PNT2022TMID02546

Project Report

Team ID	**PNT2022TMID02546**
Project Name	**Smart waste management system for metropolitan cities**

1. INTRODUCTION:

1.1Project Overview:

With the increasing population and industrialization of nations throughout the globe, waste has become a great concern for all of us. Over years, researchers figured that only waste management is not enough for its proper treatment and disposal techniques to preserve our environment and keeping it clean in this era of globalization. With the help of technology researchers have, introduced IoT based Smart Waste Management solutions and initiatives that ensures reduced amount of time and energy required to provide waste management services and reduce the amount of waste generated. Unfortunately, developing countries are not being able to implement those existing solutions due to many factors like socio-economic environment. Therefore, in this research we have concentrated our thought on developing a smart IoT based waste management system for developing countries like INDIA that will ensure proper disposal, collection, transportation and recycling of household waste with the minimum amount of resources being available.

1.2Purpose:

We amalgamate technology along with waste management in order to effectively create a safe and a hygienic environment. Smart waste management is about using technology and data to create a more efficient waste industry. Based on IoT (Internet of Things) technology, smart waste management aims to optimize resource allocation, reduce running costs, and increase the sustainability of waste services. This makes it possible to plan more efficient routes for the trash collectors who empty the bins, but also lowers the chance of any bin being full for over a week. A good level of coordination exists between the garbage collectors and the information supplied via technology. This makes them well aware of the existing garbage level and instigate them whenever the bins reach the threshold level. They are sent with alert messages so that they can collect the garbage on time without littering the surrounding area. The fill patterns of specific containers can be identified by historical data and managed accordingly in the long term. In addition to hardware solutions, mobile applications are used to overcome the challenges in the regular waste management system, such as keeping track of the drivers while they are operating on the field. Thus, smart waste management provides us with the most optimal way of managing the waste in an efficient manner using technology.

2. LITERATURE SURVEY:

- Existing problem:

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

- References:

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

   PUBLICATION YEAR: 2016

   DESCRIPTION:

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

2. **TITLE:** Arduino Microcontroller Based Smart Dustbins for Smart Cities

   AUTHOR NAME: K. Suresh, S. Bhuvanesh and B. Krishna Devan

   PUBLICATION YEAR: 2019

   DESCRIPTION:

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

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

   AUTHOR NAME: Parkash Tambare, Prabu Venkatachalam

   PUBLICATION YEAR: 2016

   DESCRIPTION:

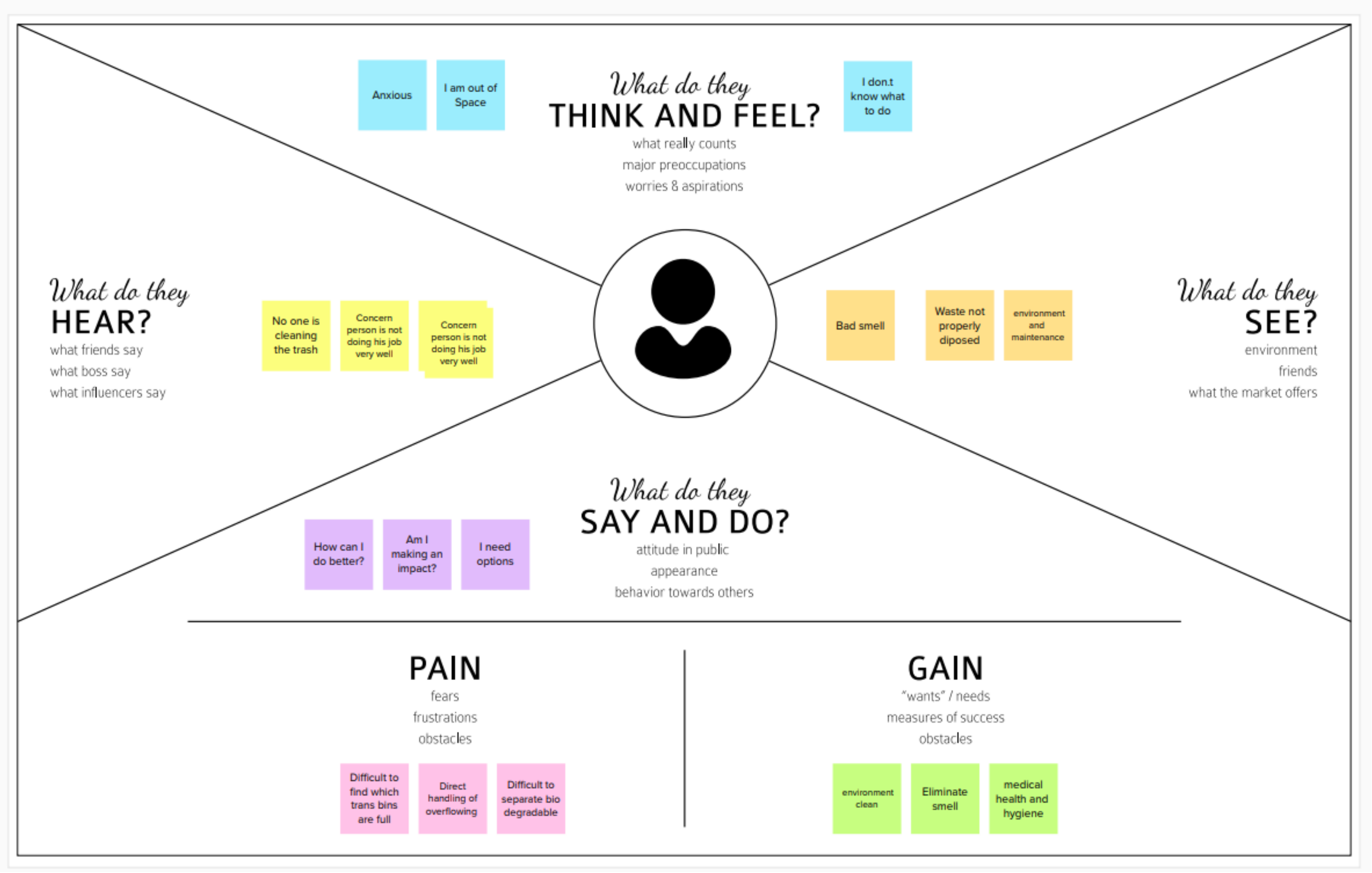
In the current situation, we frequently observe that the trash cans or dust cans that are located in public spaces in cities are overflowing due to an increase in the amount of waste produced each day. We are planning to construct "IoT Based Waste Management for Smart Cities" to prevent this from happening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

2.3 Problem Statement Definition:

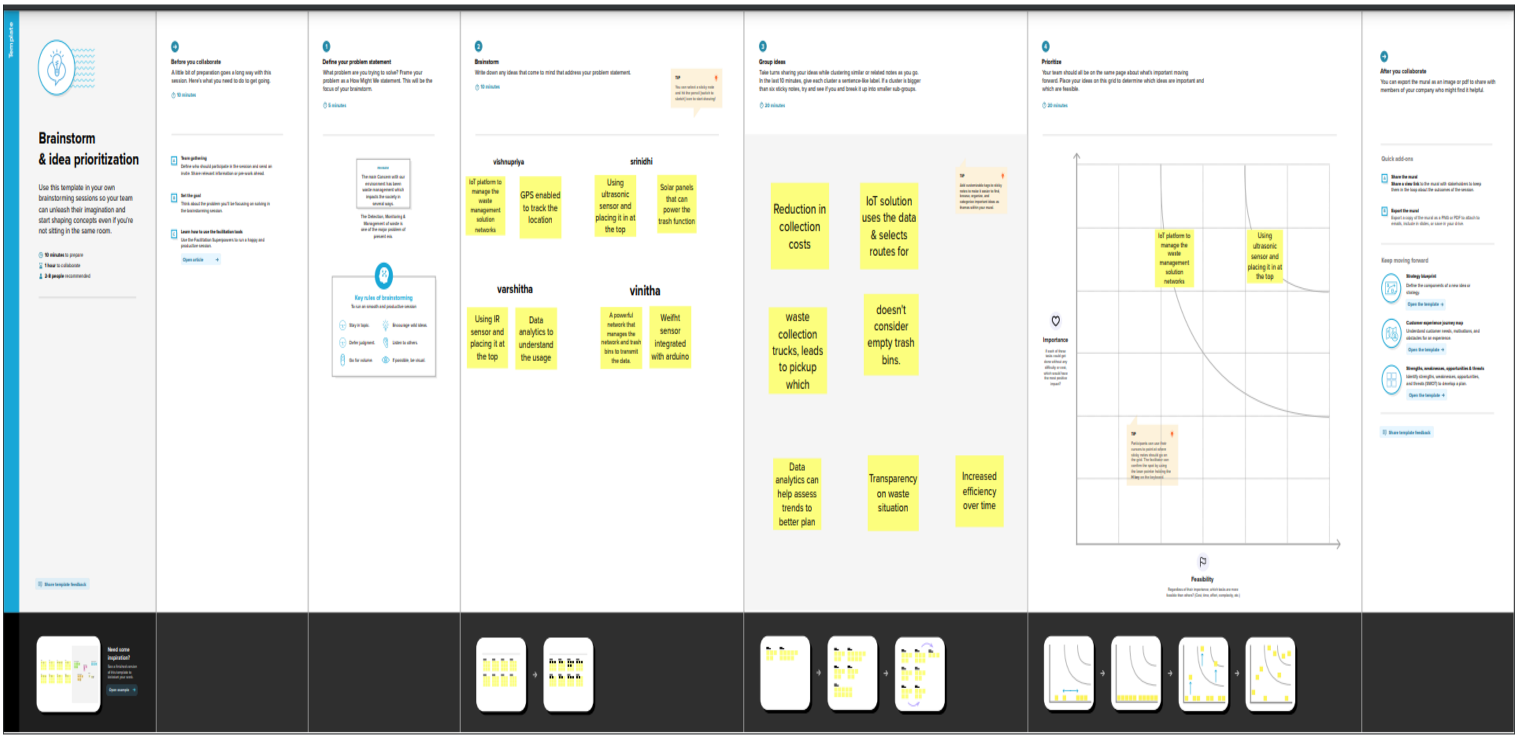
Problem Statement (PS)	**I am (Customer)**	**I'm trying to**	**But**	**Because**	**Which makes me feel**
PS-1	Municipal corporation authority	Get notified when the trash cans are full and be made aware of where the full cans are located.	Don't have the facilities at the moment	There is no tool available to determine the level of bins.	Frustrated
PS-2	Individual working for a private limited corporation	Get rid of the example of a surplus of waste	The trash cans are always filled	I occupy a metropolitan where there is a city is invariably crowd.	Worried

3.IDEATION & PROPOSED SOLUTION:

Empathy Map Canvas : https://github.com/IBM-EPBL/IBM-Project-23877-1659932527/blob/main/PROJECT%20DESIGN%20%26%20PLANNING/Ideation%20Phase/empathy%20map.pdf



3.2 Ideation & Brainstorming



Template

Brainstorm
& idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare
1 hour to collaborate
2-8 people recommended

Share template feedback

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.
10 minutes

A Team gathering
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B Set the goal
Think about the problem you'll be focusing on solving in the brainstorming session.

C Learn how to use the facilitation tools
Use the Facilitation Superpowers to run a happy and productive session.
Open article →

1 Define your problem statement
What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.
5 minutes

The main Concern with our environment has been waste management which impacts the society in several ways.

The Detection, Monitoring & Management of waste is one of the major problem of present era.

Key rules of brainstorming
To run an smooth and productive session

Stay in topic. Encourage wild ideas.
Defer judgment. Listen to others.
Go for volume. If possible, be visual.

2 Brainstorm
Write down any ideas that come to mind that address your problem statement.
10 minutes

TIP
You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

vishnupriya
IoT platform to manage the waste management solution networks
GPS enabled to track the location

srinidhi
Using ultrasonic sensor and placing it in at the top
Solar panels that can power the trash function

varshitha
Using IR sensor and placing it at the top
Data analytics to understand the usage

vinitha
A powerful network that manages the network and trash bins to transmit the data.
Weifht sensor integrated with arduino

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 and break it up into smaller sub-groups.
20 minutes

TIP
Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

Reduction in collection costs
IoT solution uses the data & selects routes for
waste collection trucks, leads to pickup which
doesn't consider empty trash bins.
Data analytics can help assess trends to better plan
Transparency on waste situation
Increased efficiency over time

4 Prioritize
Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.
20 minutes

IoT platform to manage the waste management solution networks
Using ultrasonic sensor and placing it in at the top

Importance
If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?

TIP
Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the H key on the keyboard.

Feasibility
Regardless of their importance, which tasks are more feasible than others? (Cost, time, effort, complexity, etc.)

After you collaborate
You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

A Share the mural
Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

B Export the mural
Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint
Define the components of a new idea or strategy.
Open the template →

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template →

Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.
Open the template →

Share template feedback

Need some inspiration?
See a finished version of this template to kickstart your work.
Open example →

3.3 Proposed Solution

Problem Statement :

- The manual monitoring of wastes in trash cans is a laborious operation that requires additional time, money, and human labor

- Unsafe trash disposal is generating problems for people.
- Bad odor all around the place from uncollected trash or rubbish.

Idea / Solution description:

- This procedure uses a cloud connection and non-bio degradable wastes and an ultrasonic sensor to determine the level of a rubbish container

- By developing an app, the company of a certain neighbourhood inside a large metropolis will be able to check the trash cans to see if they are full or not.

Novelty / Uniqueness:

- In contrast to the traditional ways for collecting trash cans, this strategy instructs us to utilize the transportation only when necessary.
- Keeping an eye on the trash cans easier and less labor-intensive for humans.

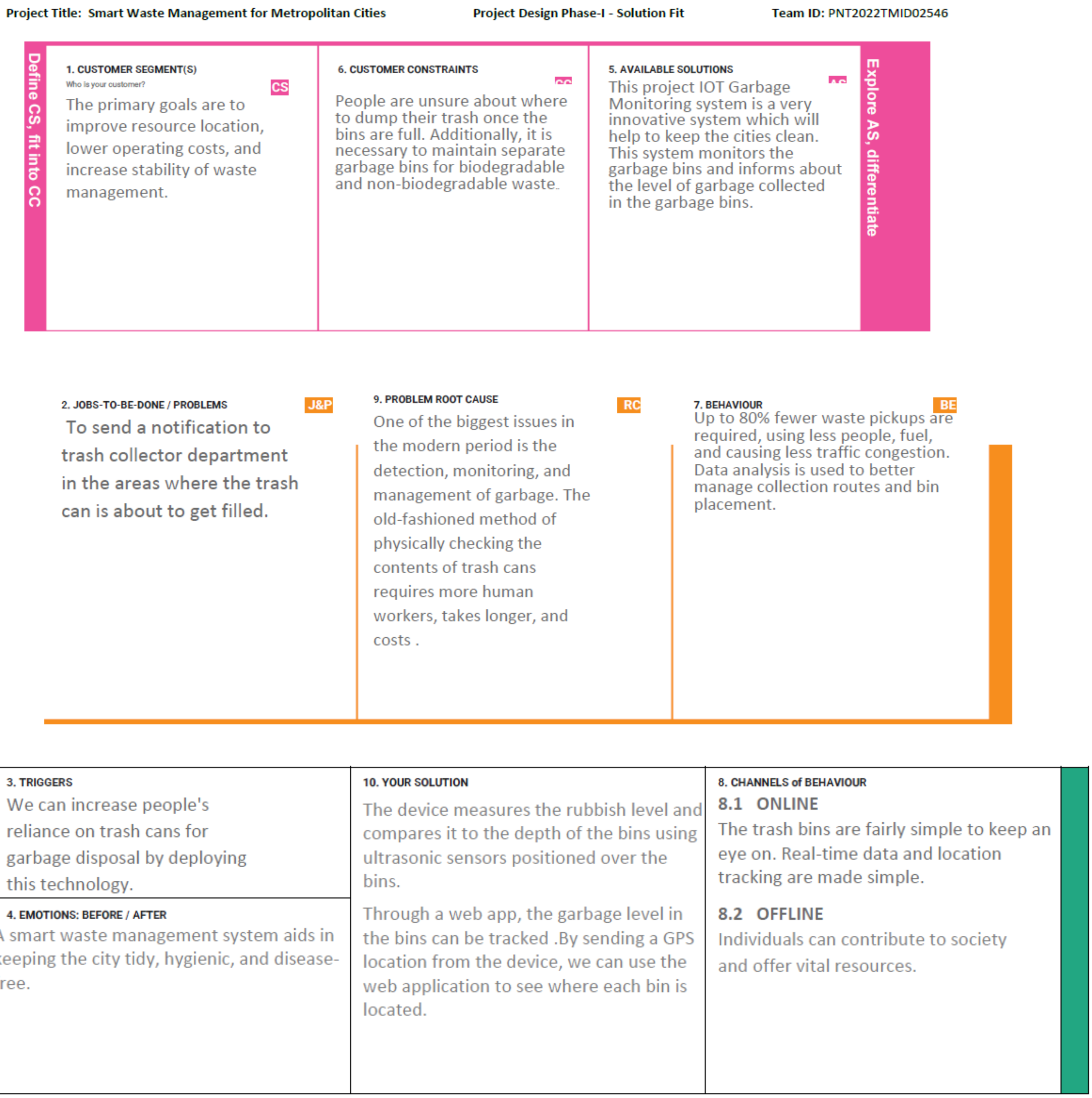
Social Impact / Customer Satisfaction :

- People can experience a clean atmosphere.
- Reduces the amount of labour required from humans for waste disposal.
- For a municipal corporation to monitor the cleanliness of different areas of the city, this proposal will be quite helpful.

Business Model :

- By cutting back on unneeded transportation costs to pointless locations, this lowers a significant amount of fuel costs for city businesses.
- This initiative intends to assist municipal corporation.
- Provide a sanitary atmosphere.

3.4 Problem Solution fit



Project Title: Smart Waste Management for Metropolitan Cities

Project Design Phase-I - Solution Fit

Team ID: PNT2022TMID02546

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Who is your customer?

The primary goals are to improve resource location, lower operating costs, and increase stability of waste management.

6. CUSTOMER CONSTRAINTS

People are unsure about where to dump their trash once the bins are full. Additionally, it is necessary to maintain separate garbage bins for biodegradable and non-biodegradable waste.

5. AVAILABLE SOLUTIONS

This project IOT Garbage Monitoring system is a very innovative system which will help to keep the cities clean. This system monitors the garbage bins and informs about the level of garbage collected in the garbage bins.

Explore AS, differentiate

2. JOBS-TO-BE-DONE / PROBLEMS J&P

To send a notification to trash collector department in the areas where the trash can is about to get filled.

9. PROBLEM ROOT CAUSE RC

One of the biggest issues in the modern period is the detection, monitoring, and management of garbage. The old-fashioned method of physically checking the contents of trash cans requires more human workers, takes longer, and costs .

7. BEHAVIOUR BE

Up to 80% fewer waste pickups are required, using less people, fuel, and causing less traffic congestion. Data analysis is used to better manage collection routes and bin placement.

3. TRIGGERS

We can increase people's reliance on trash cans for garbage disposal by deploying this technology.

4. EMOTIONS: BEFORE / AFTER

A smart waste management system aids in keeping the city tidy, hygienic, and disease-free.

10. YOUR SOLUTION

The device measures the rubbish level and compares it to the depth of the bins using ultrasonic sensors positioned over the bins.

Through a web app, the garbage level in the bins can be tracked .By sending a GPS location from the device, we can use the web application to see where each bin is located.

8. CHANNELS of BEHAVIOUR

8.1 ONLINE

The trash bins are fairly simple to keep an eye on. Real-time data and location tracking are made simple.

8.2 OFFLINE

Individuals can contribute to society and offer vital resources.

4.REQUIREMENT ANALYSIS

4.1Functional 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 bins as it is being 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 recognized by the sensors, you can determine when the bin was last emptied. You can get rid of the overflowing bins and cease 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 recognized 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 rubbish 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 stand. 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 cost rating for each bin. The tool takes local average depo- bin discharge 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**	Usability is a unique and significant perspective to examine user needs, which may further enhance the design quality, according to IoT devices. 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 in 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 data-driven daily operations and a waste management app, using a variety of IoT networks (NB-IoT, GPRS). As a consequence, customers receive data-driven 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.

4. PROJECT DESIGN

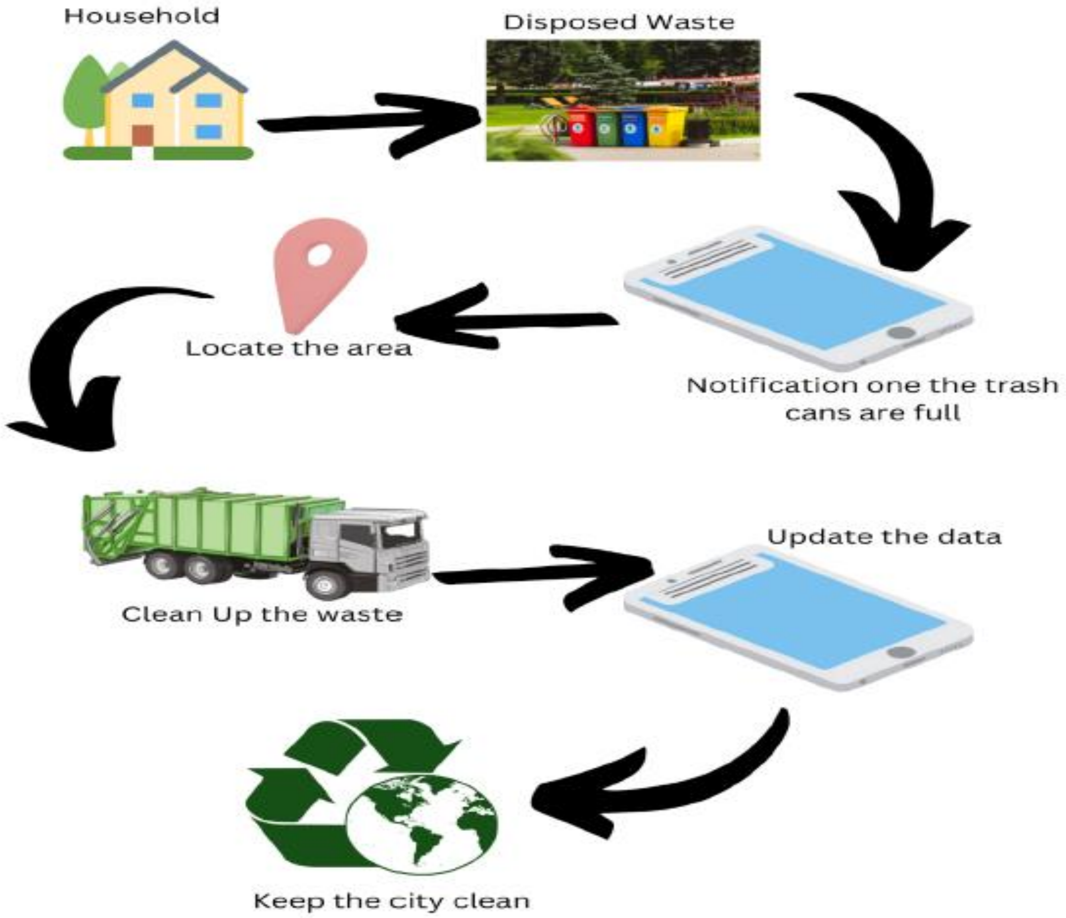
5.1 Data Flow Diagrams

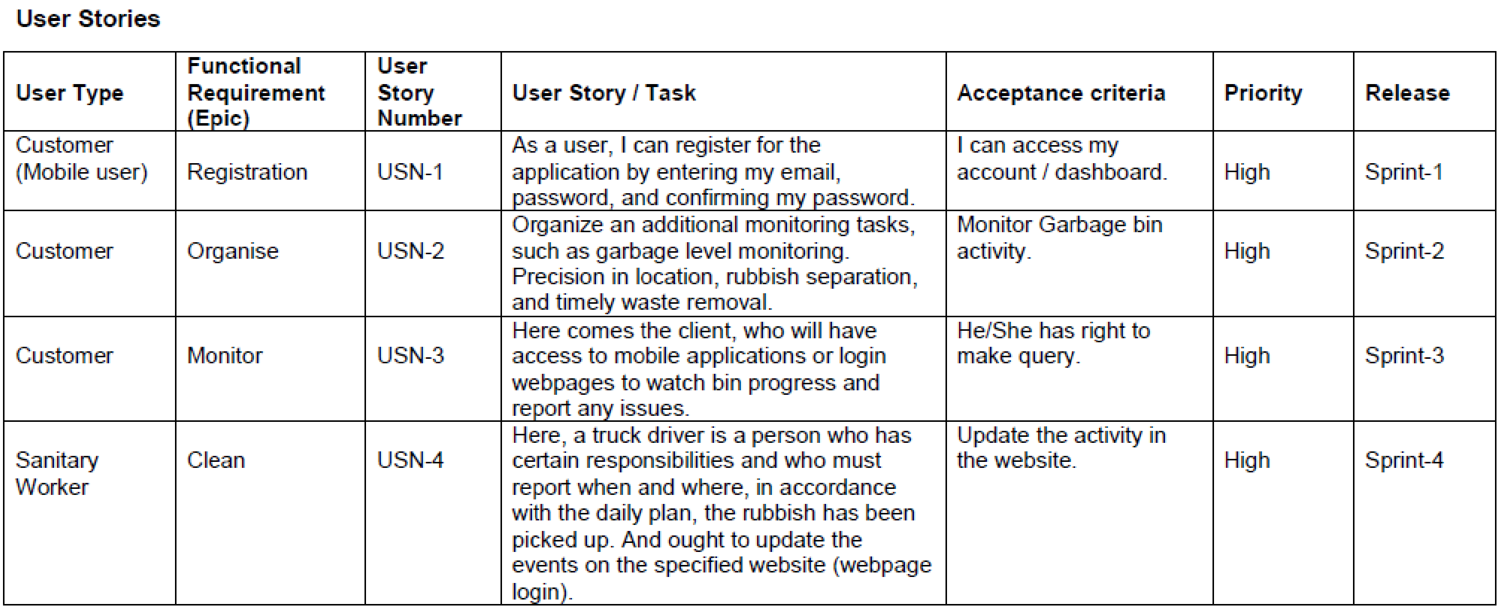
- A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system.
- A neat and clear DFD can depict the right amount of the system requirement graphically.
- It shows how data enters and leaves the system, what changes the information, and where data is stored.
- A smart waste management platform uses analytics to translate the data gather in your **bins into actionable insights to help you improve your waste services.**

You can receive data on metric such as:

- The first test conducted is the situation where the garbage bin is empty or its garbage level is very low
- Then, the bin is filled with more garbage until its level has surpassed the first threshold **value, which is set to 80% then the first warning SMS is being sent, as depicted**
- The first notification SMS sent by the system, once the waste reaches the level of 85% full
- The second notification SMS sent by the system, indicating that bin is at least 95% full and **the garbage needs to be collected immediately**
- Locations prone to overflow
- The number of bins needed to avoid overflowing waste
- The number of collection services that could be saved
- The amount of fuel that could be saved
- The driving distance that could be saved.

5.2 Data flow diagram:

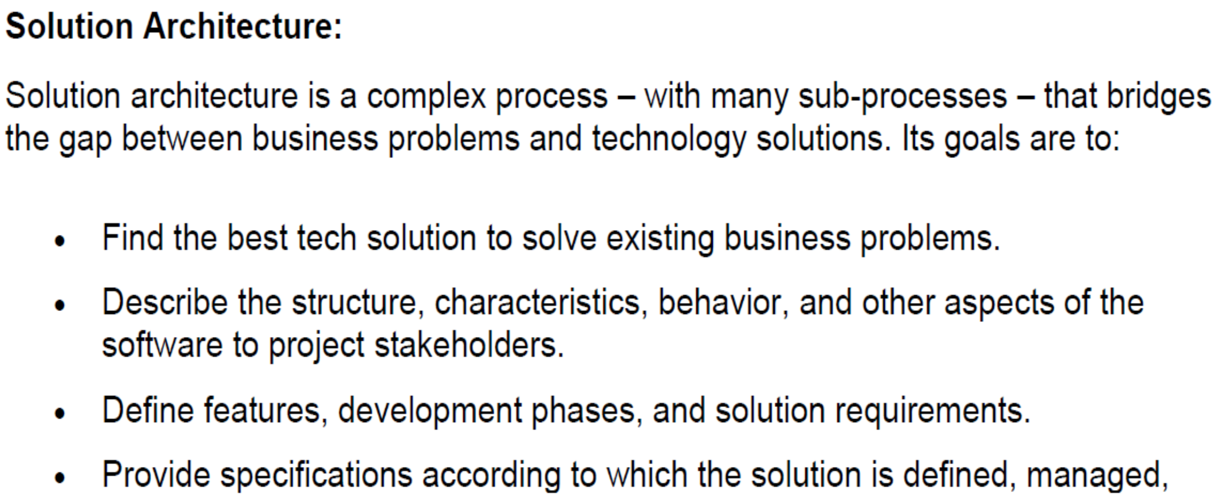




User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard.	High	Sprint-1
Customer	Organise	USN-2	Organize an additional monitoring tasks, such as garbage level monitoring. Precision in location, rubbish separation, and timely waste removal.	Monitor Garbage bin activity.	High	Sprint-2
Customer	Monitor	USN-3	Here comes the client, who will have access to mobile applications or login webpages to watch bin progress and report any issues.	He/She has right to make query.	High	Sprint-3
Sanitary Worker	Clean	USN-4	Here, a truck driver is a person who has certain responsibilities and who must report when and where, in accordance with the daily plan, the rubbish has been picked up. And ought to update the events on the specified website (webpage login).	Update the activity in the website.	High	Sprint-4

5.2 Solution & Technical Architecture:



Solution Architecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed,

Example - Solution Architecture Diagram:

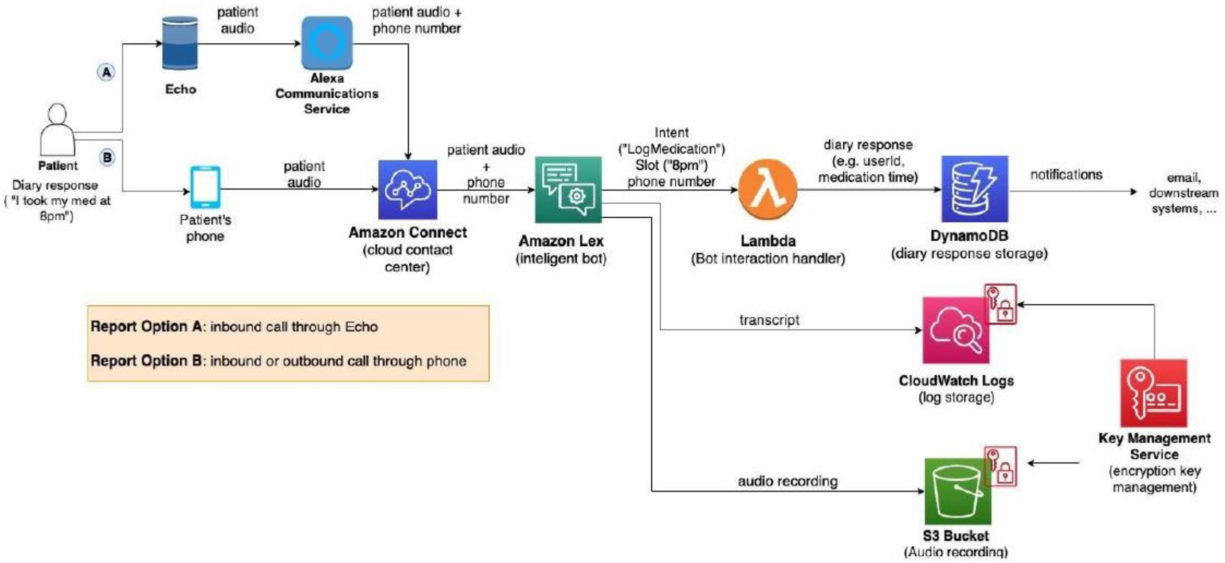

patient audio
patient audio + phone number
A
Echo
Alexa Communications Service
Patient
Diary response ("I took my med at 8pm")
B
patient audio
Patient's phone
Amazon Connect (cloud contact center)
patient audio + phone number
Amazon Lex (inteligent bot)
Intent ("LogMedication") Slot ("8pm") phone number
Lambda (Bot interaction handler)
diary response (e.g. userId, medication time)
DynamoDB (diary response storage)
notifications
email, downstream systems, ...
transcript
CloudWatch Logs (log storage)
Key Management Service (encryption key management)
audio recording
S3 Bucket (Audio recording)
Report Option A: inbound call through Echo
Report Option B: inbound or outbound call through phone

Figure 1: Architecture and data flow of the voice patient diary sample application

Reference: https://aws.amazon.com/blogs/industries/voice-applications-in-clinical-research-powered-by-ai-on-aws-part-1-architecture-and-design-considerations/

Table-1: Components & Technologies:

S.no	Component	Description	Technology
1.	User Interface	Mobile Application	HTML, CSS, JavaScript.
2.	Application Logic	Logic for a process in the application	Java script
3.	Database	Data Type, Configurations etc.	Firebase, ibm cloud
4.	Cloud Database	Database Service on Cloud	IBM Cloud
5.	File Storage	File storage requirements	Local Filesystem and IBM cloud
6.	Infrastructure (Server / Cloud)	Application Deployment on Cloud Local Server Configuration	Local and Cloud Foundry

Table-2:Application Characteristics:

S.no	Characteristics	Description	Technology
1.	Open-Source Frameworks	GitHub	Internet hosting service
2.	Security Implementations	Application security: Veracode.	Network automation
3.	Scalable Architecture	It provides the room for expansion more data base of smart bins added additionally can be updated.	Cloud storage
4.	Availability	As the system control is connected to web server itis available 24*7 and can be accessed whenever needed.	Server, Appleixe, reple
5.	Performance	Performance is high it uses 5mb caches	Wireless Sensor Net work

5.3 User Stories

Use the below template to list all the user stories for the product.

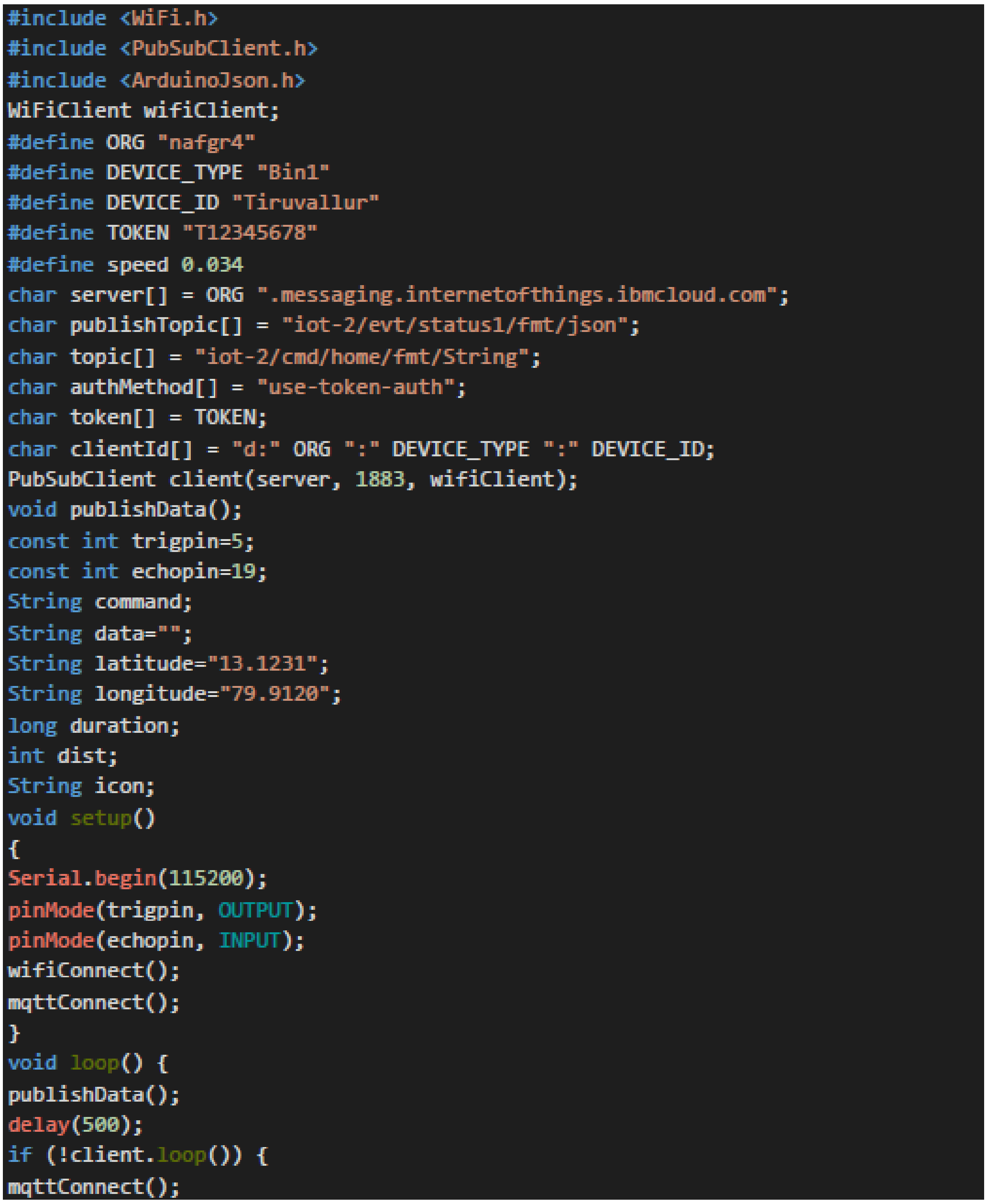
User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Admin	Login	USN-1	As an administrator, I assigned user names and passwords to each employee and managed them.	I can control my online account and dashboard.	Medium	Sprint-1
Co-Admin	Login	USN-2	As a Co-Admin, I'll control the waste level monitor. If a garbage filling alert occurs, I will notify the trash truck of the	I can handle the waste collection.	High	Sprint-1

			location and rubbish ID.			
Truck Driver	Login	USN-3	As a Truck Driver, I'll follow Co Admin's instruction to reach the filled garbage.	I can take the shortest path to reach the waste filled route specified.	Medium	Sprint-2
Local Garbage Collector	Login	USN-4	As a Local Garbage Collector, I’II gather all the waste from the garbage, load it onto a garbage truck, and deliver it to Landfills	I can collect the trach, pull it to the truck, and send it out.	Medium	Sprint-3
Municipality officer	Login	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems.	All of these processes are under my control.	High	Sprint-4

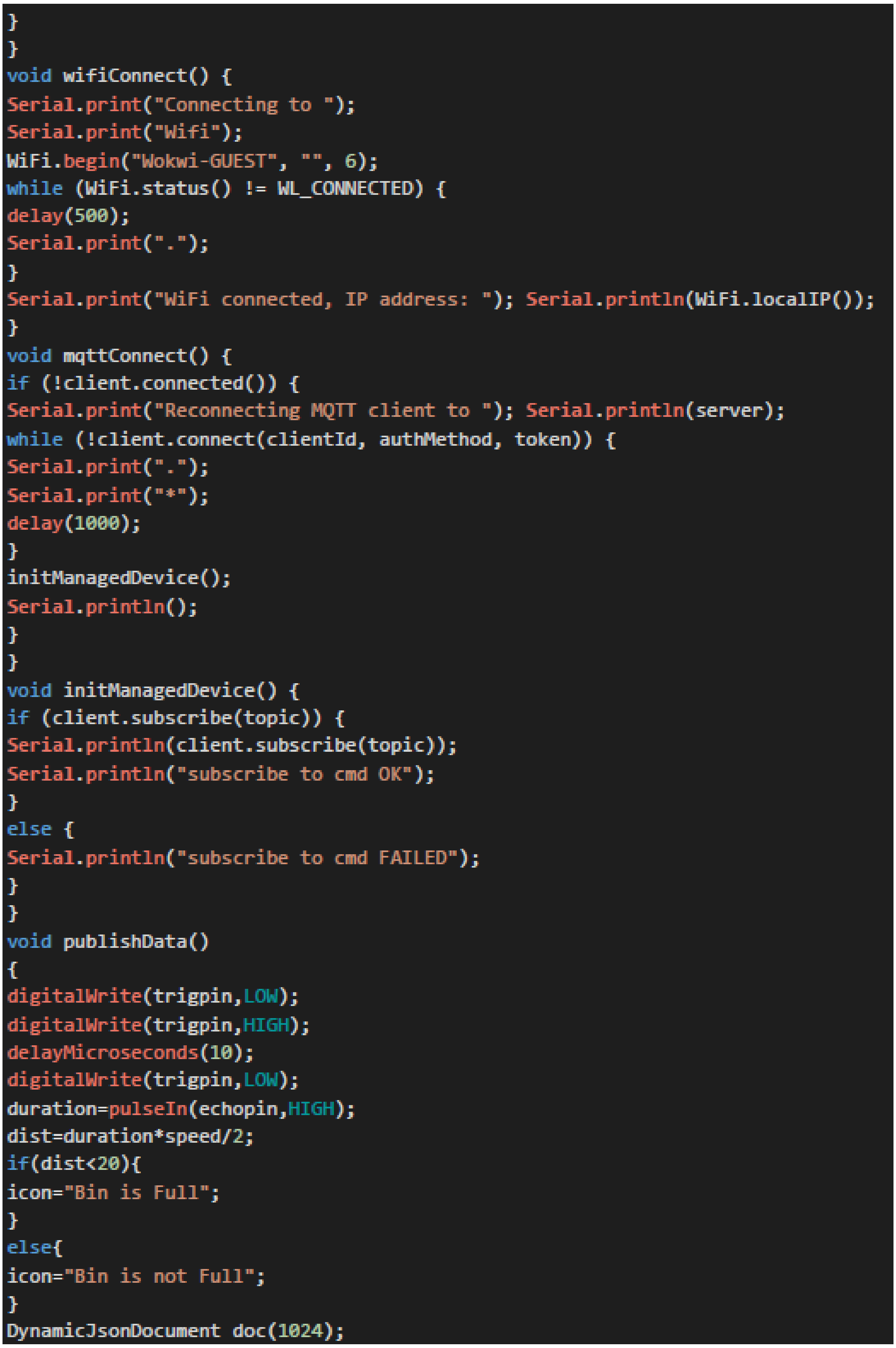
5.PROJECT PLANNING & SCHEDULING

Sprint Planning & Estimation

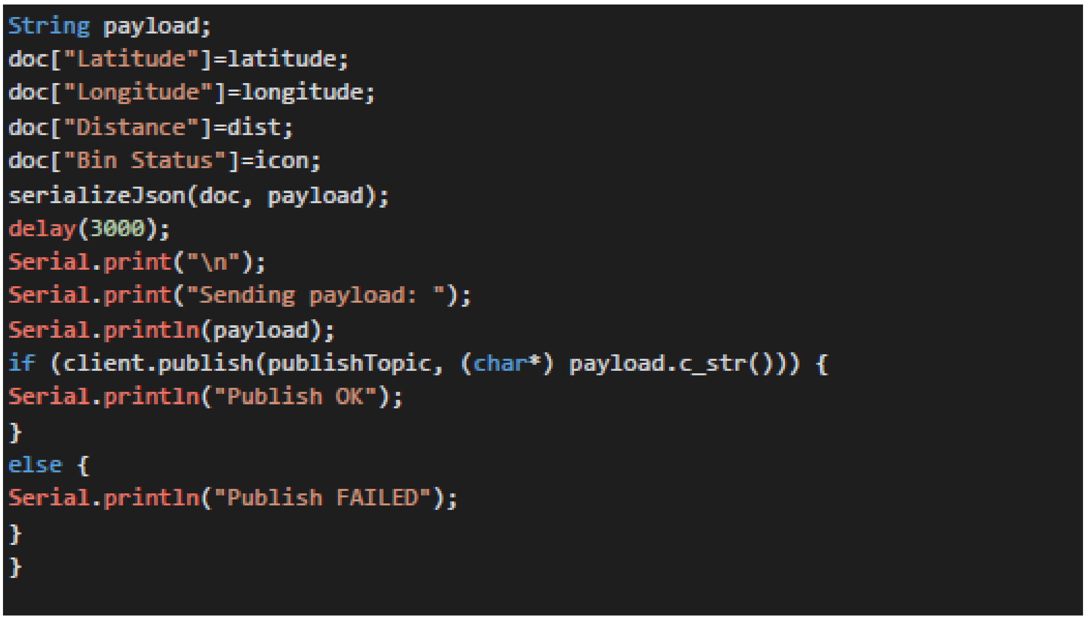
BIN 1 :-



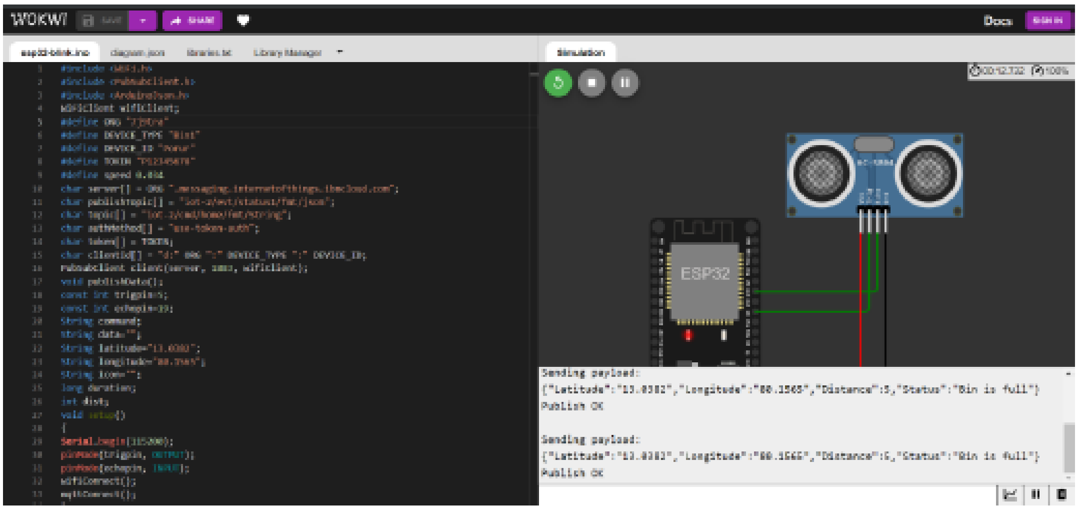
```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>
WiFiClient wifiClient;
#define ORG "nafgr4"
#define DEVICE_TYPE "Bin1"
#define DEVICE_ID "Tiruvallur"
#define TOKEN "T12345678"
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/status1/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();
const int trigpin=5;
const int echopin=19;
String command;
String data="";
String latitude="13.1231";
String longitude="79.9120";
long duration;
int dist;
String icon;
void setup()
{
Serial.begin(115200);
pinMode(trigpin, OUTPUT);
pinMode(echopin, INPUT);
wifiConnect();
mqttConnect();
}
void loop() {
publishData();
delay(500);
if (!client.loop()) {
mqttConnect();
```



```
}
}
void wifiConnect() {
Serial.print("Connecting to ");
Serial.print("Wifi");
WiFi.begin("Wokwi-GUEST", "", 6);
while (WiFi.status() != WL_CONNECTED) {
delay(500);
Serial.print(".");
}
Serial.print("WiFi connected, IP address: "); Serial.println(WiFi.localIP());
}
void mqttConnect() {
if (!client.connected()) {
Serial.print("Reconnecting MQTT client to "); Serial.println(server);
while (!client.connect(clientId, authMethod, token)) {
Serial.print(".");
Serial.print("*");
delay(1000);
}
initManagedDevice();
Serial.println();
}
}
void initManagedDevice() {
if (client.subscribe(topic)) {
Serial.println(client.subscribe(topic));
Serial.println("subscribe to cmd OK");
}
else {
Serial.println("subscribe to cmd FAILED");
}
}
void publishData()
{
digitalWrite(trigpin,LOW);
digitalWrite(trigpin,HIGH);
delayMicroseconds(10);
digitalWrite(trigpin,LOW);
duration=pulseIn(echopin,HIGH);
dist=duration*speed/2;
if(dist<20){
icon="Bin is Full";
}
else{
icon="Bin is not Full";
}
DynamicJsonDocument doc(1024);
```



```
String payload;
doc["Latitude"]=latitude;
doc["Longitude"]=longitude;
doc["Distance"]=dist;
doc["Bin Status"]=icon;
serializeJson(doc, payload);
delay(3000);
Serial.print("\n");
Serial.print("Sending payload: ");
Serial.println(payload);
if (client.publish(publishTopic, (char*) payload.c_str())) {
Serial.println("Publish OK");
}
else {
Serial.println("Publish FAILED");
}
}
```

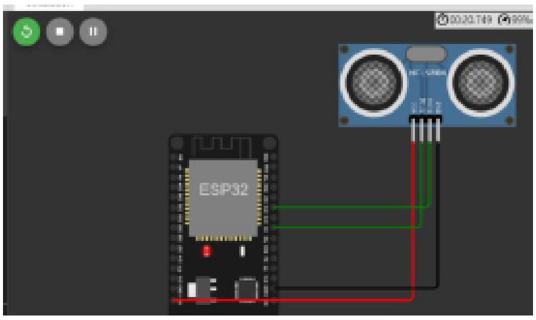


```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>
WiFiClient wifiClient;
#define ORG "[illegible]"
#define DEVICE_TYPE "Bin1"
#define DEVICE_ID "[illegible]"
#define TOKEN "[illegible]"
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/status1/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();
const int trigpin=5;
const int echopin=18;
String command;
String data="";
String latitude="13.0382";
String longitude="80.1565";
String icon="";
long duration;
int dist;
void setup()
{
Serial.begin(115200);
pinMode(trigpin, OUTPUT);
pinMode(echopin, INPUT);
wifiConnect();
mqttConnect();
```

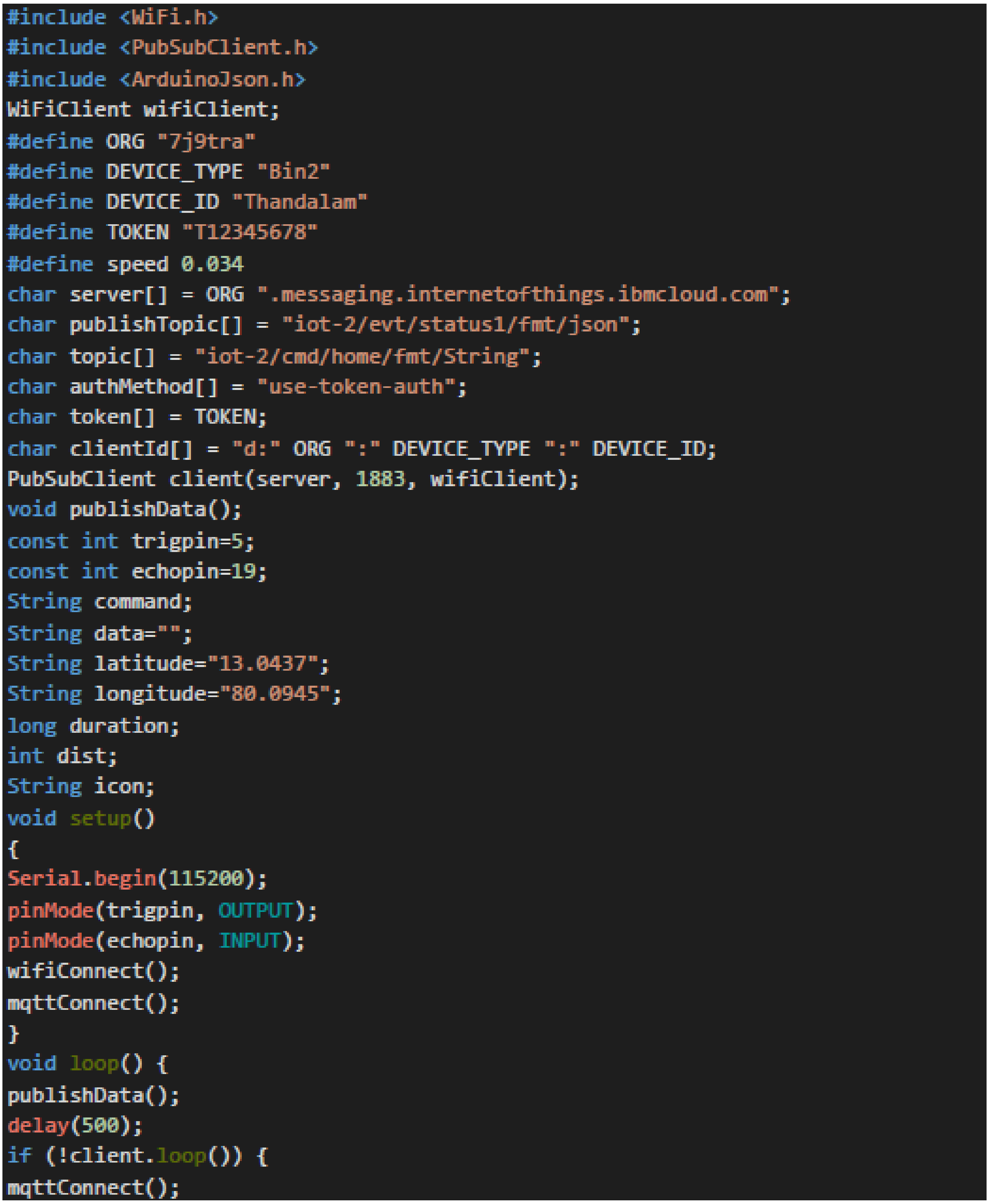
```
Sending payload:
{"Latitude":"13.0382","Longitude":"80.1565","Distance":5,"Status":"Bin is full"}
Publish OK

Sending payload:
{"Latitude":"13.0383","Longitude":"80.1566","Distance":6,"Status":"Bin is full"}
Publish OK
```

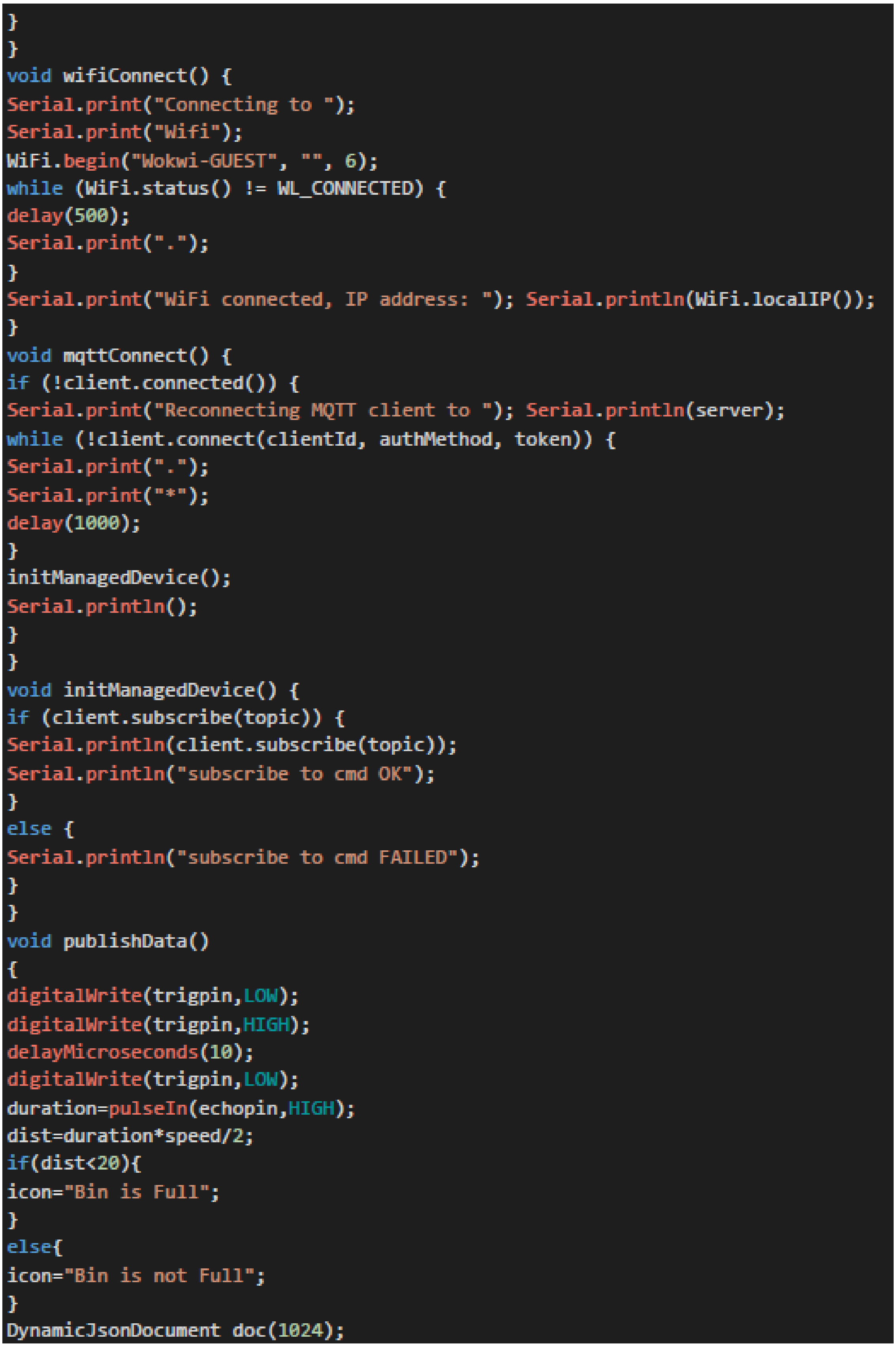
Circuit:



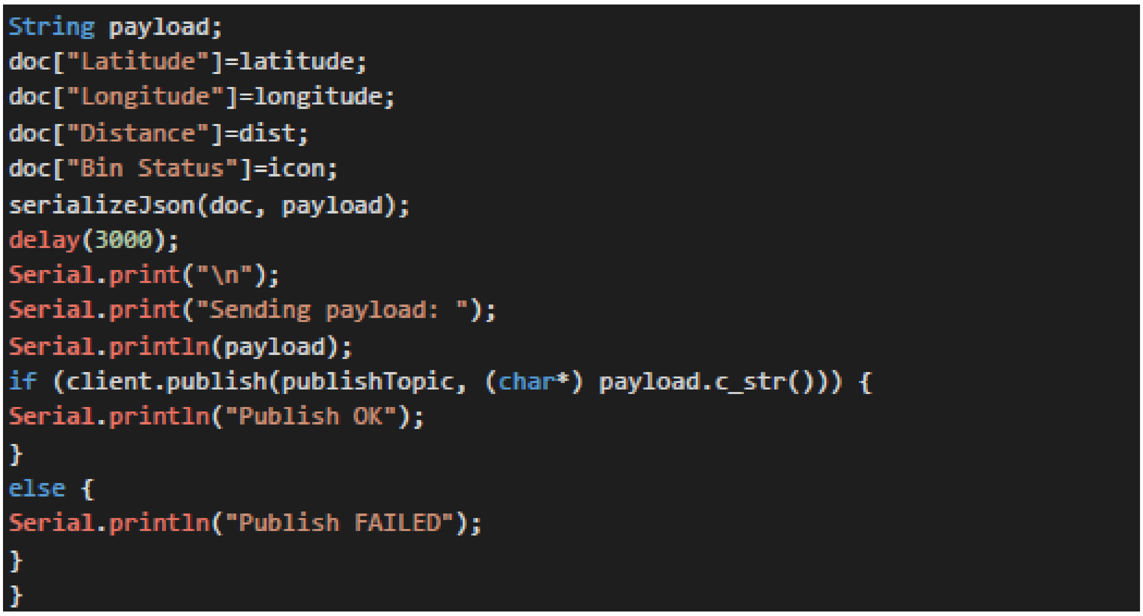
BIN 2:-



```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>
WiFiClient wifiClient;
#define ORG "7j9tra"
#define DEVICE_TYPE "Bin2"
#define DEVICE_ID "Thandalam"
#define TOKEN "T12345678"
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/status1/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();
const int trigpin=5;
const int echopin=19;
String command;
String data="";
String latitude="13.0437";
String longitude="80.0945";
long duration;
int dist;
String icon;
void setup()
{
Serial.begin(115200);
pinMode(trigpin, OUTPUT);
pinMode(echopin, INPUT);
wifiConnect();
mqttConnect();
}
void loop() {
publishData();
delay(500);
if (!client.loop()) {
mqttConnect();
```

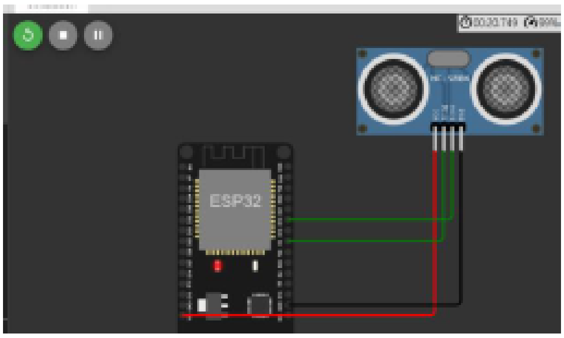


```
}
}
void wifiConnect() {
Serial.print("Connecting to ");
Serial.print("Wifi");
WiFi.begin("Wokwi-GUEST", "", 6);
while (WiFi.status() != WL_CONNECTED) {
delay(500);
Serial.print(".");
}
Serial.print("WiFi connected, IP address: "); Serial.println(WiFi.localIP());
}
void mqttConnect() {
if (!client.connected()) {
Serial.print("Reconnecting MQTT client to "); Serial.println(server);
while (!client.connect(clientId, authMethod, token)) {
Serial.print(".");
Serial.print("*");
delay(1000);
}
initManagedDevice();
Serial.println();
}
}
void initManagedDevice() {
if (client.subscribe(topic)) {
Serial.println(client.subscribe(topic));
Serial.println("subscribe to cmd OK");
}
else {
Serial.println("subscribe to cmd FAILED");
}
}
void publishData()
{
digitalWrite(trigpin,LOW);
digitalWrite(trigpin,HIGH);
delayMicroseconds(10);
digitalWrite(trigpin,LOW);
duration=pulseIn(echopin,HIGH);
dist=duration*speed/2;
if(dist<20){
icon="Bin is Full";
}
else{
icon="Bin is not Full";
}
DynamicJsonDocument doc(1024);
```

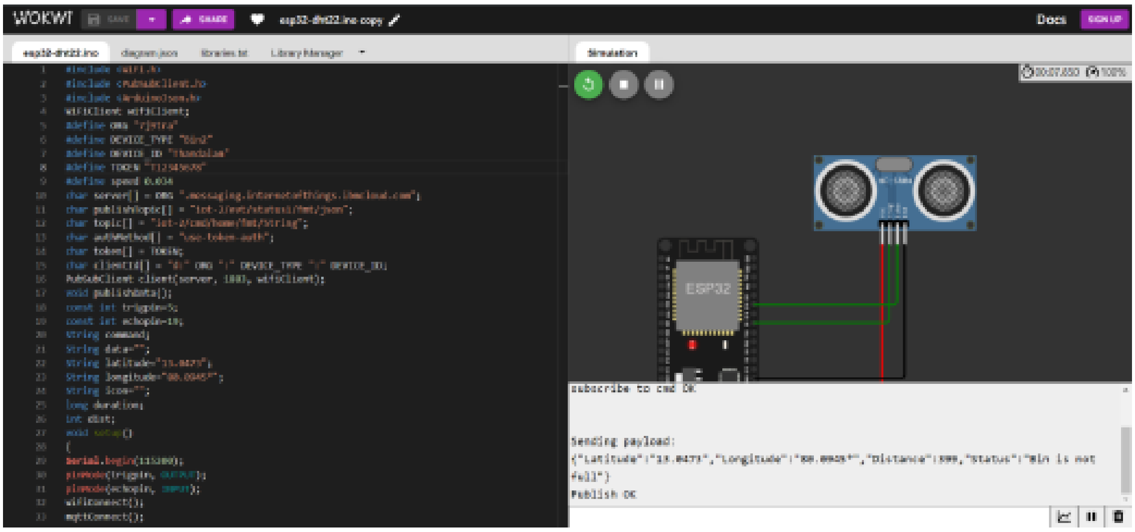


```
String payload;
doc["Latitude"]=latitude;
doc["Longitude"]=longitude;
doc["Distance"]=dist;
doc["Bin Status"]=icon;
serializeJson(doc, payload);
delay(3000);
Serial.print("\n");
Serial.print("Sending payload: ");
Serial.println(payload);
if (client.publish(publishTopic, (char*) payload.c_str())) {
Serial.println("Publish OK");
}
else {
Serial.println("Publish FAILED");
}
}
```

Circuit:



OUTPUT:7j9tra

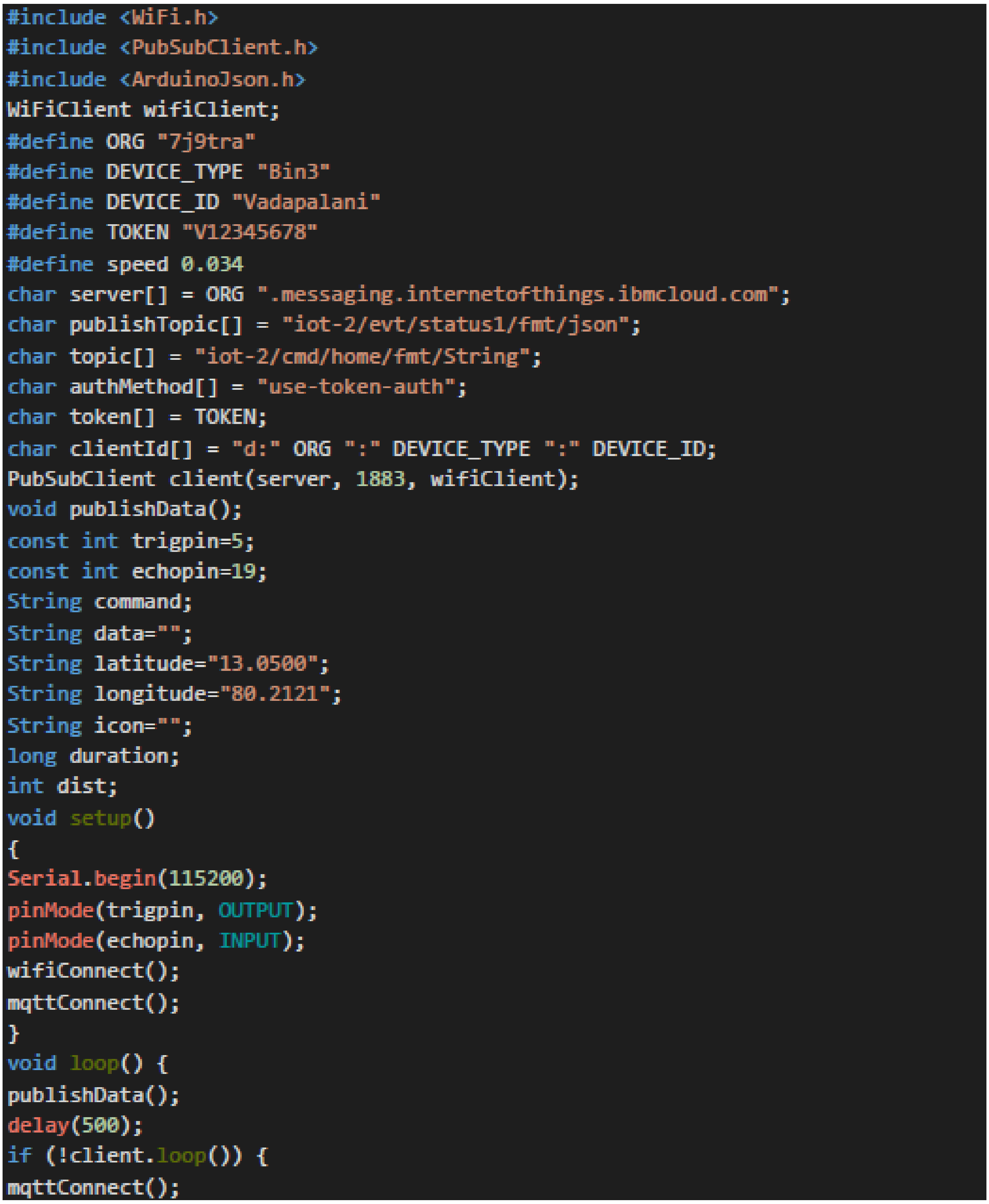


```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>
WiFiClient wifiClient;
#define ORG "7j9tra"
#define DEVICE_TYPE "Bin2"
#define DEVICE_ID "Thandalam"
#define TOKEN "12345678"
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/status1/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();
const int trigpin=5;
const int echopin=18;
String command;
String data="";
String latitude="13.0473";
String longitude="80.0945";
String icon="";
long duration;
int dist;
void setup()
{
Serial.begin(115200);
pinMode(trigpin, OUTPUT);
pinMode(echopin, INPUT);
wifiConnect();
mqttConnect();
```

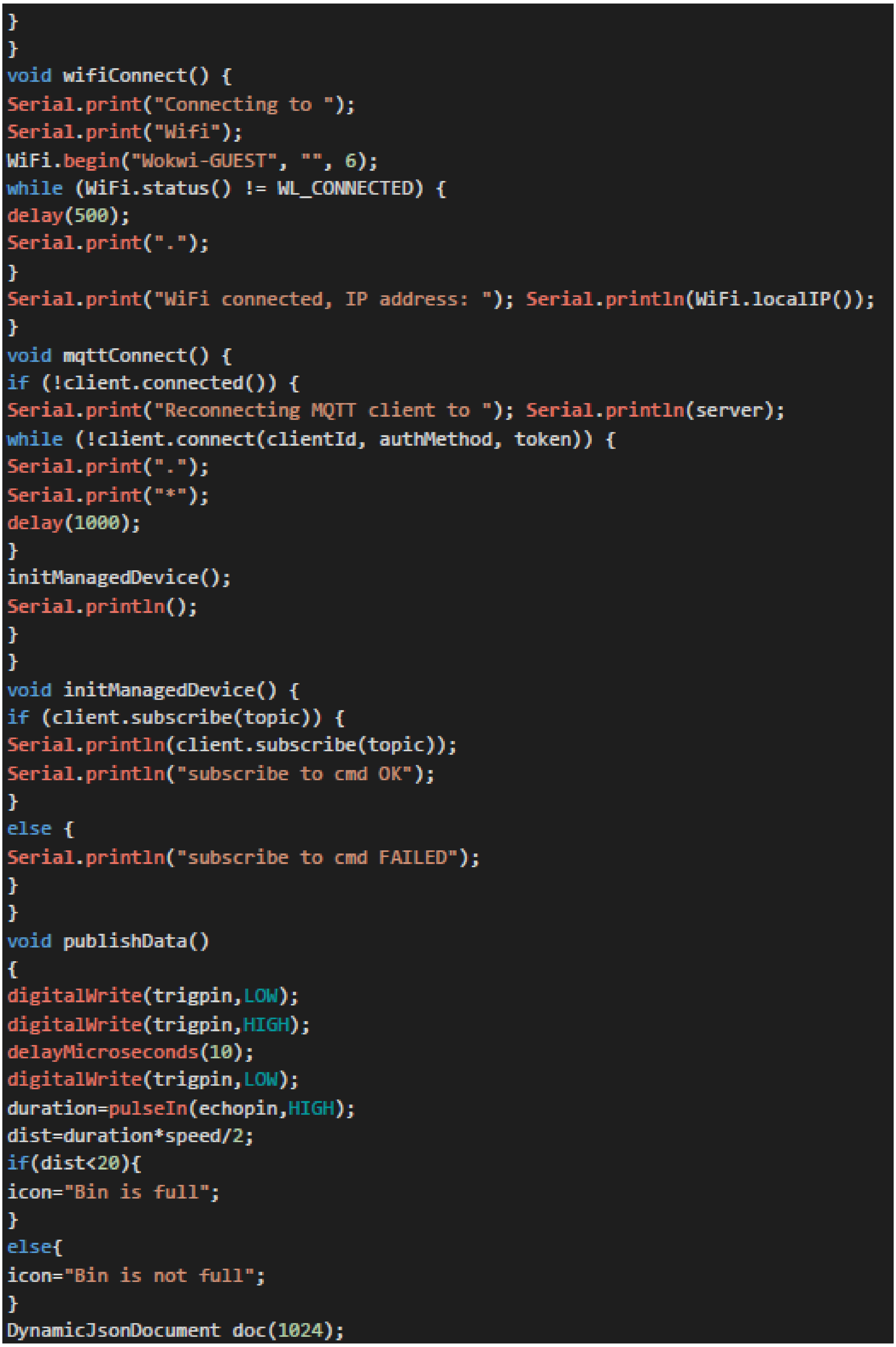
```
subscribe to cmd OK


Sending payload:
{"Latitude":"13.0473","Longitude":"80.0945","Distance":399,"Status":"Bin is not
full"}
Publish OK
```

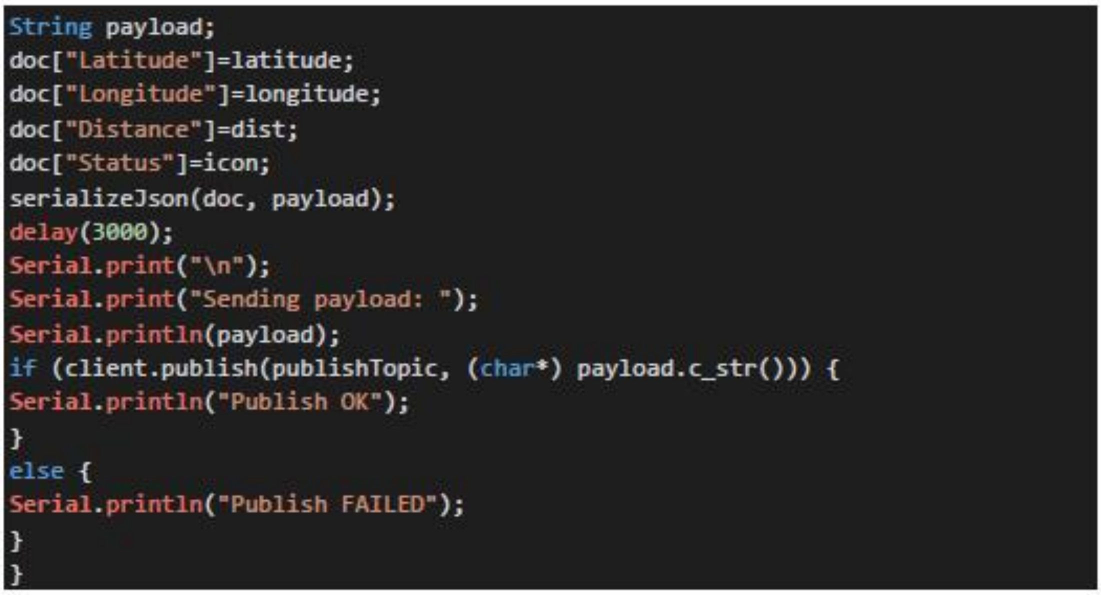
BIN 3:-



```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>
WiFiClient wifiClient;
#define ORG "7j9tra"
#define DEVICE_TYPE "Bin3"
#define DEVICE_ID "Vadapalani"
#define TOKEN "V12345678"
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/status1/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();
const int trigpin=5;
const int echopin=19;
String command;
String data="";
String latitude="13.0500";
String longitude="80.2121";
String icon="";
long duration;
int dist;
void setup()
{
Serial.begin(115200);
pinMode(trigpin, OUTPUT);
pinMode(echopin, INPUT);
wifiConnect();
mqttConnect();
}
void loop() {
publishData();
delay(500);
if (!client.loop()) {
mqttConnect();
```

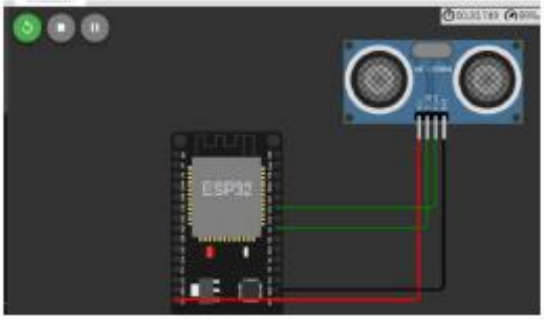


```
}
}
void wifiConnect() {
Serial.print("Connecting to ");
Serial.print("Wifi");
WiFi.begin("Wokwi-GUEST", "", 6);
while (WiFi.status() != WL_CONNECTED) {
delay(500);
Serial.print(".");
}
Serial.print("WiFi connected, IP address: "); Serial.println(WiFi.localIP());
}
void mqttConnect() {
if (!client.connected()) {
Serial.print("Reconnecting MQTT client to "); Serial.println(server);
while (!client.connect(clientId, authMethod, token)) {
Serial.print(".");
Serial.print("*");
delay(1000);
}
initManagedDevice();
Serial.println();
}
}
void initManagedDevice() {
if (client.subscribe(topic)) {
Serial.println(client.subscribe(topic));
Serial.println("subscribe to cmd OK");
}
else {
Serial.println("subscribe to cmd FAILED");
}
}
void publishData()
{
digitalWrite(trigpin,LOW);
digitalWrite(trigpin,HIGH);
delayMicroseconds(10);
digitalWrite(trigpin,LOW);
duration=pulseIn(echopin,HIGH);
dist=duration*speed/2;
if(dist<20){
icon="Bin is full";
}
else{
icon="Bin is not full";
}
DynamicJsonDocument doc(1024);
```

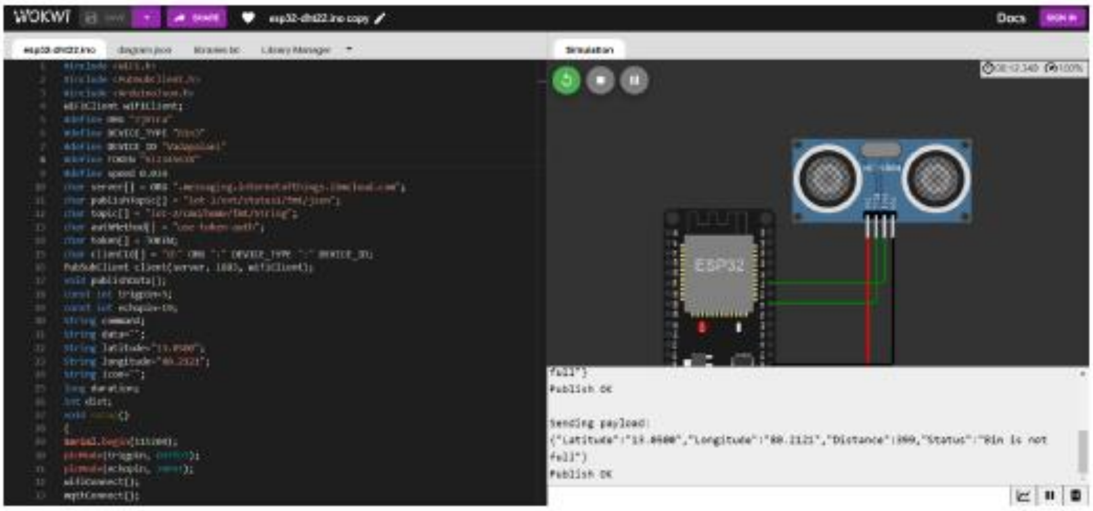


```
String payload;
doc["Latitude"]=latitude;
doc["Longitude"]=longitude;
doc["Distance"]=dist;
doc["Status"]=icon;
serializeJson(doc, payload);
delay(3000);
Serial.print("\n");
Serial.print("Sending payload: ");
Serial.println(payload);
if (client.publish(publishTopic, (char*) payload.c_str())) {
Serial.println("Publish OK");
}
else {
Serial.println("Publish FAILED");
}
}
```

Circuit:



OUTPUT:



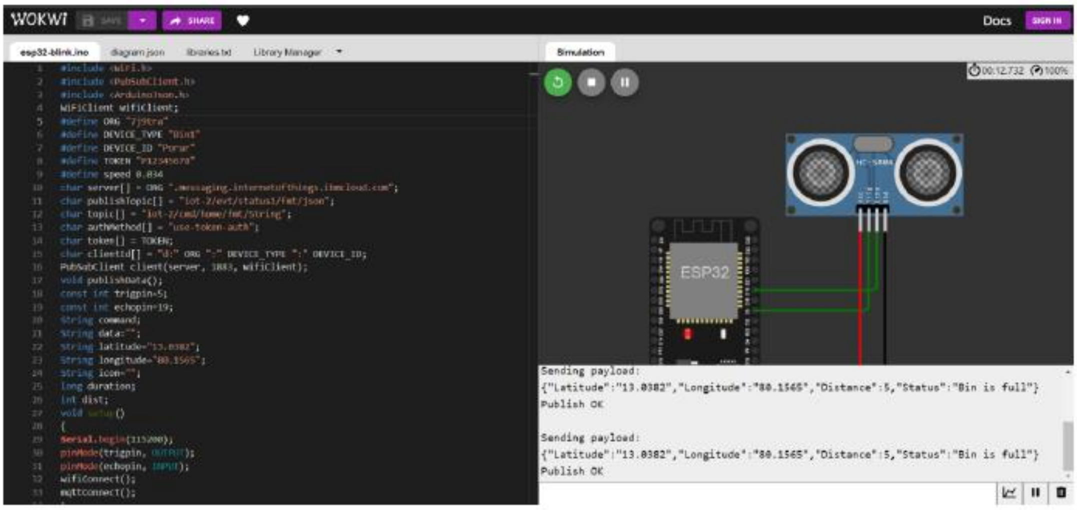
```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>
WiFiClient wifiClient;
#define ORG "[illegible]"
#define DEVICE_TYPE "[illegible]"
#define DEVICE_ID "[illegible]"
#define TOKEN "[illegible]"
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/status1/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();
const int trigpin=5;
const int echopin=18;
String command;
String data="";
String latitude="13.0600";
String longitude="80.2121";
String icon="";
long duration;
int dist;
void setup()
{
Serial.begin(115200);
pinMode(trigpin, OUTPUT);
pinMode(echopin, INPUT);
wifiConnect();
mqttConnect();
```

```
fell"}
Publish OK

Sending payload:
{"Latitude":"13.0600","Longitude":"80.2121","Distance":999,"Status":"Bin is not
fell"}
Publish OK
```

Sprint 2

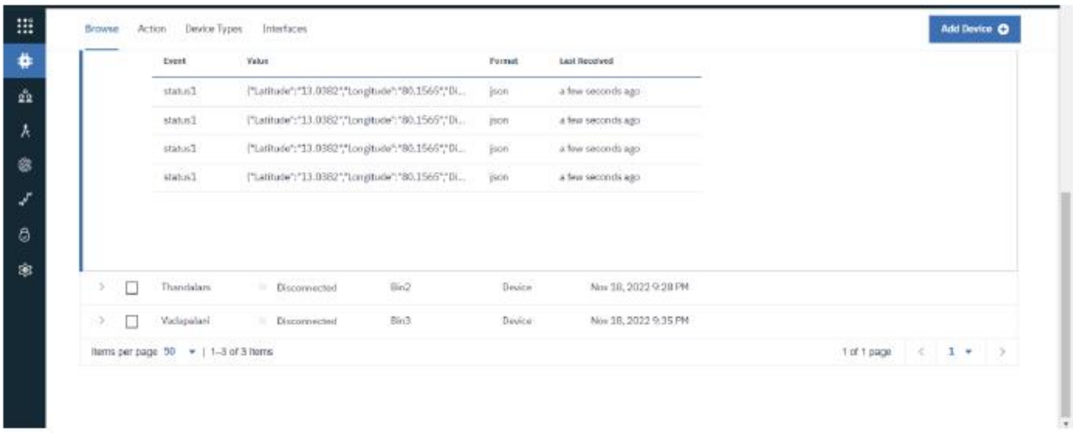
Bin 1:



```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>
WiFiClient wifiClient;
#define ORG "7j9tra"
#define DEVICE_TYPE "Bin1"
#define DEVICE_ID "Porur"
#define TOKEN "P12345678"
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/status1/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();
const int trigpin=5;
const int echopin=19;
String command;
String data="";
String latitude="13.0382";
String longitude="80.1565";
String icon="";
long duration;
int dist;
void setup()
{
Serial.begin(115200);
pinMode(trigpin, OUTPUT);
pinMode(echopin, INPUT);
wifiConnect();
mqttconnect();
```

```
Sending payload:
{"Latitude":"13.0382","Longitude":"80.1565","Distance":5,"Status":"Bin is full"}
Publish OK

Sending payload:
{"Latitude":"13.0382","Longitude":"80.1565","Distance":5,"Status":"Bin is full"}
Publish OK
```



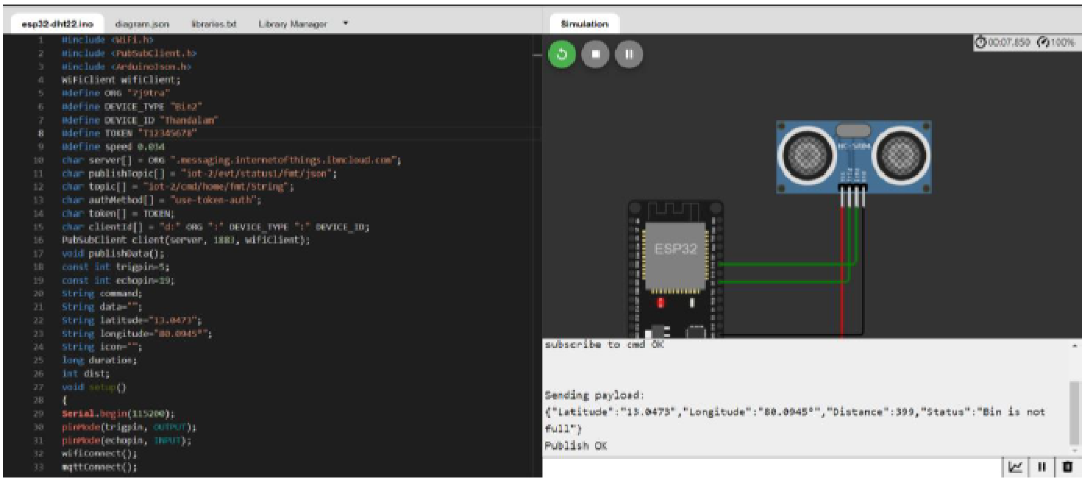
Event	Value	Format	Last Received
status1	{"Latitude":"13.0382","Longitude":"80.1565","Di...	json	a few seconds ago
status1	{"Latitude":"13.0382","Longitude":"80.1565","Di...	json	a few seconds ago
status1	{"Latitude":"13.0382","Longitude":"80.1565","Di...	json	a few seconds ago
status1	{"Latitude":"13.0382","Longitude":"80.1565","Di...	json	a few seconds ago

□	Thandalam	Disconnected	Bin2	Device	Nov 18, 2022 9:28 PM
□	Vadapalani	Disconnected	Bin3	Device	Nov 18, 2022 9:35 PM

Items per page 50 | 1–3 of 3 items

1 of 1 page 1

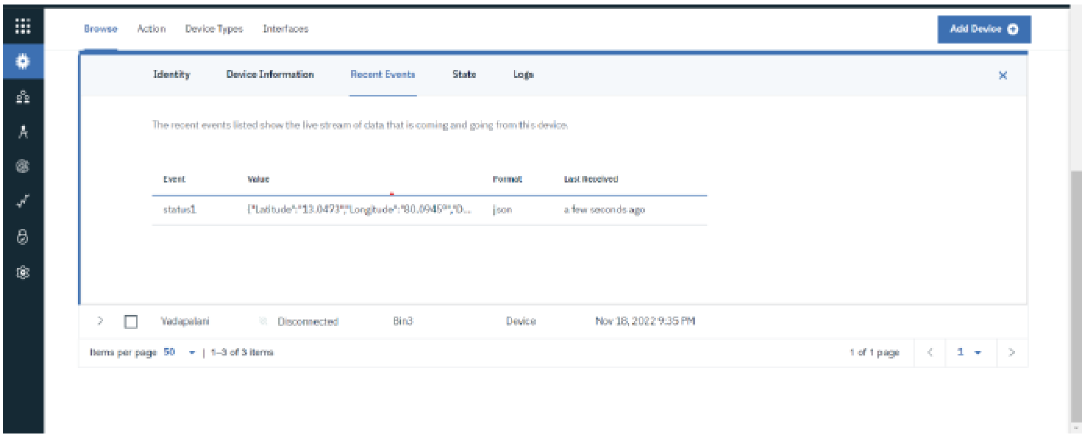
Bin 2:



```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>
WiFiClient wifiClient;
#define ORG "7j9tra"
#define DEVICE_TYPE "Bin2"
#define DEVICE_ID "Thandalam"
#define TOKEN "T12345678"
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/status1/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();
const int trigpin=5;
const int echopin=19;
String command;
String data="";
String latitude="13.0473";
String longitude="80.0945°";
String icon="";
long duration;
int dist;
void setup()
{
Serial.begin(115200);
pinMode(trigpin, OUTPUT);
pinMode(echopin, INPUT);
wificonnect();
mqttConnect();
```

```
subscribe to cmd OK


Sending payload:
{"Latitude":"13.0473","Longitude":"80.0945°","Distance":399,"Status":"Bin is not
full"}
Publish OK
```



The recent events listed show the live stream of data that is coming and going from this device.

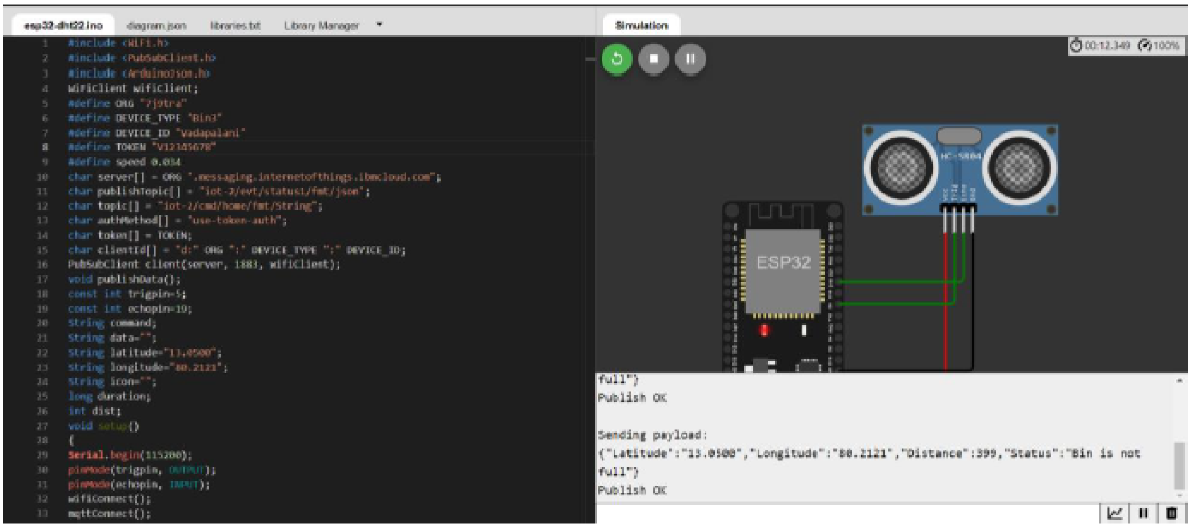
Event	Value	Format	Last Received
status1	{"Latitude":"13.0473","Longitude":"80.0945°","D...	json	a few seconds ago

>	□	Yadapalani	Disconnected	Bin3	Device	Nov 18, 2022 9:35 PM

Items per page 50 | 1–3 of 3 items

1 of 1 page 1

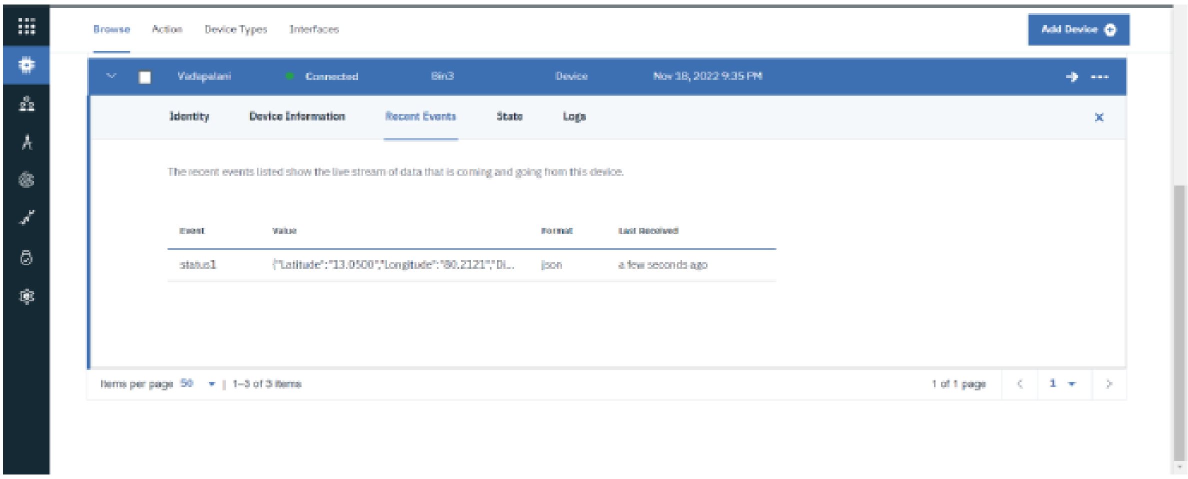
Bin3



```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>
WiFiClient wifiClient;
#define ORG "7j9tra"
#define DEVICE_TYPE "Bin3"
#define DEVICE_ID "Vadapalani"
#define TOKEN "V12345678"
#define speed 0.034
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";
char publishTopic[] = "iot-2/evt/status1/fmt/json";
char topic[] = "iot-2/cmd/home/fmt/String";
char authMethod[] = "use-token-auth";
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;
PubSubClient client(server, 1883, wifiClient);
void publishData();
const int trigpin=5;
const int echopin=19;
String command;
String data="";
String latitude="13.0500";
String longitude="80.2121";
String icon="";
long duration;
int dist;
void setup()
{
Serial.begin(115200);
pinMode(trigpin, OUTPUT);
pinMode(echopin, INPUT);
wifiConnect();
mqttConnect();
```

```
full"}
Publish OK

Sending payload:
{"Latitude":"13.0500","Longitude":"80.2121","Distance":399,"Status":"Bin is not
full"}
Publish OK
```



Vadapalani	Connected	Bin3	Device	Nov 18, 2022 9:35 PM

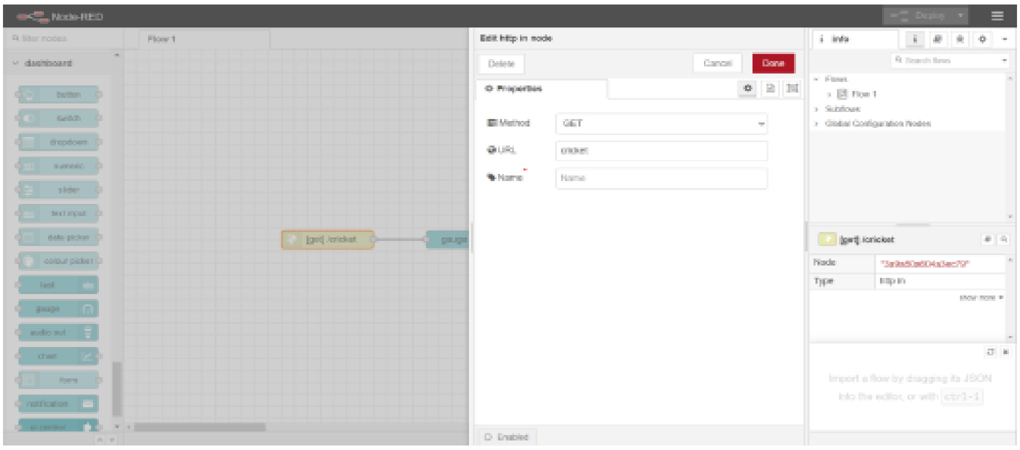
The recent events listed show the live stream of data that is coming and going from this device.

Event	Value	Format	Last Received
status1	{"Latitude":"13.0500","Longitude":"80.2121","Di...	json	a few seconds ago

Items per page 50 | 1–3 of 3 items 1 of 1 page 1

Sprint 3

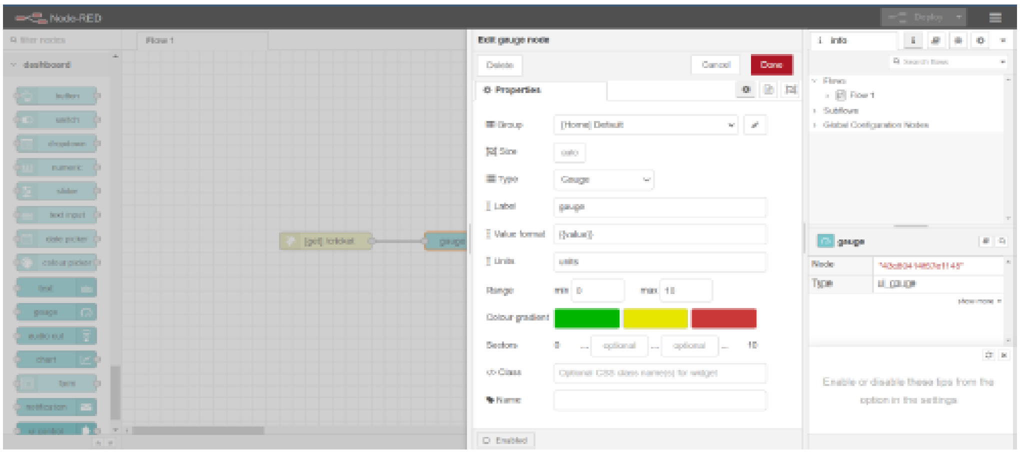
IoT scenarios using local node red



Edit http in node

- Method: GET
- URL: /cricket
- Name: Name

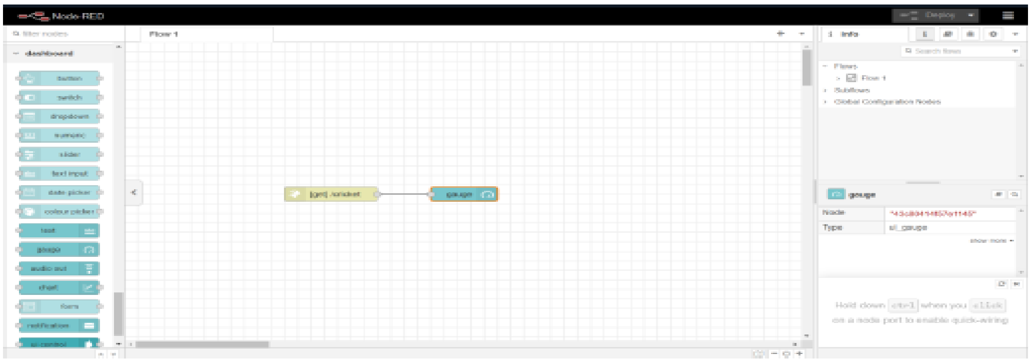
Import a flow by dragging its JSON into the editor, or with ctrl-i



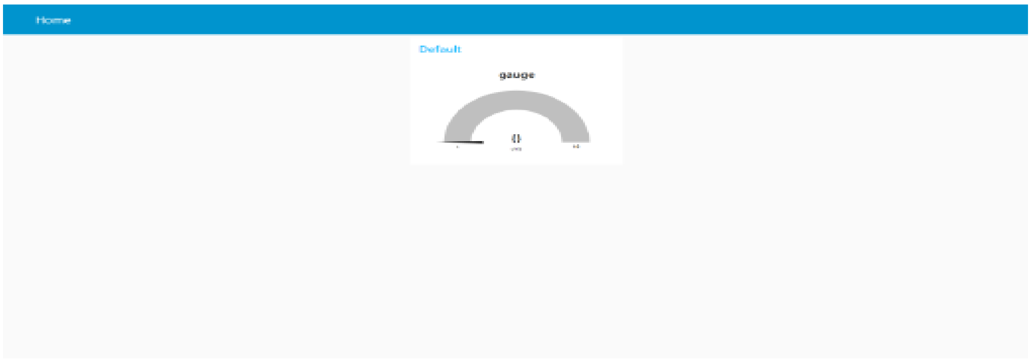
Edit gauge node

- Group: [Home] Default
- Size: auto
- Type: Gauge
- Label: gauge
- Value format: {{value}}
- Units: units
- Range: min 0 max 10
- Colour gradient: 🟩 🟨 🟥
- Sectors: 0 ... optional ... optional ... 10
- Class: Optional CSS class name(s) for widget
- Name:

Enable or disable these tips from the option in the settings

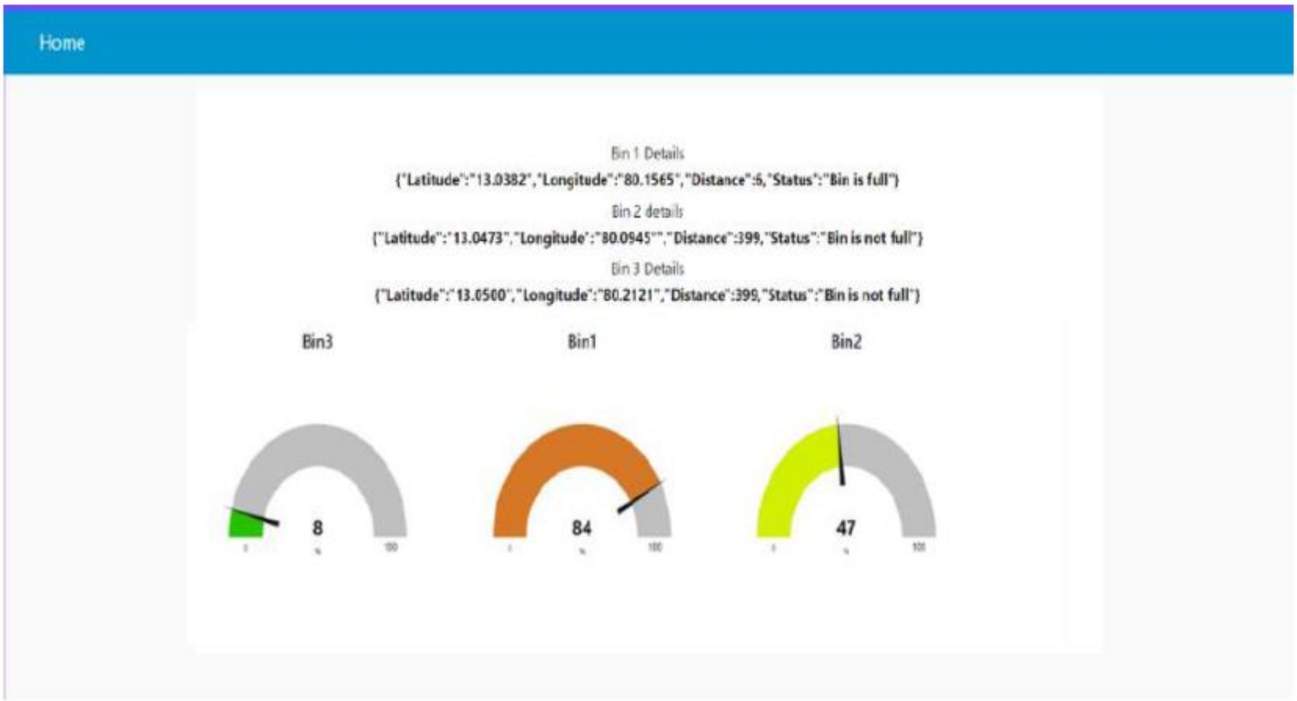


Hold down ctrl when you click on a node port to enable quick-wiring



Sprint 4

Final Output:



Bin 1 Details

```
{"Latitude":"13.0382","Longitude":"80.1565","Distance":6,"Status":"Bin is full"}
```

Bin 2 details

```
{"Latitude":"13.0473","Longitude":"80.0945"","Distance":399,"Status":"Bin is not full"}
```

Bin 3 Details

```
{"Latitude":"13.0500","Longitude":"80.2121","Distance":399,"Status":"Bin is not full"}
```

Sprint Delivery Schedule:

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As a Administrator, I need to give user id and passcode for ever workers over there in municipality	10	High	Srinidhi G Vishnupriya G Varshitha SD Vinitha D
Sprint-1	Login	USN-2	As a Co-Admin, I'll control the waste level by monitoring them vai real time web portal. Once the filling happens, I'll notify trash truck with location of bin with bin ID	10	High	Srinidhi G Vishnupriya G Varshitha SD Vinitha D
Sprint-2	Dashboard	USN-3	As a Truck Driver, I'll follow Co-Admin's Instruction to reach the filling bin in short roots and save time	20	Low	Srinidhi G Vishnupriya G Varshitha SD Vinitha D
Sprint-3	Dashboard	USN-4	As a Local Garbage Collector, I'll gather all the waste from the garbage, load it onto a garbage truck, and deliver it to Landfills	20	Medium	Srinidhi G Vishnupriya G Varshitha SD Vinitha D
Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything i proceeding as planned and without any problems	20	High	Srinidhi G Vishnupriya G Varshitha SD Vinitha D

Project Tracker, Velocity & Burndown Chart: (4 Marks)

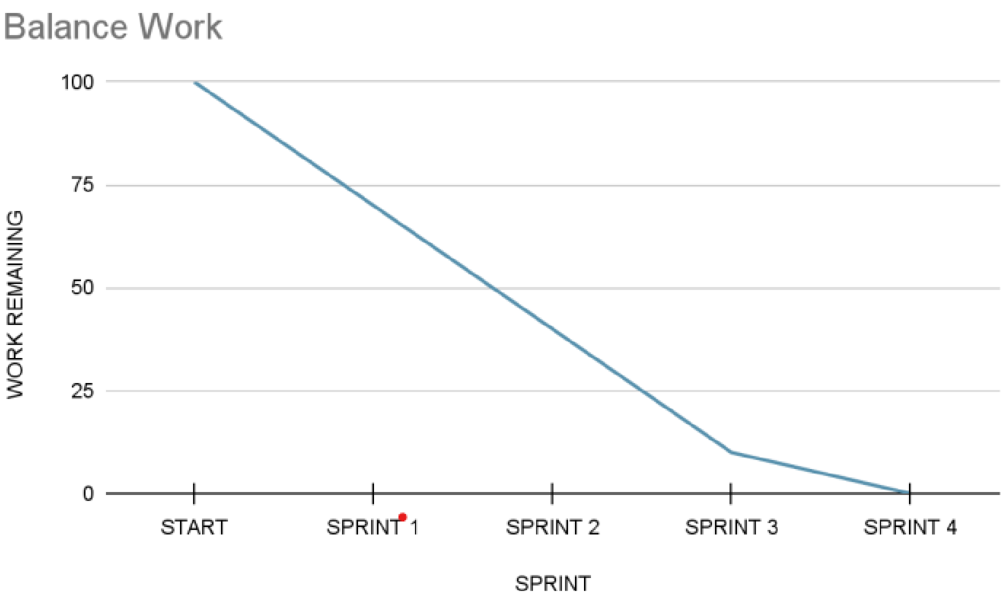
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

Burndown Chart:



9. ADVANTAGES & DISADVANTAGES

ADVANTAGES:

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

DISADVANTAGES:

- System requires a greater number of waste bins for separate waste collection as 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

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

11. FUTURE SCOPE

- There are several future works and improvements for the proposed system, including the following:
- Change the system of user authentication and atomic lock of bins, which would aid in protecting the bin from damage or theft.

- The concept of green points would encourage the involvement of residents or end users, making the idea successful and aiding in the achievement of collaborative waste management efforts, thus fulfilling the idea of Swachh Bharath.

- Having case study or data analytics on the type and times waste is collected on different days or seasons, making bin filling predictable and removing the reliance on electronic components, and fixing the coordinates.
- Improving the Server's and Android's graphical interfaces

12) APPENDIX

Source Code