PROJECT REPORT

INDUSTRY-SPECIFIC INTELLIGENT FIRE MANAGEMENT SYSTEM

TEAM ID : PNT2022TMID24427

DOMAIN : Internet Of Things(IOT)

Project Report Submitted By

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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]N N Mahzan, N I M Enzai, N M Zin and K S S K M Noh, ”Design of an Arduino-based home fire alarm system with gSM module”, 1st International conference on green and Sustainable computing (ICoGeS), 2017.

[2] ZHANG Ying-Cong, YU Jing, “Study on the Fire IOT Development Strategy”, Shenyang Fire Research Institute --Radiant Energy-Sensing Fire Detectors for Automatic Fire Alarm Signaling, US: ANSI/FMRC, pp. FM3260-2004.

[3] Public Security, Shenyang 110034, China Shenyang Institute of Engineering, Shenyang 110136, China, 2019. Liu Yunhong Qi Meini,"The Design of Building Fire Monitoring System Based on ZigBee-WiFi Networks", Eighth International Conference on Measuring Technology and Mechatronics Automation, IEEE, 2016, pp-733-735.

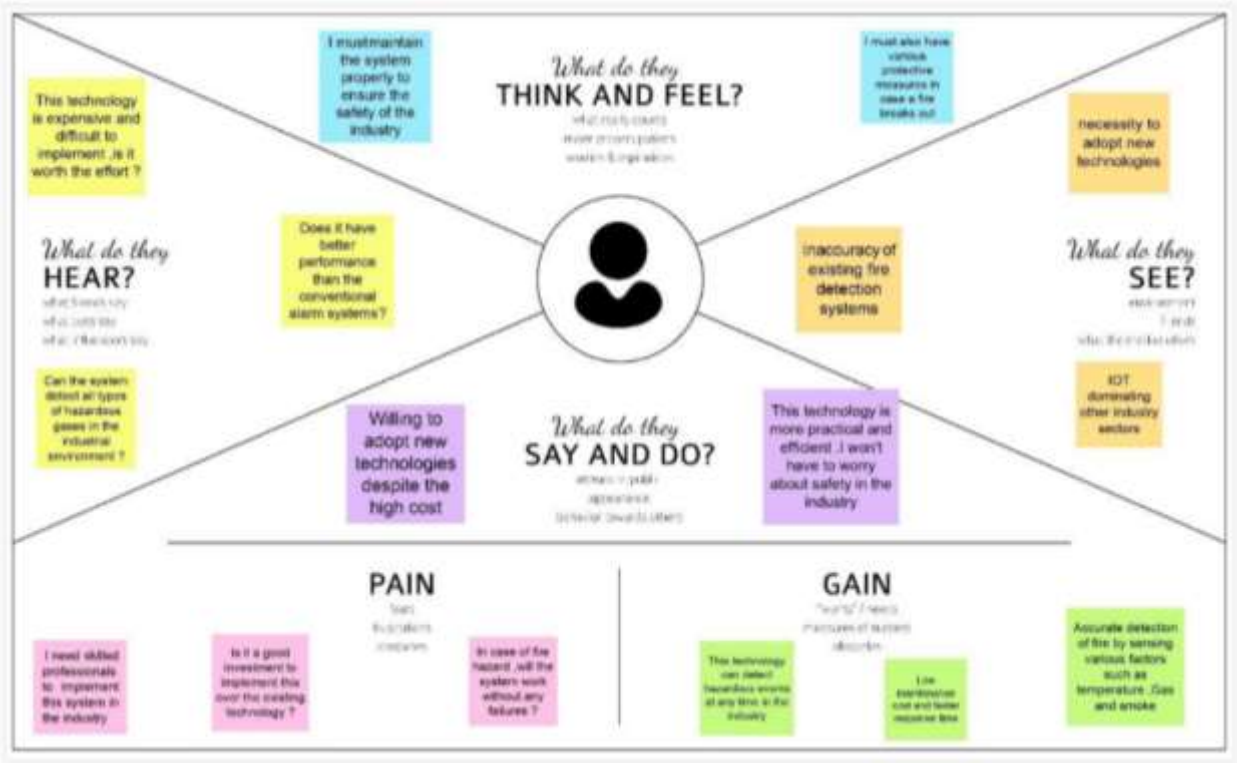
[4] R.A. Sowah, A.R. Ofoli, S.N. Krakani, S.Y. Fiawoo, hardware Design and Web-Based Communication Modules of a Real-Time multisensor Fire Detection and Notification System Using Fuzzy Logic, IEEE Transactions on Industry Applications, 53 (2016) 559-566.

2.3 Problem Statement Definition

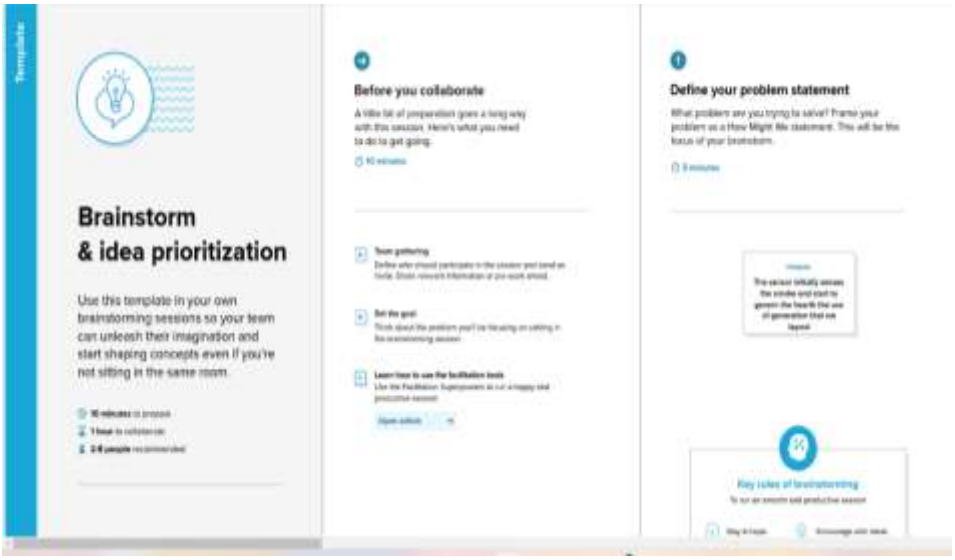
Definition Industry Specific Intelligent fire management system are designed to Prevent fire accidents due to Gas leakage and flame in industry.

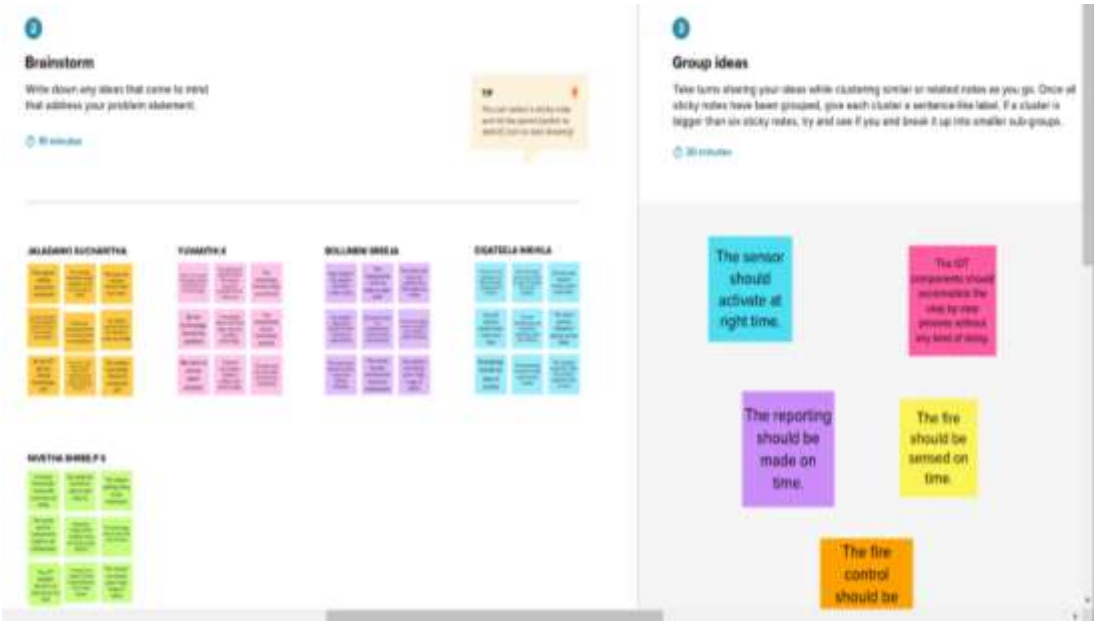
3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

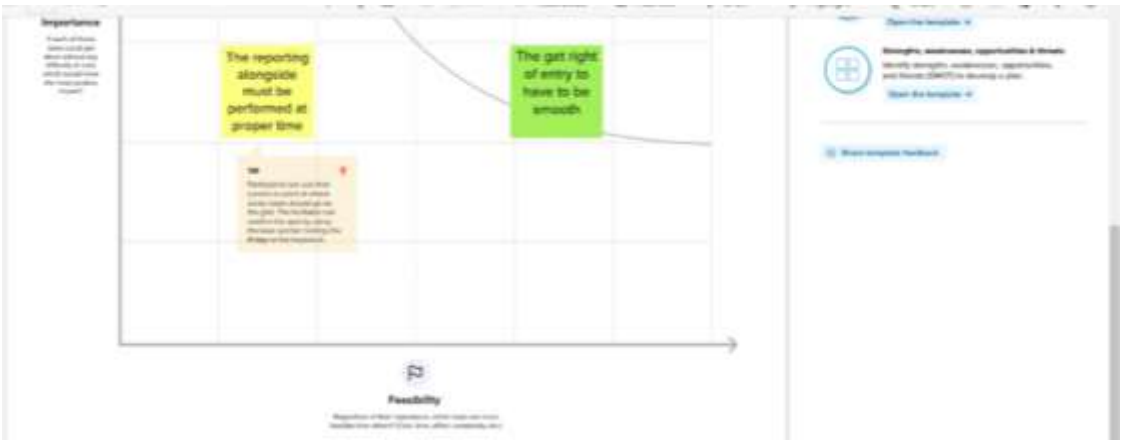


3.2 Ideation &Brainstorming




Brainstorm
Write down any ideas that come to mind that address your problem statement.
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.
The sensor should activate at right time.
The reporting should be made on time.
The fire should be sensed on time.
The fire control should be


Prioritize
The Flame sensor,smoke sensor ought to operate
The fire should be sensed on time
Modern-day generation along with artificial intelligence have to be accessed
After you collaborate


The reporting alongside must be performed at proper time
The get right of entry to have to be smooth
Feasibility

3.3 Proposed Solution

S.NO	Parameter	Description
1	Problem Statement (Problem to be solved)	We're going to remedy the fireplace explosion problem
2	Idea / Solution description	Industry specific wise fire management machine. we are going to stumble on and stop the fireplace explosion spreading within the enterprise as well as in the commonplace places.
3	Novelty / Uniqueness	The usage of the synthetic Intelligence is the uniqueness in our answer for the hearth explosion.
4	Social Impact / Customer Satisfaction	The AI detects and senses the fire the use of many sensors that we use and it facilitates the clients to access with the immediately notification and the timely access.
5	Business Model (Revenue Model).	This version is used to calculate the opportunity of the ignition and spread across a landscape.
6	Scalability of theSolution	This is absolutely modular system makes it without problems expandable and business efficient for the custom designed hearth detection, with the great value and management.

3.4 Problem Solution Fit

4.REQUIREMENT ANALYSIS

4.1Functional requirement

Following are the functional requirements of the proposed solution.

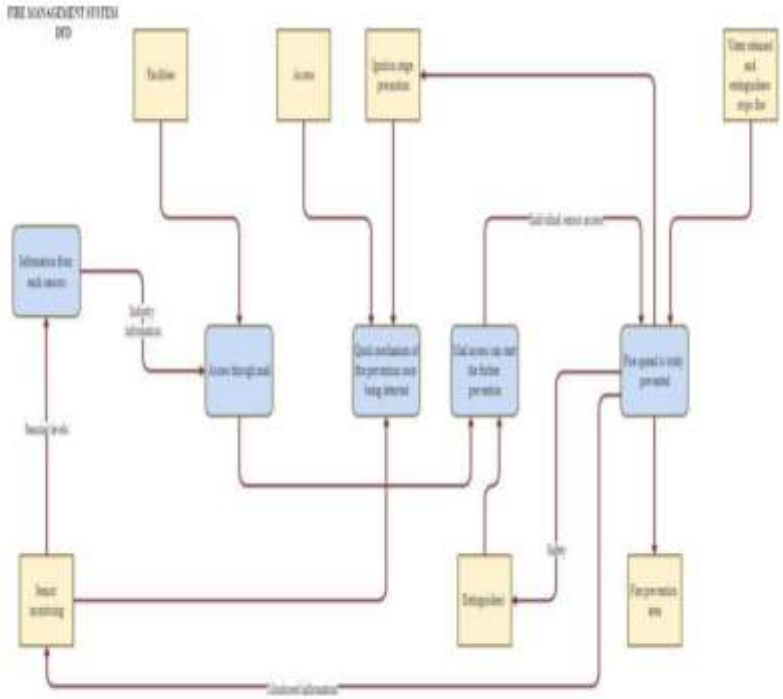
FR No.	Functional Requirement(Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through website or application Registration through Social medias Registration through LinkedIN
FR-2	User Confirmation	Verification via Emailor OTP
FR-3	User Login	Login through website or App using 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

4.2 Non-Functional requirement

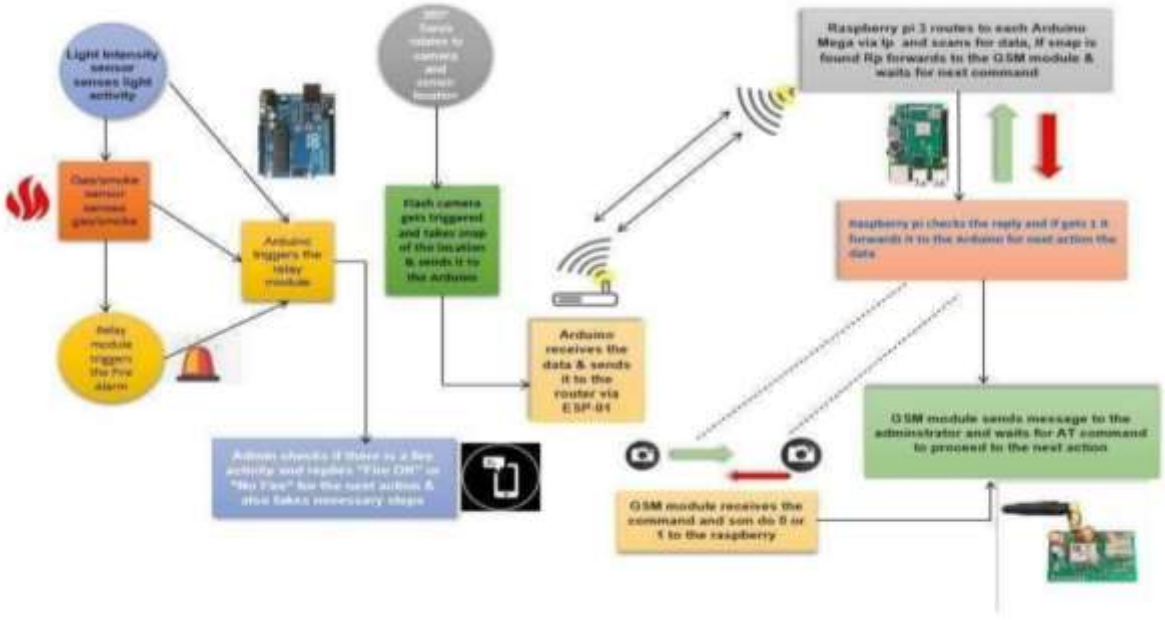
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Usability requirements includes language barriers and localization tasks. Usability can be assessed by Efficiency of use.
NFR-2	**Security**	Access permissions for the particular system information may only be changed by the system's data 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.

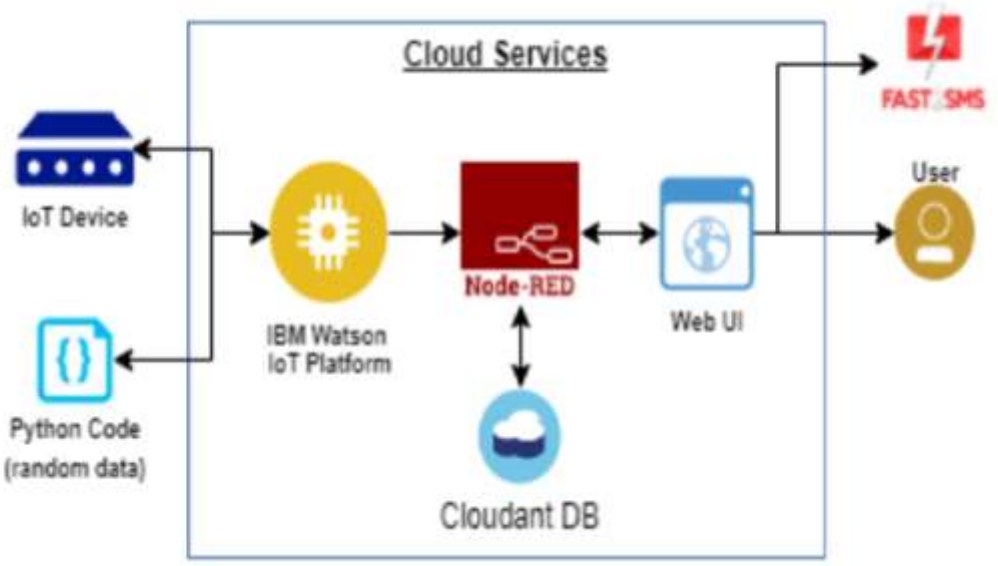
5.PROJECT DESIGN

5.1 Data Flow Diagram



5.2 Solution Architecture & Technical Architecture





5.3 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 application through internet	I can register & access the dashboard with Internet login	Low	Sprint-2

		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

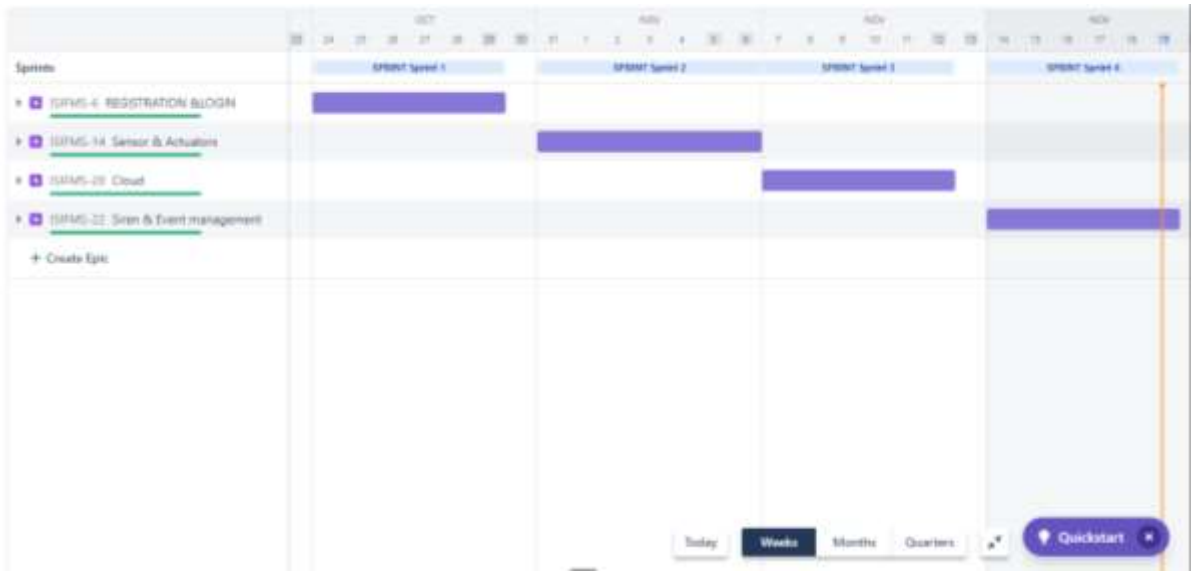
6.PROJECT PLANNING &SCHEDULING

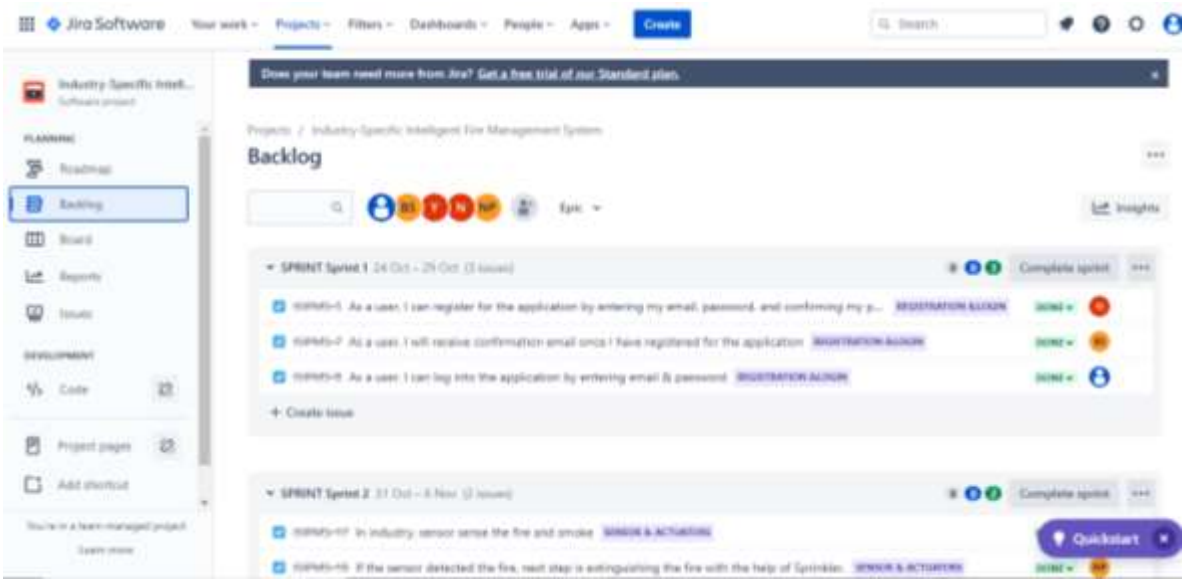
6.1 Sprint Planning & Estimation

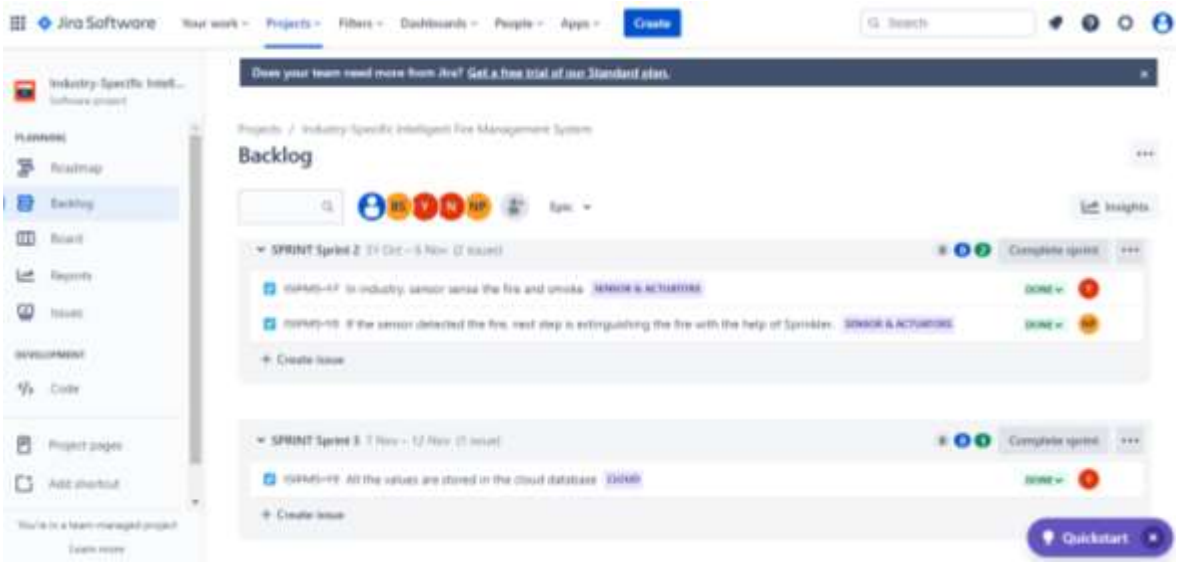
Use the below template to create product backlog and sprint schedule

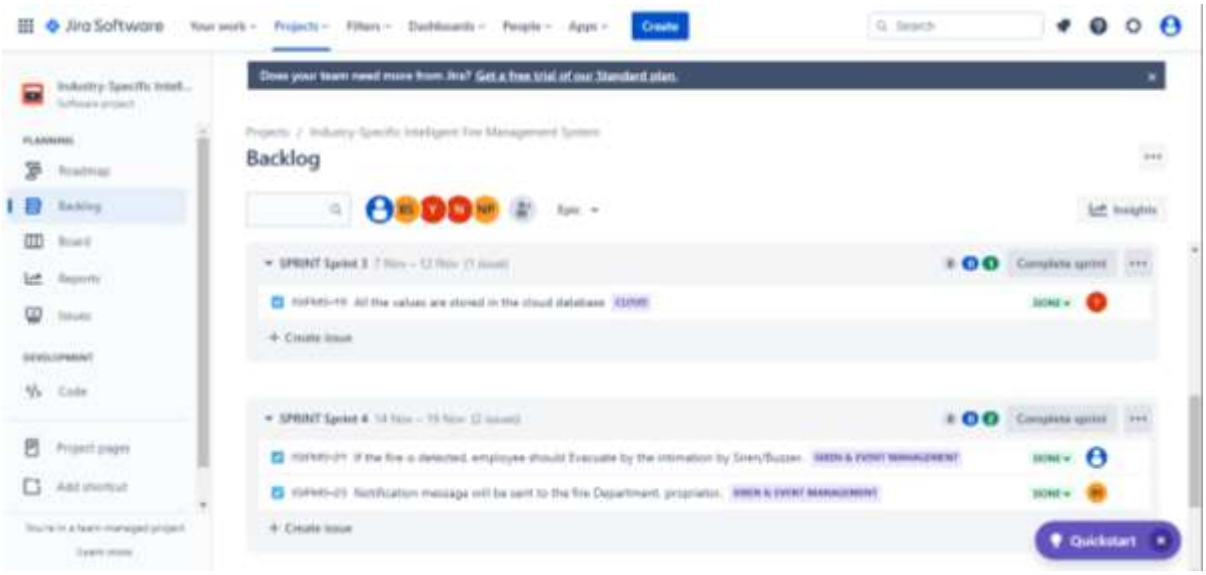
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration & Login	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	6	High	Eigateela Nikhila
		USN-2	As a user, I will receive confirmation email once I have registered for the application	7	High	Bollineni Sreeja
		USN-3	As a user, I can log into the application by entering email & password	7	High	Jaladanki Sucharitha
Sprint-2	Sensor & Actuators	USN-4	In industry, sensor sense the fire and smoke.	10	High	Yuvanthi. K
		USN-5	If the sensor detected the fire, next step is extinguishing the fire with the help of Sprinkler.	10	High	Nivetha shree
Sprint-3	Cloud	USN-6	All the values are stored in the cloud database.	20	High	Yuvanthi.K Nivethashree
Sprint-4	Siren & Event management	USN-7	If the fire is detected, employee should Evacuate by the intimation by Siren/Buzzer.	10	High	EigateelaNikhila Jaladanki Sucharitha
		USN-8	Notification message will be sent to the fire Department, proprietor.	10	High	Bollineni Sreeja

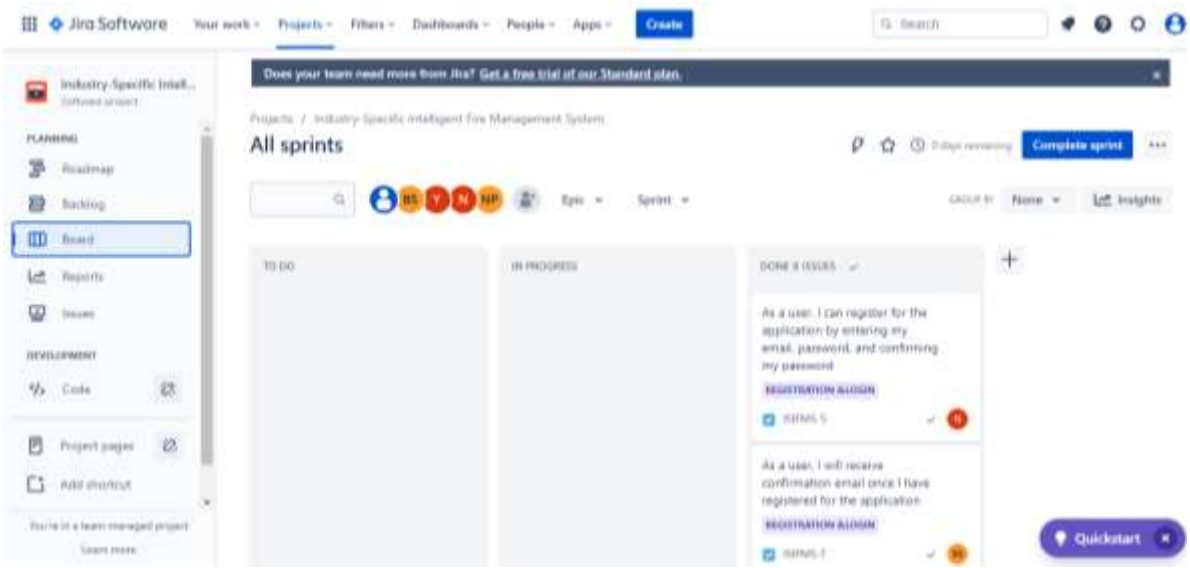
6.2 Reports from JIRA

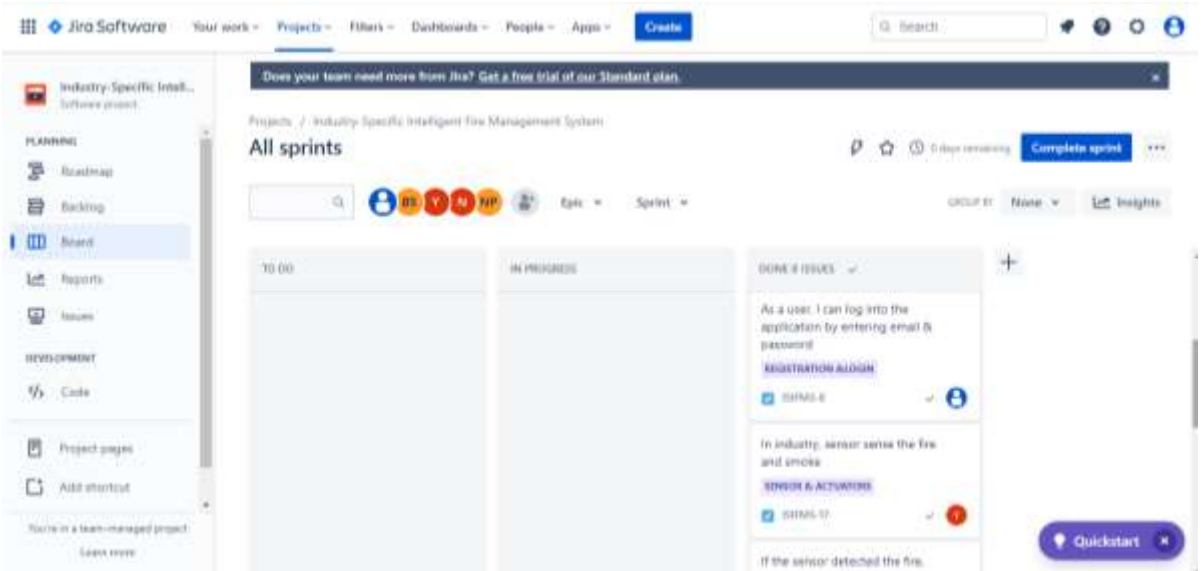


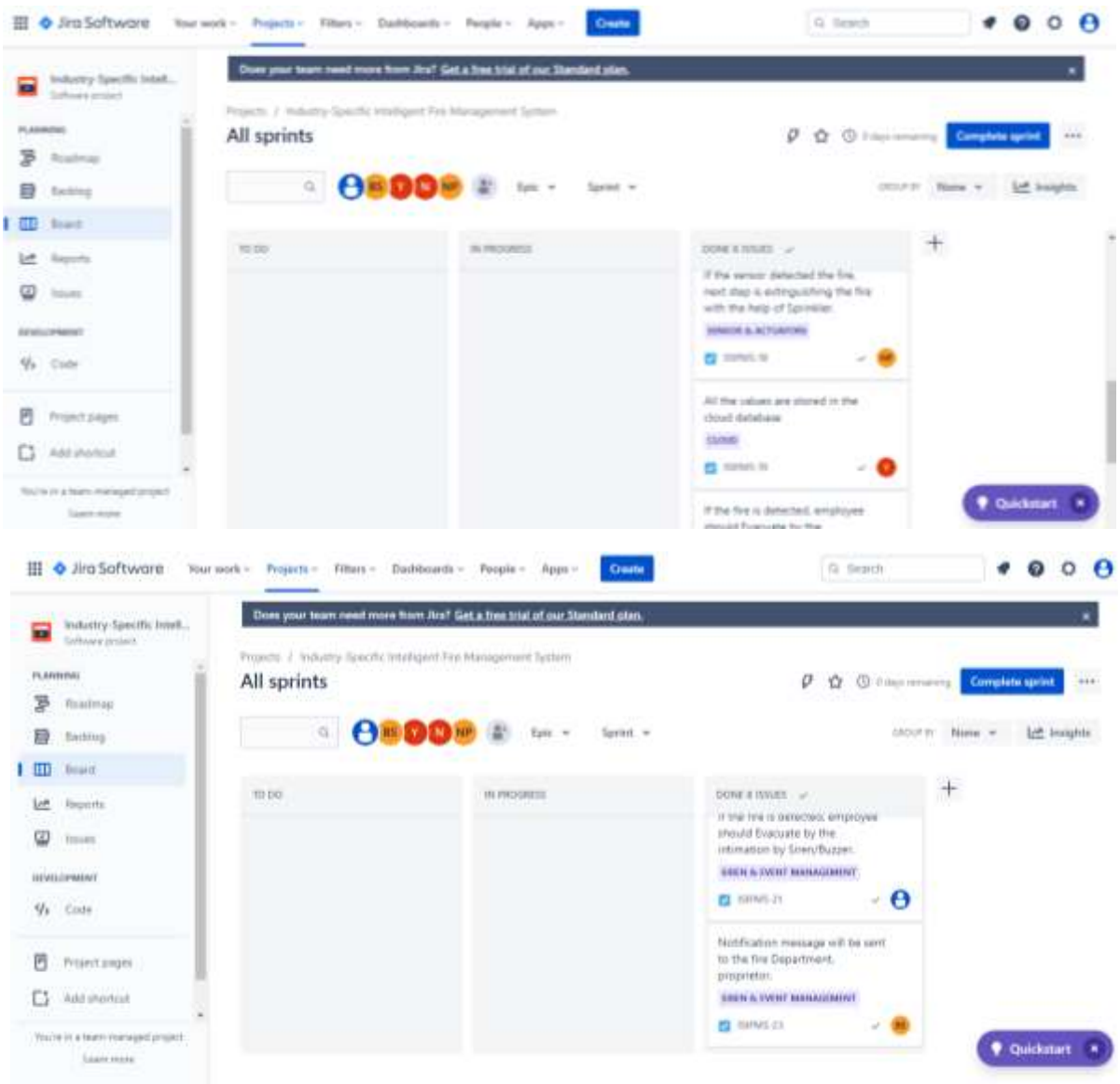





Jira Software
Backlog
Complete sprint
Create issue
Quickstart


Jira Software
All sprints
Complete sprint
TO DO
IN PROGRESS
As a user, I can register for the application by entering my email, password, and confirming my password
As a user, I will receive confirmation email once I have registered for the application
Quickstart


Jira Software
All sprints
Complete sprint
TO DO
IN PROGRESS
As a user, I can log into the application by entering email & password
In industry, sensor sense the fire and smoke
If the sensor detected the fire,
Quickstart



7.CODING & SOLUTIONING

7.1 Feature 1

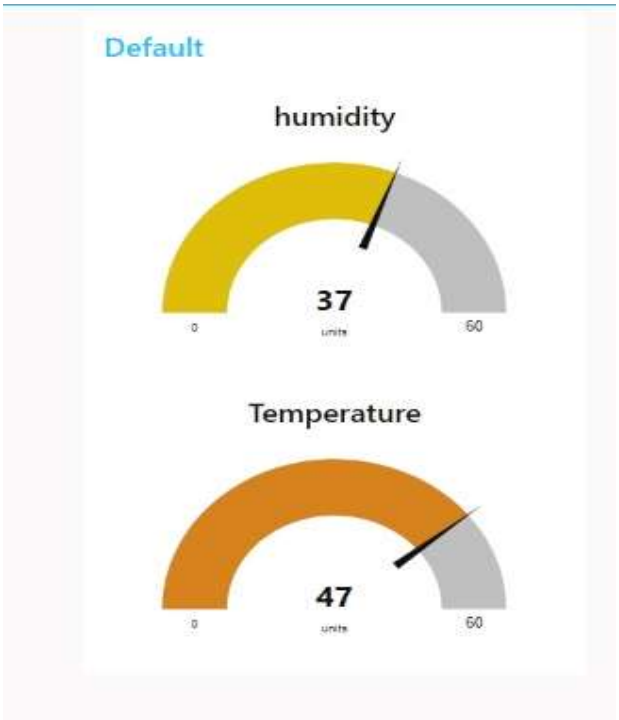
- IoT device
- IBM Watson Platform
- Node red
- Cloudant DB
- Web UI
- MIT App Inventor
- Python code

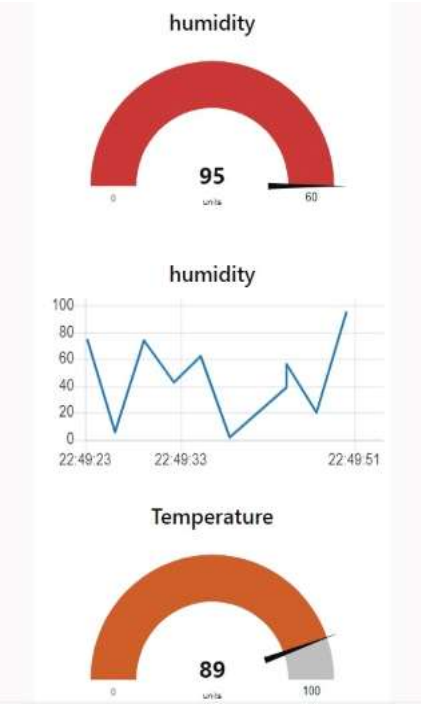
7.2 Feature 2

- 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, carbondioxide ,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

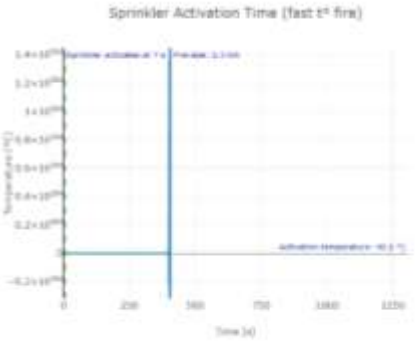
```
import pandas as pd
import ipywidgets as widgets
import plotly.express as px
```

```
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-54019-1661587492