PROJECT REPORT

PROJECT TITLE: *Industry Specific Intelligent Fire Management System*

TEAM ID: PNT2022TMID35665.

TEAM MEMBERS: Jagadish K (TEAM LEAD)

Sakthi Dasan BA

Niranjaan VM

Abinesh V

1.INTRODUCTION

1.1 Project overview

Fire, explosion and toxic release are the three major hazards in the process industry, while fire is the most common one. Increasing number of fire incidents coupled with loss of property has enhanced the demand for automatic intelligent fire alarm systems in residential and commercial buildings. An intelligent fire alarm system is specifically designed to provide advantages such as identification of the fire location, locate any fault in the alarm system wiring, and ensure easier maintenance. This system includes a Gas sensor, Flame sensor and temperature sensors to detect any changes in the environment. Based on the temperature readings and if any Gases are present the exhaust fans are powered ON. If any flame is detected the sprinklers will be switched on automatically. Emergency alerts are notified to the authorities and Fire station. Moreover, these modern intelligent fire alarm systems are more sensitive as compared to the classic models and are competent to detect false alarms.

1.2 Purpose

The primary purpose of fire alarm system is to provide an early warning of fire so that people can be evacuated & immediate action can be taken to stop or eliminate the fire effect as soon as possible.

2.LITERATURE SURVEY

2.1 Existing problem

Fire monitoring systems have usually been based on a single sensor such as smoke or flame. These single sensor systems have been unable to distinguish between true and false presence of fire . Consuming energy all day long and being dependent on one sensor that might end with false alert is not efficient and environmentally friendly. We need a system that is efficient not only in sensing fire accurately, but we also need a solution which is smart. In order to improve upon the results of existing single sensor systems , the smart fire management system includes a Gas sensor, Flame sensor and a temperature sensor . This system also requires a proper network with individual smart devices connected to various panels .

2.2 References

[1] S.Sri Vidhya , Suresh Samkaranarayan “IoT–Fog Enabled Framework for Forest Fire Management System” 2020 World Conference on Smart Trends in Systems, Security and Sustainability **DOI:** 10.1109/WorldS450073.2020.9210328

[2] Noorinder; Jaspreet Singh; Ekambir Sidhu “Raspberry pi based smart fire management system employing sensor based automatic water sprinkler” 2017 International Conference on Power and Embedded Drive Control (ICPEDC) **DOI:** 10.1109/ICPEDC.2017.8081068

[3] Rafat Shams,Shafkat Hossain,Shaoni Priyom,Nusrat Fatema “An automated fire fighting system” 2015 12th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD) **DOI:** 10.1109/FSKD.2015.7382316

[4] Ebubekir Erdem,Sercan Vançin,Karwan Muheden “Design and implementation of the mobile fire alarm system using wireless sensor networks” 2016 IEEE 17th International Symposium on Computational Intelligence and Informatics (CINTI) **DOI:** 10.1109/CINTI.2016.7846411

[5] Francis F. Balahadia,Ace C. Lagman,Shirley D. Moraga “Development of Fire Report Management Portal with Mapping of Fire Hotspot, Data Mining, and Prescriptions of Fire Prevention Activities” 2019 International Symposium on Multimedia and Communication Technology (ISMAC) **DOI:** 10.1109/ISMAC.2019.8836151

[6] Md Saiam,Md. Sarower Jahan,Md. Shoab Akther “A Microcontroller-based Fire Protection System for the Safety of Industries in Bangladesh” 2021 International Conference on Information and Communication Technology for Sustainable Development **DOI:** 10.1109/ICICT4SD50815.2021.9396964

[7] B Prabha “An IoT Based Efficient Fire Supervision Monitoring and Alerting System” 2019 Third International conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC) **DOI:** 10.1109/I-SMAC47947.2019.9032530

[8] Asma Mahgoub ,Nourhan Tarrad ,Rana Elsherif ,Abdulla Al-Ali “IoT-Based Fire Alarm System” 2019 Third World Conference on Smart Trends in Systems Security and Sustainablity (WorldS4) **DOI:** 10.1109/WorldS4.2019.8904001

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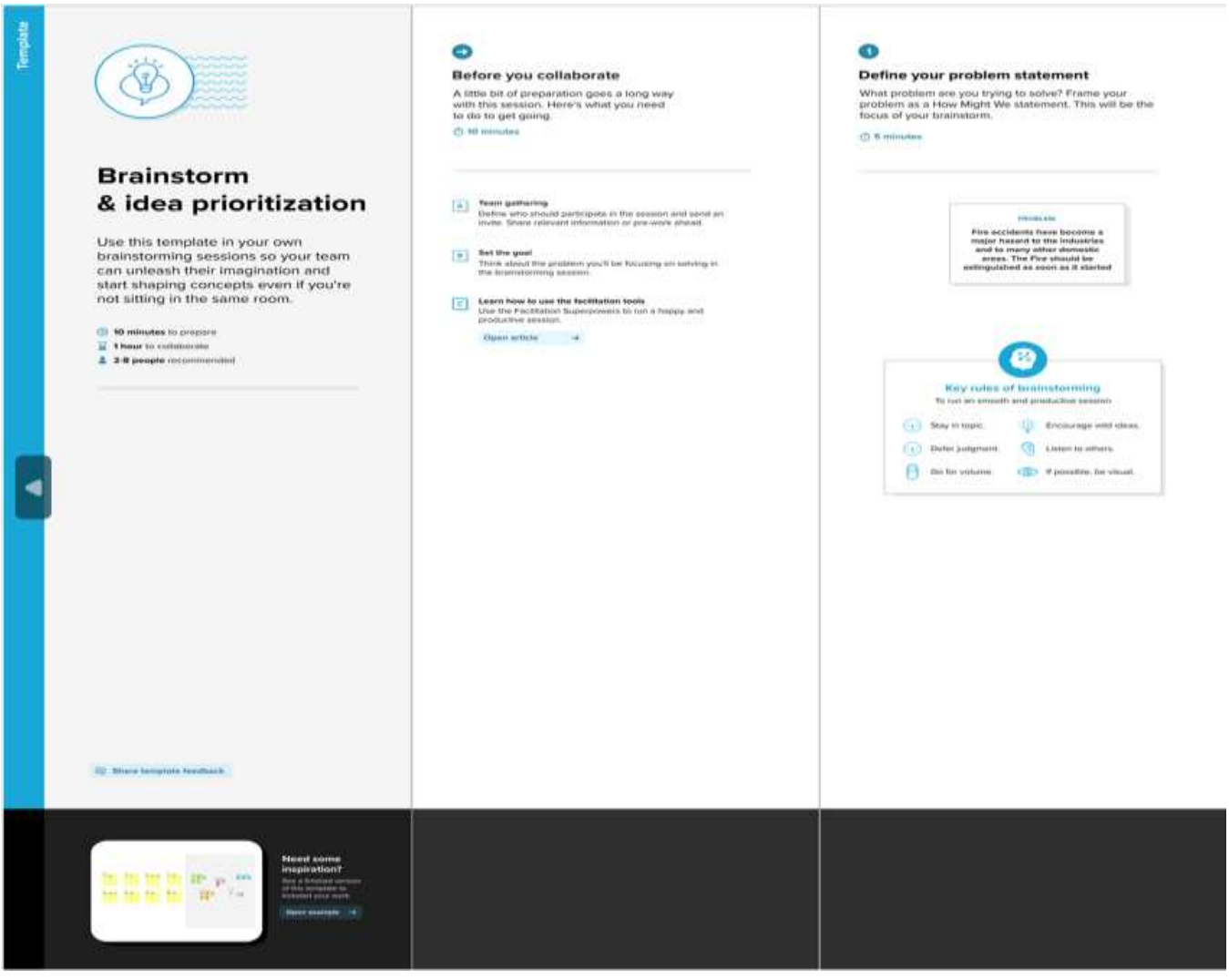
2.3 Problem Statement

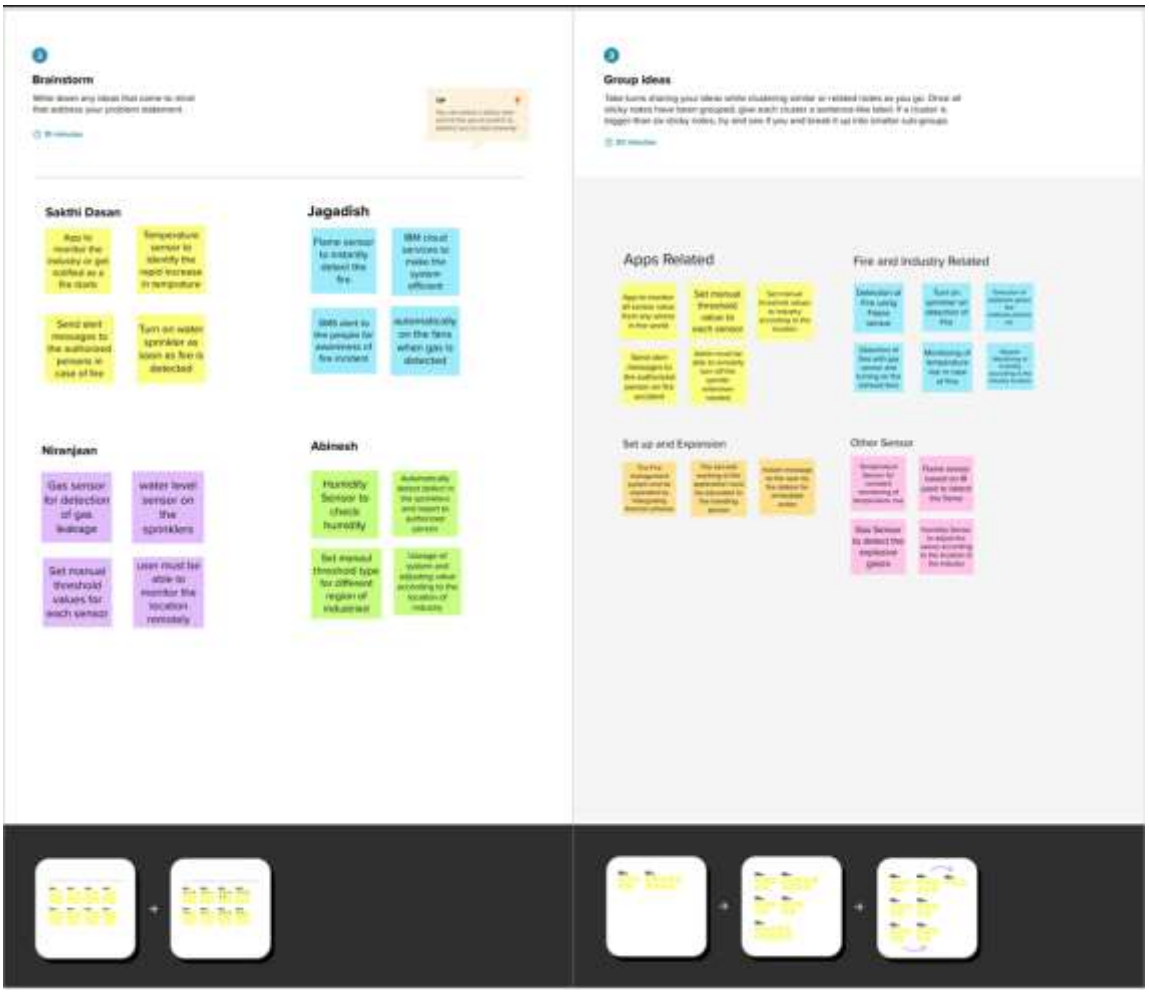
Definition Industry Specific Intelligent fire management system are designed to Prevent fire accidents due to Gas leakage and flame in industry.

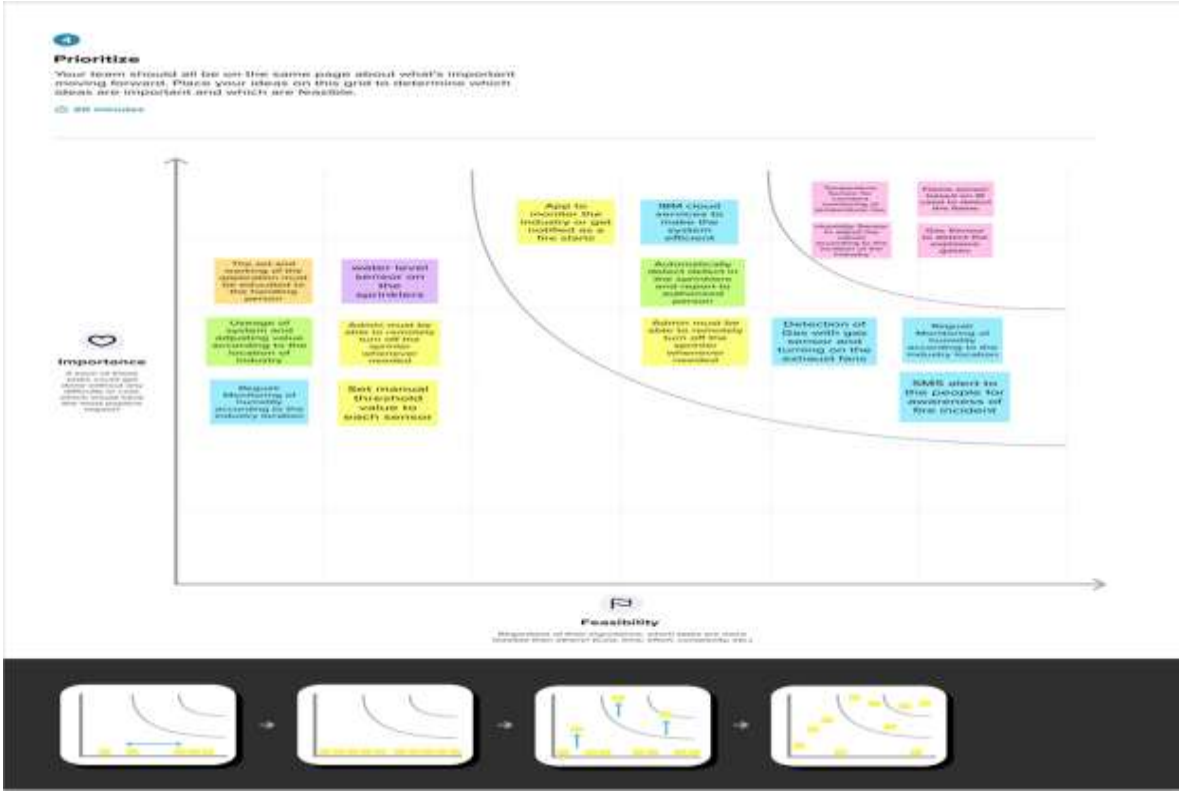
IDEATION & PROPOSED SOLUTION

2.4 Empathy Map Canvas

2.5 Ideation &Brainstorming




3
Brainstorm
Write down any ideas that come to mind that address your problem statement
Sakthi Dasan
App to monitor the industry or gas notified as a fire starts
Temperature sensor to identify the rapid increase in temperature
Send alert messages to the authorized persons in case of fire
Turn on water sprinkler as soon as fire is detected
Jagadish
Flame sensor to instantly detect the fire
IBM cloud services to make the system efficient
SMS alert to the people for awareness of fire incident
automatically on the fans when gas is detected
Niranjaan
Gas sensor for detection of gas leakage
water level sensor on the sprinklers
Set manual threshold values for each sensor
User must be able to monitor the location remotely
Abinesh
Humidity Sensor to check humidity
Automatically detect defect in the sprinklers and report to authorized person
Set manual threshold type for different region of industries
Usage of system and adjusting value according to the location of industry
3
Group ideas
Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.
Apps Related
Set manual threshold value to each sensor
Fire and Industry Related
Detection of fire using Flame sensor
Turn on sprinkler on detection of fire
Detection of fire with gas sensor and turning on the exhaust fans
Monitoring of temperature rise in case of fire
Set up and Expansion
Other Sensor
Flame sensor based on IR used to detect the flame
Gas Sensor to detect the explosive gases

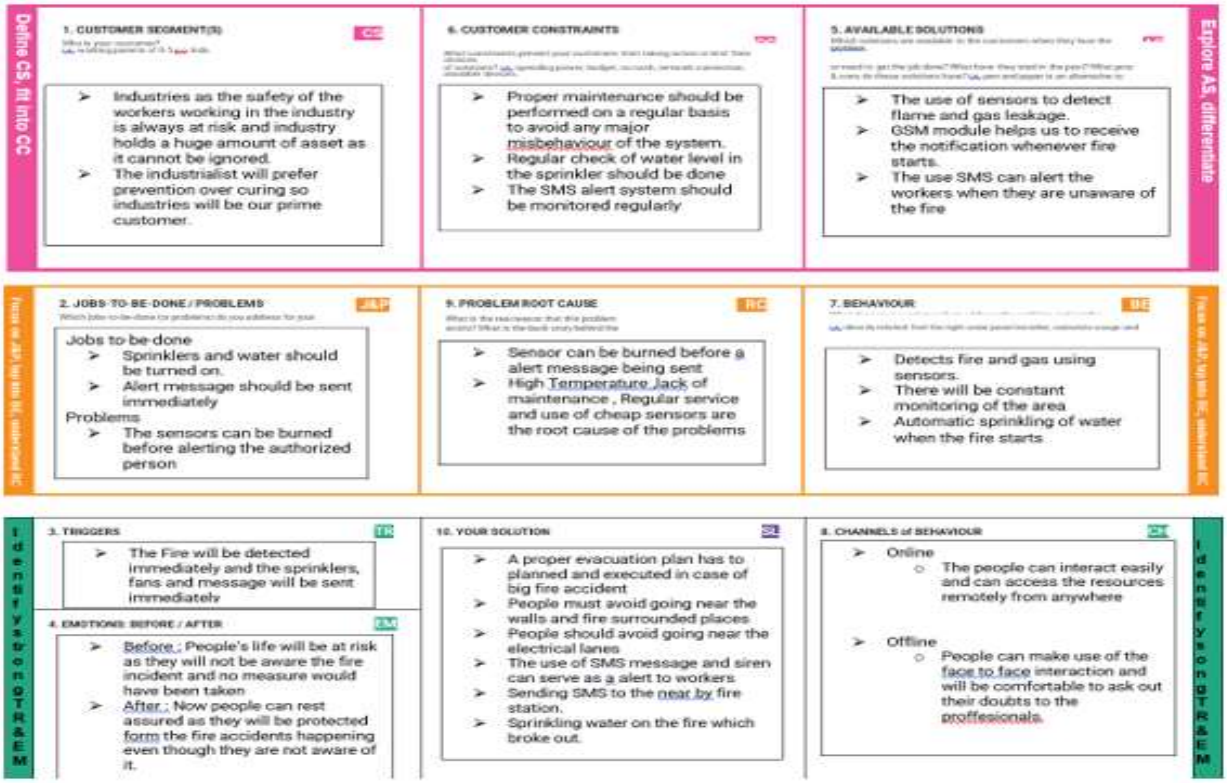

4
Prioritize
Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.
App to monitor the industry or gas notified as a fire starts
IBM cloud services to make the system efficient
Automatically detect defect in the sprinklers and report to authorized person
Admin must be able to remotely turn off the sprinkler whenever needed
Detection of Gas with gas sensor and turning on the exhaust fans
Regular Monitoring of humidity according to the industry location
SMS alert to the people for awareness of fire incident
Importance
Feasibility

2.6 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement(Problem to be Solved)	The problem is to ensure the safety of the industries from fires accident before any serious accident happens. This Fire management system should ensure that the fire should be extinguished as well as the authorized person is alerted about the fire incident.
2.	Idea / Solution description	The main idea of this Fire management system is to make sure no fire is spread and to prevent any major fire accidents. This is done by employing a number of sensors as Flame sensor, Temperature sensor, Humidity Sensor and Gas sensor. The readings from these sensors are fed to a Node MCU which in turn will turn on the sprinkler and fans which control the fire.
3.	Novelty / Uniqueness	⌘ This Fire management system is a integrated system of sensors and MCU. This has the unique feature of alerting the authorized Person through SMS or mail. The fire is also control through water sprinklers and exhaust fans ⌘ Through the IBM cloud our management system not only notifies the industry person but also nearby fire stations. ⌘ Low latencies which makes sure that the authorized persons are notified immediately which make the system more efficient. If a gas leak occurs within the industry or in a residential area, the fans are turned on to expel the gas.
4.	Social Impact / Customer Satisfaction	⌘ Prevention is better than curing in that way our Fire management system prevents any major fire accidents. Which in turn would make sure that every person in the building is safe ⌘ This Fire Management System will be extremely beneficial to the worker and the communities that are associated with the near industries. ⌘ This solution will help many people's life and save a lot of assets from being engulfed in fire. ▪ This makes sure all the workers and employers can rest assured knowing no fire accidents can occur in the industries being the industry is monitored 24/7 by our Fire management system.

5.	Business Model (Revenue Model)	⌘ Being deployed in the industries which are the major fire prone zones. The industry ownerships can be assured the safety and can be assured that they can minimize the loss in case of accident will make a way for our Fire Management system. The Agenda of this Fire management system will be to save people from big fire accidents. Since people are concerned about their life and assets deploying a Fire management system in industry will be a beneficial Business model.
6.	Scalability of the solution	⌘ Since the primary concern of the model is reduction of loss and safety of people the scalability of the model is not limited. ⌘ Every industry will prefers to have a Fire management system than to face the loss. ▪ So the scalability of the model is huge where it serves a demanding role in each industry.

2.7 Problem Solution Fit



3. REQUIREMENT ANALYSIS

3.1 Functional requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement(Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through website or application Registration through Social medias Registration through LinkedIn
FR-2	User Confirmation	Verification via Emailor OTP
FR-3	User Login	Login through website or App using the respective username and password
FR-4	User Access	Access the app requirements
FR-5	User Upload	User should be able to upload the data
FR-6	User Solution	Data report should be generated and delivered to user for every 24 hours
FR-7	User Data Sync	API interface to increase to invoice system

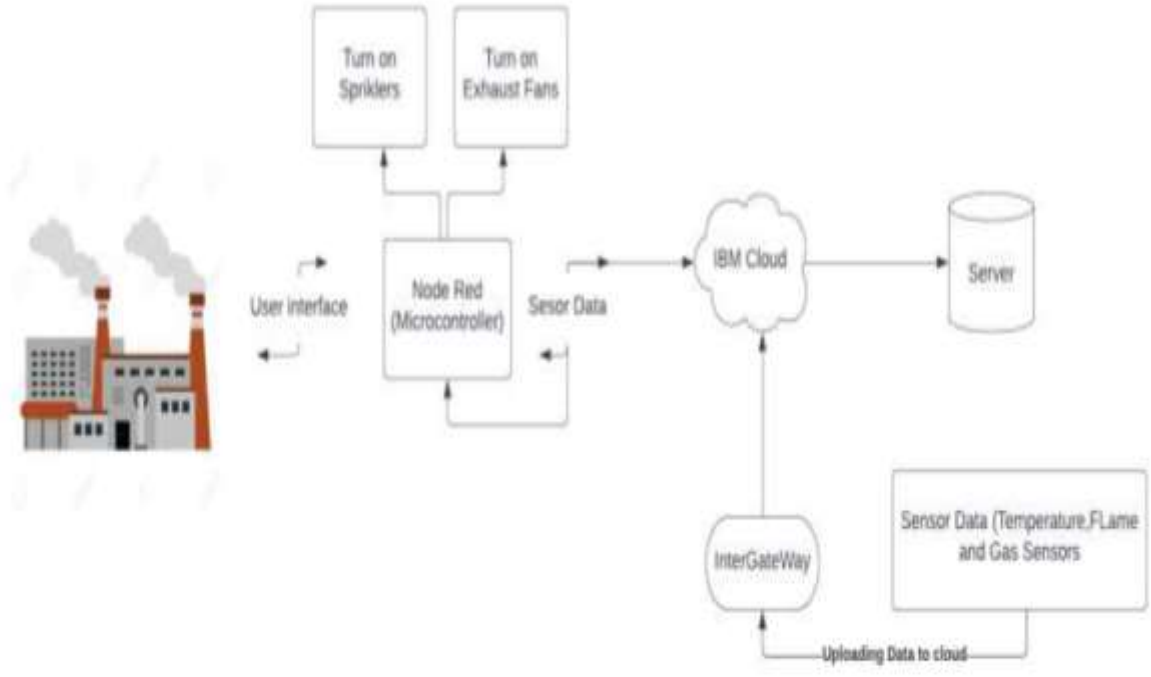
3.2 Non-Functional requirement

FR No.	Non-Functional Requirement	Description

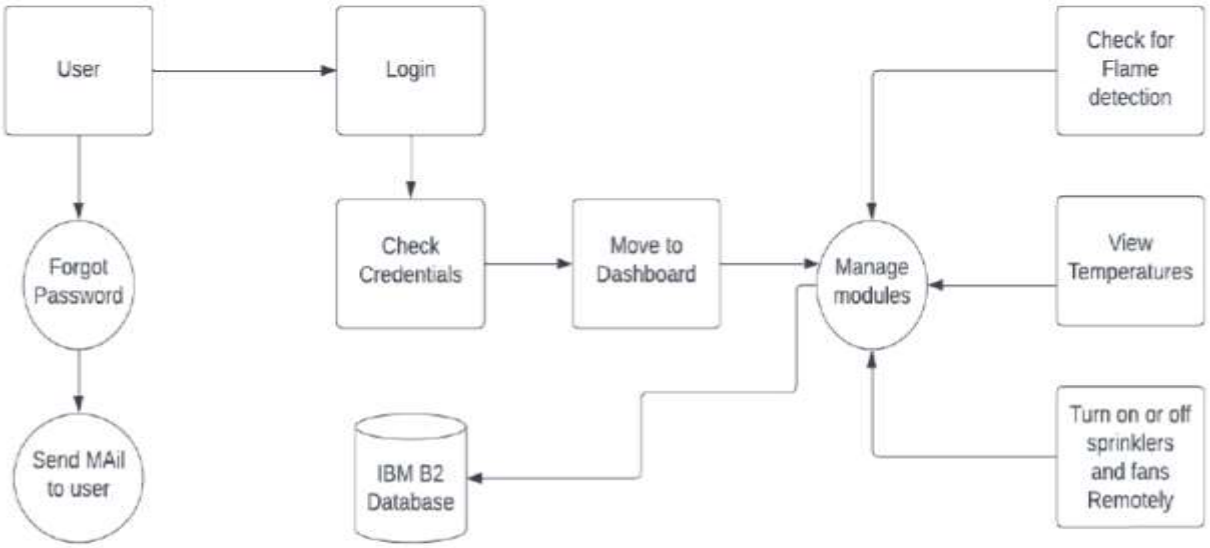
NFR-1	**Usability**	Usability requirements includes language barriers and localization tasks. Usability can be assessed by Efficiency of use.
NFR-2	**Security**	Access permissions for the particular system information may only be changed by the system's data administrator.
NFR-3	**Reliability**	The database update process must roll back all related updates when any update fails.
NFR-4	**Performance**	The front-page load time must be no more than2 seconds for users that access the website using an VoLTE mobile connection.
NFR-5	**Availability**	New module deployment must not impact front page, product pages, and check out pages availability and mustn't take longer than one hour.
NFR-6	**Scalability**	We can increase scalability by adding memory, servers, or disk space. On the other hand, we can compress data, use optimizing algorithms.

4.PROJECT DESIGN

4.1 Data Flow Diagram



4.2 Solution Architecture



4.3 User Stories

User Type	Functional requirement	User story number	User story/task	Acceptance criteria	Priority	Release
Customer (Mobile user, Web user, Care executive, Administrator)	Registration	USN-1	As a user, I can register for the application by entering my mail, password, and confirming my password	I can access my account/ dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
	Dashboard	USN-3	As a user, I can register for the	I can register & access the dashboard	Low	Sprint-2

			application through internet	with Internet login		
		USN-4	As a user, I can register for the application through Gmail	I can confirm the registration in Gmail	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password	I can login with my id and password	High	Sprint-1

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	Sensing	USN-1	Sensing the environment using thesensors.	3	High	Pelluru Manasa Polu Tejaswini M Deepika RC Chandhana
	Operating	USN-2	Turning on the exhaust fan as well asthe fire sprinkler system in cause of fire and gas leakage.	3	Medium	Pelluru Manasa Polu Tejaswini M Deepika RC Chandhana
Sprint-2	Sending collected data tothe IBM Watson platform	USN-3	Sending the data of the Sensors to the IBM Watson.	3	High	Pelluru Manasa Polu Tejaswini M Deepika RC Chandhana

7.CODING & SOLUTIONING

7.1 Feature 1

IoT device

IBM Watson Platform

Node red

Cloudant DB

Web UI

MIT App Inventor

Python code

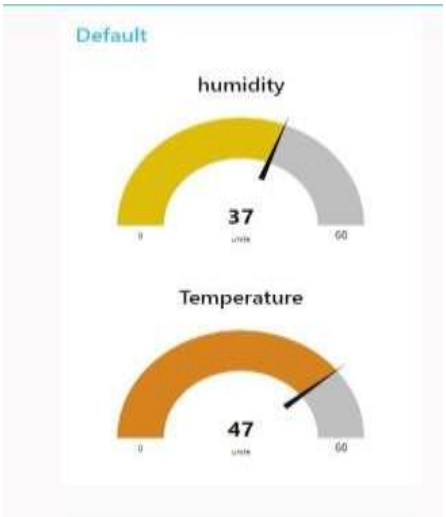
7.2 Feature 2

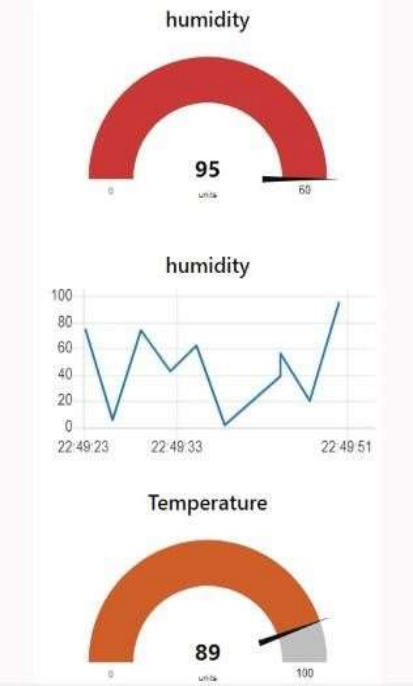
Login

Wokwi

8.TESTING AND RESULTS

8.1 Test Cases





9. ADVANTAGES

Reduced installation cost.

They monitor 24/7.

Improved security in homes, industries and Offices.

It pin points location of the fire.

10. DISADVANTAGES

Heat detectors are not considered as life saving devices because they are sensitive only to heat.

High battery or current consumption will need for these detectors.

Control pannel may need to be replaced if it becomes damaged**.**

11. CONCLUSION

This gas leakage system can be applied for household safety and many other applications in the industry . Gas leakages and fire outbreaks in industries as well as houses have lead to wide destruction and losses in the past. Gas leakages and fire outbreaks both spread widely and lead to even greater loss of life and property if proper action is not taken on time. So here we proposed a system that detects gas as well as fire outbreaks and alert us accordingly so that proper action may be taken to control it.

12. FUTURE SCOPE

Smoke detectors and alarms are migrating from just the detection of smoke, to combination detectors and multicriteria detector. The future will be with multicriteria detection in which the detector will be more of a sensor,with the detection more for the products of combustion, such as carbon monoxide, carbon dioxide ,sulfur dioxide ,nitrogen dioxide in addition to heat and particulate matter. Within the next decade, video image detection (VID) will become more mainstream in which, through analytics, the image of either smoke or flame will be able to be isolated and detected from within a room or space. The VID system would also be able to detect if an individual is within the space and through the integration with the notification appliances, provide a path of exit.

13. APPENDIX

13.1 Source Code:

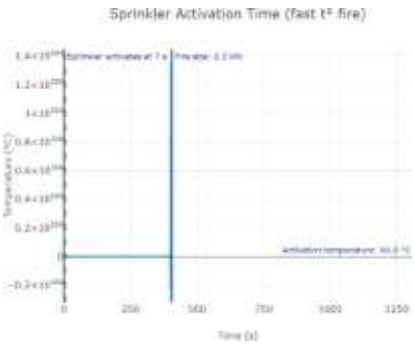
```
import pandas as pd
import ipywidgets as widgets
import plotly.express as px

while True:
    try:
        amb_temp = float(input('Enter ambient room temperature (°C): '))
        rad_distance = float(input('Enter the horizontal distance between
the fire and sprinkler head (m): '))
        height_above_fire = float(input('Enter the vertical distance
between the fire and sprinkler head (m): '))
        RTI = float(input('Enter RTI value of the sprinkler head: '))
        c = float(input('Enter conduction value of the sprinkler head: '))
        activation = float(input('Enter sprinkler activation temperature
(°C): '))
        break
    except ValueError as e:
        print('Error: Enter a valid number')

t_sq_list = ["slow", "medium", "fast", "ultra-fast"]
t_sq  = None

while t_sq not in t_sq_list:
    t_sq = input('Enter fire t² growth rate. Select from the list [slow,
medium, fast, ultra-fast]: ').lower().strip()

if t_sq == 'slow':
    growth = 0.00293
elif t_sq == 'medium':
    growth = 0.01172
elif t_sq == 'fast':
    growth = 0.0469
else:
    growth = 0.1876

index = pd.RangeIndex(0, 1308, 1) # a slow t² fire will take 1307 seconds
```

```
to reach 5 MW
columns = ['Time', 'HRR', 'Gas Temp 1', 'Gas Temp 2', 'Gas Vel 1', 'Gas Vel
2', 'Gas Temp', 'Temp Sprinkler']

df = pd.DataFrame(index=index, columns=columns)
df = df.fillna(0) # with 0s rather than NaNs

df['Time'] = df.index
df['HRR'] = df['Time']*df['Time']*growth

if rad_distance/height_above_fire > 0.18:
    df['Gas Temp 1'] =
(5.38*(df['HRR']/rad_distance)**(2/3))/(height_above_fire)
    df['Gas Temp'] = df['Gas Temp 1'] + amb_temp
    a = 'one'
else:
    df['Gas Temp 2'] = (16.9*(df['HRR'])**(1/3))/height_above_fire**(5/3)
    df['Gas Temp'] = df['Gas Temp 2'] + amb_temp
    a = 'two'

if rad_distance/height_above_fire > 0.15:
    df['Gas Vel 1'] =
(0.2*df['HRR']**(1/3)*height_above_fire**(1/2))/(rad_distance**(5/6))
    b = 'one'
else:
    df['Gas Vel 2'] = 0.95*((df['HRR']/height_above_fire)**(1/3))
    b= 'two'

x = 2

# initialise row 0
df.loc[0, 'Temp Sprinkler'] = amb_temp
if (a == 'one') & (b == 'one'):
    # initialise row 1
    df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1,'Gas Vel
1']**0.5)/RTI)*((df.loc[1,'Gas Temp']-amb_temp)-((1+(c/df.loc[1,'Gas Vel
1']**0.5)))*(df.loc[0,'Temp Sprinkler']-amb_temp))
    # initialise remaining rows
    while x < 1308:
        df.loc[x,'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] +
((df.loc[x-1, 'Gas Vel 1']**0.5)/RTI)*((df.loc[x-1, 'Gas Temp']-amb_temp)-
((1+(c/df.loc[x-1, 'Gas Vel 1']**0.5)))*(df.loc[x-1, 'Temp Sprinkler']-
amb_temp))
        x = x+1
elif (a == 'one') & (b == 'two'):
    df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1,'Gas Vel
2']**0.5)/RTI)*((df.loc[1,'Gas Temp']-amb_temp)-((1+(c/df.loc[1,'Gas Vel
2']**0.5)))*(df.loc[0,'Temp Sprinkler']-amb_temp))
    while x < 1308:
        df.loc[x,'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] +
((df.loc[x-1, 'Gas Vel 2']**0.5)/RTI)*((df.loc[x-1, 'Gas Temp']-amb_temp)-
((1+(c/df.loc[x-1, 'Gas Vel 2']**0.5)))*(df.loc[x-1, 'Temp Sprinkler']-
amb_temp))
        x = x+1
elif (a == 'two') & (b == 'one'):
    df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1,'Gas Vel
1']**0.5)/RTI)*((df.loc[1,'Gas Temp']-amb_temp)-((1+(c/df.loc[1,'Gas Vel
1']**0.5)))*(df.loc[0,'Temp Sprinkler']-amb_temp))
    while x < 1308:
        df.loc[x,'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] +
((df.loc[x-1, 'Gas Vel 1']**0.5)/RTI)*((df.loc[x-1, 'Gas Temp']-amb_temp)-
```

```
((1+(c/df.loc[x-1, 'Gas Vel 1']**0.5)))*(df.loc[x-1, 'Temp Sprinkler']-
amb_temp))
        x = x+1
else:
    df.loc[1, 'Temp Sprinkler'] = amb_temp + ((df.loc[1,'Gas Vel
2']**0.5)/RTI)*((df.loc[1,'Gas Temp']-amb_temp)-((1+(c/df.loc[1,'Gas Vel
2']**0.5)))*(df.loc[0,'Temp Sprinkler']-amb_temp))
    while x < 1308:
        df.loc[x,'Temp Sprinkler'] = df.loc[x-1, 'Temp Sprinkler'] +
((df.loc[x-1, 'Gas Vel 2']**0.5)/RTI)*((df.loc[x-1, 'Gas Temp']-amb_temp)-
((1+(c/df.loc[x-1, 'Gas Vel 2']**0.5)))*(df.loc[x-1, 'Temp Sprinkler']-
amb_temp))
        x = x+1

try:
    act_time = df.loc[df['Temp Sprinkler']>activation, 'Time'].iloc[0]
except:
    print('The sprinkler does not activate')

try:
    act_hrr = round(df.loc[df['Temp Sprinkler'] > activation,
'HRR'].iloc[0],1)
except:
    print('The sprinkler does not activate')

act_time_text = 'Sprinkler activates at ' + str(act_time) + ' s.' + '\n'+ '
Fire size: ' + str(act_hrr) + ' kW'
act_temp_text = 'Activation temperature: ' + str(activation) + ' °C'

fig = px.line(df, x="Time", y="Temp Sprinkler", title="Sprinkler Activation
Time (" + t_sq +' t² fire)', template = 'none')

fig.update_layout(
    autosize=False,
    width=600,
    height=500,
    yaxis=dict(
       title_text="Temperature (°C)",
        titlefont=dict(size=12),
    ),
    xaxis=dict(
       title_text="Time (s)",
        titlefont=dict(size=12),
    )
)


fig.update_layout(
    title={
        'y':0.9,
        'x':0.5,
        'xanchor': 'center',
        'yanchor': 'top'})

fig.update_layout(
    xaxis = dict(
        tickmode = 'linear',
        tick0 = 0,
        dtick = 250
    )
)
```

```
fig.add_hline(y=activation, line_width=1, line_dash="dash",
line_color="green", annotation_text = act_temp_text)
fig.add_vline(x=act_time, line_width=1, line_dash="dash",
line_color="green",  annotation_text = act_time_text)

fig.update_annotations(font_size=10, font_color = 'darkblue')


fig.show()
```

OUTPUT:



GitHub Link: https://github.com/IBM-EPBL/IBM-Project-5288-1658755720