TEAM ID: **PNT2022TMID18390**

TITLE : **SMART WASTE MANAGEMENT USING IoT IN METROPOLITAN CITIES**

Project Report Format

1. INTRODUCTION:

1.1 Project Overview

Recently there are very poor solid waste disposal and collection mechanism for commercial and market areas. The waste/garbage in most these areas are not collected in a proper ways.The greenery does much more than add to the visual attractiveness. The trees clean the air by absorbing the pollutants.Similarly, improperly disposed trash leads to problems of land pollution and contamination apart from a dirty appearance. Everyone must take the responsibility to keep the city clean and green.

1.2 Purpose

The main aim of the project is to keep the metropolitan cities clean so we are building a model ,which is used for detecting garbage levels in the city and gaining the weight of the garbage bin and alerts the authorized person to empty the bin whenever the bins are full and the garbage level of the bins are monitored by the web app.

2. LITERATURE SURVEY

2.1 Existing problem

There is no arrangement of door to door collection and segregation of municipal waste at source in the city.The residents of city dump the household waste outside their residences from where sweepers collect waste by means of handcarts and dump the same into the containers or roadside (open dump).Very poor solid waste disposal and collection mechanism for commercial and market areas. The waste/garbage in most these areas is collected once in two or three days.The common and prevalent problems faced by general public in markets areas is improper garbage disposal causing the blockage of roads, foul smell, clogging of drains.

2.2 References

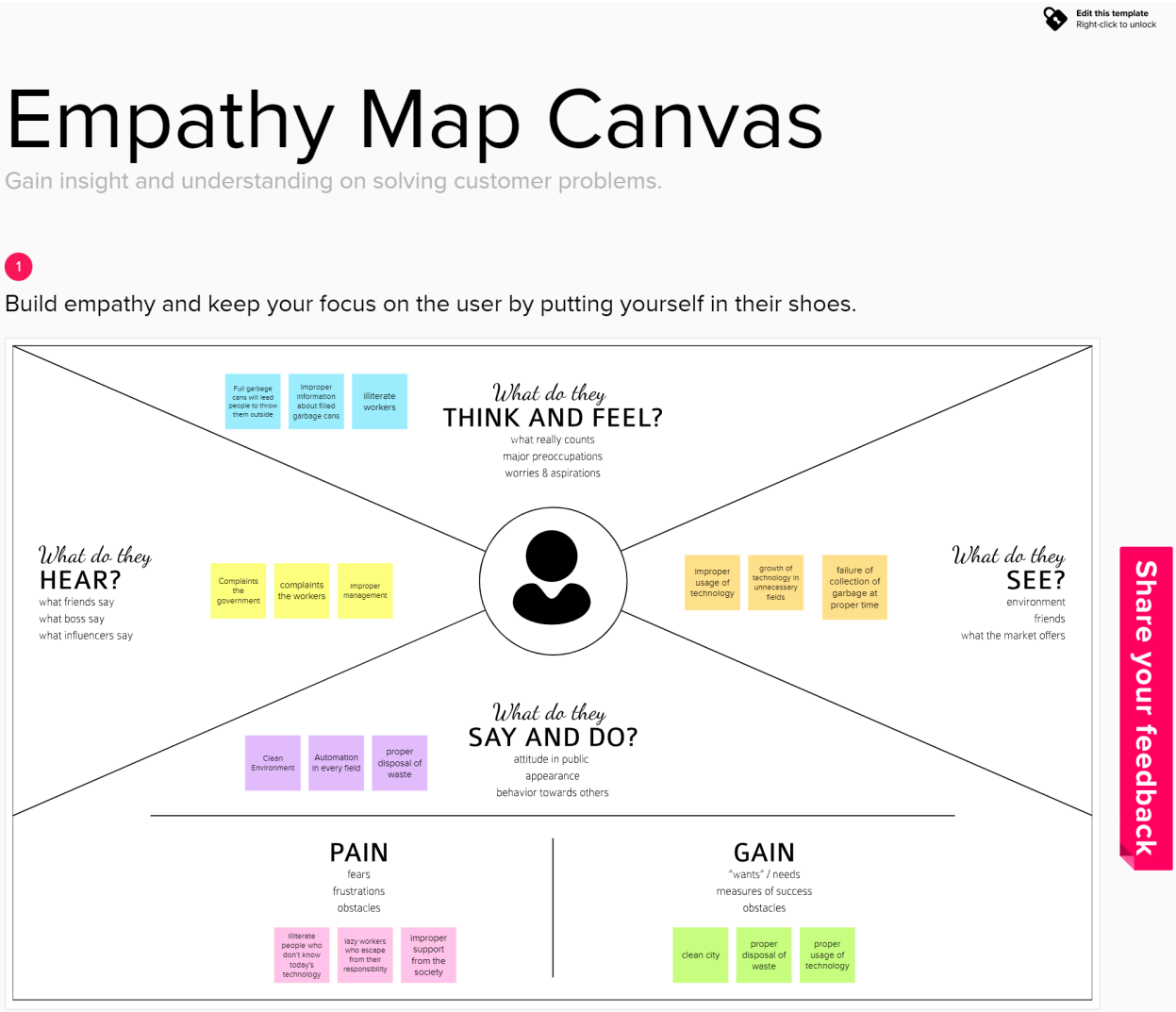
https://www.iotforall.com/smart-waste-management

2.3 Problem Statement Definition

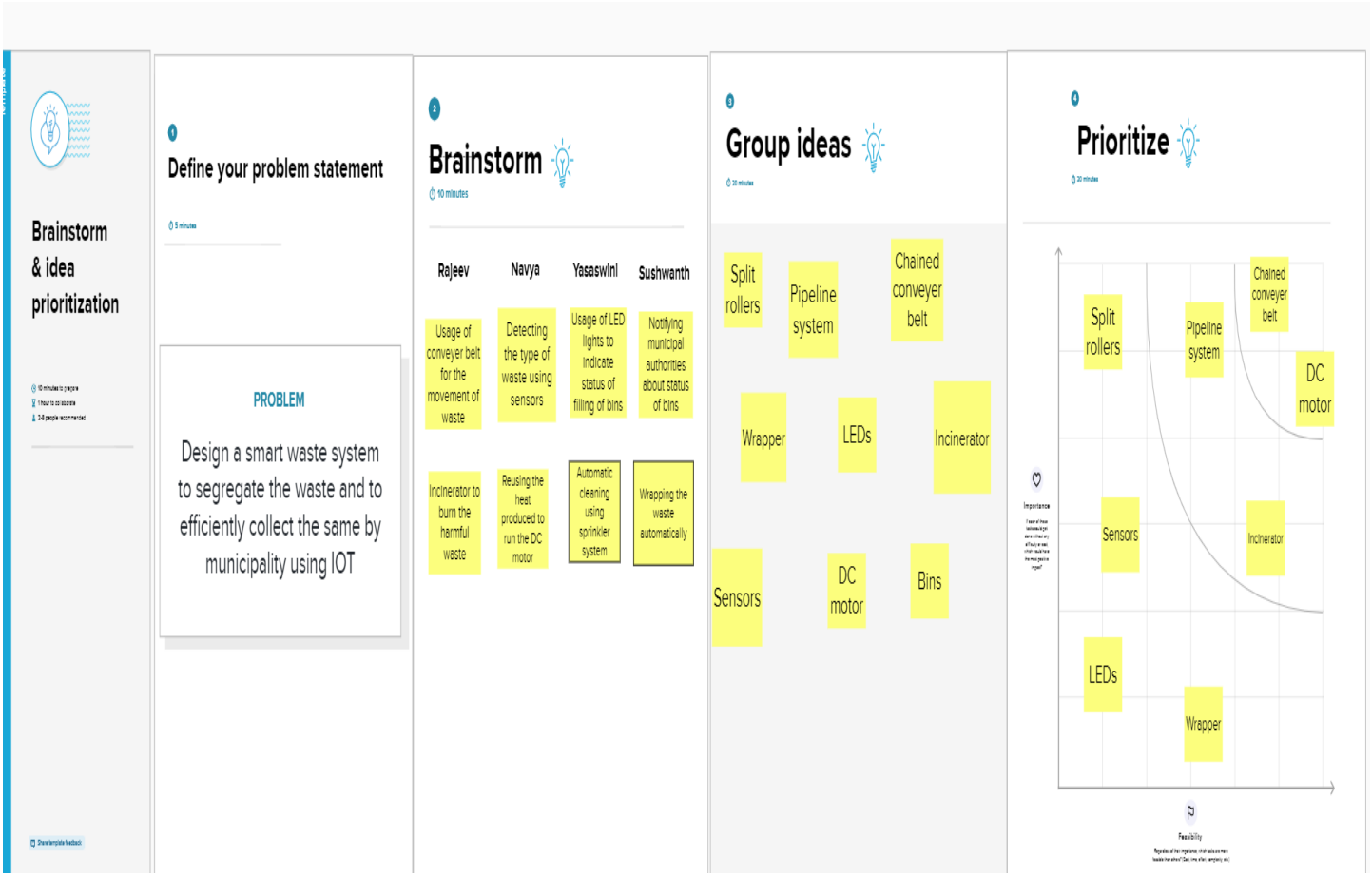
The main aim of the project is to keep the metropolitan cities clean so we are building a model ,which is used for detecting garbage levels in the city and gaining the weight of the garbage bin and alerts the authorized person to empty the bin whenever the bins are full and the garbage level of the bins are monitored by the web app.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

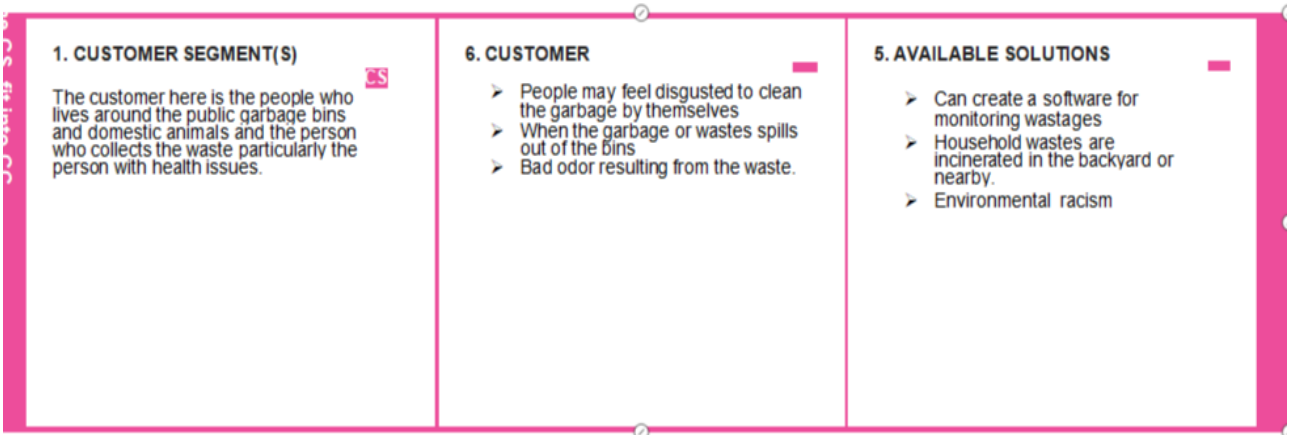


3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to besolved)	The municipal workers who are engaged in the collection of garbage require a sustainable, streamlined process for an efficient waste collection system and to integrate the databases containing information about waste from each of the municipal offices to design an improvised system where the garbage collectors or municipal workers will be given an alert regarding the availability of waste.
2.	Idea / Solution description	Smart waste management helps to **reduce the waste**, create waste to energy source also it helps to keep the environment clean and neat. All the city's urban local bodies depending upon the available technology have to spend the money and innovate the new concept of waste management that is the main purpose of smart waste management.
3.	Novelty / Uniqueness	Sensoneo Analytics: Sensoneo Analytics has a smart process for waste management, which includes placing sensors on garbage collection bins to monitor which of them are full or not. This integrates with their analytics software to help automate and optimize when and how waste is collected in the city
4.	Social Impact / Customer Satisfaction	1. raisepublicawarenessofutilizingrenewable energy 2. improve street sanitation 3. collect and analyze area-specific data onwaste volumes for better planning

5.	Business Model (Revenue Model)	As a result, time and fuel consumption are achieved and garbage collection operations are performed in a much more fluid way
6.	Scalability of the Solution	The device can use in all metropolitan cities.Major efficiency of device: Easily identify the level of waste in garbage because it has a sensor

3.4 Problem Solution fit



Focus on J&P, tap into BE, understand RC

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

- Notifying the garbage collector about the overflow of trash containers to empty the garbage container frequently.
- Making the environment clean and eco-friendly.
- Preventing people from respiratory diseases.

9. PROBLEM ROOT CAUSE RC

- No proper monitorization of the fill level of garbage in the bins kept for public disposal of waste.
- People's lethargicness and irresponsibility.

7. BEHAVIOUR BE

- Monitoring of waste level by using some technologies and software to dispose it in the correct time.

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TR

- Since wastes are collected and disposed properly at a right time, people will be aware of the act and triggered to put the waste only in the trash container.

4. EMOTIONS: BEFORE / AFTER EM

- **BEFORE** : Frustration, fear of health issues like shin diseases and respiratory infections.
- **AFTER** : Satisfaction, Calm state of mind, cleanliness, Eco-friendly

10. YOUR SOLUTION SL

- Proper monitoring of garbage level using sensors to avoid overflow of wastes
- Frequent collection of wastes by the waste collectors by the proper channel of communication.

8.CHANNELS of BEHAVIOUR CH

Online:

- Advertise or spread news over social media on keeping the environment clean.

Offline:

- People who actually cares about the sanitization of environment conduct awareness campaign as volunteers, rally.
- Conduction of awareness programs.
- Inclusion of this issue in the schools books to create awareness and making the upcoming young generation with responsibilities and concern towards the society and its

Identify strong TR & EM

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-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 Viewfeature from Google. Bins or stands are visible on the map as green, orangeor red circles. You can see bin details in the Dashboard – capacity, waste type, last measurement, GPS location and collection schedule or pick recognition.
FR-2	Real time bin monitoring.	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 historicaldata, the tool predicts when the bin will become full, one of the functionalities that are not included even inthe best waste management software.. Sensors recognize picks as well; so you can check when the bin was last collected. With real-time data and predictions, you can eliminate the overflowing bins and stop collecting half-empty ones.
FR-3	Expensive bins.	We help you identify bins that drive up your collection costs. The tool calculates a rating for each bin in termsof collection costs. 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.

FR-4	Adjust bin distribution.	Ensure the most optimal distribution of bins. Identify areas with either dense or sparse bindistribution. Make sure all trash types are represented within a stand. Based on the historical data, you can adjust bin capacityor location where necessary.
FR-5	Eliminate inefficient picks.	Eliminate the collection of half-empty bins.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.
FR-6	Plan waste collection routes.	The tool semi-automates waste collection route planning. Based on current bin fill-levels and predictionsof reaching full capacity, you are ready to respond and schedule waste collection. You can compare planned vs. executed routes toidentify any inconsistencies.

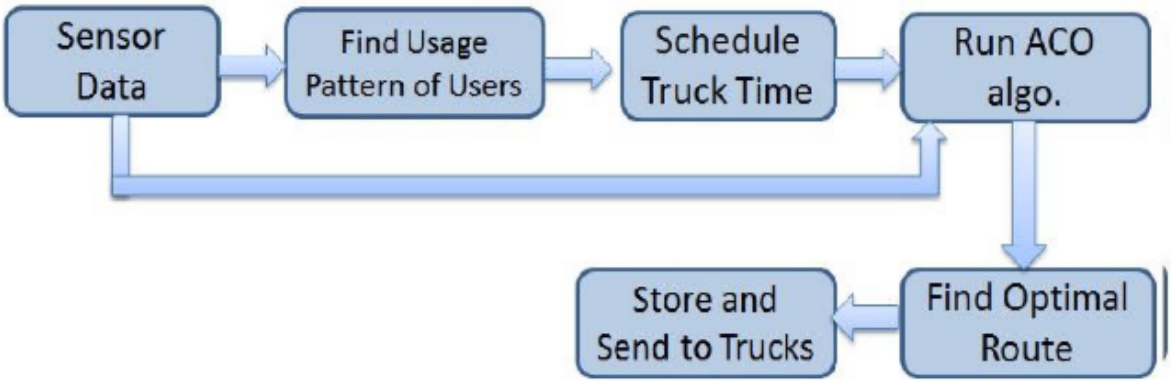
4.2 Non-Functional requirement

FR No.	Non-Functional Requirement	Description
NFR-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 thedesign process with user experience as the core, theanalysis of users' product usability can indeed help designers better understand users' potential needs in waste management, behavior and experience.

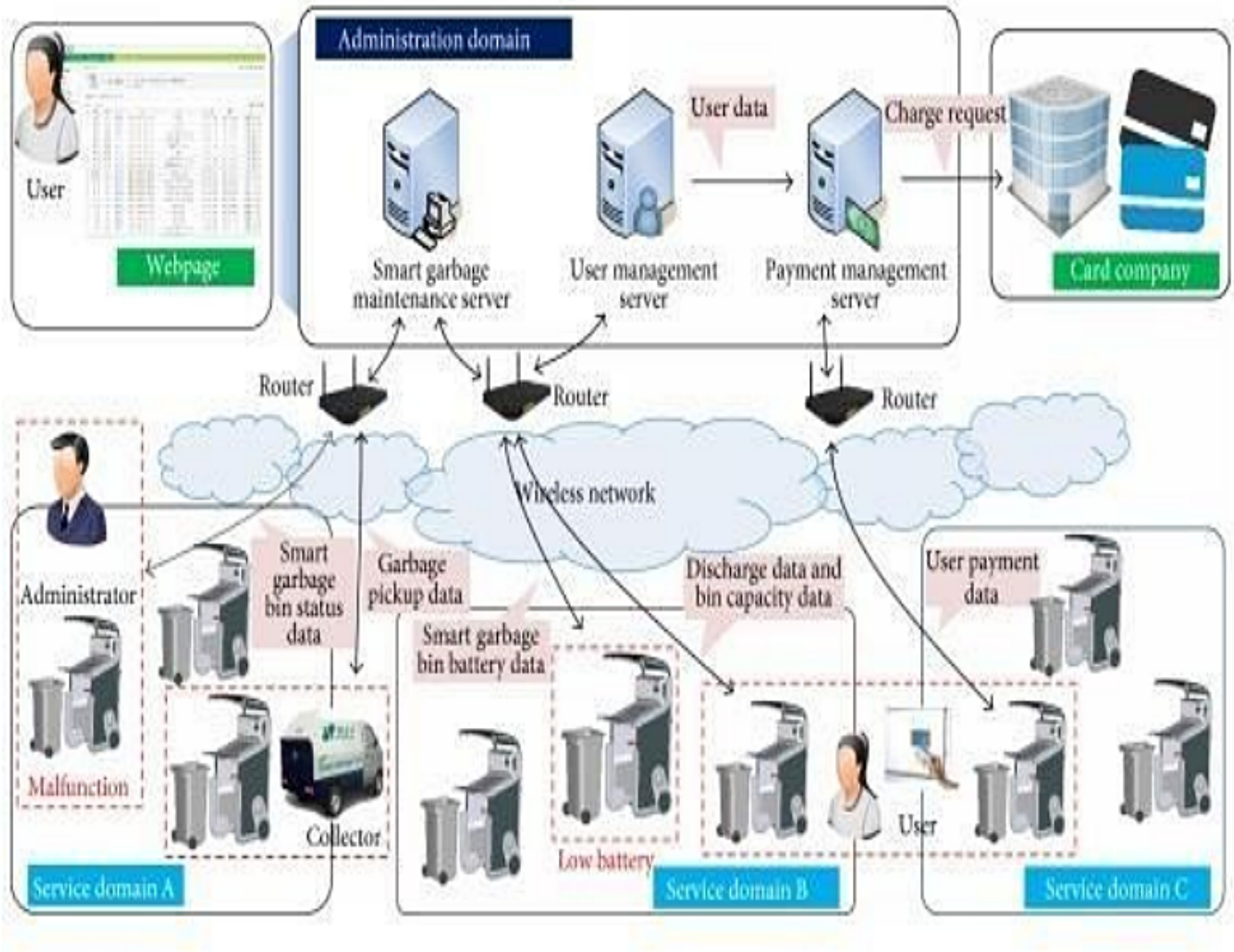
NFR-2	**Security**	Use a reusable bottles Use reusable grocery bags Purchase wisely and recycle Avoid single use food and drink containers.
NFR-3	**Reliability**	Smart waste management is also about creating better working conditions for waste collectors and drivers. Instead of driving the same collection routesand servicing empty bins, waste collectors will spend their time more efficiently, taking care of bins that need servicing.
NFR-4	**Performance**	The Smart Sensors use ultrasound technology to measure the fill levels (along with other data) in binsseveral 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%.
NFR-5	**Availability**	By developing & deploying resilient hardware and beautiful software we empower cities, businesses, and countries to manage waste smarter.
NFR-6	**Scalability**	Using smart waste bins reduce the number of bins inside town , cities because we able to monitor cities

5. PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution & Technical Architecture



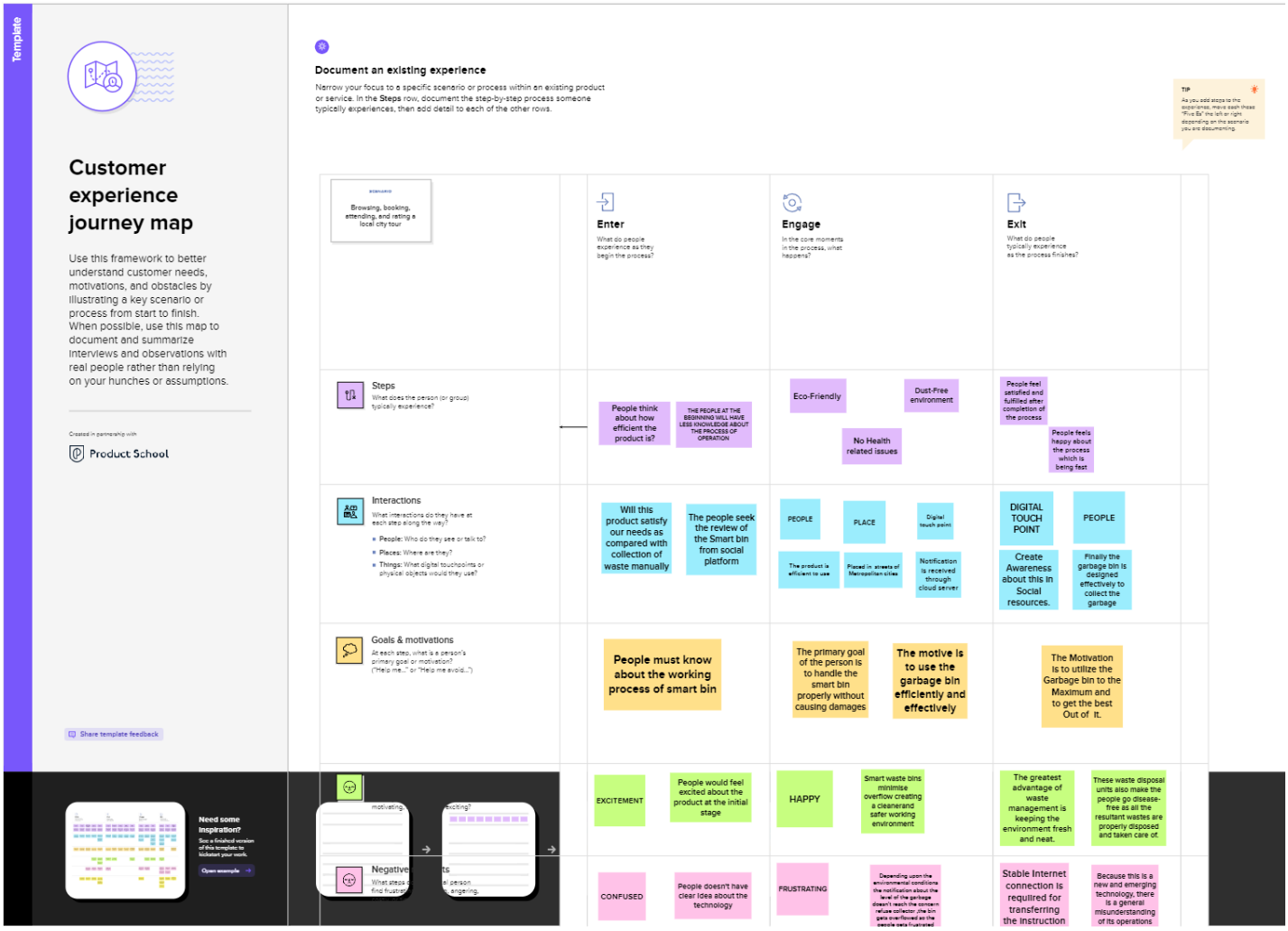
Components and technologies

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

Application Characteristics:

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

5.3 Users Stories



6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

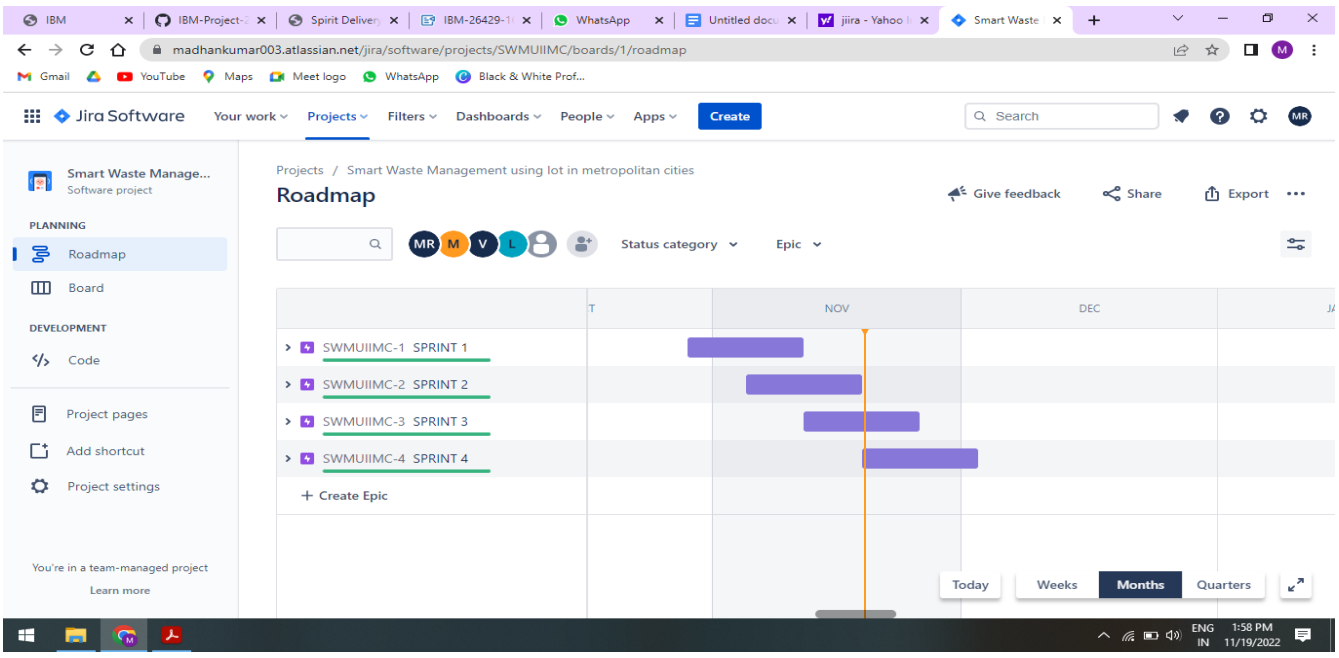
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As a Administrator, I need to give user id andpasscode for ever workers over there in municipality	10	High	Lokeshwar P
Sprint-1	Login	USN-2	As a Co-Admin, I'll control the waste level by monitoring them real time web portal. Once the filling happens, I'll notify trash truck with location of bin with bin ID	10	High	Lokeshwar P
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	Madhankumar R
Sprint-3	Dashboard	USN-4	As a Local Garbage Collector, I'll gather all the waste from the garbage, load it onto a garbagetruck, and deliver it to Landfills	20	Medium	Kancharla vengababu

Sprint-4	Dashboard	USN-5	As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems	20	High	Manoj kumar A

6.2 Sprint Delivery Schedule

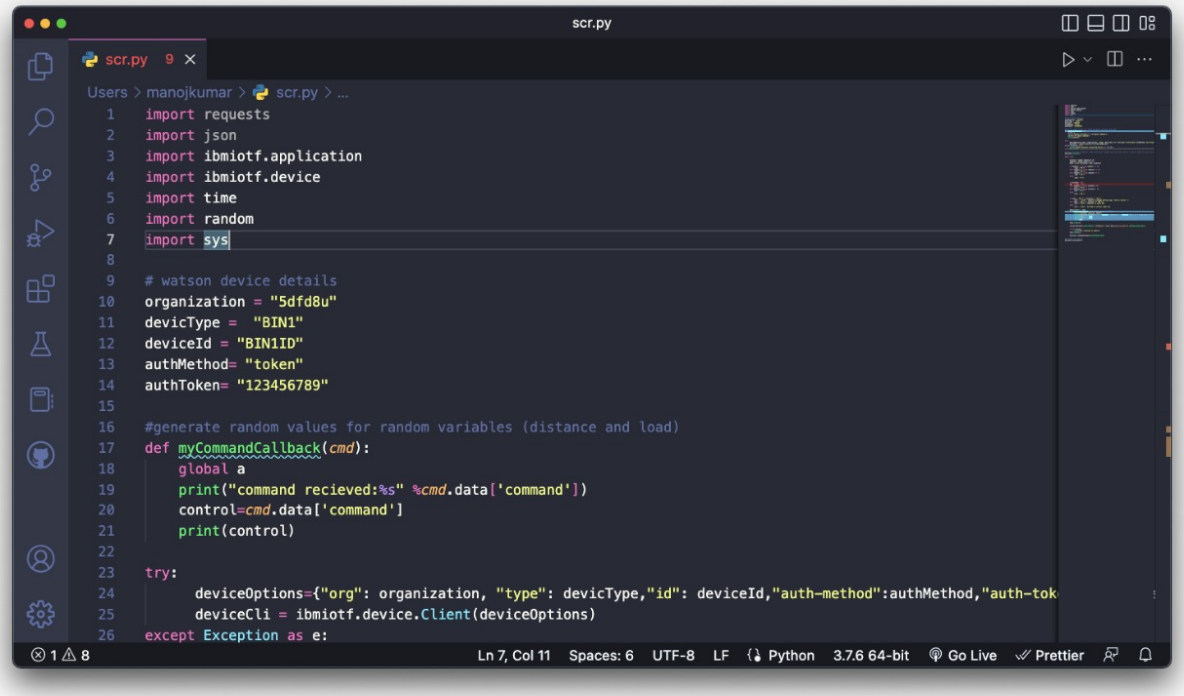
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

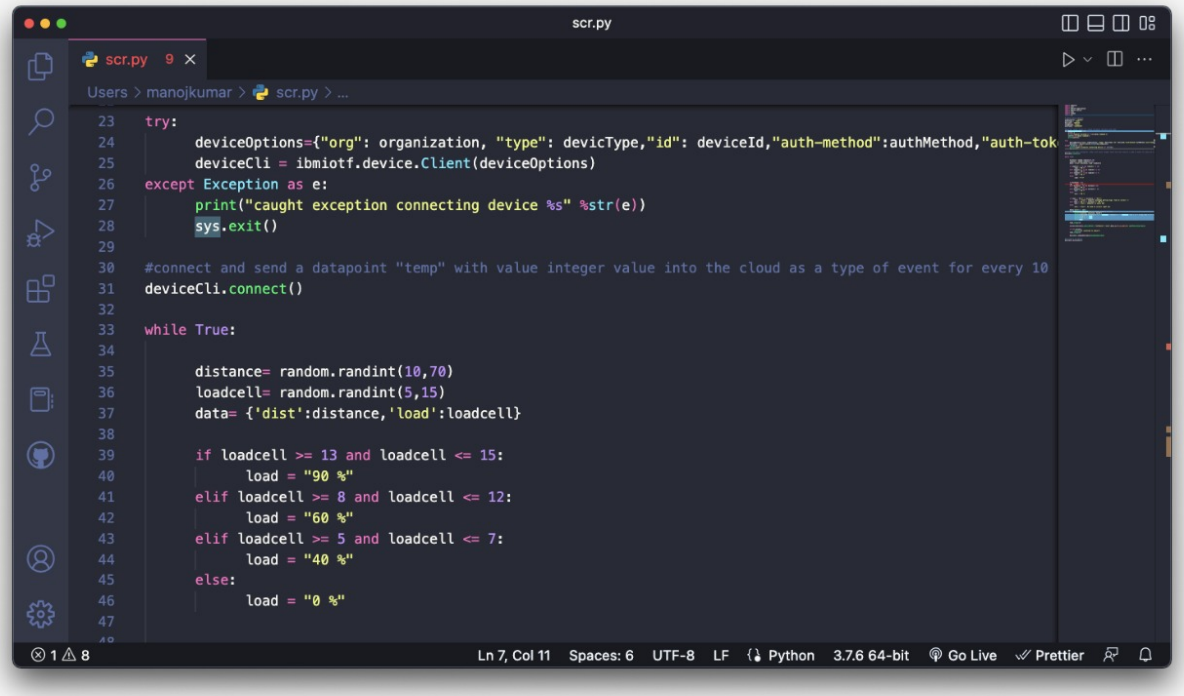
6.3 Reports from JIRA

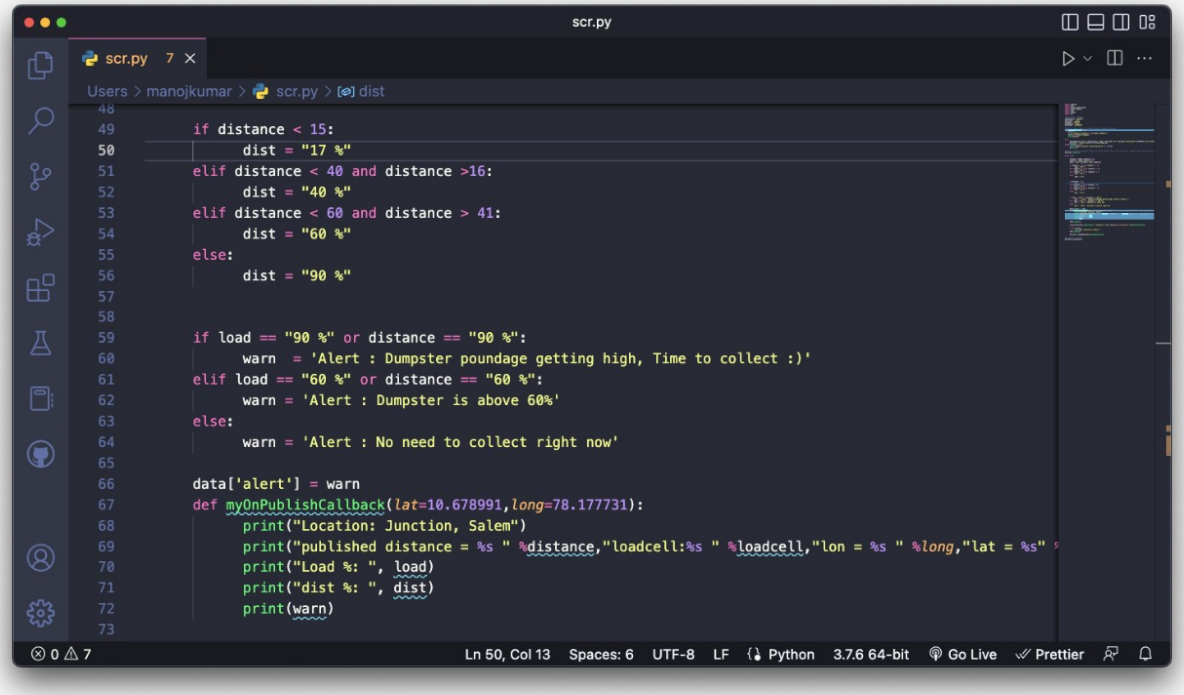


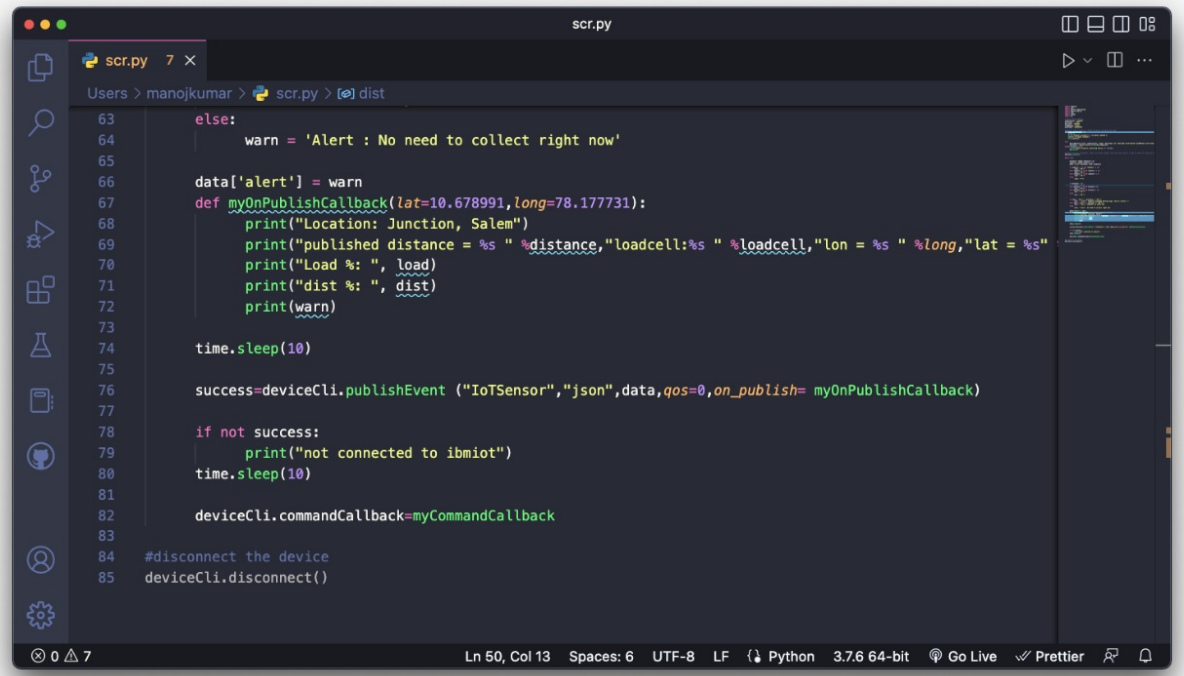
7. CODING & SOLUTIONING (Explain the features added in the project along with code)

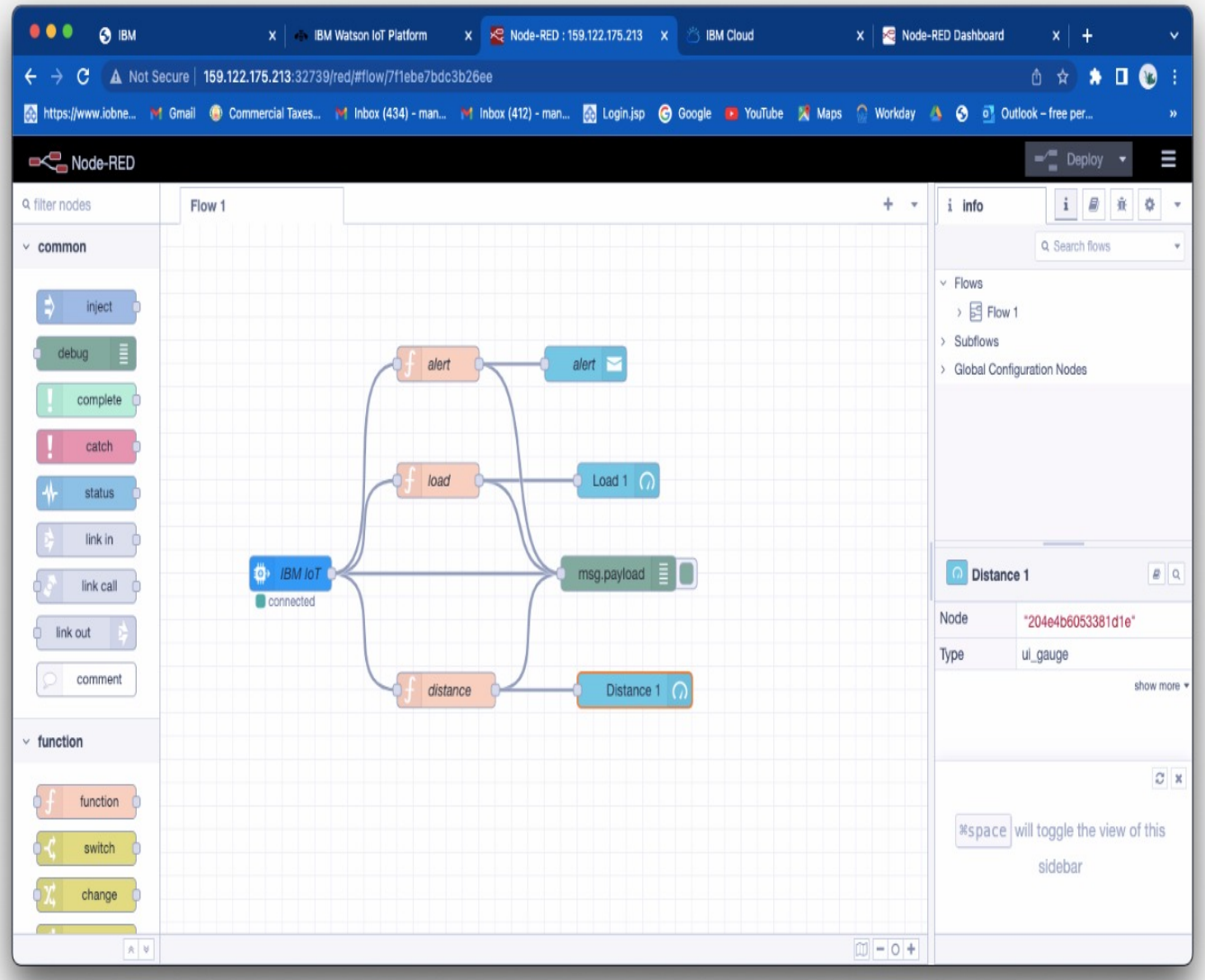
7.1 Feature 1






scr.py
scr.py 7
Users > manojkumar > scr.py > dist
if distance < 15:
dist = "17 %"
elif distance < 40 and distance >16:
dist = "40 %"
elif distance < 60 and distance > 41:
dist = "60 %"
else:
dist = "90 %"
if load == "90 %" or distance == "90 %":
warn = 'Alert : Dumpster poundage getting high, Time to collect :)'
elif load == "60 %" or distance == "60 %":
warn = 'Alert : Dumpster is above 60%'
else:
warn = 'Alert : No need to collect right now'
data['alert'] = warn
def myOnPublishCallback(lat=10.678991,long=78.177731):
print("Location: Junction, Salem")
print("published distance = %s " %distance,"loadcell:%s " %loadcell,"lon = %s " %long,"lat = %s"
print("Load %: ", load)
print("dist %: ", dist)
print(warn)
0 7
Ln 50, Col 13
Spaces: 6
UTF-8
LF
Python
3.7.6 64-bit
Go Live
Prettier


scr.py
scr.py 7
Users > manojkumar > scr.py > dist
else:
warn = 'Alert : No need to collect right now'
data['alert'] = warn
def myOnPublishCallback(lat=10.678991,long=78.177731):
print("Location: Junction, Salem")
print("published distance = %s " %distance,"loadcell:%s " %loadcell,"lon = %s " %long,"lat = %s"
print("Load %: ", load)
print("dist %: ", dist)
print(warn)
time.sleep(10)
success=deviceCli.publishEvent ("IoTSensor","json",data,qos=0,on_publish= myOnPublishCallback)
if not success:
print("not connected to ibmiot")
time.sleep(10)
deviceCli.commandCallback=myCommandCallback
#disconnect the device
deviceCli.disconnect()
0 7
Ln 50, Col 13
Spaces: 6
UTF-8
LF
Python
3.7.6 64-bit
Go Live
Prettier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IBM Cloud
Node-RED Dashboard
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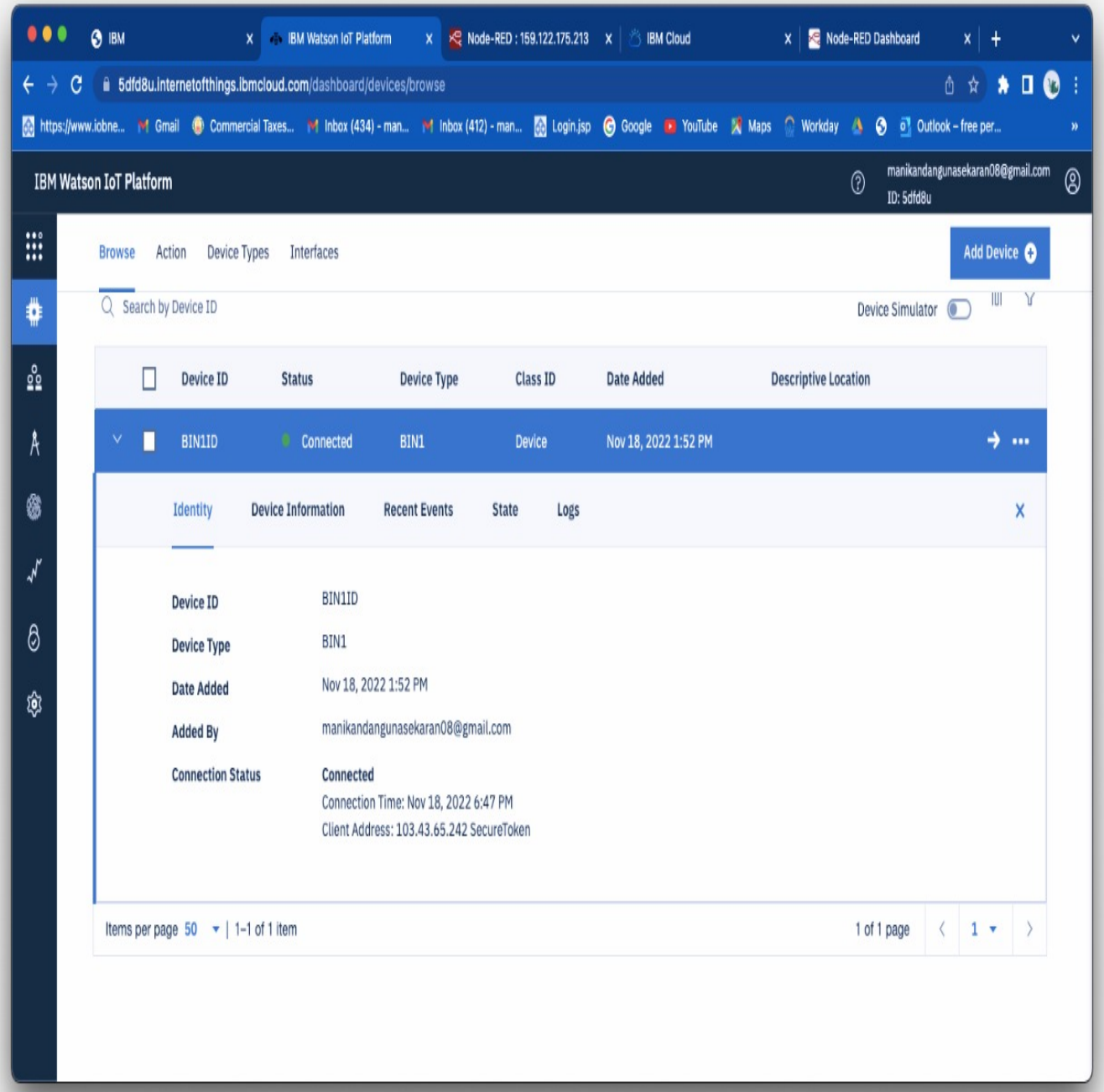
Node-RED
Deploy
filter nodes
Flow 1
common
inject
debug
complete
catch
status
link in
link call
link out
comment
function
function
switch
change
alert
alert
load
Load 1
IBM IoT
connected
msg.payload
distance
Distance 1
info
Search flows
Flows
Flow 1
Subflows
Global Configuration Nodes
Distance 1
Node
"204e4b6053381d1e"
Type
ui_gauge
show more
⌘space will toggle the view of this sidebar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ID: 5dfd8u
Browse
Action
Device Types
Interfaces
Add Device
Search by Device ID
Device Simulator
Device ID
Status
Device Type
Class ID
Date Added
Descriptive Location
BIN1ID
Connected
BIN1
Device
Nov 18, 2022 1:52 PM
Identity
Device Information
Recent Events
State
Logs
Device ID
BIN1ID
Device Type
BIN1
Date Added
Nov 18, 2022 1:52 PM
Added By
manikandangunasekaran08@gmail.com
Connection Status
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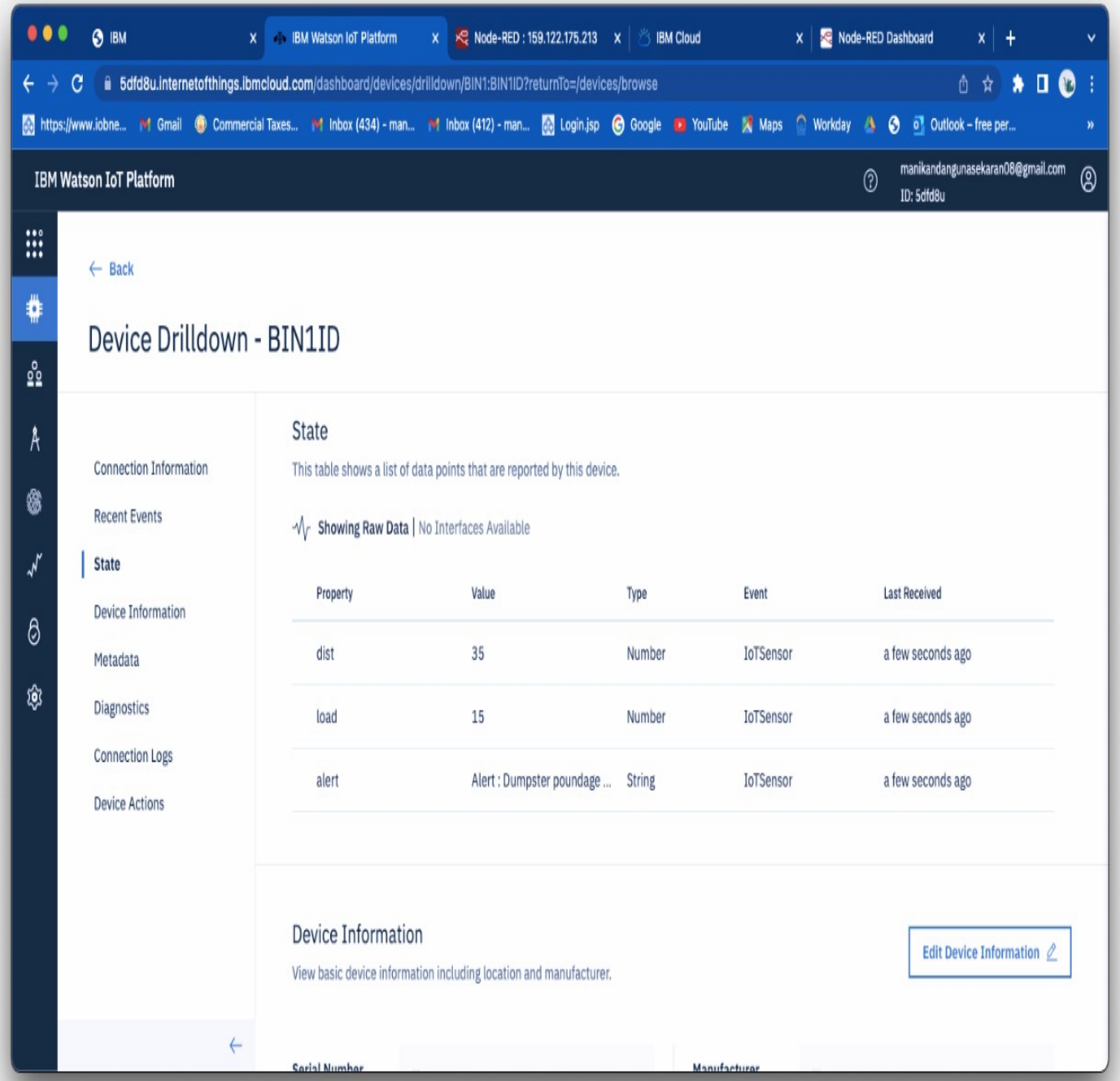
Client Address: 103.43.65.242 SecureToken
Items per page 50
1-1 of 1 item
1 of 1 page
1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IBM Watson IoT Platform
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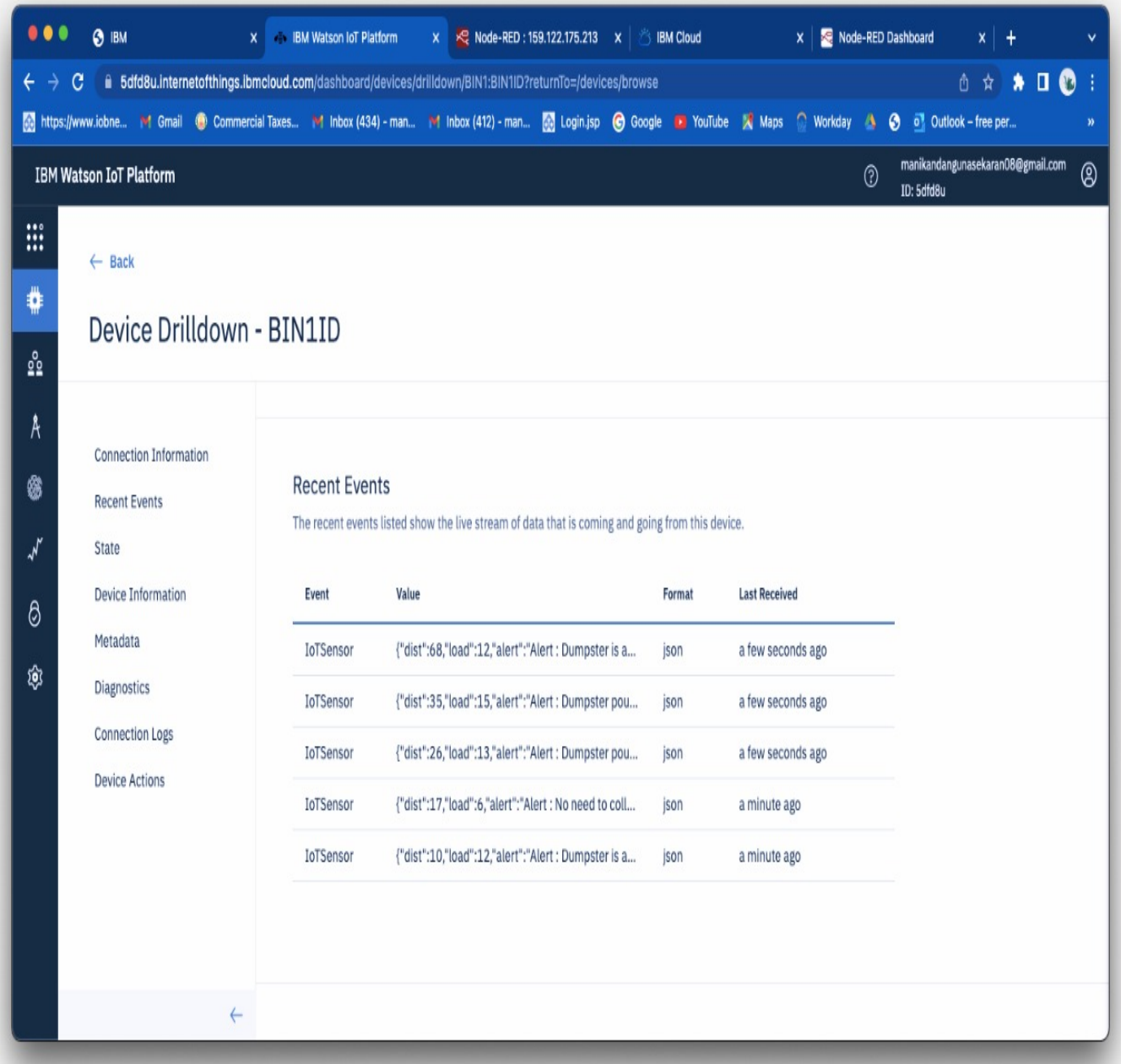
ID: 5dfd8u
Back
Device Drilldown - BIN1ID
Connection Information
Recent Events
State
Device Information
Metadata
Diagnostics
Connection Logs
Device Actions
State
This table shows a list of data points that are reported by this device.
Showing Raw Data | No Interfaces Available
Property
Value
Type
Event
Last Received
dist
35
Number
IoTSensor
a few seconds ago
load
15
Number
IoTSensor
a few seconds ago
alert
Alert : Dumpster poundage ...
String
IoTSensor
a few seconds ago
Device Information
View basic device information including location and manufacturer.
Edit Device Information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Node-RED Dashboard
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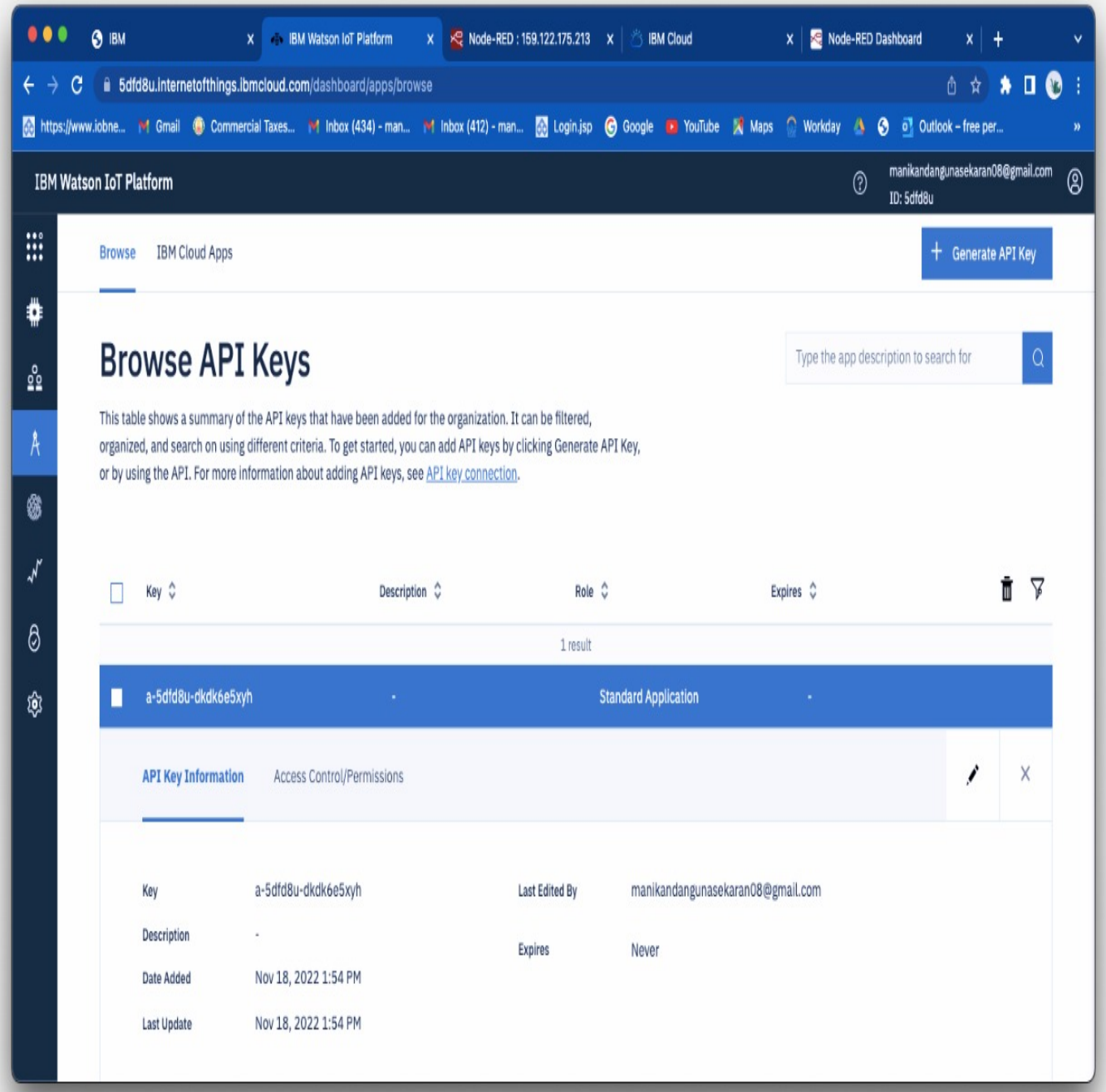
ID: 5dfd8u
Back
Device Drilldown - BIN1ID
Connection Information
Recent Events
State
Device Information
Metadata
Diagnostics
Connection Logs
Device Actions
Recent Events
The recent events listed show the live stream of data that is coming and going from this device.
Event
Value
Format
Last Received
IoTSensor
{"dist":68,"load":12,"alert":"Alert : Dumpster is a...
json
a few seconds ago
IoTSensor
{"dist":35,"load":15,"alert":"Alert : Dumpster pou...
json
a few seconds ago
IoTSensor
{"dist":26,"load":13,"alert":"Alert : Dumpster pou...
json
a few seconds ago
IoTSensor
{"dist":17,"load":6,"alert":"Alert : No need to coll...
json
a minute ago
IoTSensor
{"dist":10,"load":12,"alert":"Alert : Dumpster is a...
json
a minute ago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IBM Cloud
Node-RED Dashboard
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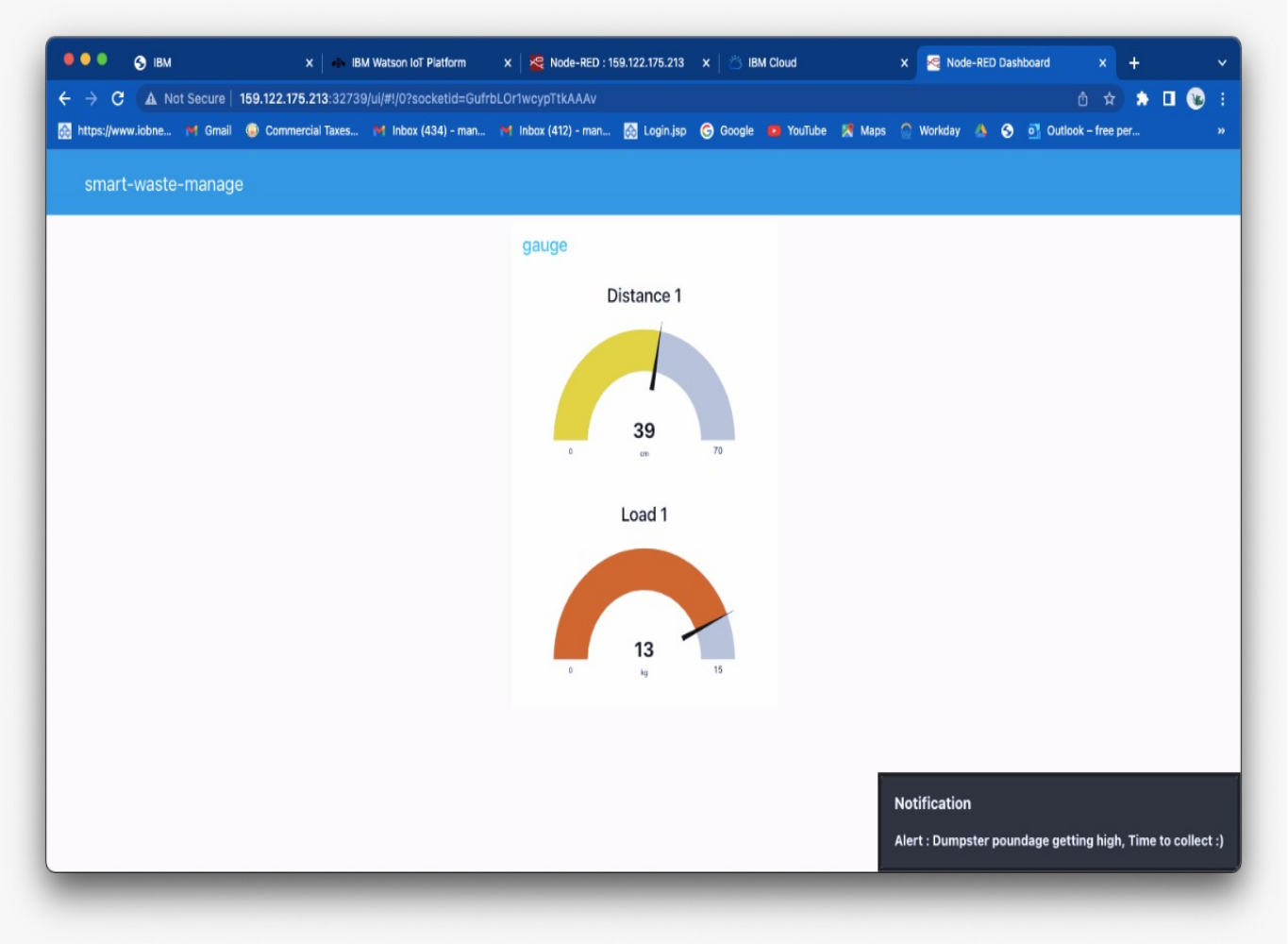
IBM Watson IoT Platform
manikandangunasekaran08@gmail.com
ID: 5dfd8u
Browse
IBM Cloud Apps
Generate API Key
Browse API Keys
Type the app description to search for
This table shows a summary of the API keys that have been added for the organization. It can be filtered, organized, and search on using different criteria. To get started, you can add API keys by clicking Generate API Key, or by using the API. For more information about adding API keys, see API key connection.
Key
Description
Role
Expires
1 result
a-5dfd8u-dkdk6e5xyh
Standard Application
API Key Information
Access Control/Permissions
Key
a-5dfd8u-dkdk6e5xyh
Description
-
Date Added
Nov 18, 2022 1:54 PM
Last Update
Nov 18, 2022 1:54 PM
Last Edited By
manikandangunasekaran08@gmail.com
Expires
Never

7.2 Feature 2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Node-RED Dashboard
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smart-waste-manage
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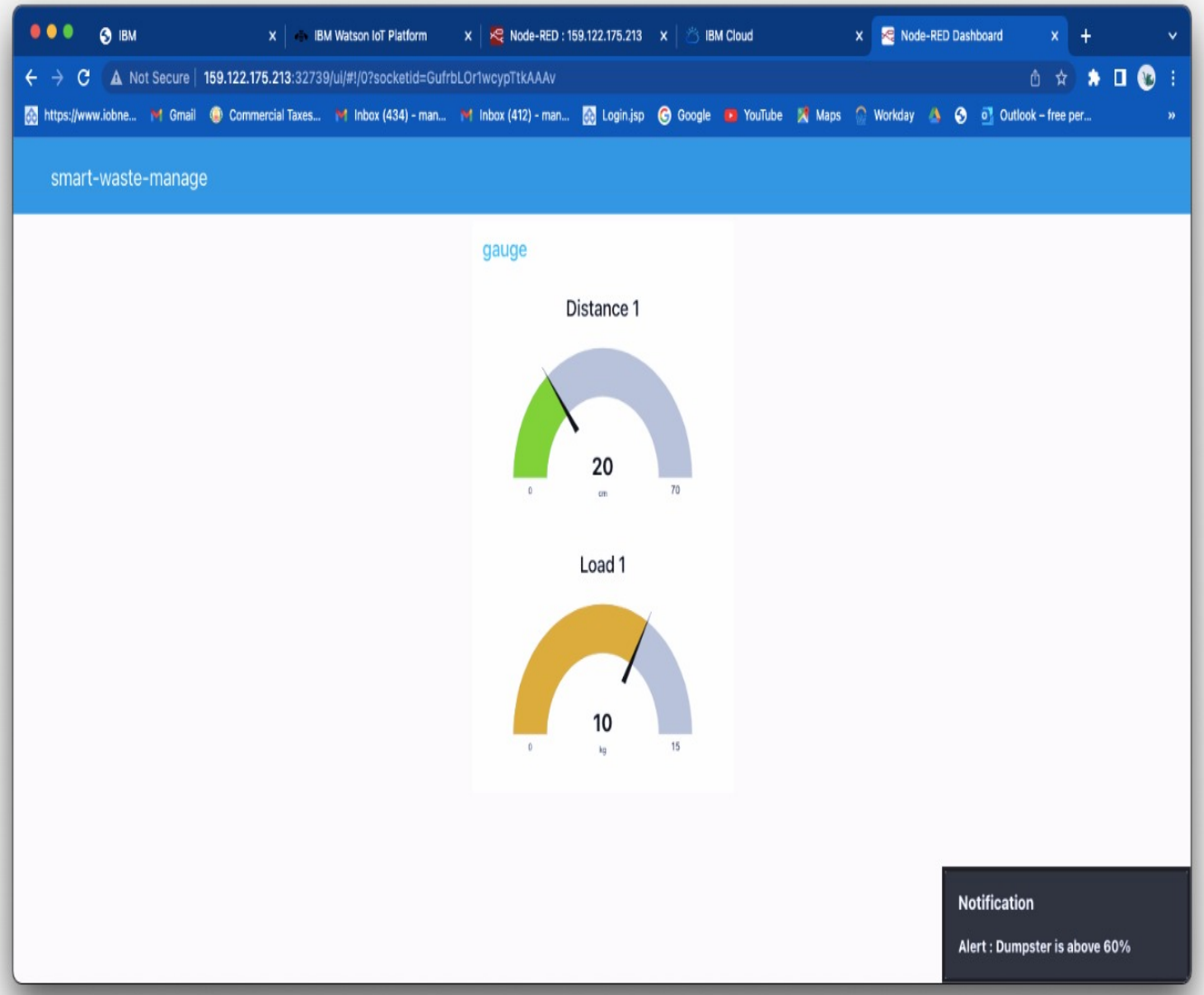
Distance 1
39
0
70
cm
Load 1
13
0
15
kg
Notification
Alert : Dumpster poundage getting high, Time to collect :)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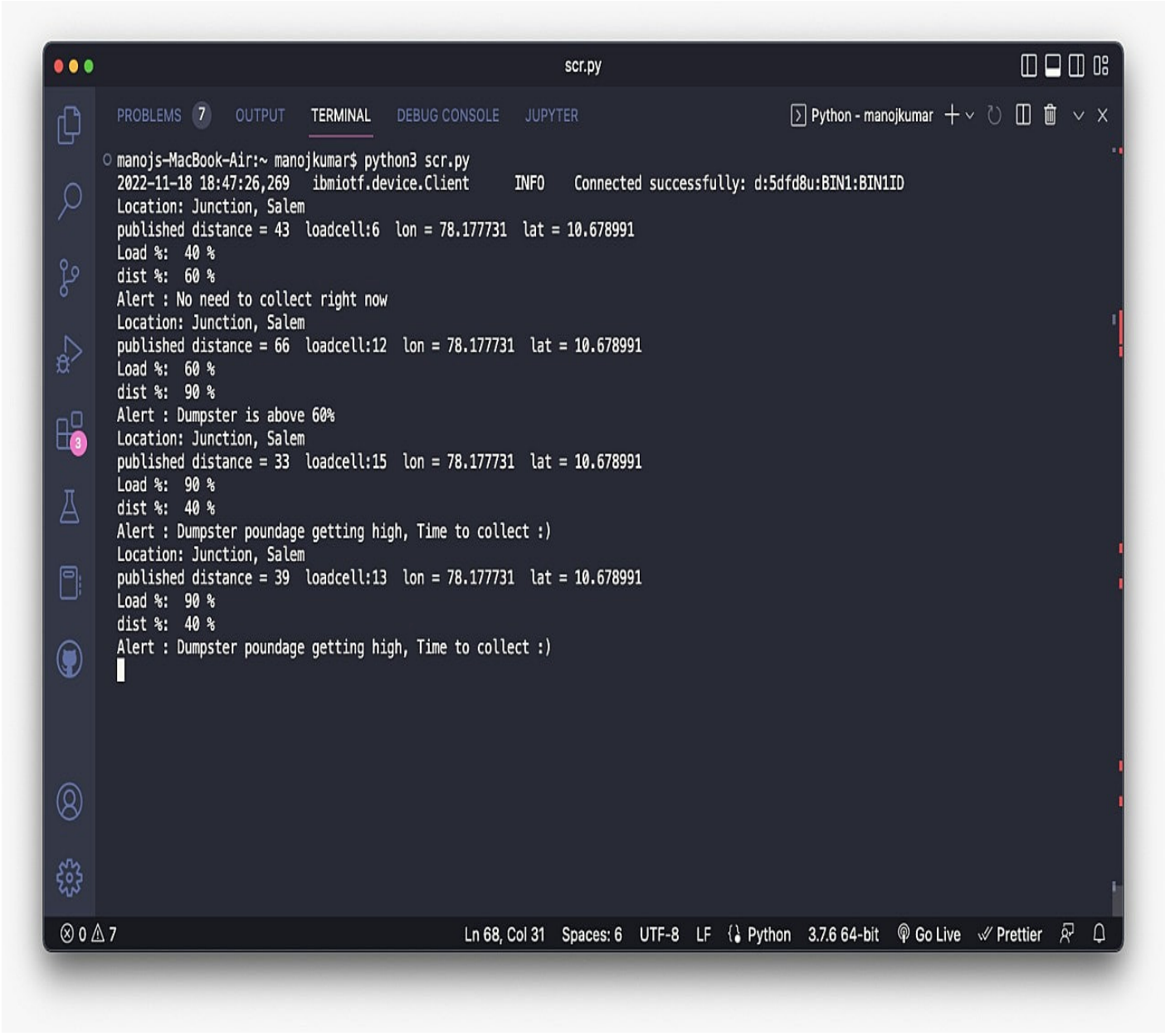
smart-waste-manage
gauge
Distance 1
20
0
cm
70
Load 1
10
0
kg
15
Notification
Alert : Dumpster is above 60%

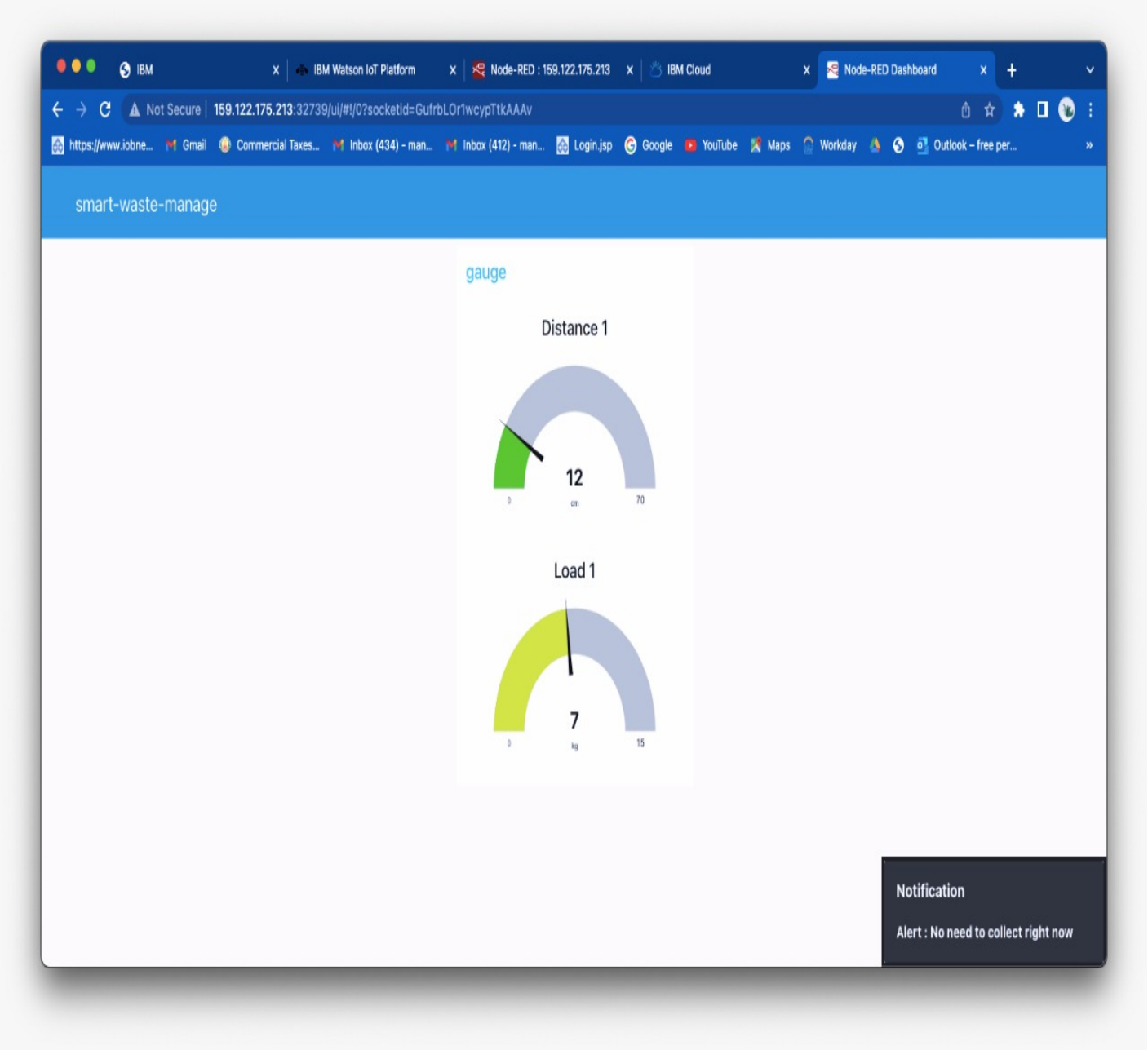
8 TESTING

8.1 Test Cases



9. RESULT

9.1 Performance Metrics



10. ADVANTAGES AND DISADVANTAGES

ADVANTAGES:

1) It saves time and money by using smart waste collection bins and systems equipped with fill level sensors.
2) It further reduces manpower requirements to handle the garbage collection process.
3) It keeps our surroundings clean and green and free from bad odour of wastes, emphasizes on healthy environment and keep cities more beautiful.
4) It helps administration to generate extra revenue by advertisements on smart devices.

DISADVANTAGES:

1) System requires more 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.
2) Sensor nodes used in the dustbins have limited memory size.
3) It reduces man power requirements which results into increase in unemployments for unskilled people.
4)The trainining has to be provided to the people involved in the management.

11. CONCLUSION

Smart waste management is a idea where we can control lots of problems which disturbs the society in pollution and diseases. The waste management has to be done instantly else it leads to irregular management which will have adverse effect on nature. The Smart waste management is compatible mainly with concept of smart cities

12. FUTURE SCOPE

The future of IoT is virtually unlimited due to advances in technology and consumers desire to integrate devices such as smart phones with household machines. As we done for the random values from the sensor, there is a idea for developing Iot devices with physical devices to more number of smart bins across the cities.

13. APPENDIX

Source Code :

https://docs.google.com/document/d/1d-ob9t33wG79poNXlvS5_SthFrQvQsC2dGLWq1EYFGU/edit?usp=sharing

Github :

https://github.com/IBM-EPBL/IBM-Project-26429-1660026551

Video Demo Link :

https://drive.google.com/file/d/1mc0-LyUMYh4WGtPyikpffZBdzM2U9N3R/view?usp=drivesdk