REMOTE GAS PIPELINE TUNNEL TEMPERATURE MONITORING SYSTEM

PROJECT REPORT

Submitted By

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in partial fulfilment for the award of the degreeof

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BONAFIDE CERTIFICATE

Certified that this project report titled **"REMOTE GAS PIPELINE TUNNEL TEMPERATURE MONITORING SYSTEM"** is the bonafide work of **"NITHYA G, CHANDHINI S, TEECHANA T, KOWSHIKA M"** who carried out the project work under my supervision.

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CHAPTER - 1

INTRODUCTION

1.1 PROJECT OVERVIEW

The remote gas pipeline tunnel temperature monitoring system is an innovative project designed to enhance the safety and efficiency of gas pipeline operations. The system utilizes advanced sensing technologies and remote monitoring capabilities to continuously monitor the temperature conditions inside gas pipeline tunnels. By accurately monitoring temperature fluctuations, the system aims to detect potential issues such as overheating or abnormal temperature variations that could lead to pipeline failures or operational disruptions. The project involves the installation of temperature sensors strategically placed along the length of the gas pipeline tunnels. These sensors are designed to capture real-time temperature data and transmit it to a central monitoring station via a secure wireless network. At the monitoring station, the data is processed and analyzed using sophisticated algorithms to identify any deviations from the normal temperature range. In case of abnormal temperature patterns, the system generates alerts and notifications to alert the pipeline operators, enabling them to take immediate action to prevent any potential risks or failures. The remote gas pipeline tunnel temperature monitoring system provides several key benefits. Firstly, it improves the safety of gas pipeline operations by enabling early detection of temperature anomalies that could indicate potential issues. Secondly, it enhances operational efficiency by allowing continuous monitoring without the need for manual inspections, reducing the reliance on human intervention. Lastly, the system offers cost savings by minimizing the risk of pipeline failures, which can lead to expensive repairs, environmental damage, and operational downtime. Overall, the project aims to ensure the smooth and uninterrupted operation of gas pipelines while mitigating potential risks associated with temperature-related issues.

1.2 PURPOSE

The purpose of a remote gas pipeline tunnel temperature monitoring system is to ensure the safe and efficient operation of gas pipelines by continuously monitoring and analyzing temperature variations within the tunnel. Gas pipelines are vulnerable to temperature fluctuations, which can affect the integrity and performance of the pipeline. By implementing a remote monitoring system, operators can detect and respond to abnormal temperature changes promptly, minimizing the risk of accidents, leaks, or pipeline failures.

This monitoring system serves two primary purposes. Firstly, it enables real-time monitoring of temperature variations along the pipeline tunnel, allowing operators to identify potential hotspots or areas of excessive heat. By detecting such anomalies, maintenance or mitigation measures can be implemented promptly to prevent any potential damage or hazards. Secondly, the remote aspect of the system enables operators to monitor the temperature data from a central control room or off-site location. This eliminates the need for physical inspections or manual temperature measurements, improving operational efficiency and reducing costs. By providing continuous monitoring capabilities, the system ensures the safety, reliability, and longevity of the gas pipeline infrastructure.

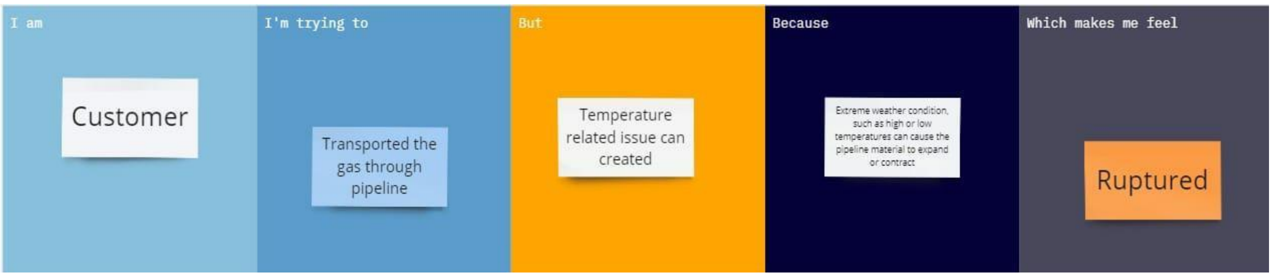
CHAPTER - 2

2. IDEATION & PROPOSED SOLUTION

2.1 PROBLEM STATEMENT DEFINITION

Creating a problem statement to understand your customer's point of view. The Customer Problem Statement template helps you focus on what matters to create experiences people will love.

Problem Statement -1



Problem Statement-2

Problem Statement- 3

Figure 2.1. Problem Statement

2.2 EMPATHY MAP CANVAS

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviors and attitudes. It is a useful tool to help teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

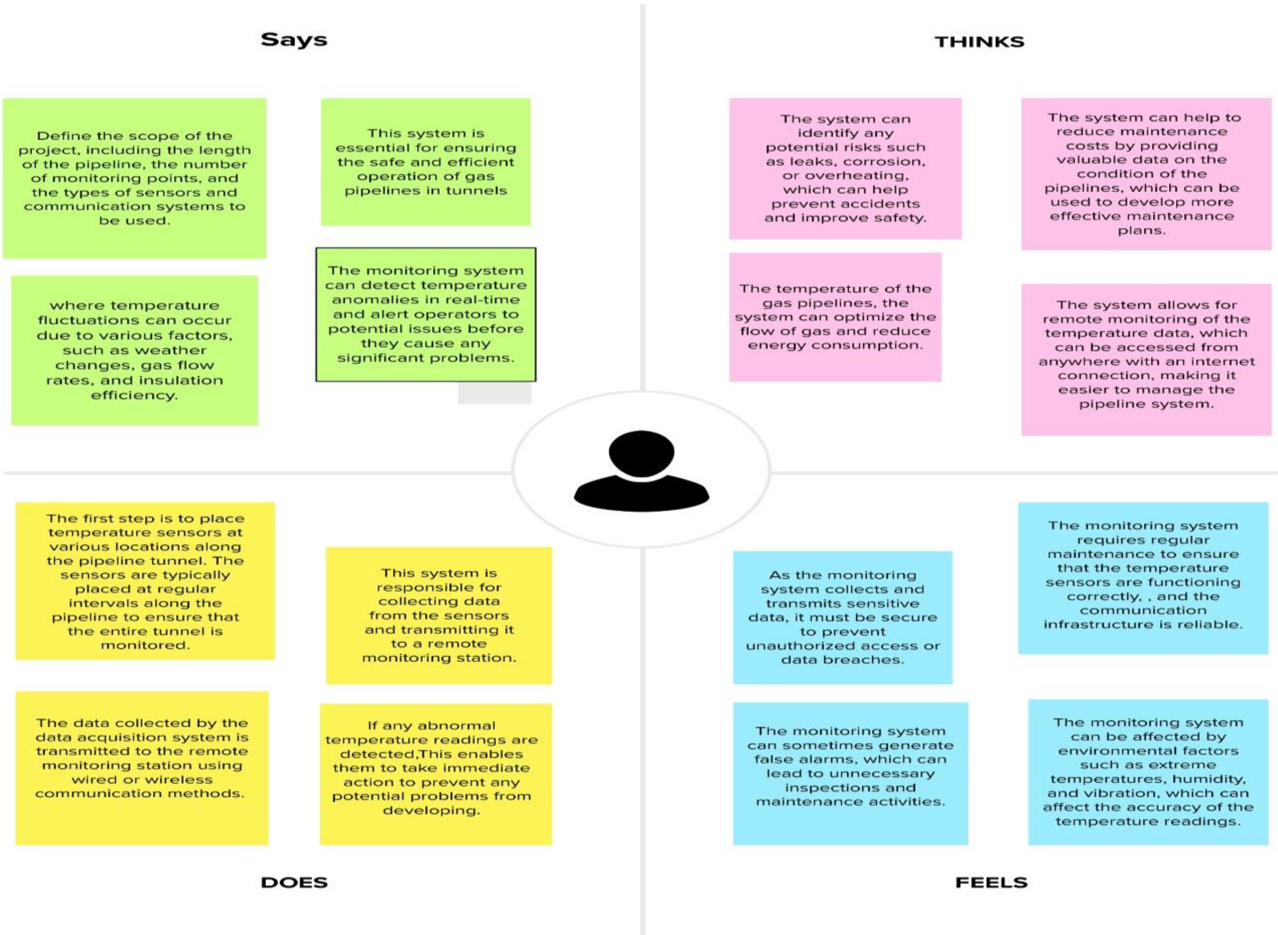


Figure 2.2. Empathy Map

2.3 IDEATION & BRAINSTORMING

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem-solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich number of creative solutions.

STEP-1 TEAM GATHERING, COLLABORATION AND SELECTING THE PROBLEM STATEMENT

This step includes the formation of a team, collaborating with the team by collecting the problems of the domain we have taken and consolidating the collected information into a single problem statement.

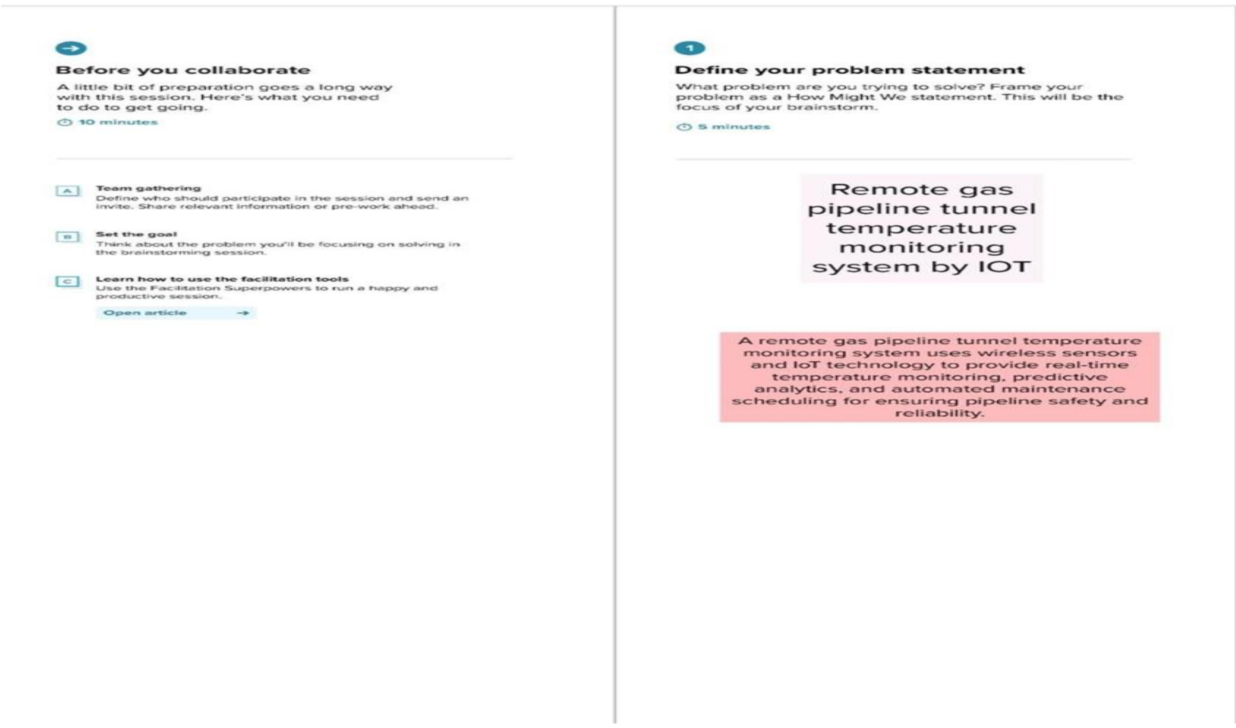


Figure 2.3.1. Ideation and Brainstorming

STEP 2 BRAINSTORM, IDEA LISTING AND GROUPING

This step of ideation includes the listing of individual ideas by teammates to help with the problem statement framed. All the individual ideas have been valued and made individual clusters.

Then discussed as a team and finally made an ideation Cluster A and concluded with the most voted ideas from all the clusters together and Cluster B with the least needed ideas.

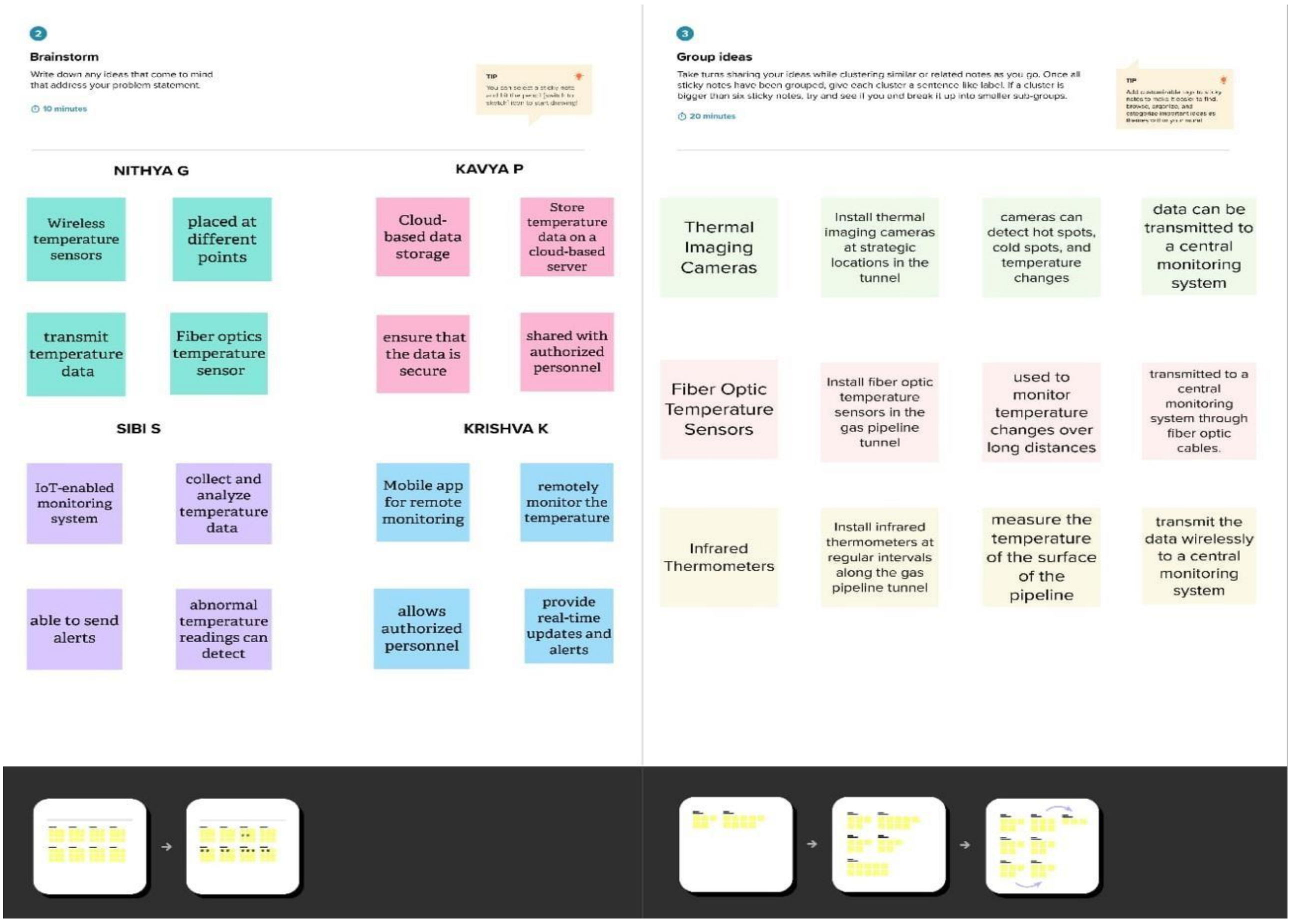


Figure 2.3.2. Brainstorm, Idea Listing and Grouping

STEP 3 IDEA PRIORITIZATION

This step includes the process of listing necessary components to come up with the working solution and making a hierarchy chart by prioritizing the components based on importance, say from the higher being backend and lower being the user interfacing components.

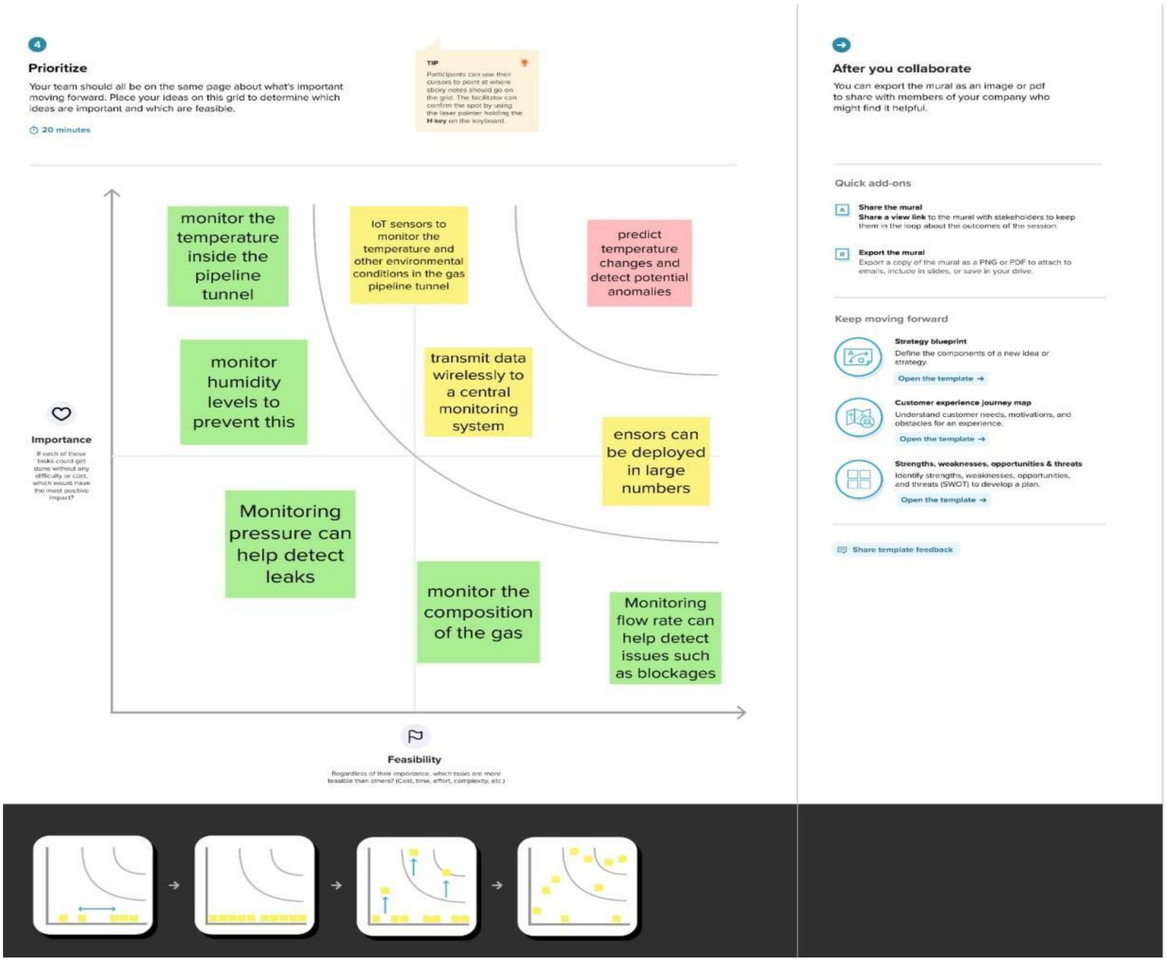


Figure 2.3.3. Idea Prioritization

2.4 PROPOSED SOLUTION

Problem statement (problem to be solved)

IOT technology to provide real-time temperature monitoring, predictive analytics, and automated maintenance scheduling for ensuring pipeline safety and reliability.

Idea / Solution description

Deploy a network of temperature sensors inside the gas pipeline tunnel, connected to a wireless IoT platform.

Novelty / Uniqueness

The novelty of a pipeline temperature monitoring system lies in its ability to provide continuous and accurate monitong of pipeline temperature

Social Impact / Customer Satisfaction

Pipeline temperature monitoring systems can help prevent accidents caused by pipeline failures due to overheating. This can help protect the safety of people living near the pipeline, as well as those who work on or near the pipeline.

Business Model (Revenue Model)

You could sell the temperature monitoring hardware to pipeline owners and operators. The hardware could include sensors, data loggers, and other equipment necessary to collect and transmit temperature data. You could offer different hardware packages depending on the size and complexity of the pipeline network.

Scalability of the Solution

Our application can be used by the company which located in under the gas leakage area. We use IBM Watson cloud server to collect the live data the current data.

CHAPTER - 3
REQUIREMENT ANALYSIS

3.1 Functional Requirements

- Real-time temperature monitoring - Able to monitor the temperature of the gas pipeline tunnel
- Data logging - Able to log and store temperature data
- Alert notifications - Able to send alerts to designated personnel via email or text message
- User-friendly interface - User-friendly interface that is easy to navigate and operate

3.2 Non-FunctionalRequirements

Usability

Easy to install, configure, and maintain.

Security

Ensure the confidentiality, integrity, and availability of the data collected and transmitted.

Reliability

Highly reliable and able to operate consistently over long periods of time without failure.

Performance

High performance in terms of data processing, transmission, and storage.

Availability

Highly available with minimal downtime or maintenance windows to ensure continuous monitoring of the pipeline temperatures.

Scalability

Able to handle a large number of sensors and scale up as the number of sensors.

CHAPTER - 4

PROJECT DESIGN

4.1 DATA FLOW DIAGRAMS

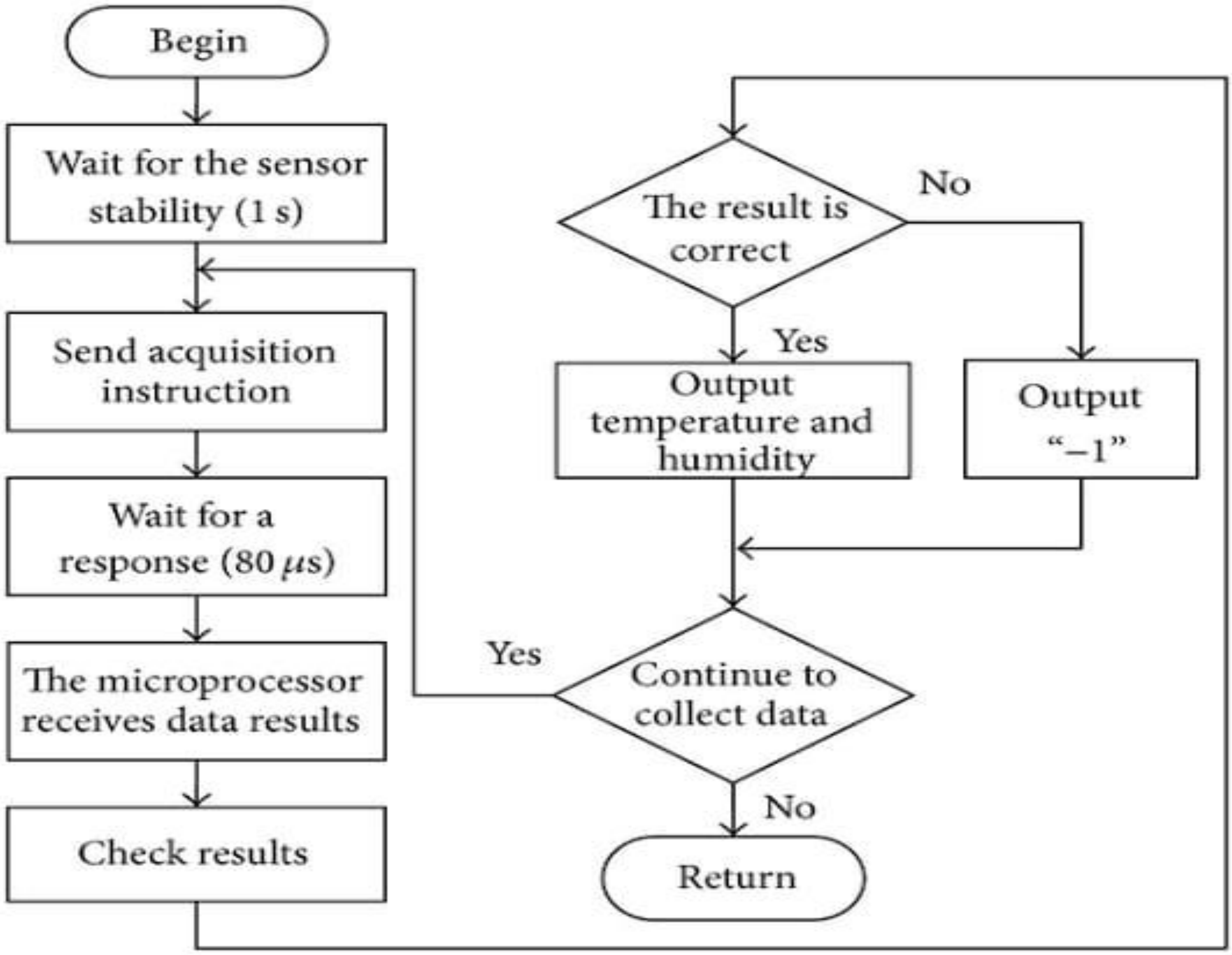


Figure 4.1. Data flow Diagram

4.2 SOLUTION AND TECHNICAL ARCHITECTURE

The solution architecture includes the components and the flow we have designed to deliver the solution.

Here, the application is planned to be designed, where the software monitors the gas leakages in industry sends the alerting message through SMS or Mail

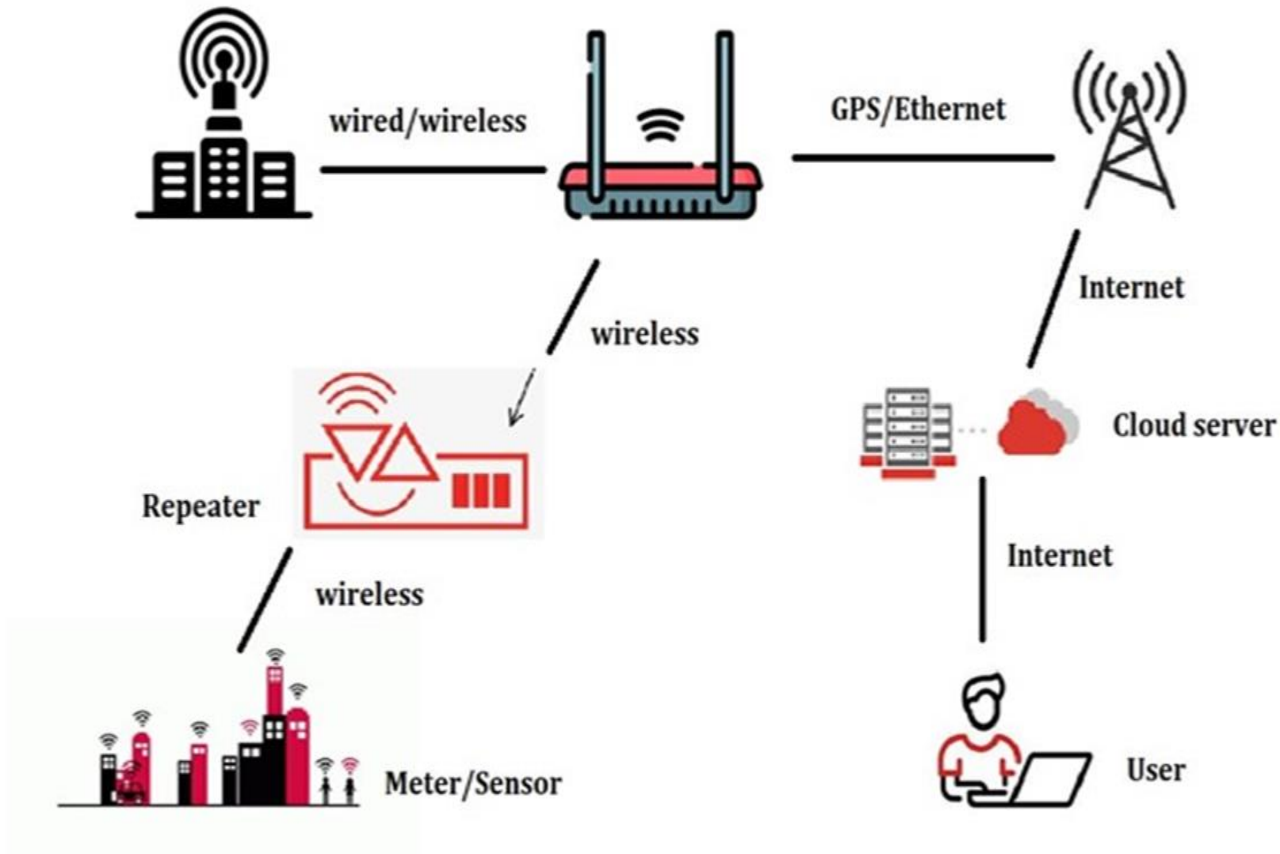


Figure 4.2. Technology Architecture

4.3USER STORIES

Table 4.3. User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story /Task	Acceptance criteria	Priority	Release
The Gas Company/ The pipeline Operator	Real time tunnel temperature monitorin.	USN-1	As a tunnel operator, I want to have a realtime monitoring system for the temperature inside the tunnel	The system should be able to monitor the temperature of the tunnel in real-time	High	Sprint-1
The Gas Company/ The pipeline Operator	Detection of pipeline leaks	USN-2	As a pipeline operator, I want to be able to detect leaks in my pipelines quickly and accurately	The system should be able to provide adequate pipeline leak detection	Medium	Sprint-2

The Gas Company/ The pipeline Operator .	Monitoring of operational data from electric submersible pumps	USN-3	As a field engineer responsible for the operation of electric submersible pumps (ESPs)	I can be able to monitor the working characteristics and operating environment	Medium	Sprint-3
The Gas Company/ The pipeline Operator	Mimicking real time pipeline monitoring	USN-4	As a data engineer, I want to be able to monitor the status of my pipeline in real-time	I can be able to use an internet of things (IoT) analytics platform service	Medium	Sprint-4
The Gas Company/ The pipeline Operator	Critical operational data monitoring	USN-5	As a remote operations manager for a gas pipeline company	I can be able to monitor specific types of data, including study admission data	Medium	Sprint-5

CHAPTER - 5

CODING AND SOLUTIONS

5.1 FEATURE 1

Node-RED Supports browser-based flow editing making it user friendly, accessible and visual. It is built on Node.js, which is a none-blocking, lightweight I/O model, making it lightweight and efficient. Flows created in Node-RED are stored using JSON, and can imported and exported and shared with ease.

Features of React

Ability to run in cloud environments

Simple user interface creation

OUTPUT OF NODE RED:

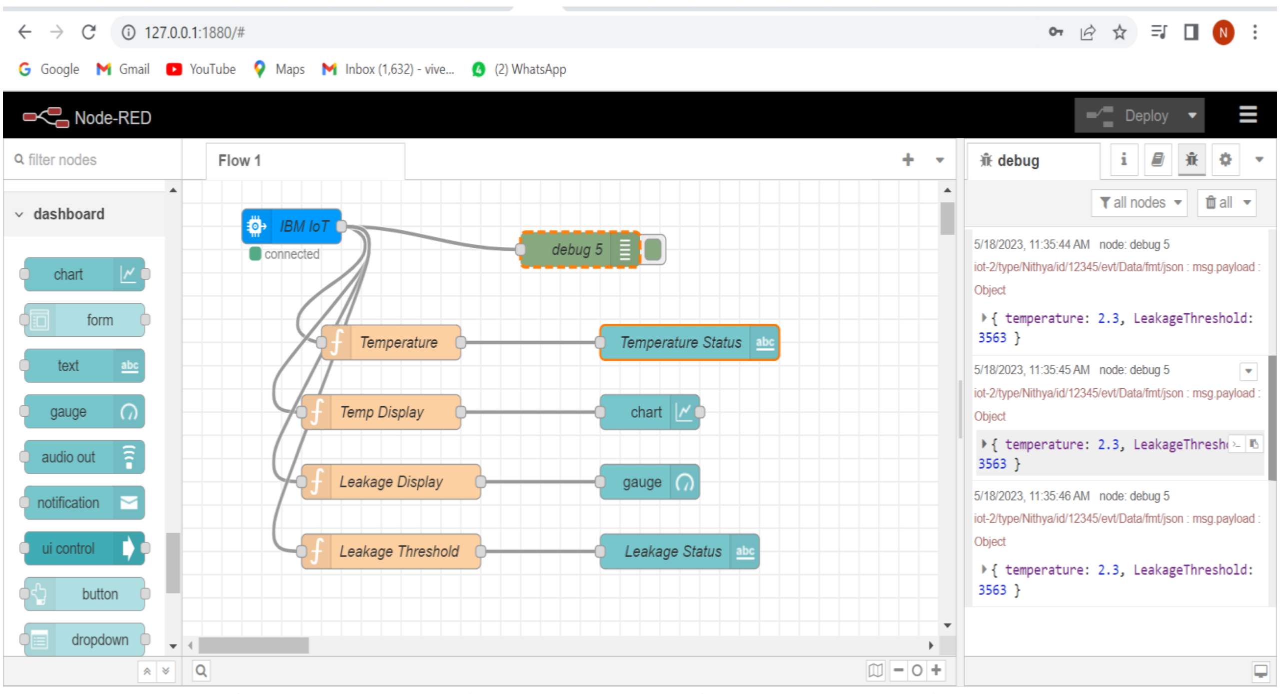


Figure 5.1.1

5.2 FEATURE 2

Wowki is an undefined term in the provided search results. Therefore, it is not possible to list the features of Wowki for an IoT project. However, Wokwi is an online Arduino and ESP32 simulator that provides simulation solutions for embedded and IoT system engineers. It integrates with existing development environments, allowing users to simulate their projects directly from their code editor. Wokwi supports various embedded development frameworks and toolchains such as Zephyr Project, PlatformIO, ESP-IDF, Pi Pico SDK, NuttX, Rust, and Arduino CLI. Some of the features of Wokwi include creating, renaming, and deleting folders, moving projects to folders or out of folders, and simulating projects with interactive art.

Output of wowki :

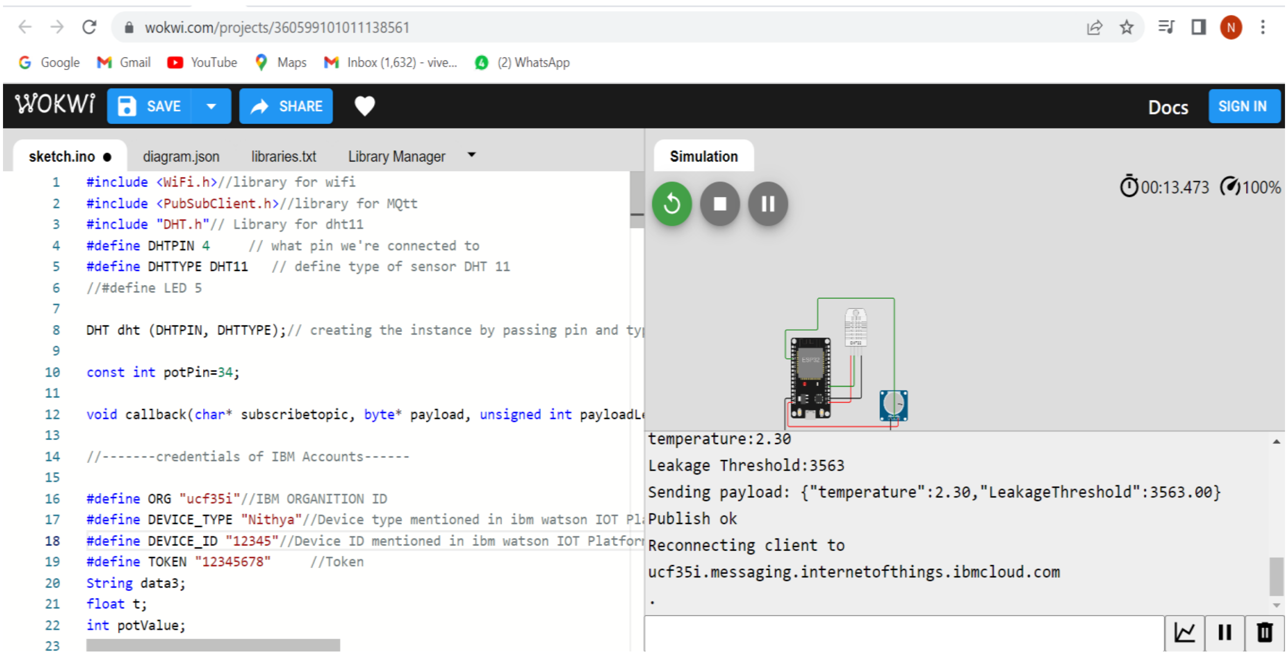
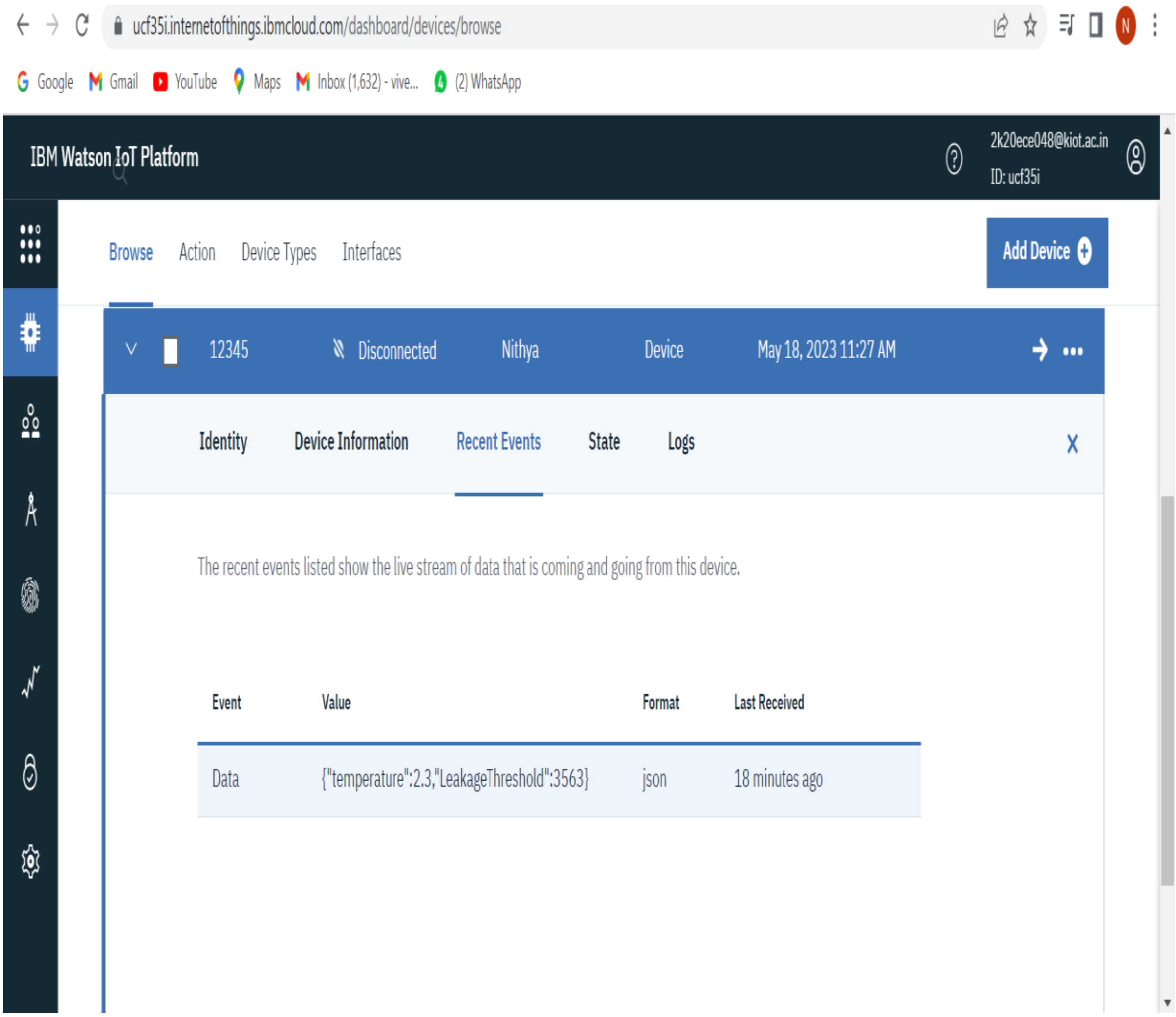


Figure 5.2.1

Figure 5.2.2


ucf35i.internetofthings.ibmcloud.com/dashboard/devices/browse
Google
Gmail
YouTube
Maps
Inbox (1,632) - vive...
(2) WhatsApp
IBM Watson IoT Platform
2k20ece048@kiot.ac.in
ID: ucf35i
Browse
Action
Device Types
Interfaces
Add Device
12345
Disconnected
Nithya
Device
May 18, 2023 11:27 AM
Identity
Device Information
Recent Events
State
Logs
The recent events listed show the live stream of data that is coming and going from this device.
Event
Value
Format
Last Received
Data
{"temperature":2.3,"LeakageThreshold":3563}
json
18 minutes ago

CHAPTER-6

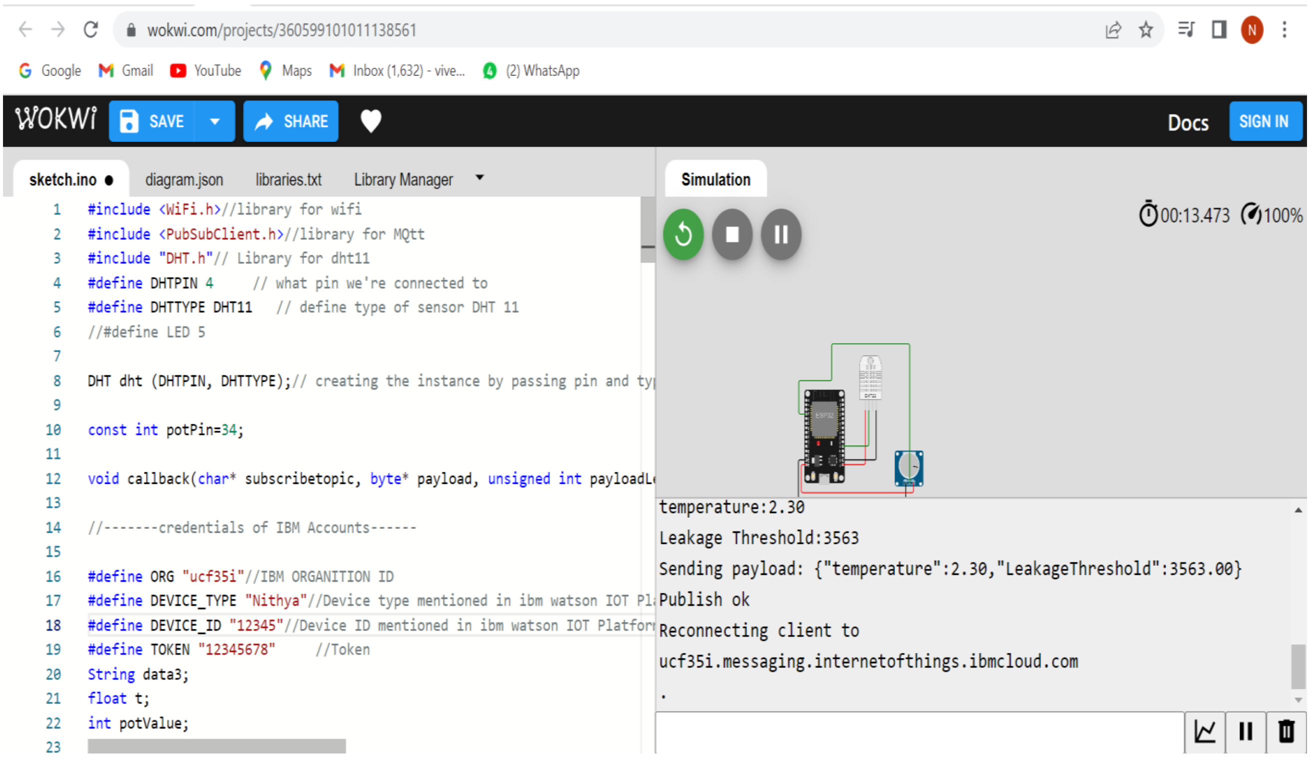
RESULTS

6.1 Performance Metrics

Table 6.1.Performance metrics

Parameters	values
Metrics	Wowki Execution time 00:13.473

Output Screenshot:



CHAPTER - 7

ADVANTAGES AND DISADVANTAGES

ADVANTAGES

- Real-time temperature updates.
- Early detection of gas leaks.
- Improved safety.
- Reduced product loss.
- Increased productivity.
- Cost savings.
- Improved efficiency.

DISADVANTAGES

- Connectivity Issues
- Data Security Risks
- Dependency on Power Supply
- Maintenance and Upkeep
- Initial Setup and Infrastructure Costs
- Environmental Challenges
- Limited Compatibility and Interoperability
- False Alarms and Data Noise
- Limited Human Intervention
- Regulatory Compliance

CHAPTER - 8

CONCLUSION

After this project performance, can conclude that the implementation of a remote gas pipeline tunnel temperature monitoring system using IoT technology offers several significant advantages. Firstly, the system provides real-time monitoring of temperature conditions within the pipeline tunnel, enabling immediate detection and response to any temperature anomalies or potential risks. This helps enhance safety by preventing accidents and ensuring the well-being of personnel and infrastructure.

Secondly, the system offers cost-effective maintenance by eliminating the need for manual inspections and regular site visits. With automated data collection and analysis, operational efficiency is improved, and maintenance costs are reduced. This allows for proactive decision-making and efficient allocation of resources.

Lastly, the remote accessibility of the system enables personnel to monitor temperature data and receive alerts from anywhere, facilitating quick response and reducing downtime. The collected data can be analyzed to gain valuable insights, enabling predictive maintenance and minimizing disruptions to gas pipeline operations.

Overall, the remote gas pipeline tunnel temperature monitoring system using IoT project proves to be a valuable tool in ensuring the safety, efficiency, and cost-effectiveness of gas pipeline operations. By leveraging real-time monitoring, automation, and remote accessibility, the system empowers personnel to make informed decisions and take timely actions, ultimately improving the overall reliability and performance of gas pipeline infrastructure.

FUTURE SCOPE

Enhanced Predictive Maintenance: One of the key areas of development is the integration of advanced analytics and machine learning algorithms into the monitoring system. By analyzing historical temperature data, along with other relevant parameters, the system can develop predictive models to anticipate potential temperature-related issues. This proactive approach enables operators to schedule maintenance activities in advance, optimizing the lifespan of the pipeline and minimizing downtime.

Integration with IoT and Sensor Networks: The Internet of Things (IoT) and sensor networks offer exciting possibilities for remote monitoring systems. By deploying a network of smart sensors throughout the pipeline tunnel, real-time temperature data can be collected from multiple points simultaneously. These sensors can also be equipped with additional functionalities such as humidity, pressure, and vibration sensing. Integrating these data streams into a centralized monitoring platform provides a comprehensive view of the pipeline's health and performance, enabling operators to make informed decisions.

Remote Control and Automation: As remote monitoring systems evolve, the integration of remote control and automation capabilities is likely to become a significant aspect of their future scope. With advanced algorithms and control mechanisms, operators can remotely adjust temperature settings, regulate flow rates, and control valves and actuators in response to the real-time temperature data. This level of automation improves operational efficiency, reduces the need for manual interventions, and enhances the overall safety and reliability of gas pipeline systems.

CHAPTER - 10
APPENDIX

10.1 SOURCE CODE

CLIENT

```
#include <WiFi.h>//library for wifi
#include <PubSubClient.h>//library for MQtt
#include "DHT.h"// Library for dht11
#define DHTPIN 4     // what pin we're connected to
#define DHTTYPE DHT11   // define type of sensor DHT 11
//#define LED 5

DHT dht (DHTPIN, DHTTYPE);// creating the instance by passing pin and typr of dht
connected

const int potPin=34;

void callback(char* subscribetopic, byte* payload, unsigned int payloadLength);

//-------credentials of IBM Accounts------

#define ORG "ucf35i"//IBM ORGANITION ID
#define DEVICE_TYPE "Nithya"//Device type mentioned in ibm watson IOT Platform
#define DEVICE_ID "12345"//Device ID mentioned in ibm watson IOT Platform
#define TOKEN "12345678"     //Token
String data3;
float t;
int potValue;


//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// Server Name
char publishTopic[] = "iot-2/evt/Data/fmt/json";// topic name and type of event perform
and format in which data to be send
```

```
char subscribetopic[] = "iot-2/cmd/test/fmt/String";// cmd  REPRESENT command type
AND COMMAND IS TEST OF FORMAT STRING
char authMethod[] = "use-token-auth";// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;//client id


//-----------------------------------------
WiFiClient wifiClient; // creating the instance for wificlient
PubSubClient client(server, 1883, callback ,wifiClient); //calling the predefined client id
by passing parameter like server id,portand wificredential
void setup()// configureing the ESP32
{
  Serial.begin(115200);
  dht.begin();
  //pinMode(LED,OUTPUT);
  delay(10);
  Serial.println();
  wificonnect();
  mqttconnect();
}

void loop()// Recursive Function
{

  //h = dht.readHumidity();
  t = dht.readTemperature();
  potValue = analogRead(potPin);
  Serial.print("temperature:");
  Serial.println(t);
  Serial.print("Leakage Threshold:");
  Serial.println(potValue);

  //Serial.print("Humidity:");
  //Serial.println(h);

  PublishData(t, potValue);
  delay(1000);
  if (!client.loop()) {
```

```
    mqttconnect();
  }
}



/....................................retrieving to Cloud............................../

void PublishData(float temp, float potenval) {
  mqttconnect();//function call for connecting to ibm
  /*
     creating the String in in form JSon to update the data to ibm cloud
  */
  String payload = "{\"temperature\":";
  payload += temp;
  payload += "," "\"LeakageThreshold\":";
  payload += potenval;
  payload += "}";


  Serial.print("Sending payload: ");
  Serial.println(payload);


  if (client.publish(publishTopic, (char*) payload.c_str())) {
    Serial.println("Publish ok");// if it sucessfully upload data on the cloud then it will print publish ok in Serial monitor or else it will print publish failed
  } else {
    Serial.println("Publish failed");
  }

}
void mqttconnect() {
  if (!client.connected()) {
    Serial.print("Reconnecting client to ");
    Serial.println(server);
    while (!!!client.connect(clientId, authMethod, token)) {
      Serial.print(".");
      delay(500);
```

```
    }

     initManagedDevice();
     Serial.println();
  }
}
void wificonnect() //function defination for wificonnect
{
  Serial.println();
  Serial.print("Connecting to ");

  WiFi.begin("Wokwi-GUEST", "", 6);//passing the wifi credentials to establish the
connection
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}

void initManagedDevice() {
  if (client.subscribe(subscribetopic)) {
    Serial.println((subscribetopic));
    Serial.println("subscribe to cmd OK");
  } else {
    Serial.println("subscribe to cmd FAILED");
  }
}



void callback(char* subscribetopic, byte* payload, unsigned int payloadLength)
{

  Serial.print("callback invoked for topic: ");
  Serial.println(subscribetopic);
```

```
  for (int i = 0; i < payloadLength; i++) {

    //Serial.print((char)payload[i]);
    data3 += (char)payload[i];
  }

  Serial.println("data: "+ data3);
  /*
  if(data3=="lighton")
  {
Serial.println(data3);
digitalWrite(LED,HIGH);

  }

  else
  {
Serial.println(data3);
digitalWrite(LED,LOW);

  }
  */
data3="";


}
```

10.1 SCREENSHOT:

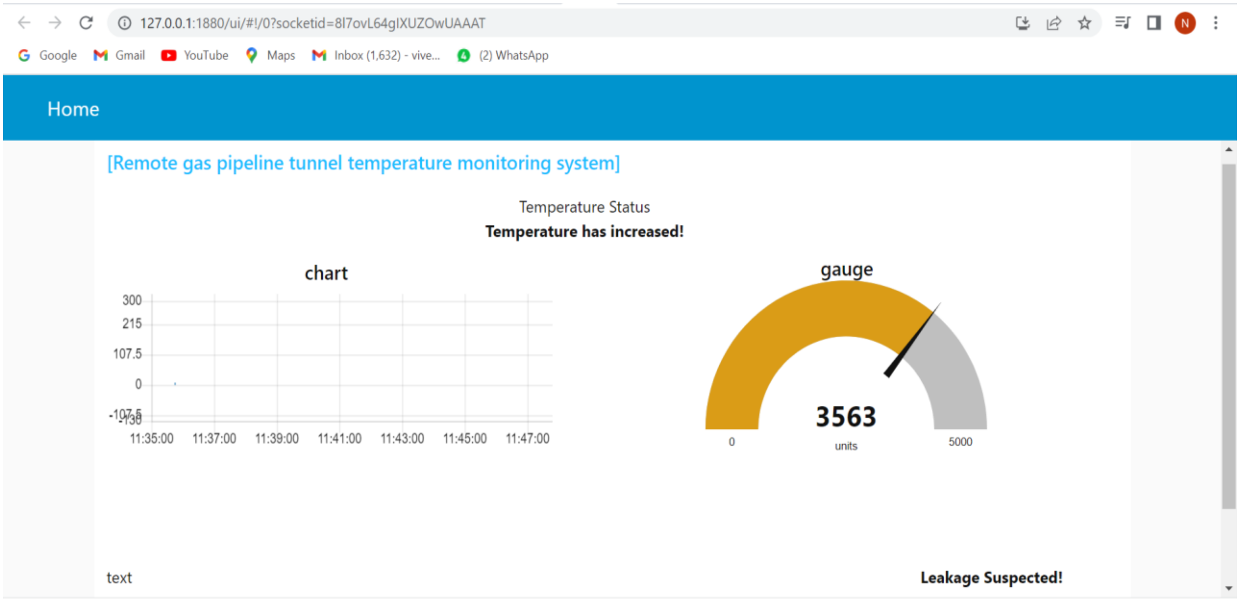


Figure.10.1. Dashboard

13.1 GITHUB & PROJECT DEMO LINK:

Content	Link
Github	https://github.com/naanmudhalvan-SI/PBL-NT-GP--2926-1680667874
Project Demonstration video	https://drive.google.com/file/d/1aXxe_rgSXngFloYsTVpGmSgA_0HVubl1/view?usp=share_link

CHAPTER - 11

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J. A. Patel, R. A. Makwana, and M. A. Patel (2018)’ IOTBased Gas pipeline temperature detection system

A. F. Abdul Samad, M. F. Baharudin, and S. B. Shaikh Ali (2018)’ Internet of Things (IoT) Based Tunnel temperature monitoring system

A. G. Metkari, V. P. Bagade, and A. P. Dharmadhikari (2018)’ Gas pipeline tunnel temperature monitoring system.