**Smart Waste Management System For Metropolitan Cities**

**NALAIYA THIRAN PROJECT BASED LEARNING**

**On**

**PROFESSIONAL READINESS FOR INNOVATION,**

**EMPLOYABILITY AND ENTREPRENEURSHIP**

**A PROJECT REPORT**

|  |  |
| --- | --- |
| KAVINESH V U | 720719104082 |
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**BACHELOR OF ENGINEERING**

**IN**

**COMPUTER SCIENCE AND ENGINEERING**

**HINDUSTHAN COLLEGE OF ENGINEERING AND TECHOLOGY**

COIMBATORE – 641032

NOVEMBER 2022

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NOVEMBER 2022

***Hindusthan College of Engineering And Technology***

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Approved by AICTE, New Delhi, Accredited with ‘A’ Grade by NAAC **(An Autonomous Institution, Affiliated to Anna University, Chennai)** Valley Campus, Pollachi Highway, Coimbatore – 641 032



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**ABSTRACT**

*At present solid waste management is a major concern in the metropolitan cities of the developing and developed countries. As the population is growing, the garbage is also increasing. This huge unmanaged accumulation of garbage is polluting the environment, spoiling the beauty of the area and also leading to the health hazard. In this era of Internet, IOT (Internet of Things) can be used effectively to manage this solid waste. In this paper, we have discussed the definition of Internet of Things and its elements, testing and prototyping tool cooja simulator and finally the study of various literatures available on smart waste management system using IOT.*

**1.INTRODUCTION**

This project automates the task of waste segregation in public dustbins by classifying waste as either recyclable or non-recyclable . We use a Raspberry Pi along with a servo motor , IR , Ultra-Sonic Sensor ,Pi Cam and a server to accomplish the project.

The project has been implemented as an IoT system which capture images through the Pi and sends, it to the server for processing. On the server , we use CNNs for the Machine learning/Image processing algorithms, which are used to identify type of waste that was dumped. The server communicates back to the Pi and the Pi actuates accordingly by turning the servo motor and thus dumping the garbage to either the recycle or non-cyclable side . We use an ultrasonic sensor to detect the level of garbage accumulated in the bin

**2.OBJECTIVES**

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. The main objectives of our proposed system are as follows

1. Monitoring the waste management.

2. Providing a smart technology for waste system.

3. Avoiding human intervention.

4. Reducing human time and effort

5. Resulting in healthy and waste ridden environment.

**3.IDEATION PHASE**

**3.1 LITERATURE SURVEY**

**[1]**

# TITLE:Solid waste management in Abuja, Nigeria

# The new city of Abuja provided an opportunity to avoid some of the environmental problems associated with other major cities in Africa. The current status of solid waste management in Abuja has been reviewed and recommendations for improvements are made. The existing solid waste management system is affected by unfavourable economic, institutional, legislative, technical and operational constraints. A reliable waste collection service is needed and waste collection vehicles need to be appropriate to local conditions. More vehicles are required to cope with increasing waste generation. Wastes need to be sorted at source as much as possible, to reduce the amount requiring disposal. Co-operation among communities, the informal sector, the formal waste collectors and the authorities is necessary if recycling rates are to increase. Markets for recycled materials need to be encouraged. Despite recent improvements in the operation of the existing dumpsite, a properly sited engineered landfill should be constructed with operation contracted to the private sector. Wastes dumped along roads, underneath bridges, in culverts and in drainage channels need to be cleared. Small-scale waste composting plants could promote employment, income generation and poverty alleviation. Enforcement of waste management legislation and a proper policy and planning framework for waste management are required. Unauthorized use of land must be controlled by enforcing relevant clauses in development guidelines. Accurate population data is necessary so that waste management systems and infrastructure can be properly planned. Funding and affordability remain major constraints and challenges..

# [2]

# TITLE:Municipal solid waste management in Indian cities

# Municipal solid waste management (MSWM) is one of the major environmental problems of Indian cities. Improper management of municipal solid waste (MSW) causes hazards to inhabitants. Various studies reveal that about 90% of MSW is disposed of unscientifically in open dumps and landfills, creating problems to public health and the environment. In the present study, an attempt has been made to provide a comprehensive review of the characteristics, generation, collection and transportation, disposal and treatment technologies of MSW practiced in India. The study pertaining to MSWM for Indian cities has been carried out to evaluate the current status and identify the major problems. Various adopted treatment technologies for MSW are critically reviewed, along with their advantages and limitations. The study is concluded with a few fruitful suggestions, which may be beneficial to encourage the competent authorities/researchers to work towards further improvement of the present system.

# [3]

# TITLE:Sustainable metropolitan areas perspectives through assessment of the existing waste management strategies

# Human activities are considered among the main producers of any kind of pollution. This paper, through a Driver-Pressure-State-Impact-Response (DPSIR) model analyses, focuses on the evaluation and assessment of the existing practices, procedures, and results obtained in order to determine whether the municipal solid waste (MSW) management implemented in three major Greek municipalities in the greater urban area of Attica, namely the municipalities of NeaSmirni, Vyronas, and Piraeus, could be considered viable and sustainable. The evaluation indicated that MSW in Greek cities have reduced over the last years, also suggesting a steady downward trend, which could be considered consistent with that of the per capita incomes in Greece due to the extended economic austerity, while at the same time the recycling indicator seems to optimize. The results are very useful for policymakers and local authorities towards taking actions related to the targets set from the circular economy strategies as well as the targets set from United Nation Development Program and the European Green Deal Strategy.

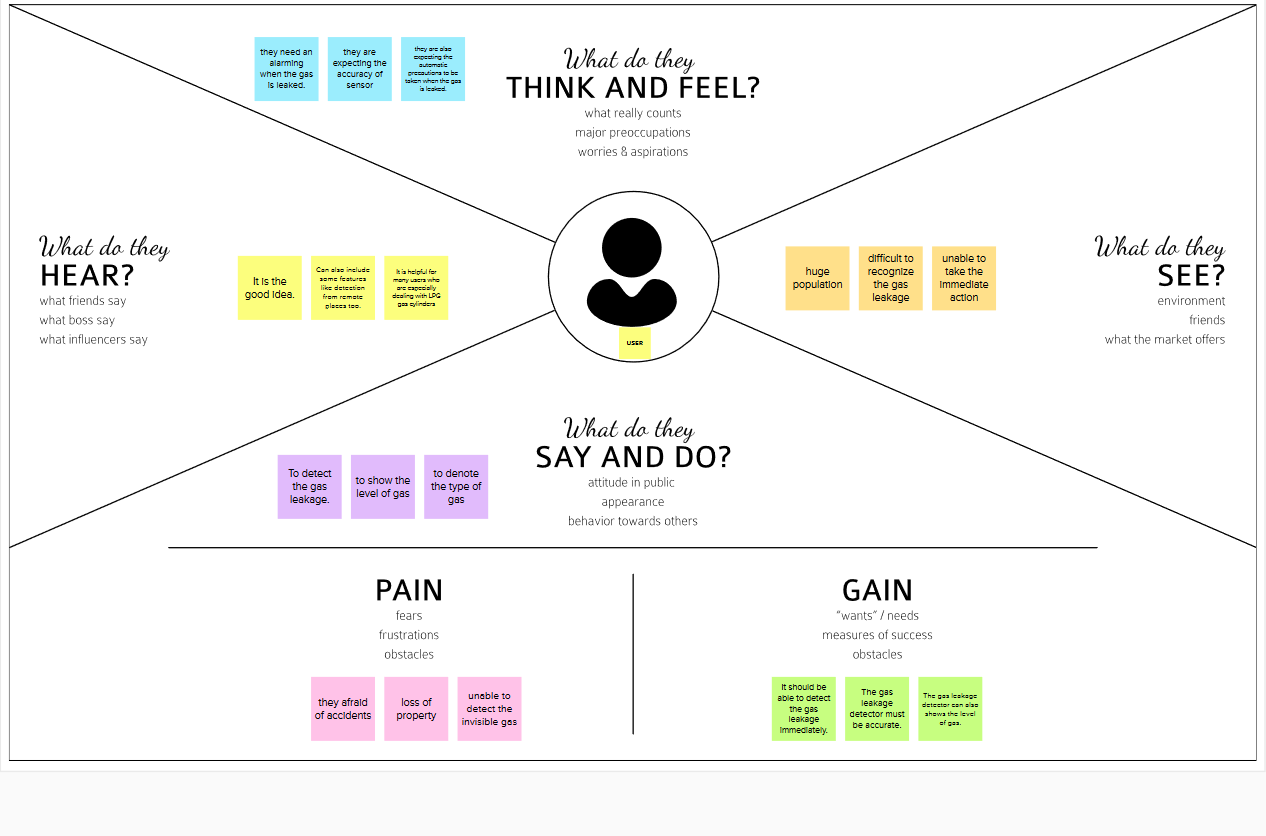
# [4]

# TITLE:IOT based Smart Bin Waste Management

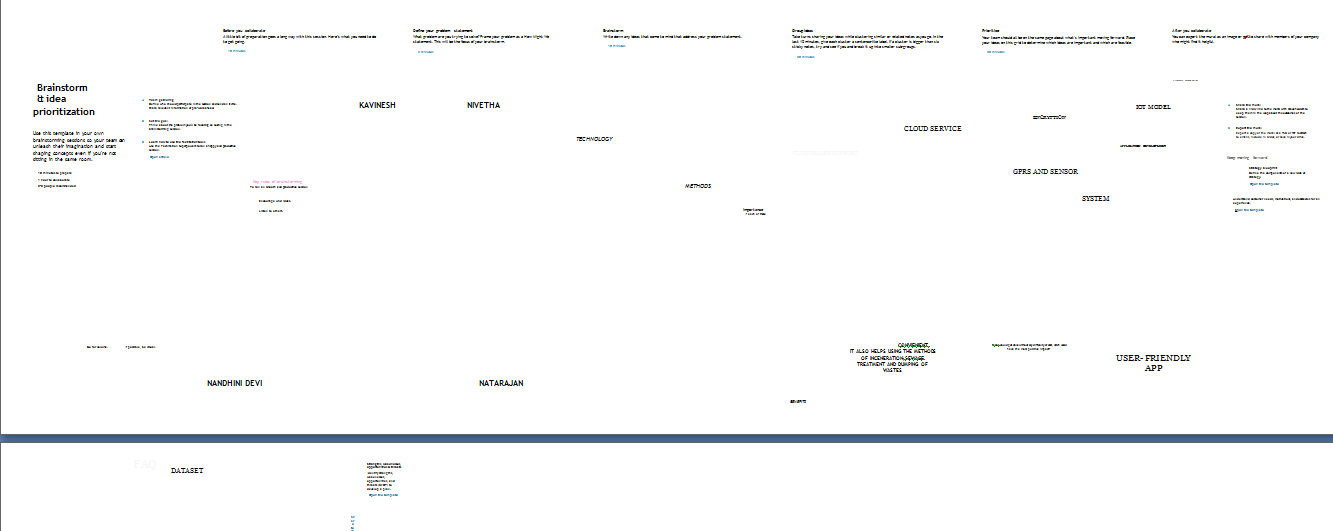
Many times, in our city we see that the garbage bins or dustbins placed at public places are overloaded. It creates unhygienic conditions for people as well as ugliness to that place leaving bad smell. To avoid such situations the proposed project will be implemented for efficient waste management using IOT. These dustbins are interfaced with arduino based system having ultrasonic wireless systems along with central system showing current status of garbage, on mobile web application with Android app by Wi-Fi. Hence the status will be updated on to the App. Major part of the proposed project depends upon the working of the Wi-Fi module; essential for its implementation. The main aim of this project is to reduce human resources and efforts along with the enhancement of a smart city vision.

**3.2 EMPATHY MAP**

**3.2 EMPATHY MAP**

****

**3.3 IDEATION**

****

**3.4 PROBLEM STATEMENT**

In the present scenario, we see the garbage bins being overloaded and all the garbage spills out resulting in pollution. The detection, monitoring and management of waste is one of the primary problems of the present world. The traditional way of monitoring the wastes in waste bins is complex, cumbersome process which takes more human effort, time and cost which is not compatable with the present-day technologies in any way. This method is advanced in which garbage management is automated. This project Garbage Monitoring system using IOT is a very innovative system which will help to keep the cities clean. With an increase in population at an unprecedented rate, the scenario of cleanliness with respect to garbage management in terms of collection, sorting and finally disposal is facing an increasing number of challenges. The overflow of garbage in public areas creates the unhygienic condition in the nearby surrounding which may cause serious diseases. To avoid this and to automate the cleaning and ensure end to end efficient garbage disposal “IOT BASED GARBAGE MANAGEMENT SYSTEM” is proposed

**4.PROJECT DESIGN PHASE 1**

**4.1PROPOSED SOLUTION**

|  |  |  |
| --- | --- | --- |
| **S.No** | **Parameter** | **Description** |
| 1. | Problem Statement | * Develop an efficient system & application that can monitor and alert the users. * If there is any leakage of gas in their surroundings so that they can work efficiently on major crises rather than worrying about monitoring the leakage of gas, this will indeed reduce the manpower of the industry and create a peaceful environment. |
| 2. | Idea / Solution Description | * This system helps the industries in monitoring the emission of harmful gases. * In Several areas, the gas sensors will be integrated to monitor the gas leakage. * If it any large gas leakage is detected the admins will be notified along with the location. * In the web application admins can view the sensor parameters. |
| 3. | Novelty / Uniqueness | * Fastest alerts to the workers. * User Friendly * Cloud based application solution. |
| 4. | Social Impact / Customer Satisfaction | * Cost Efficient * Easy installation and provide efficient results. * Can work with irrespective of fear. |
| 5. | Business Model (Revenue Model) | * This system is advertised all over the platforms. Since it is economical, even helps small scale industries from disasters. * As the product usage can be understood by everyone, it is easy for them to use in properly for their safest organization |
| 6. | Scalability of the Solution | * Since the product is efficient, it can be placed in many places of the industries. * Even when gas leakage is more, the product sense the accurate values and alerts the workers effectively. * Our solution can be integrated for further future use because the solution we have provided will be lay on the basic or initial stage of any upgraded version. |

**4.2 PROBLEM SOLUTION FIT:**

Problem Solution cards

#problem statement

1.What’s most valuable to the customer?

2.What are we the best at?

3.What are we looking to improve?



Step 2:

Framing Statements

Smart waste management system framing

The greatest problem regarding waste management in developing countries begins at the very starting point of the process. Due to lack of proper systems for disposal and collections, wastes and garbage's end up in the roads and surrounding. According to a report from Google research, the amount of waste generation in 2010 was around 20,000 tons per day, and it is estimated that by 2025 the amount will be no less than around 47000 tons per day. With the existing methods of collecting and disposal it is near impossible to manage such amount of waste in the future as around 30% of waste end up on the roads and public places due to ineffective disposing and collecting methods. Not only that, there is even no systematic methodology for the collected garbage for treating and recycling thus most of them end up in land filling and river water, making the environment unhealthier.

The prime impediment of implementing smart waste management system based on lot in a developing country is the social and economic infrastructure of the country itself.

The initial stage of this system comprises of proper disposal and collection, which is the biggest challenge. In addition, to motivate and influence people to follow proper waste disposal methods is also important.

Step 3:

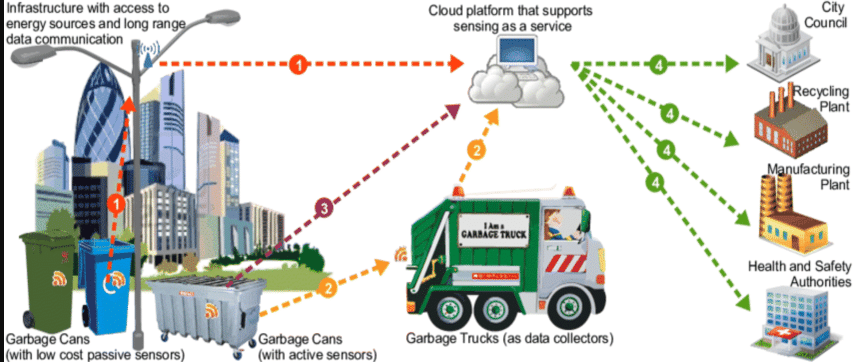
Ideas

Problem Solution



Previously there were numerous initiatives on waste management and educating people to dispose waste properly, and as they failed to achieve significant results, we have figured out the scopes that could be develop. To solve this problem, we have designed a process that ensures proper disposal and efficient waste collection. The procedures we designed involves creative initiative that will inspire people to dump in designated area or bins, and innovative method by using Decreasing Time algorithm or DTA for monitoring garbage generation and collection of the garbage's.

**4.3 SOLUTION ARCHITECTURE**

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**5. PROJECT DESIGN PHASE 2**

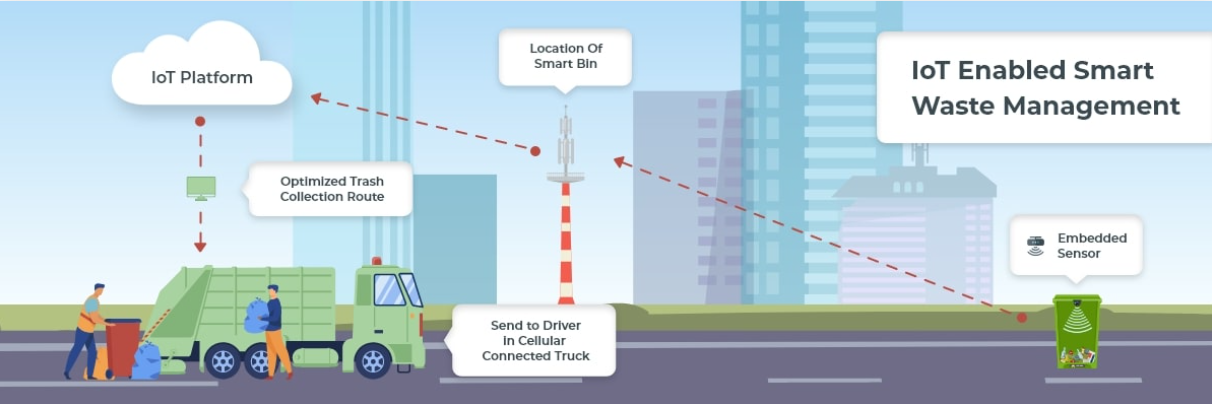
**5.1 CUSTOMER JOURNEY MAP**

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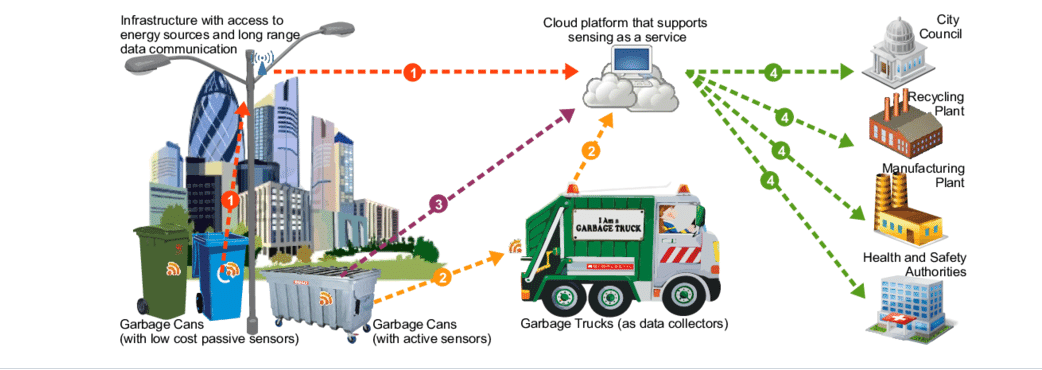
**5.2 SOLUTION REQUIREMENTS**

|  |  |  |
| --- | --- | --- |
| **FRNo.** | **FunctionalRequirement(Epic)** | **SubRequirement (Story /Sub-Task)** |
| FR-1 | Monitoring | Level of gas is monitored using sensor and if there is any leakage,alertcanbesentthroughmessagesandwithabuzzersound. |
| FR-2 | UserReception | Thedatalikethelevelofgascanbesendthroughmessages |
| FR-3 | UserUnderstanding | Theusercanmonitorthelevelofgaswiththehelpofthedata.If thereisanincreaseingaslevelthenthealertwillbegivenbymessageorbuzzersound. |
| FR-4 | UserPerformance | Whentheusergetsnotified,theycouldtakeprecautionstepsliketurningthegasoff,turnontheexhaustfan/sprinklerandavoid  seriousaccidents. |

**5.3 DATA FLOW DIAGRAMS**

****

**5.4 TECHNOLOGY STACK**

****

**6. PROJECT PLANNING PHASE**

**6.1 PREPARE MILESTONE AND ACTIVITY LIST**

| **TITLE** | **DESCRIPTION** | **DATE** |
| --- | --- | --- |
| **Literature Survey & Information Gathering** | Literature survey on the selected project & gathering information by referring the, technical papers,research publications etc. | 24 SEPTEMBER 2022 |
| **Prepare Empathy Map** | Prepare Empathy Map Canvas to capture the user Pains & Gains, Prepare list of problem statements | 24 SEPTEMBER 2022 |
| **Ideation** | List the by organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance. | 28 SEPTEMBER 2022 |
| **Proposed Solution** | Prepare the proposed solution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc. | 07 OCTOBER 2022 |
| **Problem Solution Fit** | Prepare problem - solution fit document. | 07 OCTOBER 2022 |
| **Solution Architecture** | Prepare solution architecture document. | 07 OCTOBER 2022 |
| **Customer Journey** | Prepare the customer journey maps to understand the user interactions & experiences with the application. | 27 OCTOBER 2022 |
| **Functional Requirement** | Prepare the functional requirement document. | 27 OCTOBER 2022 |
| **Data Flow Diagrams** | Draw the data flow diagrams and submit for review. | 27 OCTOBER 2022 |
| **Technology Architecture** | Preparethetechnology architecture diagram. | 30 OCTOBER 2022 |
| **Prepare Milestone & Activity List** | Prepare the milestones & activity list of the project. | 03 NOVEMBER 2022 |
| **Project Development - Delivery of Sprint-1, 2, 3 & 4** | Develop & submit the developed code by testing it. | In progress…. |

**6.2 SPRINT DELIVERY PLAN**

| **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 pass code for ever workers over there in municipality | 10 | High | Nandhini Devi |
| Sprint-1 | Login | USN-2 | As a Co-Admin, I’ll control the waste level by monitoring them via real time web portal. Once the filling happens, I’ll notify trash truck with location of bin with bin ID | 10 | High | Nivetha |
| 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 | Kavinesh |
| Sprint-3 | Dashboard | 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 | 20 | Medium | Kavinesh |
| Sprint-4 | Dashboard | USN-5 | As a Municipality officer, I'll make sure everything is proceeding as planned and without any problems | 20 | High | Natarajan |

| **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 | 23 Oct 2022 | 28 Oct 2022 | 20 | 28 Oct 2022 |
| Sprint-2 | 20 | 6 Days | 1 Nov 2022 | 6 Nov 2022 | 20 | 6 Nov 2022 |
| Sprint-3 | 20 | 6 Days | 7 Nov 2022 | 12 Nov 2022 | 20 | 12 Nov 2022 |
| Sprint-4 | 20 | 6 Days | 13 Nov 2022 | 18 Nov 2022 | 20 | 18 Nov 2022 |

**7.PROJECT DEVELOPMENT PHASE**

**7.1 PROJECT DEVELOPMENT - DELIVERY OF SPRINT – 1**

**SPRINT 1:**

In this sprint we have developed a python code to generate random sensor data and publish that data to the IBM internet of things platform using a python package called ibmiotf. These data will be published to the respected device in that platform.

**PYTHON CODE:**

import time

import sys

import ibmiotf.application

import ibmiotf.device

import random

#Provide your IBM Watson Device Credentials

organization = "7qml3n"

deviceType = "IOT"

deviceId = "Waste\_management"

authMethod = "use-token-auth"

authToken = "l4FVB93I&hZMANLp?D"

# Initialize GPIO

def myCommandCallback(cmd):

print("Command received: %s" % cmd.data['command'])

status=cmd.data['command']

if status=="lighton":

print ("led is on")

else :

print ("led is off")

#print(cmd)

try:

deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod, "auth-token": authToken}

deviceCli = ibmiotf.device.Client(deviceOptions)

#..............................................

except Exception as e:

print("Caught exception connecting device: %s" % str(e))

sys.exit()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting" 10 times

deviceCli.connect()

while True:

#Get Sensor Data from DHT11

weight=random.randint(0,100)

level=random.randint(0,100)

data = { 'weight' : weight, 'level':level }

#print data

def myOnPublishCallback():

print ("Published Weight = %s Kg" % weight, "level = %s %%" % level, "to IBM Watson")

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

if not success:

print("Not connected to IoTF")

time.sleep(1)

deviceCli.commandCallback = myCommandCallback

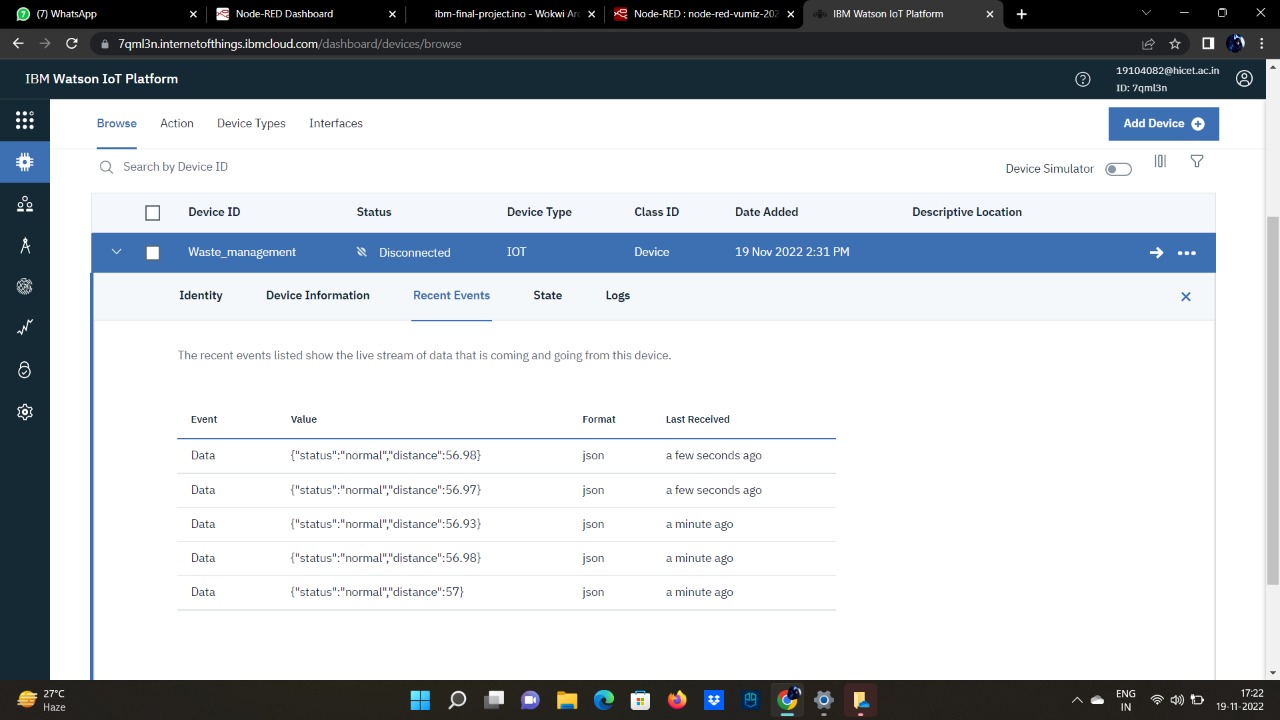
# Disconnect the device and application from the cloud

deviceCli.disconnect()

**7.2 PROJECT DEVELOPMENT - DELIVERY OF SPRINT – 2**

**SPRINT 2:**

In this sprint we have created IBM Watson internet of things platform cloud services and 2 devices, one for publishing sensor data another one for subscribing to alert system.



Here the random sensor data are successfully published in the json format from the python code that we have developed during the previous sprint.

**7.3 PROJECT DEVELOPMENT - DELIVERY OF SPRINT – 3**

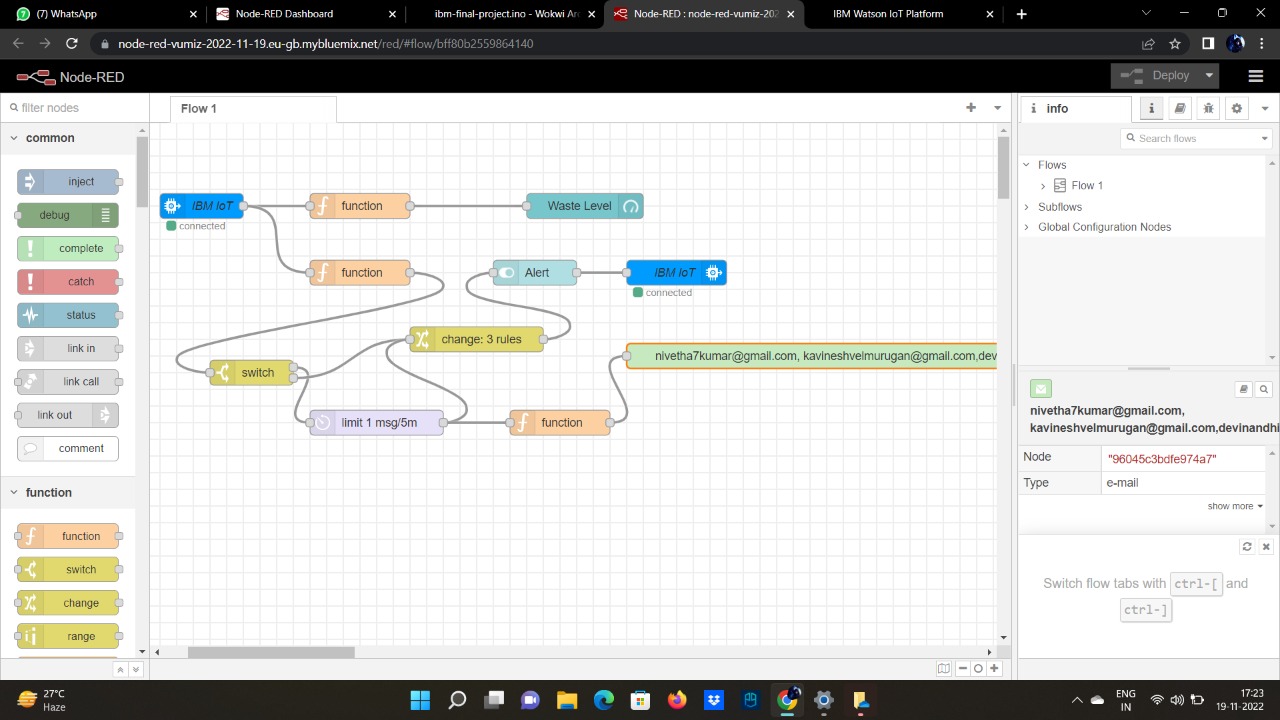
**SPRINT 3:**

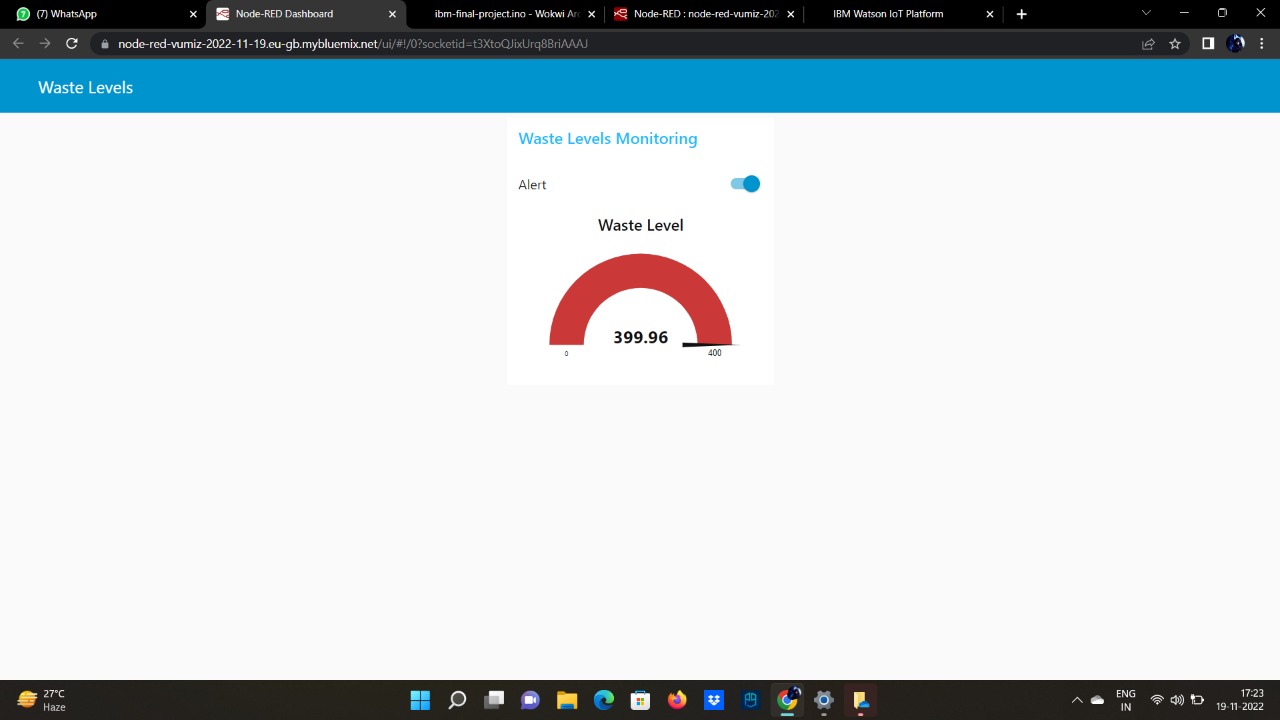
In this sprint we have created and configured the node red services and developed a Web UI dashboard for the users to monitor the sensor and to toggle the state of the alarm. The data from the IBM Watson IOT platform are sent to this node red application and an email is sent to the admins every 5 minutes with the node red UI dashboard link if the gas leakage is detected and the alarm is automatically triggered. Using that link the admin can monitor the gas levels and can toggle the alarm switch from any device using the internet.

**NODE RED UI DASHBOARD LINK:**

<https://node-red-vumiz-2022-11-19.eu-gb.mybluemix.net/red/#flow/bff80b2559864140>

**SCREENSHOTS:**

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**7.4 PROJECT DEVELOPMENT - DELIVERY OF SPRINT – 4**

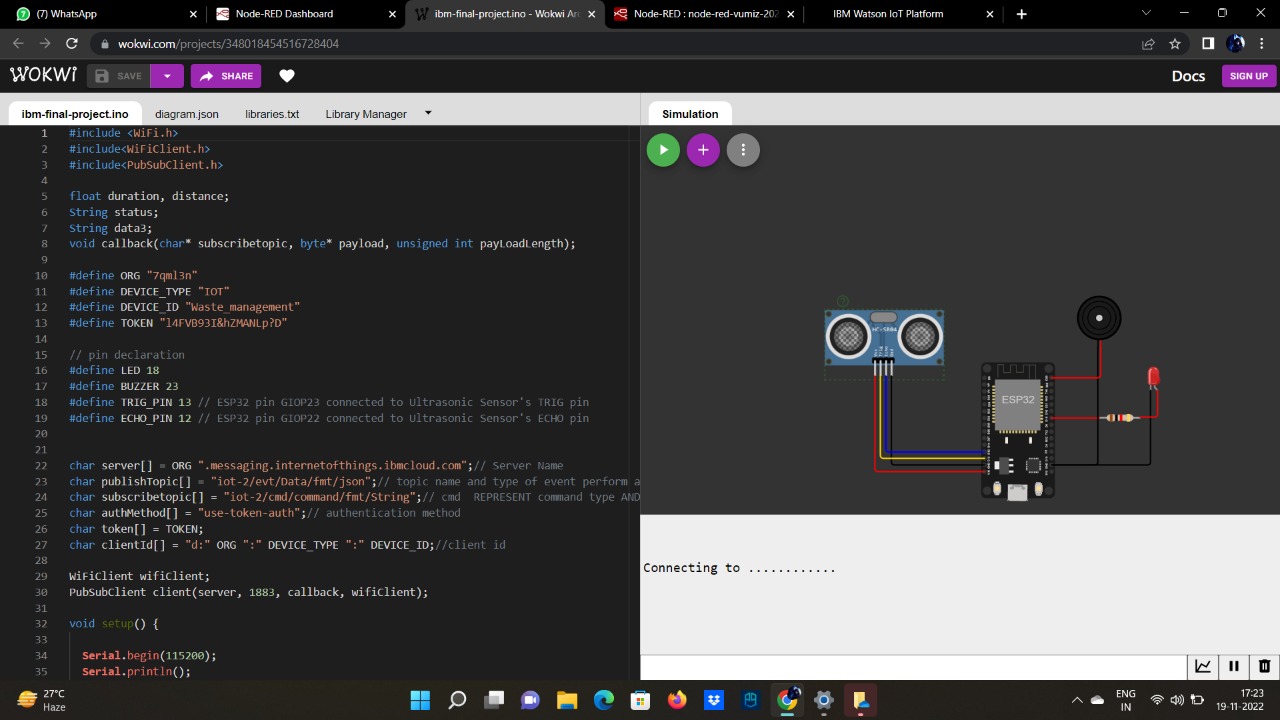
**SPRINT 4:**

In this sprint we have developed an alarm system simulation using a led, buzzer and ESP32 microcontroller. The subscribe model device named Alert\_System in IBM Watson IOT platform is connected to this simulation using device credentials. Thus the alarm gets toggles ON automatically when a gas leakage is detected. However, this alarm can be toggled ON and OFF manually from the Node Red Web Application dashboard by the admins.

**WOKWI WEBSITE LINK:**

<https://wokwi.com/projects/348018454516728404>

**SCREENSHOTS:**



**8.CONCLUSION**

Solid waste management is faced with a number of issues which include lack of

throughput, inadequate solid waste data, efficiency problem, delays in collection and

resistance to new technologies. Presently, waste management is a major problem for

authorities who are responsible for such task because it’s a costly service and it huge-

ly impacts the environment as a whole. This study introduced a smart waste monitor-

ing system that uses several sensors and communication technologies to achieve the

set task. The proposed system was achieved through the development of theoretical

models, layout and decision-making algorithms in the course of the project.

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