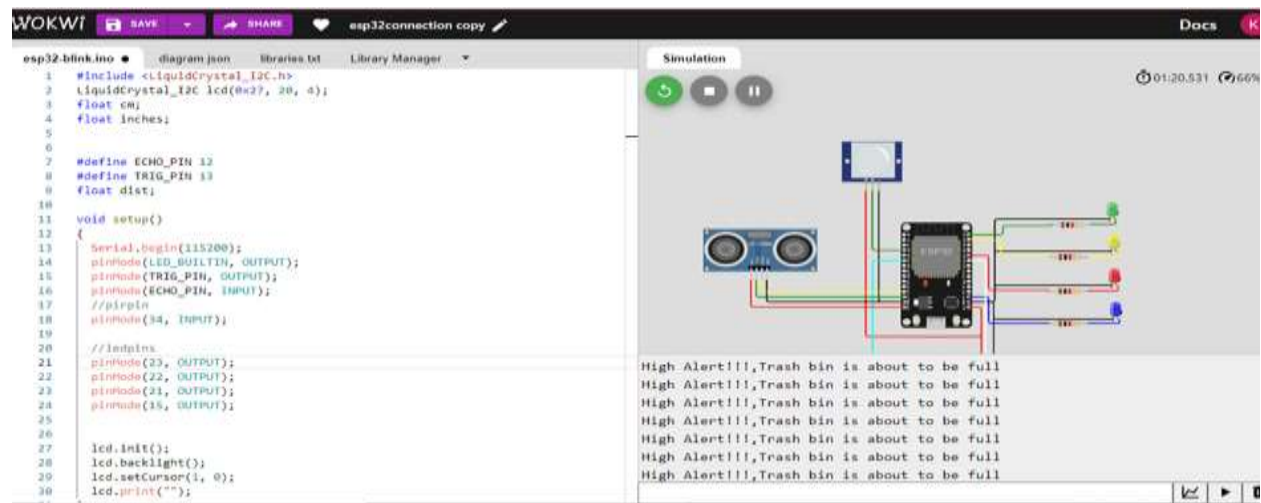


```
[ "pir1:VCC", "esp:3V3", "red", [ "v268.96", "h172.77", "v-55.17" ] ], [
"pir1:GND", "esp:GND.2", "black", [ "v0" ] ],
[ "pir1:OUT", "esp:D34", "green", [ "v0" ] ],
[ "esp:D32", "lcd1:SDA", "cyan", [ "h-46.74", "v226.73", "h207.35" ] ],
[ "lcd1:SCL", "esp:D19", "white", [ "h-38.76", "v-0.46" ] ],
[ "ultrasonic1:GND", "esp:GND.2", "black", [ "v0" ] ],
[ "ultrasonic1:ECHO", "esp:D12", "yellow", [ "v0" ] ],
[ "ultrasonic1:TRIG", "esp:D13", "green", [ "v0" ] ],
[ "ultrasonic1:VCC", "esp:VIN", "red", [ "v0" ] ]
]
}
```

# Wokwi Library List

# See <https://docs.wokwi.com/guides/libraries> LiquidCrystal I2C

OUTPUT:



## 8. Testing

### 8.1 Test cases

Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result
Login page	Verify user is able to log into application with Invalid credentials		Enter invalid username/email in email text box . Enter valid password text box. Click on log in button	username:speed password:123456	Application should show 'incorrect email or password 'validation message.	Working as expected
Login page	verify user is able to connect with open weather api		if open weather api was connected it will show connected.		open weather api will connected	Working as expected
Login page	verify user is able to see the temperature and visibility		click the link the temperature and the visibility will be shown		if the user click on link the value will be shown otherwise it will not shown	Working as expected

			NFT - Risk Assessment					
S.No	Project Name	Scope/feature	Functional Changes	Hardware Changes	Software Changes	Impact of Downtime	Load/Volume Changes	Risk Score
1	signs with smart connectivity	Existing	Low	No Changes	moderate	No downtime	>5 to 10%	GREEN

## Performance Testing

			NFT - Risk Assessment					
S.No	Project Name	Scope/feature	Functional Changes	Hardware Changes	Software Changes	Impact of Downtime	Load/Volume Changes	Risk Score
1	signs with smart connectivity	Existing	Low	No Changes	moderate	No downtime	>5 to 10%	GREEN

## 8.2 User Acceptance Testing

### 1.Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issues of the [Signs with smart connectivity for better Waste management 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	Severity2	Severity3	Severity4	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	77

## Test Case Analysis

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

## Results

### 9.1 Performance metrics

This project used to measure garbage level and send alert message to trash collector.Reducing waste will not only protect the environment but will also save on costs or reduce expenses for disposal. In the same way, recycling and/or reusing

the waste that is produced benefits the environment by lessening the need to extract resources and lowers the potential for contamination.

## **10.Advantages**

It saves time and money by using smart waste collection bins and systems equipped with fill level sensors. As smart transport vehicles go only to the filled containers or bins. It reduces infrastructure, operating and maintenance costs by upto 30%.

1. It decreases traffic flow and consecutively noise due to less air pollution as result of less waste collection vehicles on the roads. This has become possible due to two way communication between smart dustbins and service operators.
2. It keeps our surroundings clean and green and free from bad odour of wastes, emphasizes on healthy environment and keep cities more beautiful.
3. It further reduces manpower requirements to handle the garbage collection process.
4. Applying smart waste management process to the city optimizes management, resources and costs which makes it a "smart city".
5. It helps administration to generate extra revenue by advertisements on smart devices.

### **10.1.Disadvantages**

1. Sensor nodes used in the dustbins have limited memory size.
2. It reduces man power requirements which results into increase in unemployments for unskilled people.
3. The training has to be provided to the people involved in the smart waste management system.

## **11.Conclusion**

- 1) optimization of the garbage collection process, reduction of labor and resource costs, increase in efficiency and comfort of citizens
- 2) improvement of the ecological situation in the city
- 3) increasing environmental awareness and motivation of the citizens;

## **12.Future Scope**

There are several future works and improvements for the proposed system, 1. Change the system of user's authentication and atomic lock of bins which would help in securing the bin from any kind of damage or theft. 2. Concept of green-points that would encourage the involvement of the residents or the end users making the idea successful and helping to achieve joined efforts for the waste management and hence fulfilling the idea of Swachh Bharath. 3. Having a case study or data analytics on the type and times the waste is collected on the type of days or season making the bin filling predictable and removing the dependency on electronic components and fixing the coordinates. 4. Improving graphical interfaces for the Server and complete Android applications has possibility of extending the system adding other use cases and applications for smart cities. 5. Moreover, the proposed solution is flexible and decoupled with respect to the determination of optimal number of bins and vehicles or to the algorithm that define the best route for vehicles. Therefore, future works can be made in the study of models that offer the best results in terms of decision-making.

## **13.Appendix**

### **Source Code**

```
#include <LiquidCrystal_I2C.h>
```

```

LiquidCrystal_I2C lcd(0x27, 20, 4);
float cm;
float inches;
#define ECHO_PIN 12
#define TRIG_PIN 13 float dist;
void setup()
{
  Serial.begin(115200); pinMode(LED_BUILTIN, OUTPUT); pinMode(TRIG_PIN,
  OUTPUT); pinMode(ECHO_PIN, INPUT);
  //pir pin pinMode(34, INPUT);

  //ledpins
  pinMode(23, OUTPUT); pinMode(22, OUTPUT);
  pinMode(21, OUTPUT); pinMode(15, OUTPUT);
  lcd.init(); lcd.backlight(); lcd.setCursor(1, 0); lcd.print("");
}
float readcmCM()
{
  digitalWrite(TRIG_PIN, LOW); delayMicroseconds(2); digitalWrite(TRIG_PIN,
  HIGH); delayMicroseconds(10); digitalWrite(TRIG_PIN, LOW);
  int duration = pulseIn(ECHO_PIN, HIGH); return duration * 0.034 / 2;
}
void loop()
{
  if(digitalRead(34))      //pir motion detection
  {
    Serial.println("Motion Detected"); Serial.println("Lid Opened"); digitalWrite(10,
    HIGH); delay(10000);
    Serial.println("Lid Closed");
  }
  else
  {
    digitalWrite(10, LOW);
  }

  if(cm <= 100)    //Bin level detection
  {

```

```

digitalWrite(21, HIGH);
Serial.println("High Alert!!!,Trash bin is about to be full"); digitalWrite(22, LOW);
digitalWrite(23, LOW);
}
else if(cm > 150 && cm < 250)
{
digitalWrite(22, HIGH);
Serial.println("Warning!!,Trash is about to cross 50% of bin level");
digitalWrite(21, LOW);
digitalWrite(23, LOW);
}
else if(cm > 250 && cm <=400)
{
digitalWrite(23, HIGH); Serial.println("Bin is available"); digitalWrite(21, LOW);
digitalWrite(22, LOW);
}

```

```

float inches = (cm / 2.54);    //print on lcd lcd.setCursor(0,0);
lcd.print("Inches"); lcd.setCursor(4,0); lcd.setCursor(12,0);

```

```

lcd.print("cm"); lcd.setCursor(1,1); lcd.print(inches, 1); lcd.setCursor(11,1);
lcd.print(cm, 1); lcd.setCursor(14,1); delay(1000); lcd.clear();

```

```

}
Diagram.json file

```

```

{
"version": 1,
"author": "Uri Shaked", "editor": "wokwi", "parts": [
{ "type": "wokwi-esp32-devkit-v1", "id": "esp", "top": 0, "left": 0, "attrs": { } },
{
"type": "wokwi-led",
"id": "led1",
"top": -43.97,
"left": 296.62,
"attrs": { "color": "limegreen" }
},
{

```

```
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"id": "led2",
"top": 15.48,
"left": 299.36,
"attrs": { "color": "yellow" }
},
{
"type": "wokwi-led",
"id": "led3",
"top": 140.83,
"left": 302.1,
"attrs": { "color": "blue" }
},
{
"type": "wokwi-led",
"id": "led4",
"top": 79.19,
"left": 300.24,
"attrs": { "color": "red" }
},
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"type": "wokwi-resistor",

"id": "r1",
"top": -3.9,
"left": 224.81,
"attrs": { "value": "1000" }
},
{
"type": "wokwi-resistor", "id": "r2",
"top": 55.55,
"left": 221.42,
"attrs": { "value": "1000" }
},
{
"type": "wokwi-resistor", "id": "r3",
```



```
"top": 179.36,
"left": 221.1,
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},
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"type": "wokwi-resistor", "id": "r4",
"top": 119.28,
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"attrs": { "value": "1000" }
},
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"type": "wokwi-lcd1602",
"id": "lcd1",
"top": 248.08,
"left": 161.61,
"attrs": { "pins": "i2c" }
},
{
"type": "wokwi-hc-sr04",
"id": "ultrasonic1",
"top": 13.99,
"left": -295.33,
"attrs": { "distance": "57" }
},
{
"type": "wokwi-pir-motion-sensor", "id": "pir1",
"top": -147.86,
"left": -88.23,
"attrs": {}
}

],
"connections": [
[ "esp:TX0", "$serialMonitor:RX", "", [] ],
[ "esp:RX0", "$serialMonitor:TX", "", [] ],
[ "led1:A", "r1:2", "green", [ "v0" ] ],
```

```
[ "led2:A", "r2:2", "yellow", [ "v0" ] ],
[ "led4:A", "r4:2", "red", [ "v0" ] ],
[ "led3:A", "r3:2", "blue", [ "v0" ] ],
[ "led1:C", "esp:GND.1", "black", [ "v-2.56", "h-170.98", "v116.48" ] ],
[ "led2:C", "esp:GND.1", "black", [ "v-2.24", "h-173.72", "v91.96" ] ],
[ "led4:C", "esp:GND.1", "black", [ "v-3.11", "h-174.6", "v27.59" ] ],
[ "led3:C", "esp:GND.1", "black", [ "v-1.92", "h-177.99", "v-32.18" ] ],
[ "r1:1", "esp:D23", "green", [ "v2.63", "h-71.91", "v19.92" ] ],
[ "r2:1", "esp:D22", "yellow", [ "v-1.65", "h-71.58", "v-30.65" ] ],
[ "r4:1", "esp:D21", "red", [ "v-1.01", "h-89.32", "v-64.37" ] ],
[ "r3:1", "esp:D15", "blue", [ "v0.22", "h-89.65", "v-53.64" ] ],
[ "lcd1:GND", "esp:GND.1", "black", [ "h-26.5", "v-129.82" ] ],
[ "lcd1:VCC", "esp:3V3", "red", [ "h-44.89", "v-131.65" ] ],
[ "pir1:VCC", "esp:3V3", "red", [ "v268.96", "h172.77", "v-55.17" ] ], [
"pir1:GND", "esp:GND.2", "black", [ "v0" ] ],
[ "pir1:OUT", "esp:D34", "green", [ "v0" ] ],
[ "esp:D32", "lcd1:SDA", "cyan", [ "h-46.74", "v226.73", "h207.35" ] ],
[ "lcd1:SCL", "esp:D19", "white", [ "h-38.76", "v-0.46" ] ],
[ "ultrasonic1:GND", "esp:GND.2", "black", [ "v0" ] ],
[ "ultrasonic1:ECHO", "esp:D12", "yellow", [ "v0" ] ],
[ "ultrasonic1:TRIG", "esp:D13", "green", [ "v0" ] ],
[ "ultrasonic1:VCC", "esp:VIN", "red", [ "v0" ] ]
]
}
```

# Wokwi Library List

# See <https://docs.wokwi.com/guides/libraries> LiquidCrystal I2C

GitHub Link

<https://github.com/IBM-EPBL/IBM-Project-38607-1660383406>

