

Hazardous Area Monitoring for Industrial Plant powered by IoT

Team ID : PNT2022TMID48099

A Project report

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INTRODUCTION

1.1 PROJECT OVERVIEW

By the end of this project :

- Gain knowledge of WatsonIoT Platform.
- Connecting IoT devices to the Watson IoT platform and exchanging the sensor data.
- Gain knowledge on Cloudant DB
- Creating a Web Application through which the user interacts with the device.

Project Flow:

- Sending random Humidity and Temperature values will be sent to the IBM IoT platform
- Sensors values can be viewed in the Web Application
- Notifies the admin the random values cross the threshold value

To accomplish this, we have to complete all the activities and tasks listed below:

- Create and configure IBM Cloud Services
 - Create IBM Watson IoT Platform
 - Create a device & configure the IBM IoT Platform
 - Create Node-RED service
 - Create a database in Cloudant DB to store location data
- Develop a web Application using Node-RED Service.
 - Develop the web application using Node-RED
- Develop a python script to publish the sensor data to the IBM IoT platform

1.2 PURPOSE

- Through this, we can monitor the temperature parameters of the hazardous areas in industrial plants.
- The area is integrated with smart beacon devices which will be broadcasting the temperature of that particular area.
- Every person working in those areas will be given smart wearable devices which will be acting as beacon scanners.

LITERATURE SURVEY

2.1 EXISTING PROBLEM

In this project industrial safety is one of the major issues in hazardous environment, specially industries like fireworks, chemical, foundry and manufacturing etc. In hazardous environment, safety is a very important factor. To avoid any types of unwanted phenomena all hazardous area follows some basic preventative measure and phenomena. Communication is the factor for any industry today to monitor different parameters and take necessary actions accordingly to avoid any type of hazards. To avoid health injury and material loss, protection system as well as faithful communication system is necessary inside and outside the industry. To increase both safety and productivity, a reliable communication must be established between workers and a fixed base station. The wired communication system is not effective. The reliability and long life of conventional communications systems in harsh hazardous environments has always been a problem. Inside the industry due to uncomfortable situation the installation cost as well as maintenance cost is high for wired communication networks. It is very difficult to install the wired communication system it again inside industry after a landslide or damage due to some reason. Due to maintenance activity, if by any means some workers trapped, to maintain the continuity of the communication system is very much important to know the actual position and condition of the trapped workers. To monitor multi parameters during this condition it is very much necessary to maintain the communication system as usual. Accordingly, development of safety monitoring system to accurately detect temperature, radiation, flammable and poisonous gas and fire and smoke on real-time has significant meaning to safety and rescue of disaster.

2.2 REFERENCES

- [1] QingyuanZhu,ChengluWen,WenyiXie“GeneralEnvironmentIntegratedMonitoringandData ManagementSystemBasedonVirtual Instrument “,Advances in Information Technology andIndustry Applications,2012,Volume136, pp 163-168 .
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- [3] GangZhao“WirelessSensorNetworksforIndustrialProcessMonitoringandControl:ASurvey”,NetworkProtocolsandAlgorithms,2011, Vol.3,No.1,pp.46-63.
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- [6] G.AhalyaP.SureshBabu,P.PrabhakarRao“DevelopmentOfCoalMineSafetySystemUsingWirelessSensorNetworks”,International JournalofEngineeringScience&AdvancedTechnology,2013,Volume-3,Issue-3,74-78
- [7] Achonu O. Adejo , adeiza J , Onumanyi, Jane M. Anyanya , Stephen O. Oyewobi “Oil and gas process monitoring through wireless sensor networks:asurvey”,OzeanJournalofAppliedSciences,2013,issue 6(2),2013,pp.39-43
- [8] P.V. ManS.Shaikh“MicrocontrollerPic18f4550 BasedWirelessSensorNodetoMonitor.

2.3 Define the Problem Statements

Today there is a great challenge in the development of industrial hazardous safety monitoring for the application of gas leaks, fire, smoke, radiation etc. In all related fields of investigation, a key matter is the need flexible and practical virtual instruments, a way to easily expose the multi-sensors to the hazardous levels in risk concentration. The implementation of wireless sensor network provides an alternative solution by deploying a larger number of disposable sensor nodes. The Sensor data may consist of industrial environmental parameters like critical temperature, gas leakage, radiation, fire, smoke and the dynamic variations of these physical quantities. This software platform is in the terms of virtual instruments developed under PYTHON programming environment and integrated with computer controlled system.

Customer Problem Statement Template:

I am	Trying to Avoid Industrial hazardous accidents.
I'm trying to	Control and monitoring the hazardous area.
But	Many industry are not following the proper maintenance and services.
Because	Of maintenance cost high and awareness less of some industry.
Which makes me feel	We losses more employees life, industrial materials and industrial surrounding areas were polluted.



Reference: <https://miro.com/templates/customer-problem-statement/>

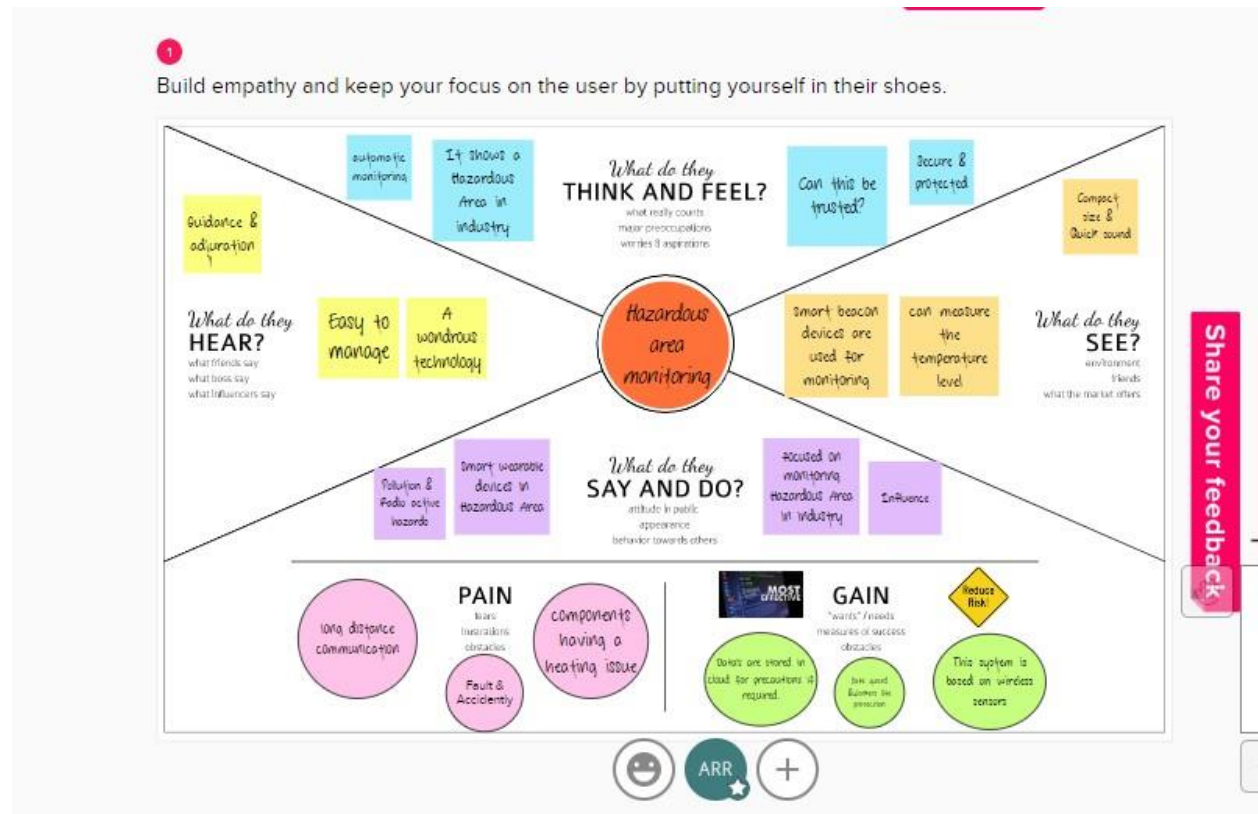
PROBLEM STATEMENTS

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	We think that to avoid industrial accident	Prevent Industrial hazardous accident	Rules are not followed by industry	Of less awareness	To avoid pollution
PS-2	To avoid pollution	To avoid the human Dead's in industry	Not proper maintenance	Carelessness	We lose our industrial employees life

IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS

An Empathy Map is a **collaborative tool teams can use to gain a deeper insight into their customers**. Much like a user persona, an empathy map can represent a group of users, such as a customer segment.




REFERENCE LINK:

<https://app.mural.co/invitation/mural/iotmakers7542/1662826043578?sender=u254a533787913ed14aa43587&key=d37b87bf-d759-4a68-9a2e-e7b25f1fb9da>

3.2 IDEATION&BRAINSTROMING

To solve a problem or make a decision by thinking of as many ideas as possible in a short time.

Brainstorm & Idea Prioritization 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
 3-8 people recommended

[Download 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

Team gathering
 Ensure everyone participates in the session and send an invite. Share relevant information or documents ahead.

Get the goal
 Think about the problem you'll be focusing on during the collaborative session.

Learn how to use the facilitation tools
 Look for facilitation Superpowers to run a really solid productive session.

[Read article](#)

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

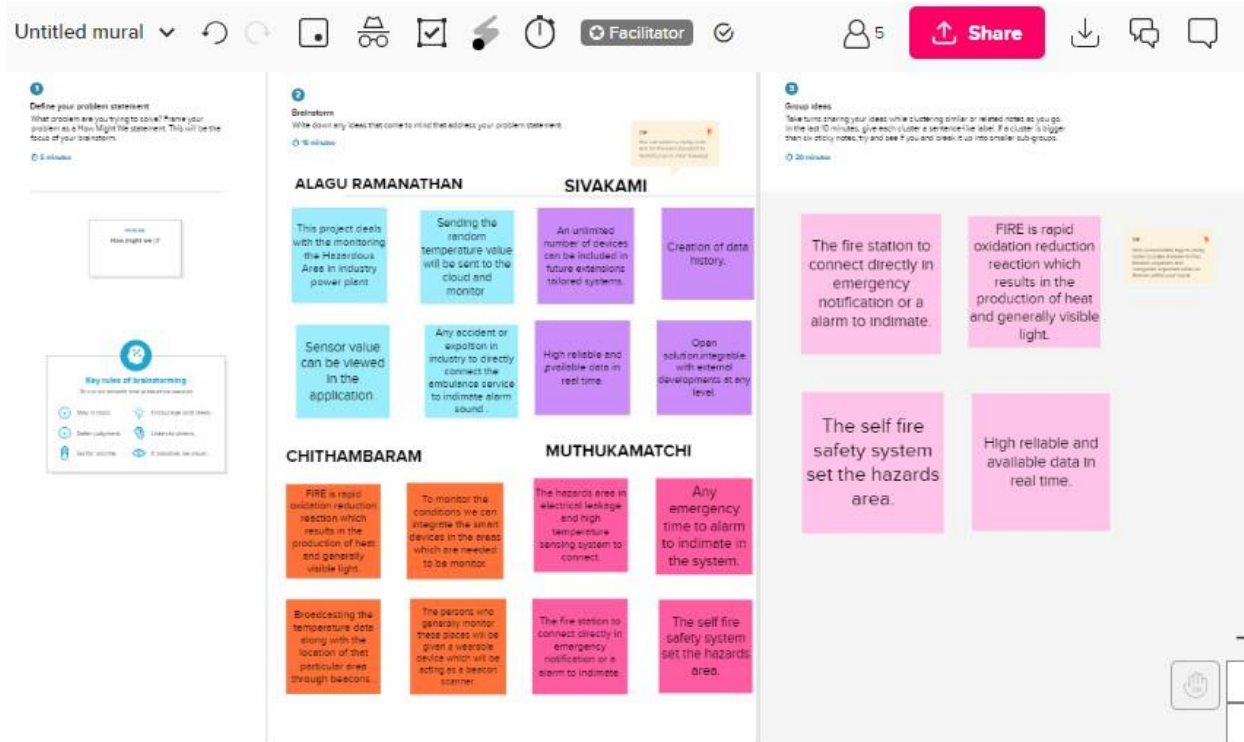
Problem

How might we?

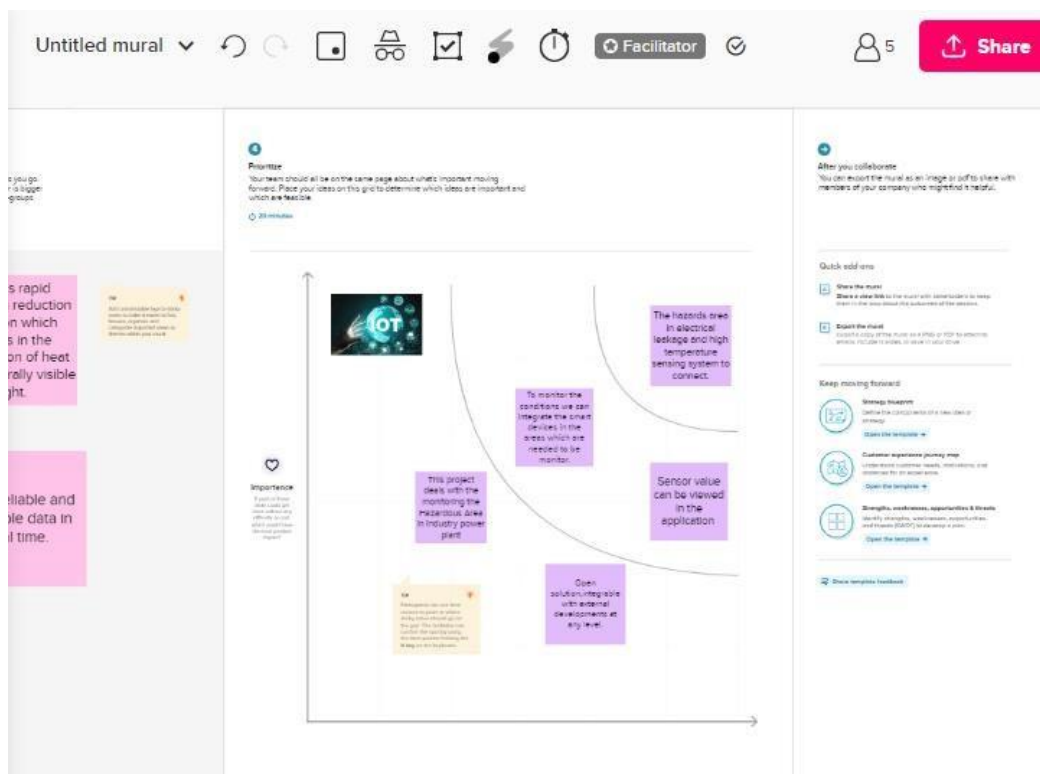
Key rules of brainstorming
 To run an absolutely productive session

- Stay in topic
- Encourage wild ideas
- Defer judgement
- Build on others
- Go for quantity
- If someone has an idea, everyone has an idea

STEP1:Team gathering,, collaboration & select the problem statement



Step2:Brain storming,idea listingand grouping



Step3 idea prioritization

REFERENCE

LINK:<https://app.mural.co/invitation/mural/iotmakers7542/1663648369943?sender=u254a533787913ed14aa43587&key=c087dd12-0b36-46a8-bc55-4ec174b37f58>

3.3 PROPOSED SOLUTION

Proposed Solution Template:

Project team shall fill the following information in proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Traditional safety system can be effectively replaced by the wireless sensor network and virtual instrumentation system proposed in the project
2.	Idea / Solution description	it implements a long-range communication protocol that, at the same time, allows to transmit data in a range able to cover the area of typical Oil & gas or chemical plants (1-2 km depending on area morphology) and save battery energy.
3.	Novelty / Uniqueness	It constantly monitors the levels of ammonia and carbon monoxide emitted in order to keep the air pollution levels in check
4.	Social Impact / Customer Satisfaction	A larger industrial area and more hazardous area are now can be covered and potential accidents can be controlled efficiently
5.	Business Model (Revenue Model)	A smart reconfigurable assembling asset is improved with internet intelligence, giving nearby control to the physical assembling asset, plug – and – play capacity, and high computational strength.
6.	Scalability of the Solution	The information about the present condition of the industry is intimated to the concerned official as SMS to their mobile. The SMS is only sent when any abnormality is detected or if any safety issues arrived

3.4 PROBLEM SOLUTION-FIT

Project Title:

Project Design Phase-I - Solution Fit Template

Team ID: PNT2022TMIDxxxxxx

PNT2022TMID48099

Define CS, fit into CC	1. CUSTOMER SEGMENT(S) Who is your customer? i.e. working parents of 0-5 y.o. kids industrial owners	6. CUSTOMER CONSTRAINTS What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices. Identify flammable release source for the studied area in industry	5. AVAILABLE SOLUTIONS Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking All in one solution for Hazardous Area .360 integration of our solution	Explore AS, differentiate
	2. JOBS-TO-BE-DONE / PROBLEMS Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides. obey the safety Requirements. one of the main cause of injuries and accidents.	9. PROBLEM ROOT CAUSE What is the real reason that this problem exists? What is the back story behind the need to do this job? i.e. customers have to do it because of the change in regulations. To reduce the risk from HazardousAccidents.	7. BEHAVIOUR What does your customer do to address the problem and get the job done? i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace) Directly related : find the correct place to monitor the area	
Focus on J&P, tap into BE, understand RC	3. TRIGGERS What triggers customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news. To installing and developing the monitoring systems	10. YOUR SOLUTION If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour. Monitoring the hazardous area and storing and Alerting by using sound	8. CHANNELS of BEHAVIOUR 8.1 ONLINE What kind of actions do customers take online? Extract online channels from #7 8.2 OFFLINE What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development. Monitoring Data were stored in cloud monitored value Are shown in display and It indicate the Alarm or buzzer sound	Identify strong TR & EM
	4. EMOTIONS: BEFORE / AFTER How do customers feel when they face a problem or a job and afterwards? i.e. lost, insecure > confident, in control - use it in your communication strategy & design. our Employees & Machine in control. easy secure our industry from hazardous		Identify strong TR & EM	

REQUIREMENT ANALYSIS

4.1 Functional Requirements

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement(Epic)	SubRequirement(Story/Sub-Task)
FR-1	User Registration	Registration through Form Registration through G mail
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User approval	Approval through phone call
FR-4	User transaction	Transaction through online mode Transaction through debit card
FR-5	Testing	Testing through component Testing via API and UI
FR-6	End result	End result through product features

4.2 Nonfunctional Requirements

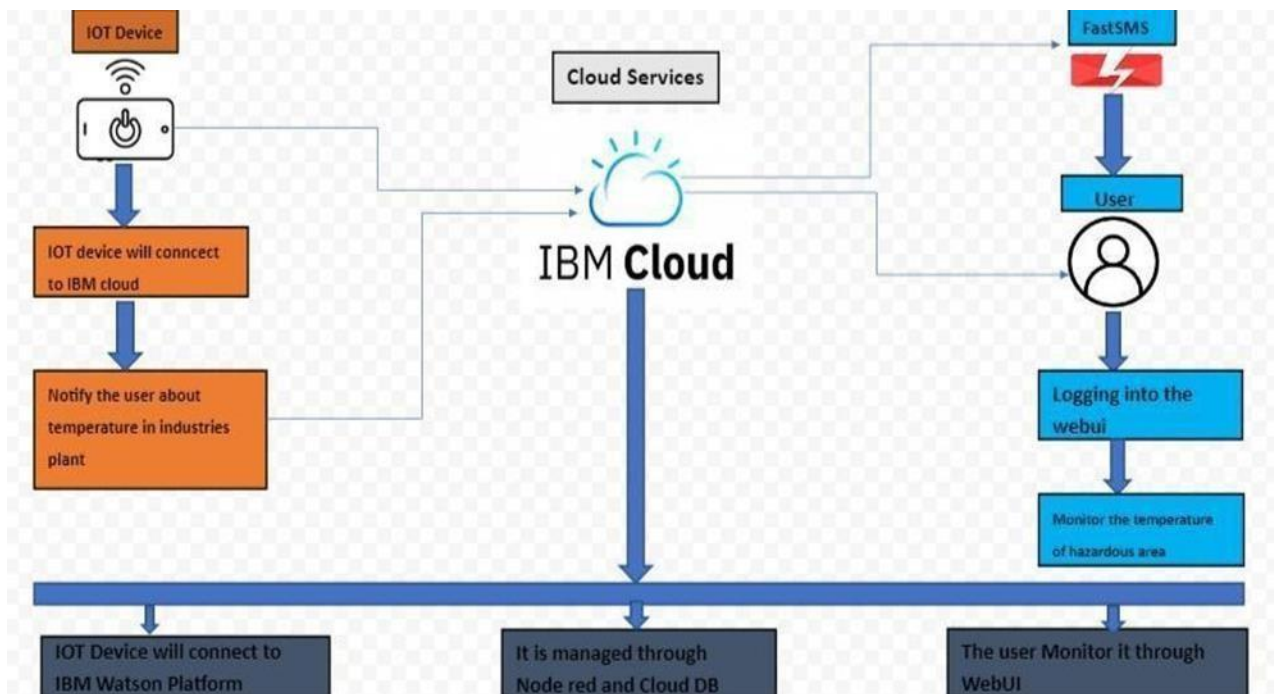
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	It refers to the average time it takes to accomplish a user's goals.
NFR-2	Security	To ensure the user that the software is protected from unauthorized access to the System and its stored data.
NFR-3	Reliability	It describes how likely it is for the software to work without failure for a given period time.

NFR-4	Performance	Quality attribute that describes the responsiveness of the system to various user interactions with it for user efficiency.
NFR-5	Availability	It is the period of time that the system's functionality and services are available for use with all operations.

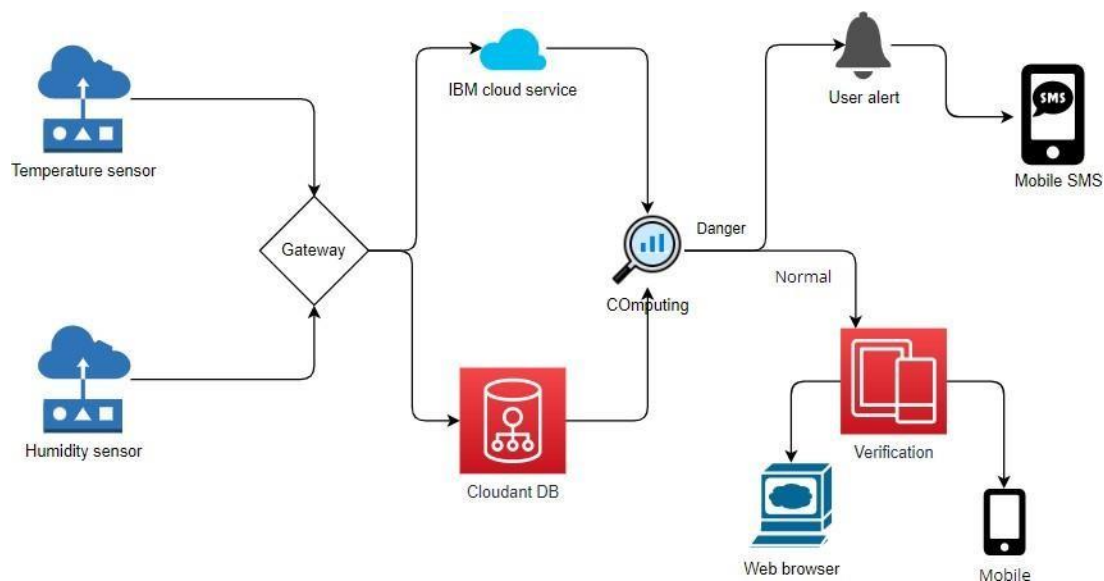
PROJECT DESIGN

5.1 DataFlowDiagrams

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.



5.2 SOLUTION & TECHNICAL ARCHITECTURE



5.3 USER STORIES

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

Customer (Industrial Worker)	Registration	USN-1	As an Industrial Worker, I can register into the application by entering email & password	I can access my account /dashboard	High	Sprint-1
	Data Modules	USN-2	As an Industrial Worker, I can get message about the temperature and humidity	I can receive confirmation email & click confirm	High	Sprint-1
	Login	USN-3	As an industrial Owner, I can login into my account through email and Password	I can access my account	Medium	Sprint-2
	Dashboard	USN-4	As an Industrial Owner, I can get alert high temperature	I can access the dashboard with individual Login id/password	High	Sprint-1

PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

Sprint	Functional Requirement	User Story Number	User Story/Task	Task Point	Priority	Team Members
Sprint-1	Installation of Beacons	USN-1	First the Admin User will be installing smart beacons at necessary places.	15	High	Alaguramanathan R Chithambaram SM Muthukamatchi LSivakami R
Sprint-2	Beacon devices	USN-2	The Admin should provide wearable devices to everyone in the industry.	5	Medium	Alaguramanathan R Chithambaram SM Muthukamatchi LSivakami R
Sprint-3	Cloud Setup	USN-3	The Smart Beacons will be connected to the IBM cloud services where we can get the realtime monitoring data from the wearable gadget.	20	High	Alaguramanathan R Chithambaram SM Muthukamatchi LSivakami R
Sprint-4	Online Monitoring via Web	USN-4	Website should be created and connected with IBM cloud which helps in viewing the realtime data from wearable device in GUI and storing the logs in the database.	20	High	Alaguramanathan R Chithambaram SM Muthukamatchi LSivakami R
Sprint-5	Monitoring via Mobile	USN-5	To alert the abnormality, Mobile Applications and Mail services are created to receive the alert notification.	20	High	Alaguramanathan R Chithambaram SM Muthukamatchi LSivakami R

6.2 SPRINT DELIVERY SCHEDULE

Project Tracker, Velocity & Burndown

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	3 Days	06 Nov 2022	08 Nov 2022	20	08 Nov 2022
Sprint-2	20	3 Days	09 Nov 2022	11 Nov 2022	20	11 Nov 2022
Sprint-3	20	4 Days	12 Nov 2022	15 Nov 2022	20	15 Nov 2022
Sprint-4	20	4 Days	16 Nov 2022	19 Nov 2022	20	19 Nov 2022

CODING &SOLUTION

7.1 FEATURE-1

```
#include<stdio.h>

//LCDI2Clibrary:
#include<LiquidCrystal_I2C.h>

//DHT22sensorlibrary:
#include<DHT.h>;

//LCD I2C address 0x27, 20 column and 4
rows!LiquidCrystal_I2Cld(0x27, 16,2);

//Constants:
#defineDHTPIN2      //what pin we're connected
to#defineDHTTYPE DHT22 //DHT22(AM2302)
DHTdht(DHTPIN,DHTTYPE);//Initialize DHTsensorfor normal16mhzArduino

//Variables:
intchk;

float H; //Humidity
valuefloat T; //Temperature
valueintbuzzer =12;

voidsetup(){
lcd.init();lcd.backlight();

//Serial Communication is starting with 9600 of baudrate
speedSerial.begin(115200);
dht.begin();
pinMode(13,OUTPUT);pinMode(buzzer,OUTPUT);
```

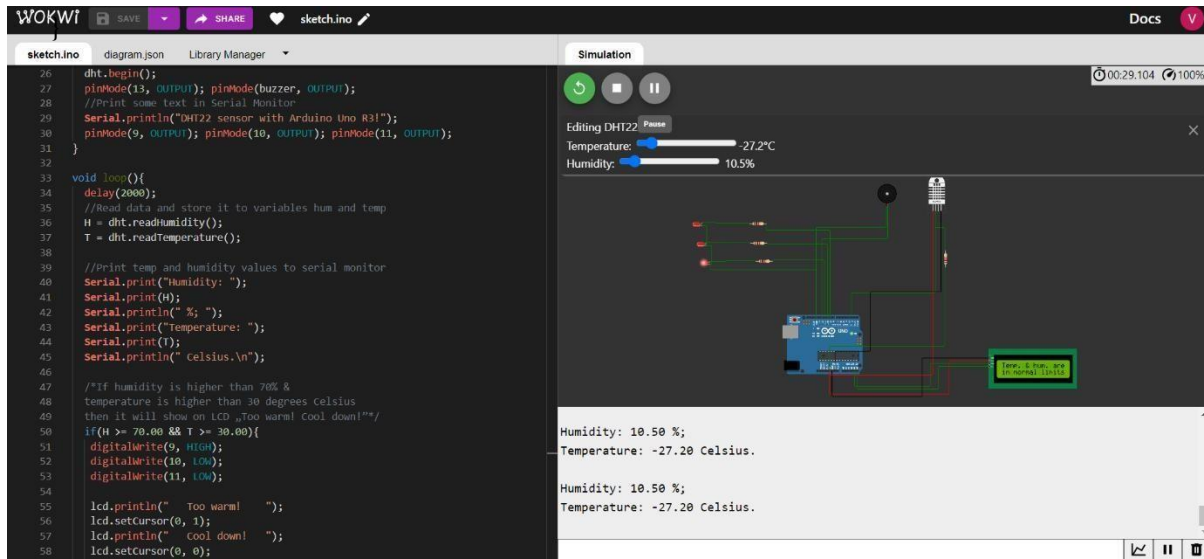
```

MonitorSerial.println("DHT22sensorwithArduinoUn
oR3!");

pinMode(9,OUTPUT);pinMode(10,OUTPUT);pinMode(11,OUTPUT);

}

```



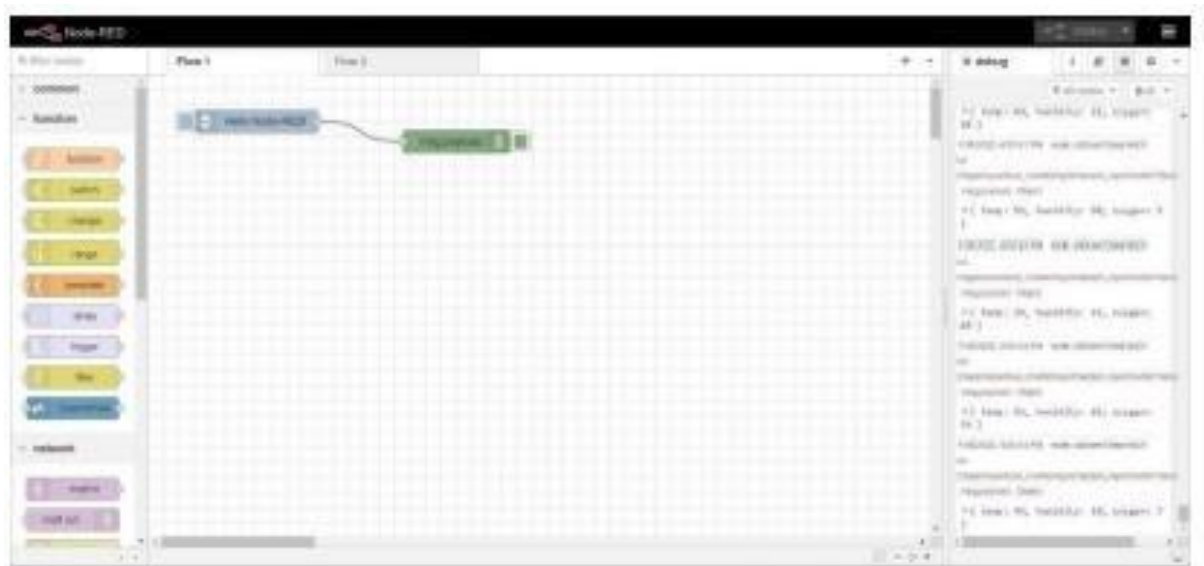
Output:

7.2 FEATURE-2

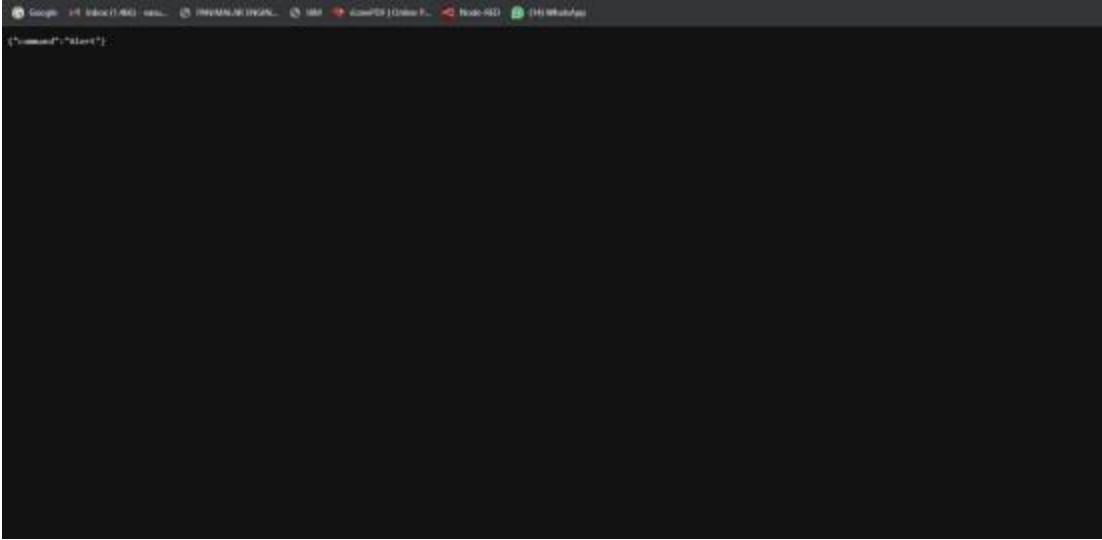
1. Device Creation using IoT Watson platform with credentials: • IBM Watson IoT platform acts as the mediator to connect the web application to the IoT device, so create the IBM Watson IoT platform. • In order to connect the IoT device to the IBM cloud, we need to create a device in the IBM Watson IoT platform and get the device credentials. • To configure the connection security and create API keys that are used in the Node-RED service for accessing the IBM IoT Platform.

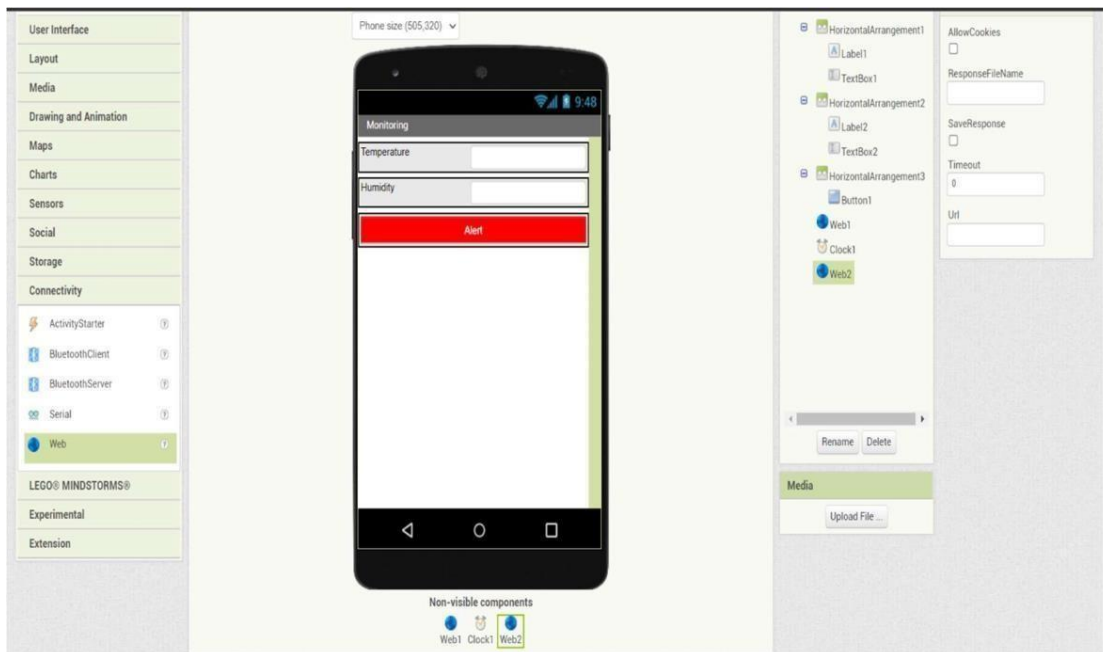
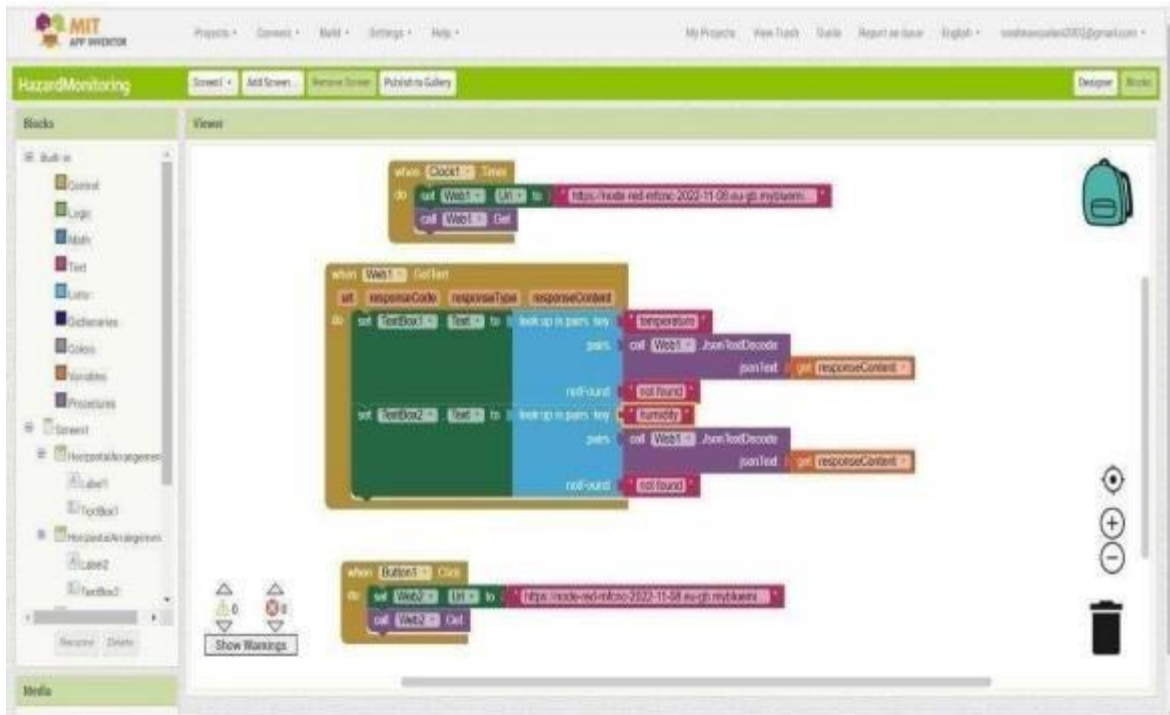
129456	Connected	IOTdevice-1	Device	16 Nov 2022 20:10	alaguram805@gmail.com
Identity	Device Information	Recent Events	State	Logs	
The recent events listed show the live stream of data that is coming and going from this device.					
Event	Value	Format	Last Received		
status	{"temperature":52,"humidity":21}	json	a few seconds ago		
status	{"temperature":52,"humidity":22}	json	a few seconds ago		
status	{"temperature":101,"humidity":4}	json	a few seconds ago		

Required Performance of device using Local Node-Red Platform



ALERT WINDOW:





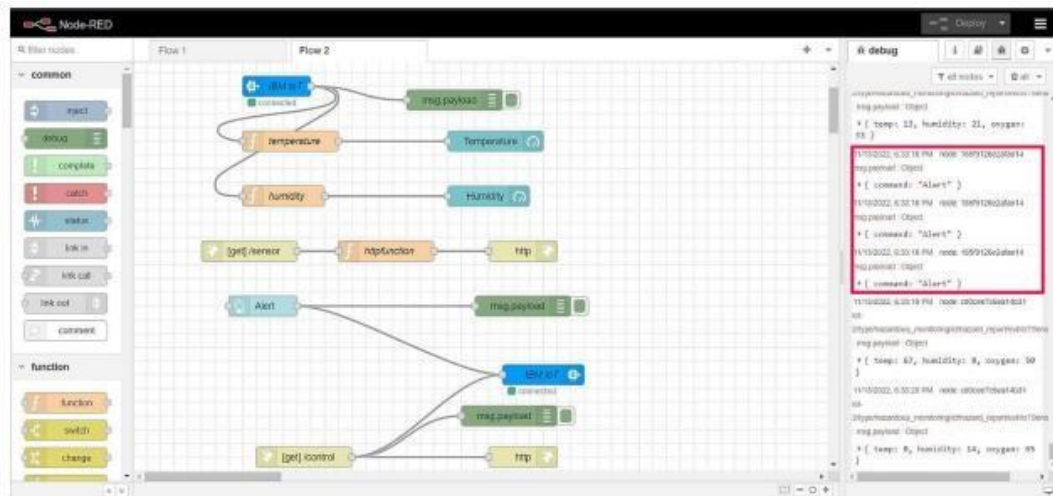
TESTING

8.1 TEST CASE



8.2 USER ACCEPTANCE TEST

The purpose of the document is to briefly explain the test coverage and issues of the Hazardous Area Monitoring for Industrial Plant powered by IoT.at the time of the release to (UAT)



RESULT

Monitoring & Control

Temperature

44

Humidity

20

Alert

123456

Connected

IOTdevice-1

Device

16 Nov 2022 20:10

alaguram805@gmail.com

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
status	({"temperature":52,"humidity":21})	json	a few seconds ago
status	({"temperature":52,"humidity":22})	json	a few seconds ago
status	({"temperature":101,"humidity":4})	json	a few seconds ago

monitoring

humiditymonitoring

Humidity

67

100

ALERT

Temperature

31

100

ADVANTAGES &DISADVANTAGES

ADVANTAGES

- This choice allows for low power consumption and a transmission range able to cover a standard plant area.
- In this way, it is possible to view and analyse the receive data.
- which can further exploited , with further processing.
- To generate safety commands in case of hazardous alarm information from the sensor node.

DISADVANTAGES

- Devices must be protected from physical tampering.
- Internet based software attacks ,network based attacks and hardware based attacks
- Data privacy is another concern, especially because IoT devicesare bring used in more sensitive industries, such as healthcare and finance.

CONCLUSION

The Internet of Things has a broad perspective in shaping tomorrow's world. Even though the IoT system has some demerits, its merits like saving consumer's time and money outstand its cons. It is predicted that soon IoT applications will be installed and used equally in both domestic and industrial areas. Companies are working hard to shoot back IoT disadvantages and making this futuristic technology more beneficial for the betterment of humanity. The number of industrial disasters due to accidents or mere negligence is steadily rising every year. The past has numerous accounts of industrial accidents that have caused the death of many human beings. This shows that one small human error could cause the lives of many innocent people and also cause distress in the lives of people who survive by causing them permanent disability. Thus, this project focuses mainly on eliminating the possibility of human errors in the industrial site which could reduce the probability of an accident. It focuses on monitoring the ideal temperature and humidity conditions in order to keep the equipment in its optimum condition for working. It constantly monitors the levels of ammonia and carbon monoxide emitted in order to keep the air pollution levels in check. Flammable gases such as hydrogen, propane, butane, and LPG are also checked which are the main causes of an explosion.

FUTURE SCOPE

- Laboratories contain many chemicals, in that many are retractable to high temperatures or heat. So, every lab must contain this detection of high level temperature so that vigorous reaction of chemicals with fire can be avoided.
- Refrigeration plants use CFC gases which highly react able with fire, so it is necessary to have this system in the plants.
- It is also used in various others industries like beverage manufacturing, biogas industry.
- A smart reconfigurable assembling asset is improved with internet intelligence, giving nearby control to the physical assembling asset, plug – and – play capacity, and high computational strength.

APPENDIX

SOURCE CODE

Python code for the Temperature Alert and Humidity check

```
import time
import sys

import
ibmiotf.application

import ibmiotf.device

import random

# Initialize GPIO

#Provide your IBM Watson Device
Credentials organization = "0vbvyp"

deviceType =
"hazardous_monitoring" deviceId = "
123456" authMethod ="token"

authToken =
"CNCJXKF5f&WYESGhdt"

def myCommandCallback(cmd):

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

    Status=cmd.data['command'] if Status=="Alert":
    print("Alert")

    #print(cmd)

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.conne

t()while True:

    #Get Sensor Data from

DHT11temp

=random.randint(0,100) humid

=random.randint(0,100) oxygen

=random.randint(0,100)

    data = { 'temp' : temp, 'humidity': humid , 'oxygen': oxygen}

data1 = { 'High temperature' : temp>60}

    #print data

        d

ef

myOnPublishCallbac

k():

    print ("Published Temperature = %s C" % temp, "humidity = %s %" % humid,"alert",
"toIBM Watson")

    success = deviceCli.publishEvent("IoTSensor", "json", data,
qos=0,on_publish=myOnPublishCallback)

if not success:

        print("N

ot connected to IoT")

time.sleep(1)

```

```
deviceCli.commandCallback = myCommandCallback
```

```
# Disconnect the device and application from the  
clouddeviceCli.disconnect()
```

GITHUB LINK

<https://github.com/IBM-EPBL/IBM-Project-1515-1658393722>

DEMONSTRATION LINK

<https://drive.google.com/file/d/14gb7GLgc3aEBbwPw8VMF8wsP1H8RtlxT/view?usp=drivesdk>