PROJECT REPORT ON

INDUSTRY-SPECIFIC INTELLIGENT FIRE MANAGEMENT SYSTEM

INTERNET OF THINGS

THANTHAI PERIYAR GOVERNMENT INSTITUTE OF TECHNOLOGY-VELLORE

TEAM ID: PNT2022TMID29717

Submitted by :

SUMATHI M -513119106085
NANDHINI S -513119106058
NETHAJI PM-513119106060
SONIYA MP-513119106080

Title **Page No**

1. **INTRODUCTION**...3
   Project Overview 3
   Purpose...3
2. **LITERATURE SURVEY** 3
   Existing problem...3
   References 3
   Problem Statement Definition 3
3. **IDEATION & PROPOSED SOLUTION**...............4
   Empathy Map Canvas 4
   Ideation & Brainstorming..5
   Proposed Solution 7
   Problem Solution fit..8
4. **REQUIREMENT ANALYSIS**................................9
   Functional requirement 9
   Non-Functional requirements 9
5. **PROJECT DESIGN**...10
   Data Flow Diagrams 10
   Solution & Technical Architecture 11
   User Stories 12
6. **PROJECT PLANNING & SCHEDULING**...........12
   Sprint Planning & Estimation..................................12
   Sprint Delivery Schedule 13
   Reports from JIRA...13
7. **CODING & SOLUTIONING** 15
   Feature 1.. 15
   Feature 2.. 19
   Feature 3.. 20
8. **TESTING** 22
   Test Cases.. 22
   User Acceptance Testing 22
9. **RESULTS**... 23
   Performance Metrics 23
10. **ADVANTAGES & DISADVANTAGES** 25
11. **CONCLUSION** 26
12. **FUTURE SCOPE**.. 26
13. **APPENDIX**... 27
    Source Code.. 28
    GitHub & Project Demo Link..................................... 40

1. Introduction

Project Overview

The smart fire management system includes a gas, flame, and temperature sensor to detect any environmental changes. 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 switchedon automatically. Emergency alerts are notified to the authorities and the Fire station. 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 of the fire effect as soon as possible. The system shall include a control panel, alarm initiating devices, notification appliances,and the accessory equipment necessary for a complete functioning fire alarm system. Internet of Things (IoT)-based intelligent fire detection and emergency response system that can control directional guidance intelligently according to the time and location of a disaster using fuzzy logic and the design of an integrated control system using sensor networks to address the problems with existing fire emergency response systems in times of fire disaster.The proposed IOT based fire alarm system basically detects fire at an early stage, generates an automatic alarm and notify the remote user or fire control station about the fire outbreak. This also tries to extinguish the fire.

Purpose

- To provide the an early warningof firexz
  - To give a detect the status of the room with IoT devices
  - To turn on sprinkler and exhaust fan when there is fire accident
  - To alert the occupants of the fire condition.
  - To send and store the temperature status in a cloud storage
  - To give a easy management system on dashboard
  - To give a overview of what’s happening to the user
  - To send a sms to the authorities when there is a fire accident
  - To increase the response times.
  - To provide the both prevention and protection

2. Literature survey

The situation is not ideal because the fire management system in houses and industries are not very reliable, efficient, cost-effective and does not have any advanced processing and does not have any features like an automatic alert system for admin and authorities and in many buildings . They are using older fire safety systems that doesn't can even activate the sprinkler system and all of they don't communicate with each other properly to prevent false alarm also monitor the entire system using applications.

Reference

https://www.nbmcw.com/article-report/others/intelligent-fire-alarm-systems-for-new-age-smart-buildings.html

https://www.researchgate.net/publication/280620907_Developed_Intelligent_Fire_alarm_system

https://pdfs.semanticscholar.org/f3e7/a7c0cf2d448be592421045033506e845e6c2.pdfhttps://www.mdpi.com/2224-2708/7/1/11

https://www.britsafe.in/publications-and-blogs/safety-management-magazine/safety-management- magazine/2021/intelligent-fire-alarm-systems-for-new-age-smart-buildings

https://www.researchgate.net/publication/353205967_IOT_Based_Fire_Detection_System

3. Ideation and Proposed solution

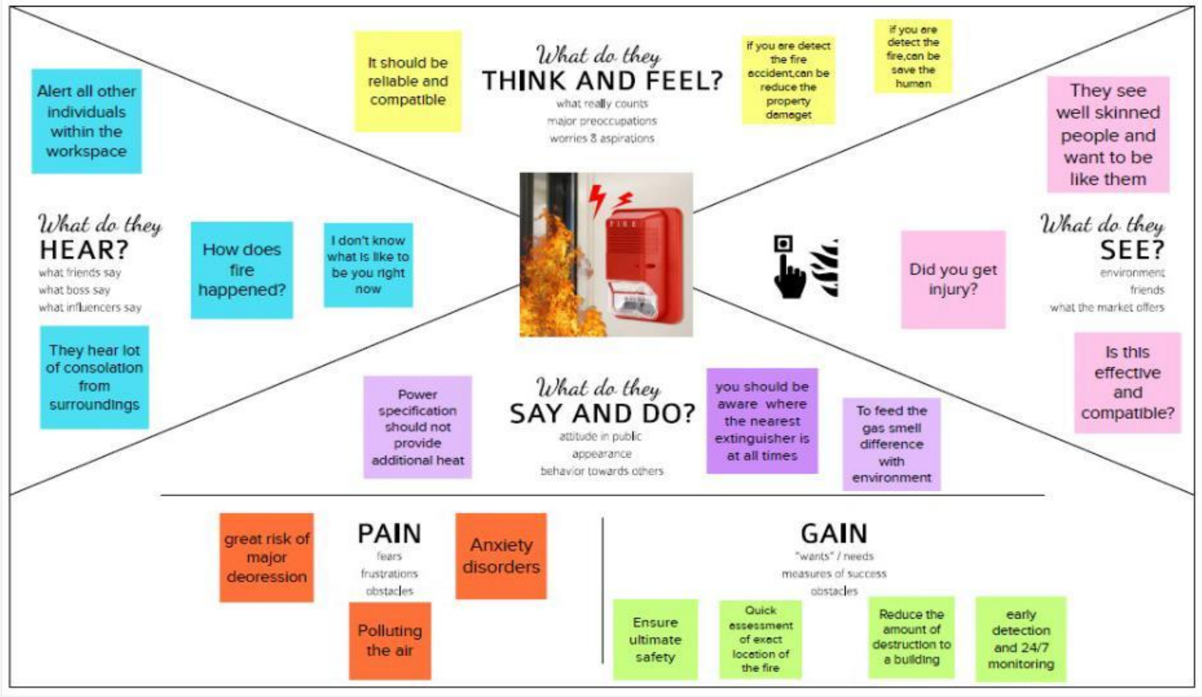
3.1 Empathy map canvas

- The empathy map canvas to capture the user Pains & Gains

- An empathy map is a simple, easy-to-digest visual that captures knowledge about a user’sbehaviours and attitudes

- It is a useful tool to helps 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’sperspective along with his or her goals and challenges.



What do they THINK AND FEEL?
what really counts
major preoccupations
worries 8 aspirations

It should be reliable and compatible

if you are detect the fire accident,can be reduce the property demeget

if you are detect the fire,can be save the human

What do they HEAR?
what friends say
what boss say
what influencers say

Alert all other individuals within the workspace

How does fire happened?

I don't know what is like to be you right now

They hear lot of consolation from surroundings

What do they SEE?
environment
friends
what the market offers

They see well skinned people and want to be like them

Did you get injury?

Is this effective and compatible?

What do they SAY AND DO?
attitude in public
appearance
behavior towards others

Power specification should not provide additional heat

you should be aware where the nearest extinguisher is at all times

To feed the gas smell difference with environment

PAIN
fears
frustrations
obstacles

great risk of major deoression

Anxiety disorders

Polluting the air

GAIN
"wants" / needs
measures of success
obstacles

Ensure ultimate safety

Quick assessment of exact location of the fire

Reduce the amount of destruction to a building

early detection and 24/7 monitoring

3.2 Ideation and 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 amount of creative solutions.The optimum size for a brainstorming group seems to be four members, and the optimum group consists of women as well as men. Brainstorming is a total-group effort. Breaking into smaller groups would defeat the purpose of the brainstorming session.

step 1: Team Gathering, Collaboration and Select the Problem Statement

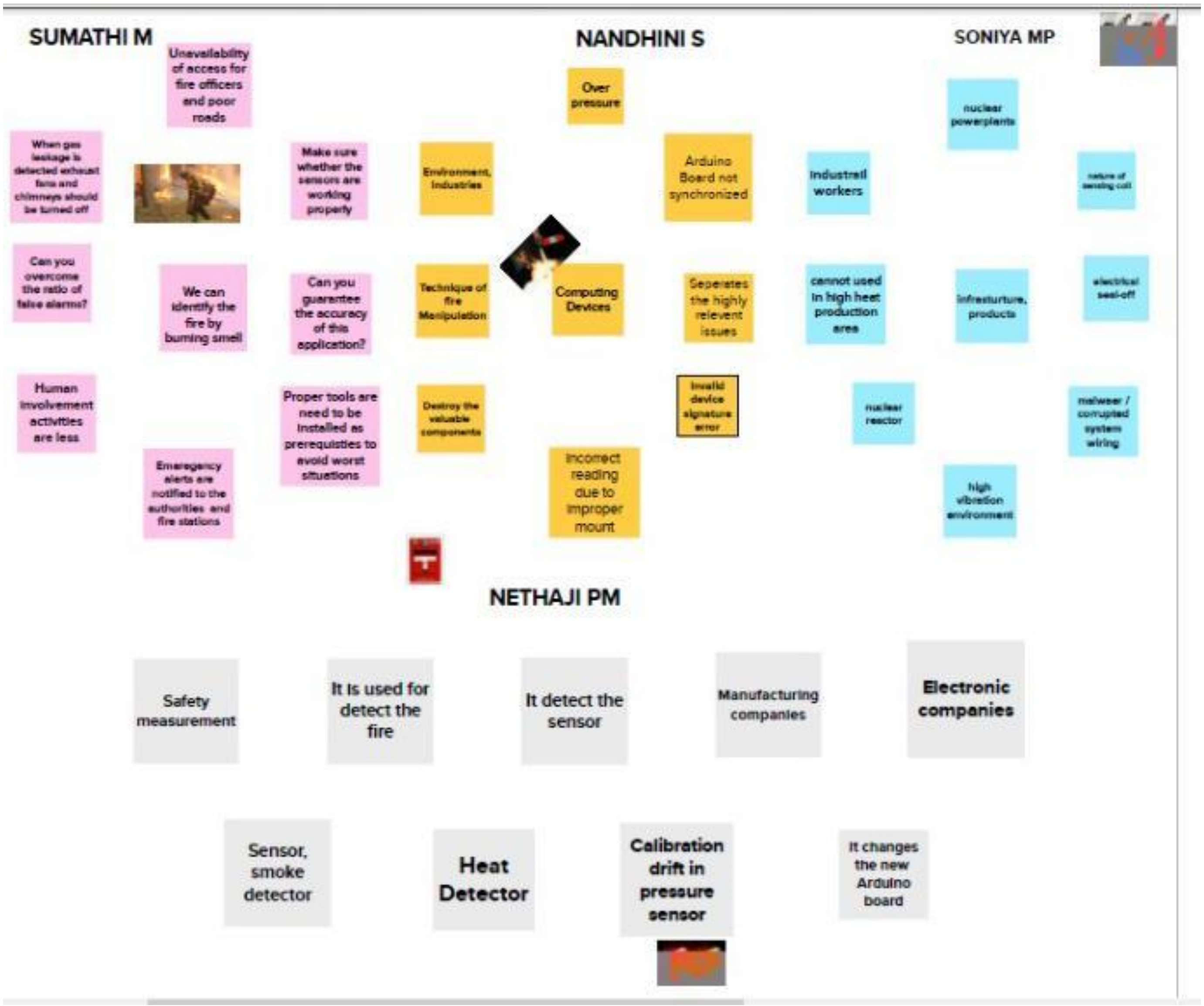
The problem should be simple rather than complex, so that the group can focus on a single target. The leader should have a list of categories, classifications, or leads (new uses, adaptation, modification, increase, decrease, substitute, rearrange, combine) that can be suggested to the group members if they seem to be getting off track. The leader also can have a few ideas about solutions ready to throw in when the group seems to lag.

Team was gathered in mural app for

collaborationThe team members are

Sumathi M
Nandhini S
Nethaji PM
Soniya MP

step 2 :Brainstorm, Idea Listing and Grouping



SUMATHI M

Unevailability of access for fire officers and poor roads

When gas leakage is detected exhaust fans and chimneys should be turned off

Make sure whether the sensors are working properly

Can you overcome the ratio of false alarms?

We can identify the fire by burning smell

Can you guarantee the accuracy of this application?

Human involvement activities are less

Proper tools are need to be installed as prerequisties to avoid worst situations

Emeregency alerts are notified to the authorities and fire stations

NANDHINI S

Over pressure

Environment, Industries

Arduino Board not synchronized

Technique of fire Manipulation

Computing Devices

Seperates the highly relevent issues

Destroy the valuable components

Invalid device signature error

Incorrect reading due to improper mount

SONIYA MP

nuclear powerplants

Industrail workers

nature of sensing coil

cannot used in high heat production area

infresturture, products

electrical seal-off

nuclear reactor

malwear / corrupted system wiring

high vibration environment

NETHAJI PM

Safety measurement

It is used for detect the fire

It detect the sensor

Manufacturing companies

Electronic companies

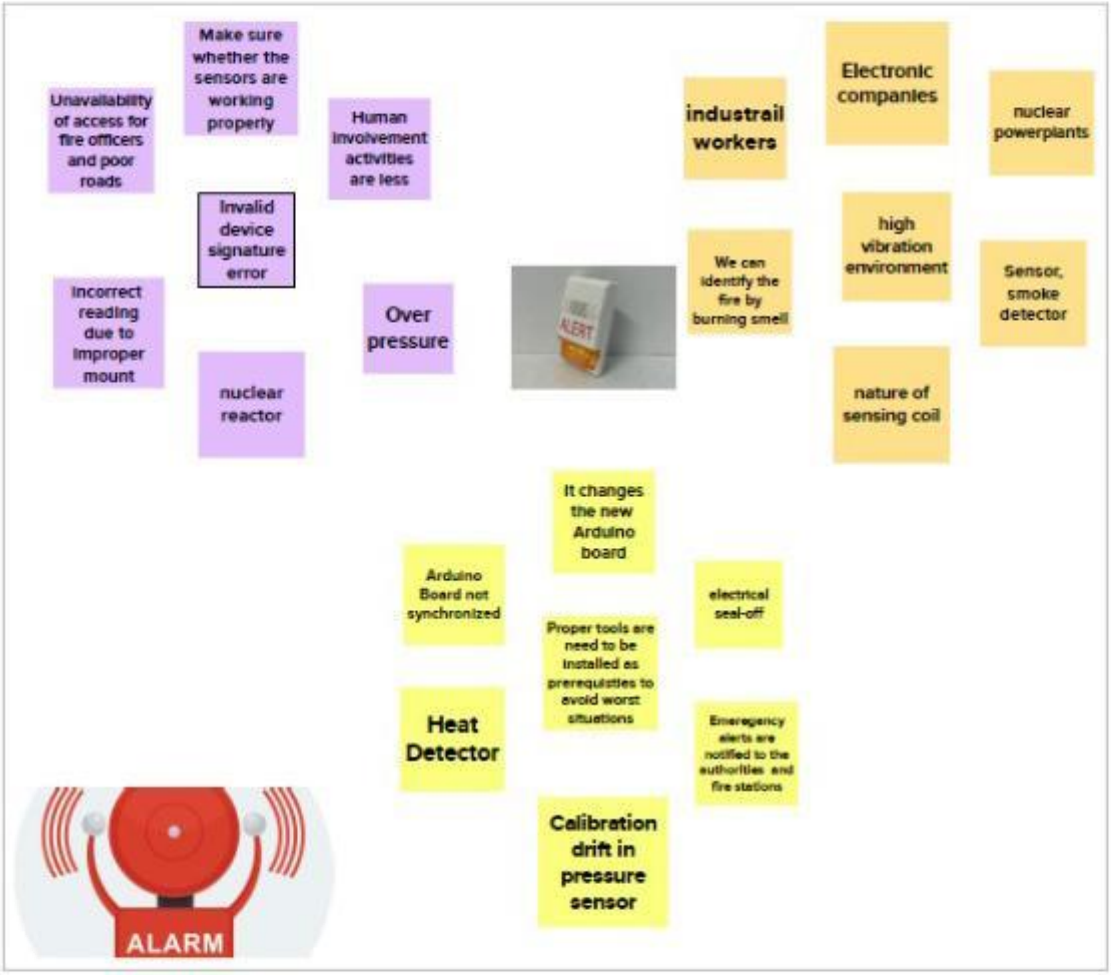
Sensor, smoke detector

Heat Detector

Calibration drift in pressure sensor

It changes the new Arduino board

step 3 :



Unavailability of access for fire officers and poor roads

Make sure whether the sensors are working properly

Human involvement activities are less

Invalid device signature error

Incorrect reading due to improper mount

nuclear reactor

Over pressure

industrail workers

Electronic companies

nuclear powerplants

We can identify the fire by burning smell

high vibration environment

Sensor, smoke detector

nature of sensing coil

It changes the new Arduino board

Arduino Board not synchronized

electrical seal-off

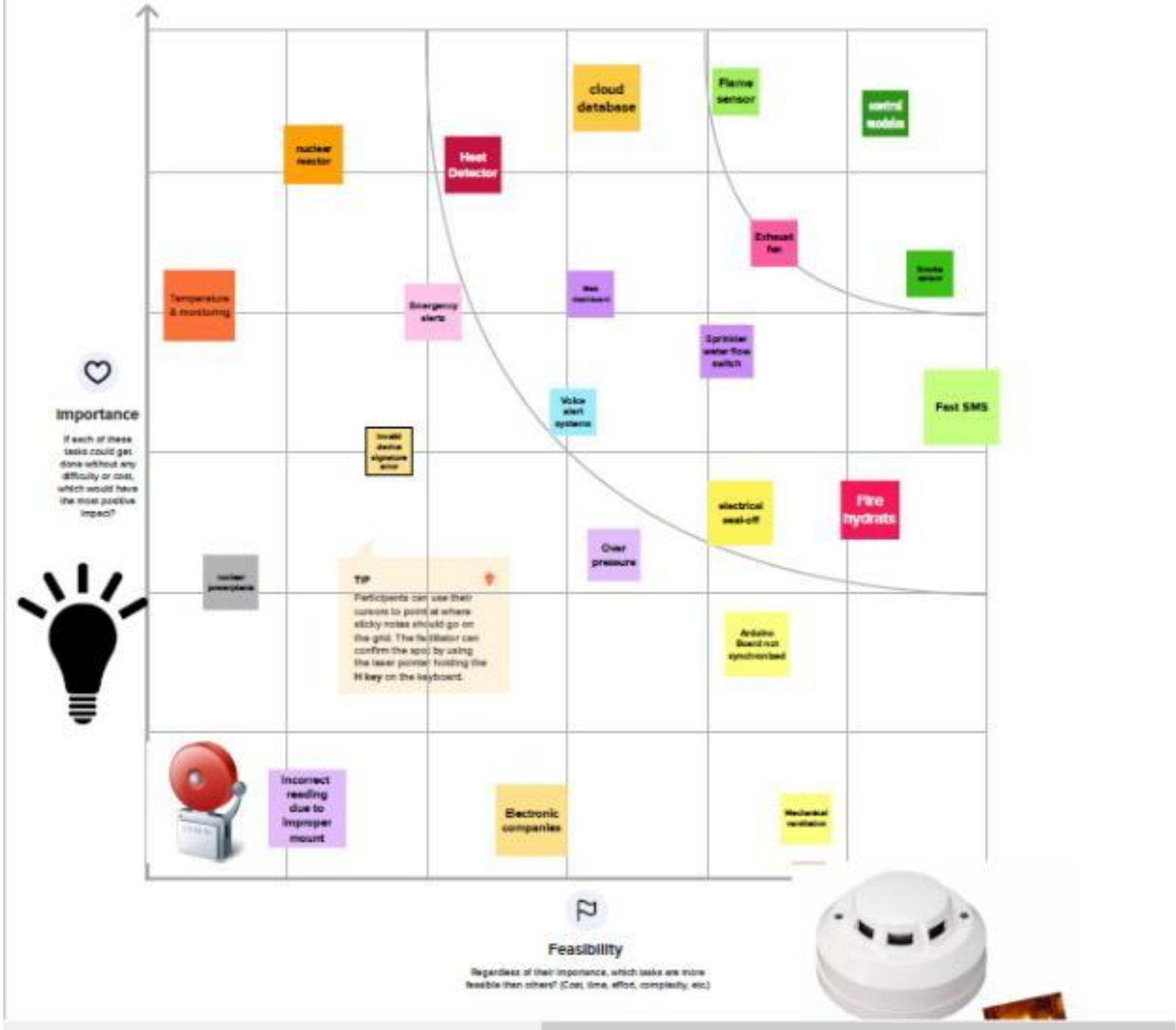
Proper tools are need to be installed as prerequisties to avoid worst situations

Heat Detector

Emeregency alerts are notified to the authorities and fire stations

Calibration drift in pressure sensor

Step4: Idea Prioritization



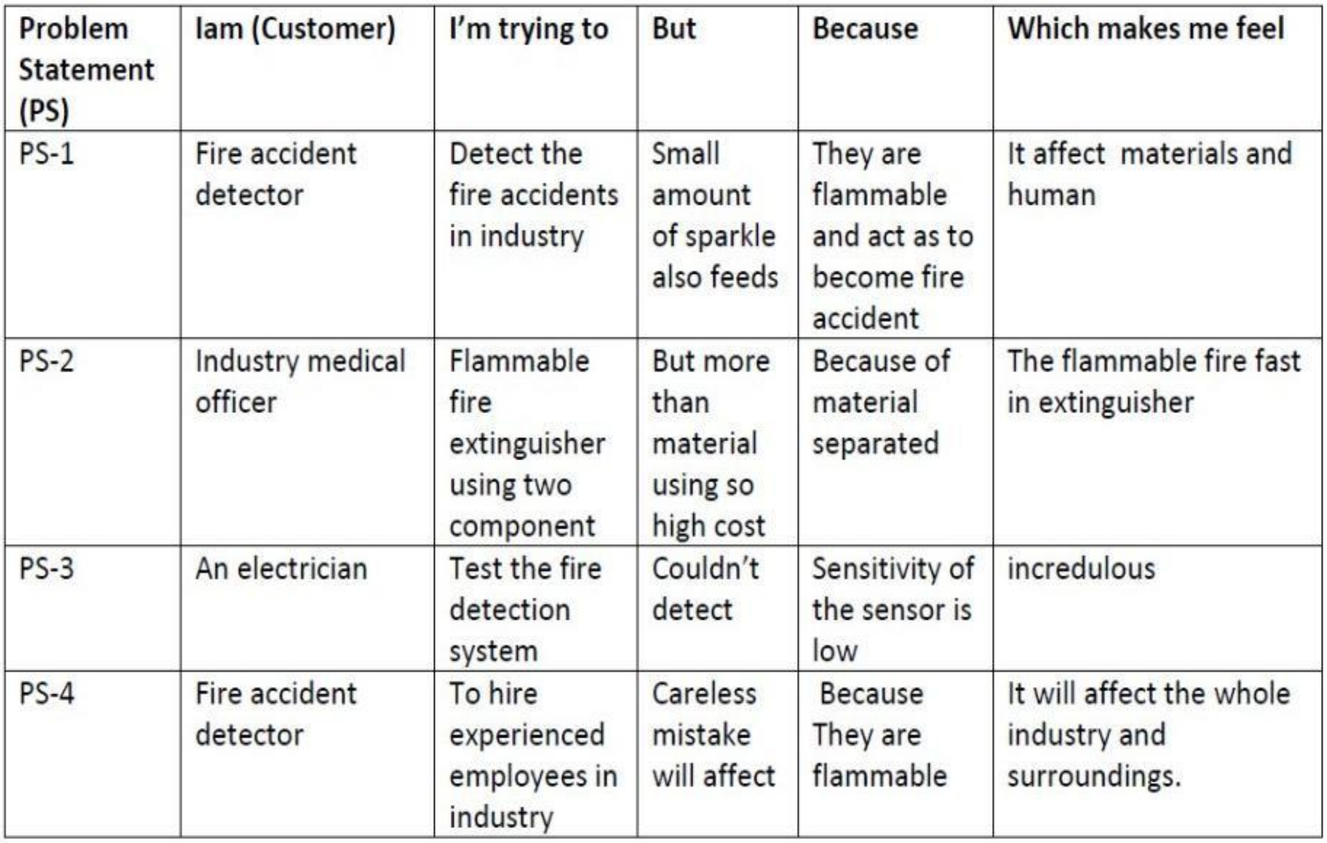
If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?

Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the **H key** on the keyboard.

Regardless of their importance, which tasks are more feasible than others? (Cost, time, effort, complexity, etc.)

Problem Statement Definition

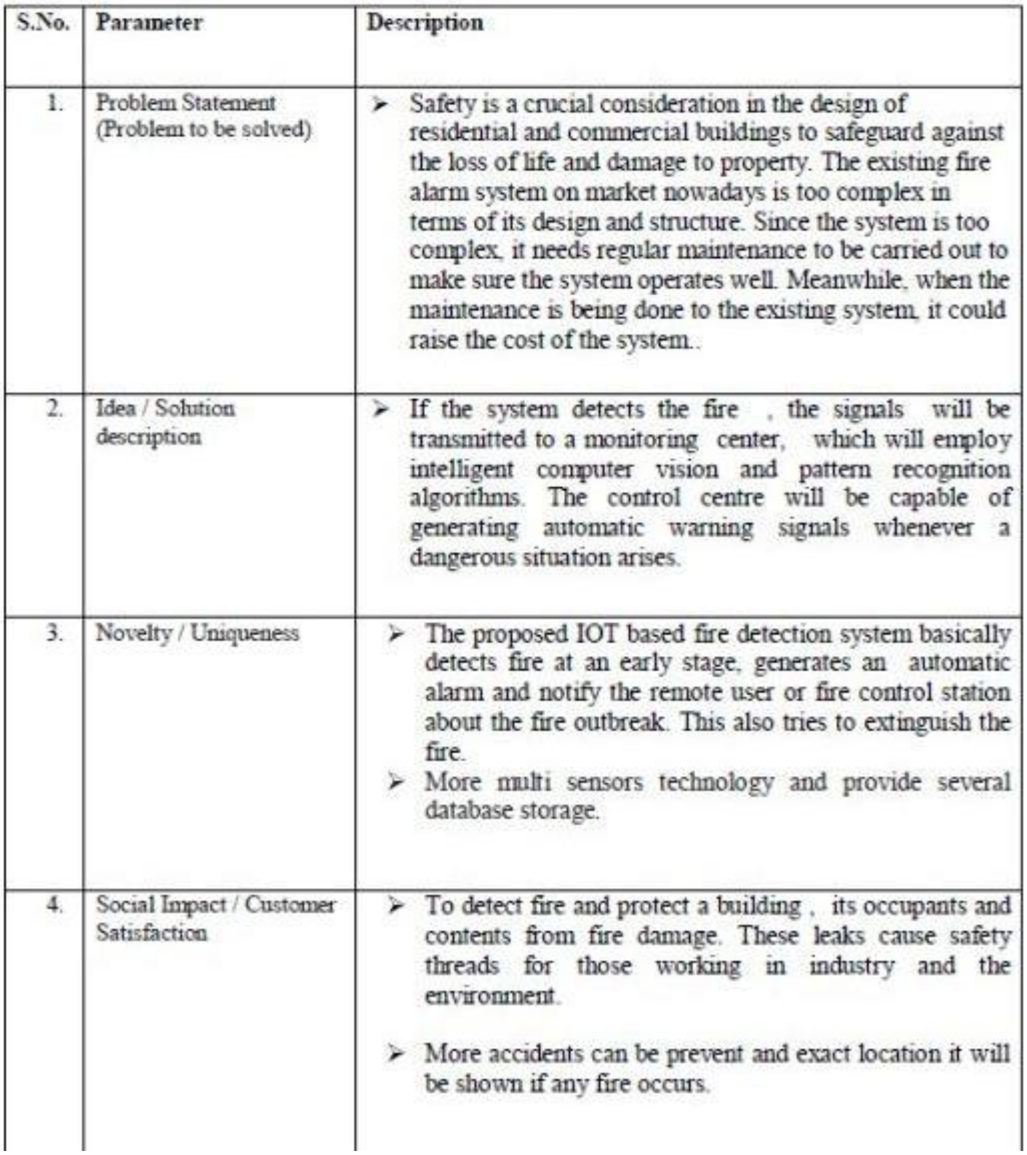
The fire management system in houses and industries are not very reliable , efficient,costeffective and does not have any advance processing and does not have any features like automatic alert system for admin and authorities and in many buildings there are using older firesafety system that doesn’t can even activate the sprinkler system and all of they don't communicate with each other properly to prevent false alarm also monitor the entire system using a applications.



Problem Statement (PS)	Iam (Customer)	I’m trying to	But	Because	Which makes me feel
PS-1	Fire accident detector	Detect the fire accidents in industry	Small amount of sparkle also feeds	They are flammable and act as to become fire accident	It affect materials and human
PS-2	Industry medical officer	Flammable fire extinguisher using two component	But more than material using so high cost	Because of material separated	The flammable fire fast in extinguisher
PS-3	An electrician	Test the fire detection system	Couldn’t detect	Sensitivity of the sensor is low	incredulous
PS-4	Fire accident detector	To hire experienced employees in industry	Careless mistake will affect	Because They are flammable	It will affect the whole industry and surroundings.

Proposed Solution

The project is designed with a low cost and all level users can have one for a safety purpose. This project therefore seeks to design a fire alarm system that will continuously monitor the presence of significant amount of heat and activate an alarm simultaneously switch off the mains of the building, send a Short Message Service(SMS) alert and extinguish the fire as a safety measure to contain the situation



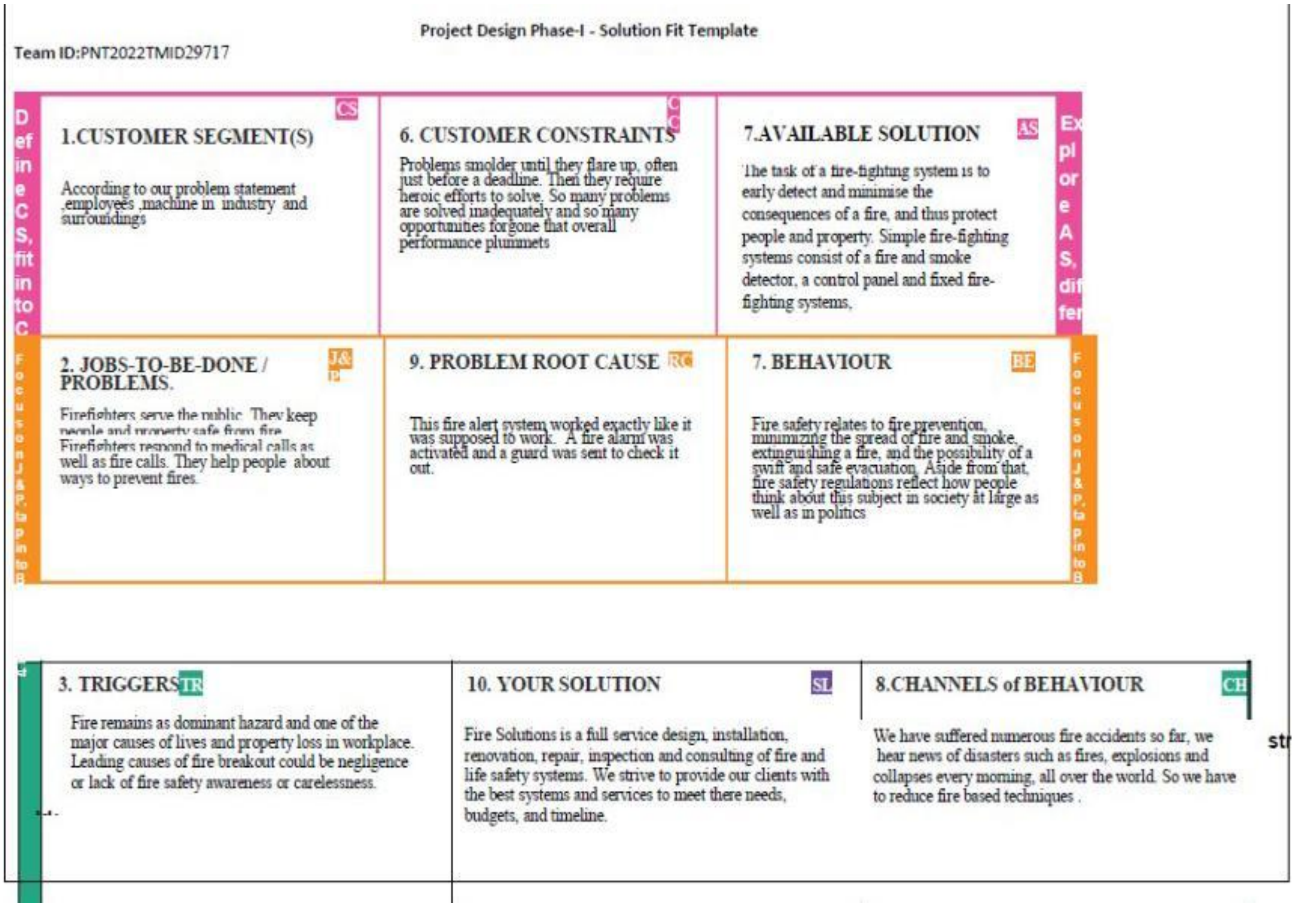
S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	➢ Safety is a crucial consideration in the design of residential and commercial buildings to safeguard against the loss of life and damage to property. The existing fire alarm system on market nowadays is too complex in terms of its design and structure. Since the system is too complex, it needs regular maintenance to be carried out to make sure the system operates well. Meanwhile, when the maintenance is being done to the existing system, it could raise the cost of the system..
2.	Idea / Solution description	➢ If the system detects the fire , the signals will be transmitted to a monitoring center, which will employ intelligent computer vision and pattern recognition algorithms. The control centre will be capable of generating automatic warning signals whenever a dangerous situation arises.
3.	Novelty / Uniqueness	➢ The proposed IOT based fire detection system basically detects fire at an early stage, generates an automatic alarm and notify the remote user or fire control station about the fire outbreak. This also tries to extinguish the fire. ➢ More multi sensors technology and provide several database storage.
4.	Social Impact / Customer Satisfaction	➢ To detect fire and protect a building , its occupants and contents from fire damage. These leaks cause safety threads for those working in industry and the environment. ➢ More accidents can be prevent and exact location it will be shown if any fire occurs.

Problem statement:

When fire alarm panels are in trouble condition, it can be difficult to find the root cause of the problem. Trouble signals occur due to ground faults, circuit problems, battery faults, or other failures within the system.

Safety is a crucial consideration in the design of residential and commercial buildings in order to safeguard against loss of life and damage to property.

The existing fire alarm system in market nowadays is too complex in terms of its design and structure. Since the system is too complex, it needs regular maintenance to be carried out to make sure the system operates well. Meanwhile, when the maintenance is being done to the existing system, it could raise the cost of the system.



Project Design Phase-I - Solution Fit Template

Team ID:PNT2022TMID29717

Define CS, fit into C

1.CUSTOMER SEGMENT(S) CS

According to our problem statement ,employees ,machine in industry and surroundings

6. CUSTOMER CONSTRAINTS CC

Problems smolder until they flare up, often just before a deadline. Then they require heroic efforts to solve. So many problems are solved inadequately and so many opportunities forgone that overall performance plummets

7.AVAILABLE SOLUTION AS

The task of a fire-fighting system is to early detect and minimise the consequences of a fire, and thus protect people and property. Simple fire-fighting systems consist of a fire and smoke detector, a control panel and fixed fire-fighting systems,

Explore AS, differ

Focus on J&P, tap into B

2. JOBS-TO-BE-DONE / PROBLEMS. J&P

Firefighters serve the public. They keep people and property safe from fire. Firefighters respond to medical calls as well as fire calls. They help people about ways to prevent fires.

9. PROBLEM ROOT CAUSE RC

This fire alert system worked exactly like it was supposed to work. A fire alarm was activated and a guard was sent to check it out.

7. BEHAVIOUR BE

Fire safety relates to fire prevention, minimizing the spread of fire and smoke, extinguishing a fire, and the possibility of a swift and safe evacuation. Aside from that, fire safety regulations reflect how people think about this subject in society at large as well as in politics

Focus on J&P, tap into B

3. TRIGGERS TR

Fire remains as dominant hazard and one of the major causes of lives and property loss in workplace. Leading causes of fire breakout could be negligence or lack of fire safety awareness or carelessness.

10. YOUR SOLUTION SL

Fire Solutions is a full service design, installation, renovation, repair, inspection and consulting of fire and life safety systems. We strive to provide our clients with the best systems and services to meet there needs, budgets, and timeline.

8.CHANNELS of BEHAVIOUR CH

We have suffered numerous fire accidents so far, we hear news of disasters such as fires, explosions and collapses every morning, all over the world. So we have to reduce fire based techniques .

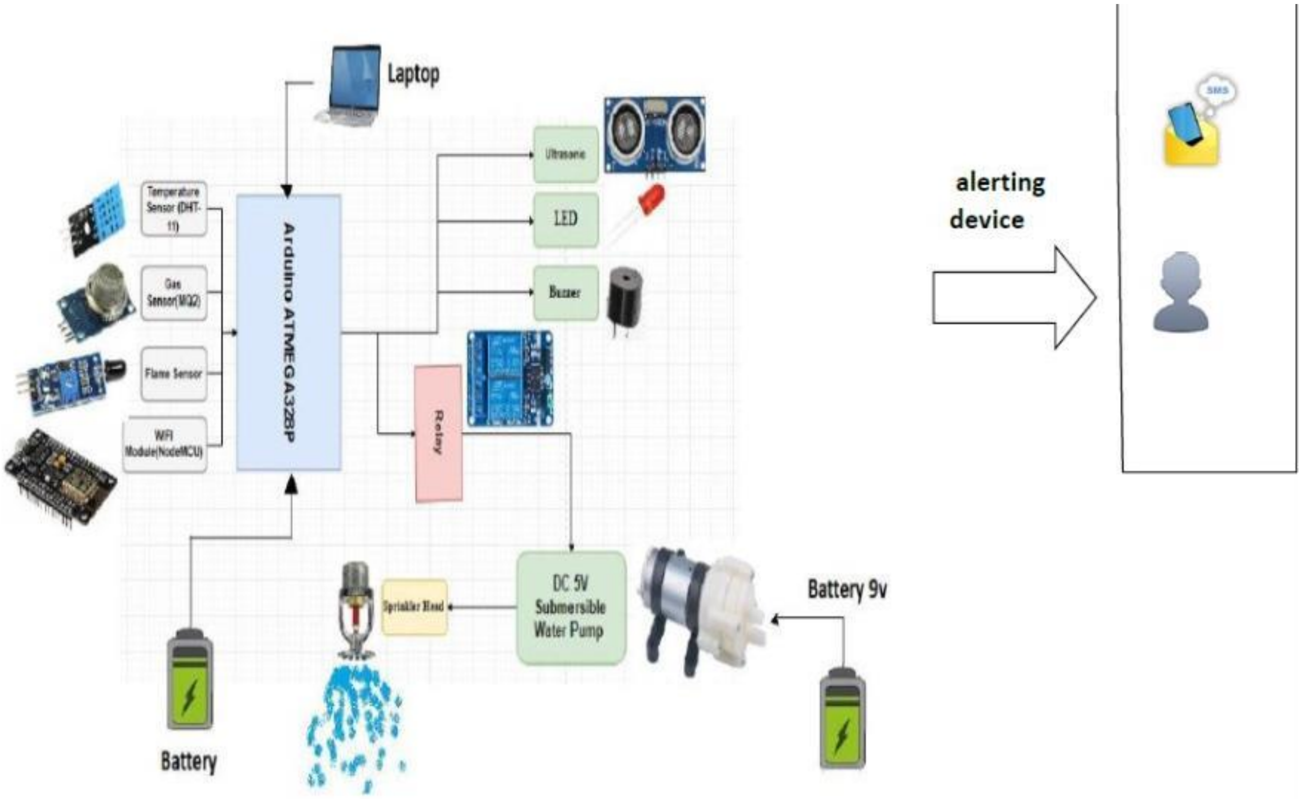
str

Solution architecture

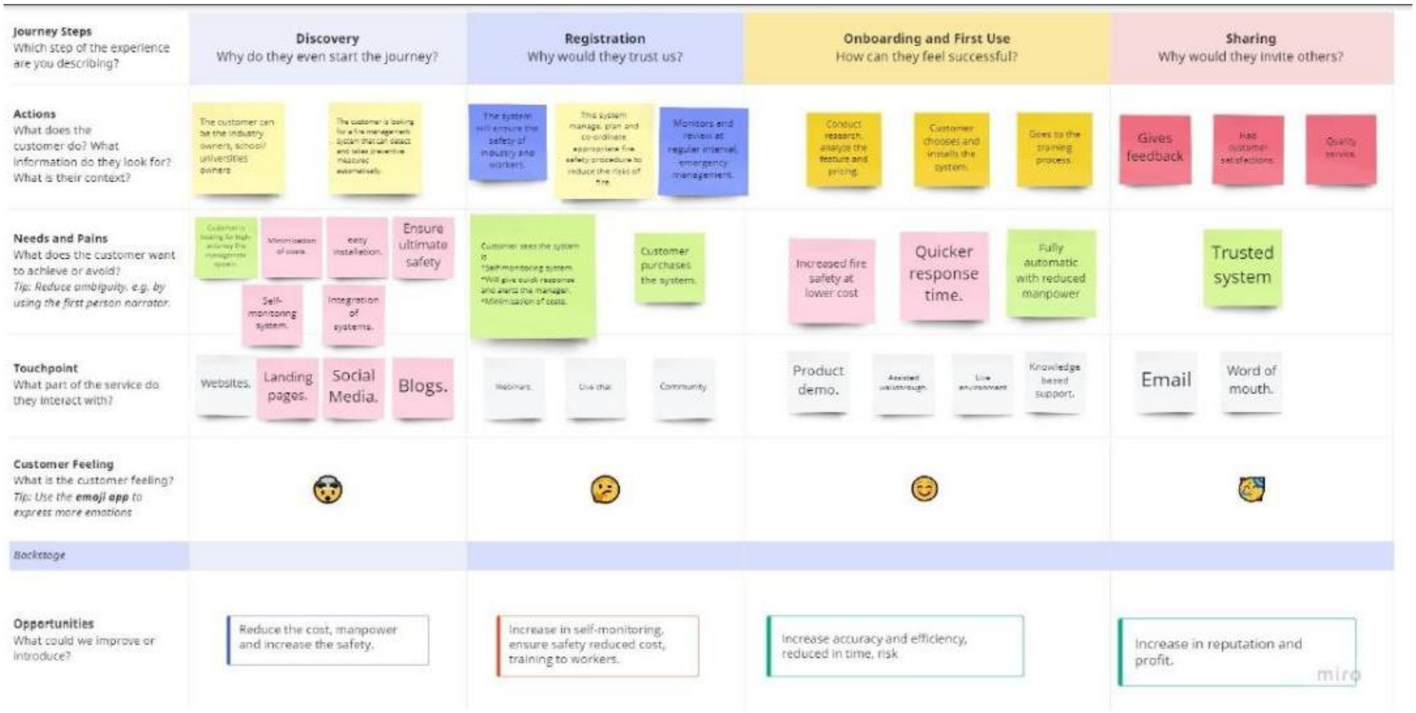
Solution architecture is a complex process − with many sub-processes − that bridges the gap between business problems and technology solutions.

GOALS :

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.



Customer journey:



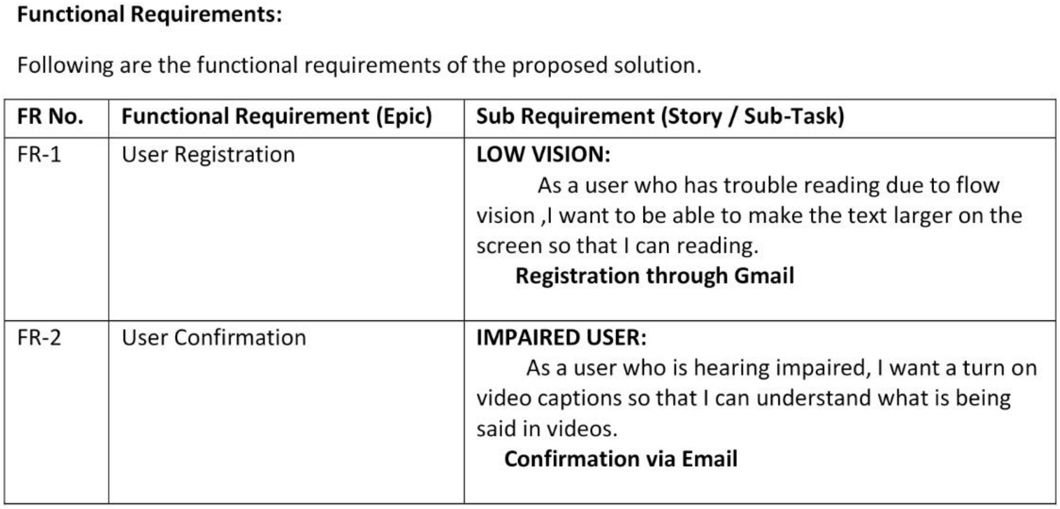
Journey Steps Which step of the experience are you describing?	**Discovery** Why do they even start the journey?	**Registration** Why would they trust us?	**Onboarding and First Use** How can they feel successful?	**Sharing** Why would they invite others?
Actions What does the customer do? What information do they look for? What is their context?	The customer can be the industry owners, school/ universities owners The customer is looking for a fire management system that can detect and takes preventive measures automatically.	The system will ensure the safety of industry and workers. This system manage, plan and co-ordinate appropriate fire safety procedure to reduce the risks of fire. Monitors and review at regular interval, emergency management.	Conduct research, analyze the feature and pricing. Customer chooses and installs the system. Goes to the training process.	Gives feedback Had customer satisfactions. Quality service.
Needs and Pains What does the customer want to achieve or avoid? *Tip: Reduce ambiguity. e.g. by using the first person narrator.*	Customer is looking for high accuracy fire management system. Minimization of costs. easy installation. Ensure ultimate safety Self-monitoring system. Integration of systems.	Customer sees the system is *Self-monitoring system. *Will give quick response and alerts the manager. *Minimization of costs. Customer purchases the system.	Increased fire safety at lower cost Quicker response time. Fully automatic with reduced manpower	Trusted system
Touchpoint What part of the service do they interact with?	Websites. Landing pages. Social Media. Blogs.	Webinars. Live chat Community	Product demo. Assisted walkthrough Live environment Knowledge based support.	Email Word of mouth.
Customer Feeling What is the customer feeling? *Tip: Use the **emoji app** to express more emotions*	😲	😕	😊	🥳
Backstage				
Opportunities What could we improve or introduce?	Reduce the cost, manpower and increase the safety.	Increase in self-monitoring, ensure safety reduced cost, training to workers.	Increase accuracy and efficiency, reduced in time, risk	Increase in reputation and profit.

miro

4.Requirement analysis

Functional Requirements

- A functional requirement defines a function of a system or its component, where afunction is
- described as a specification of behaviour between inputs and outputs.
- It specifies “what should the software system do?”
- Defined at a component level
- Usually easy to define
- Helps you verify the functionality of the software



Functional Requirements:

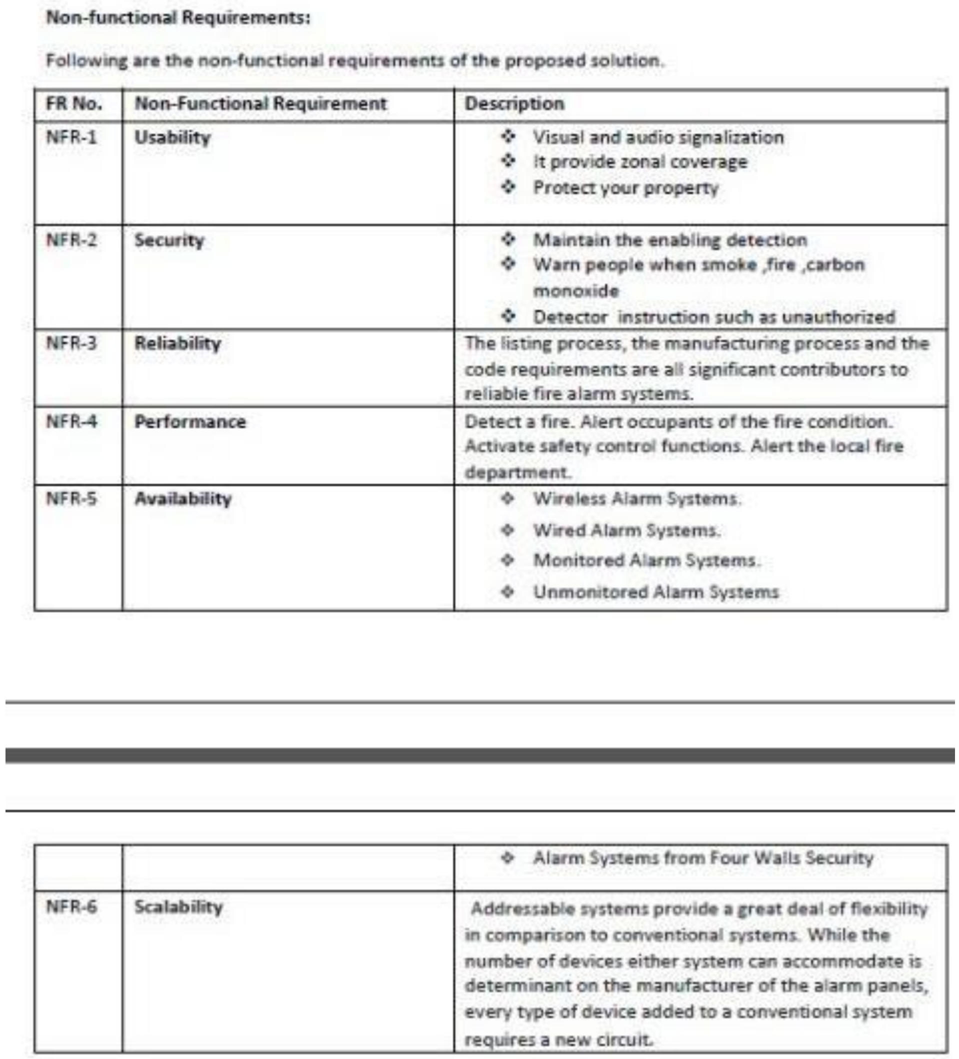
Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	**LOW VISION:** As a user who has trouble reading due to flow vision ,I want to be able to make the text larger on the screen so that I can reading. **Registration through Gmail**
FR-2	User Confirmation	**IMPAIRED USER:** As a user who is hearing impaired, I want a turn on video captions so that I can understand what is being said in videos. **Confirmation via Email**

Non Functional Requirements

- A non-functional requirement defines the quality attribute of a software system
- It places constraint on “How should the software system fulfil the functionalrequirements?”
- It is not mandatory
- Applied to system as a whole
- Usually more difficult to define

- Helps you verify the performance of the software



Non-functional Requirements:

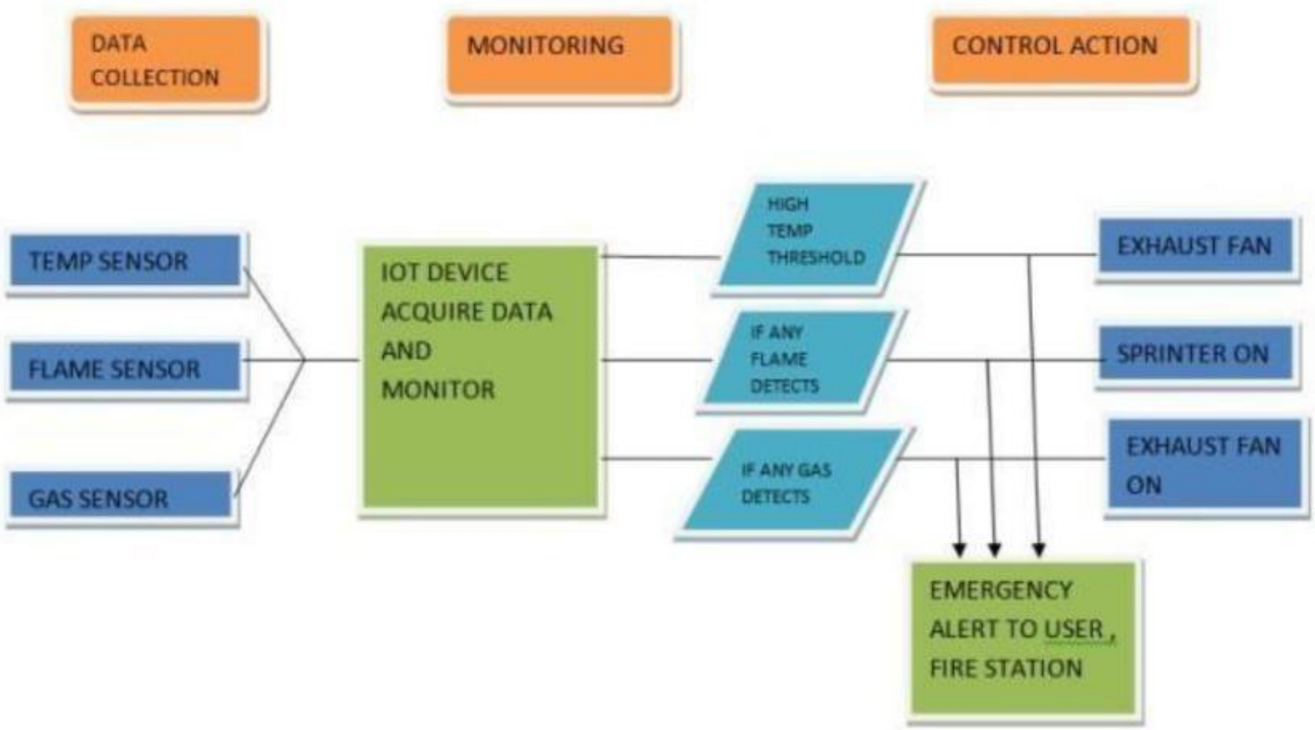
Following are the non-functional requirements of the proposed solution.

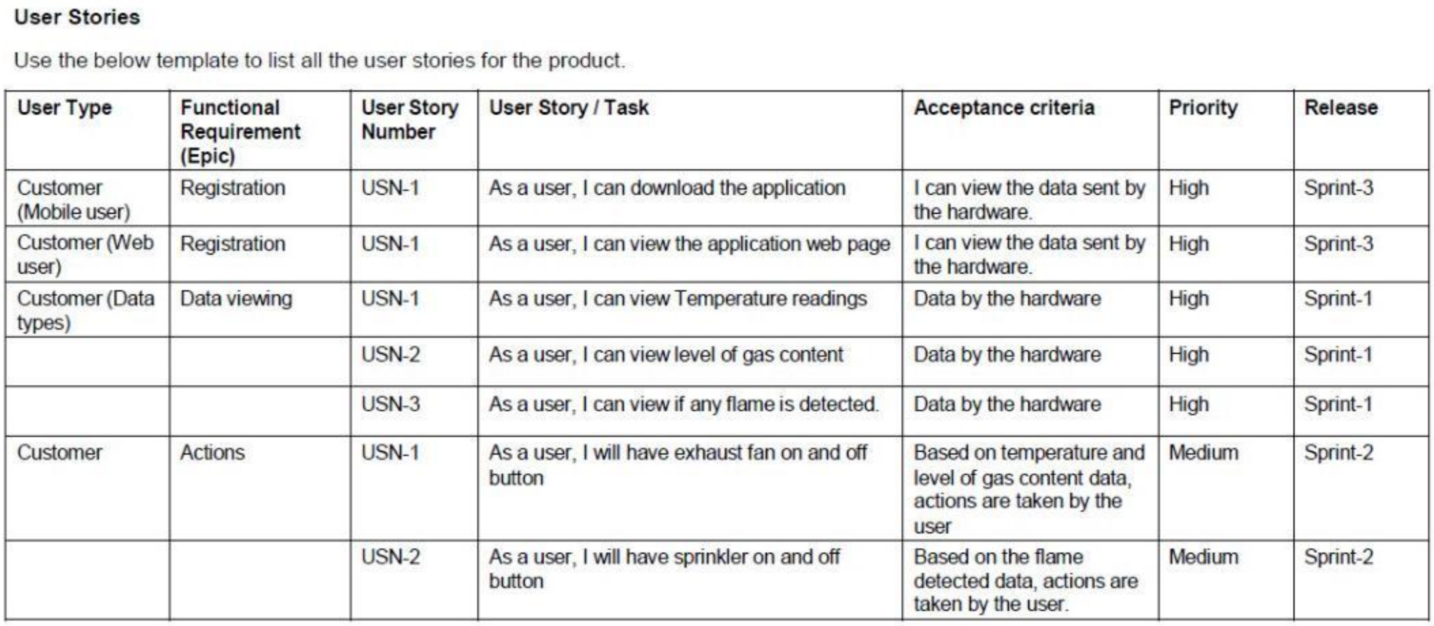
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	❖ Visual and audio signalization ❖ It provide zonal coverage ❖ Protect your property
NFR-2	**Security**	❖ Maintain the enabling detection ❖ Warn people when smoke ,fire ,carbon monoxide ❖ Detector instruction such as unauthorized
NFR-3	**Reliability**	The listing process, the manufacturing process and the code requirements are all significant contributors to reliable fire alarm systems.
NFR-4	**Performance**	Detect a fire. Alert occupants of the fire condition. Activate safety control functions. Alert the local fire department.
NFR-5	**Availability**	❖ Wireless Alarm Systems. ❖ Wired Alarm Systems. ❖ Monitored Alarm Systems. ❖ Unmonitored Alarm Systems ❖ Alarm Systems from Four Walls Security
NFR-6	**Scalability**	Addressable systems provide a great deal of flexibility in comparison to conventional systems. While the number of devices either system can accommodate is determinant on the manufacturer of the alarm panels, every type of device added to a conventional system requires a new circuit.

5. PROJECT DESIGN :

Dataflow Diagram

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.



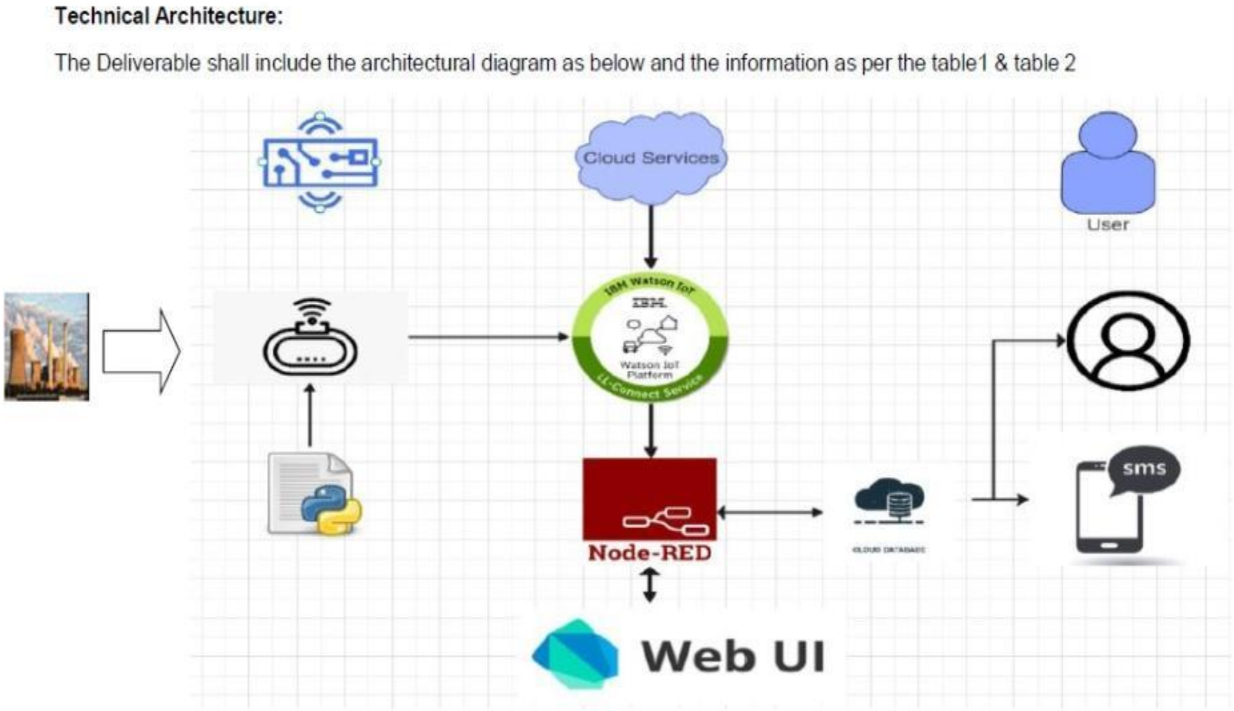


User Stories

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

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can download the application	I can view the data sent by the hardware.	High	Sprint-3
Customer (Web user)	Registration	USN-1	As a user, I can view the application web page	I can view the data sent by the hardware.	High	Sprint-3
Customer (Data types)	Data viewing	USN-1	As a user, I can view Temperature readings	Data by the hardware	High	Sprint-1
		USN-2	As a user, I can view level of gas content	Data by the hardware	High	Sprint-1
		USN-3	As a user, I can view if any flame is detected.	Data by the hardware	High	Sprint-1
Customer	Actions	USN-1	As a user, I will have exhaust fan on and off button	Based on temperature and level of gas content data, actions are taken by the user	Medium	Sprint-2
		USN-2	As a user, I will have sprinkler on and off button	Based on the flame detected data, actions are taken by the user.	Medium	Sprint-2

Technical Architecture



Technical Architecture:

The Deliverable shall include the architectural diagram as below and the information as per the table1 & table 2

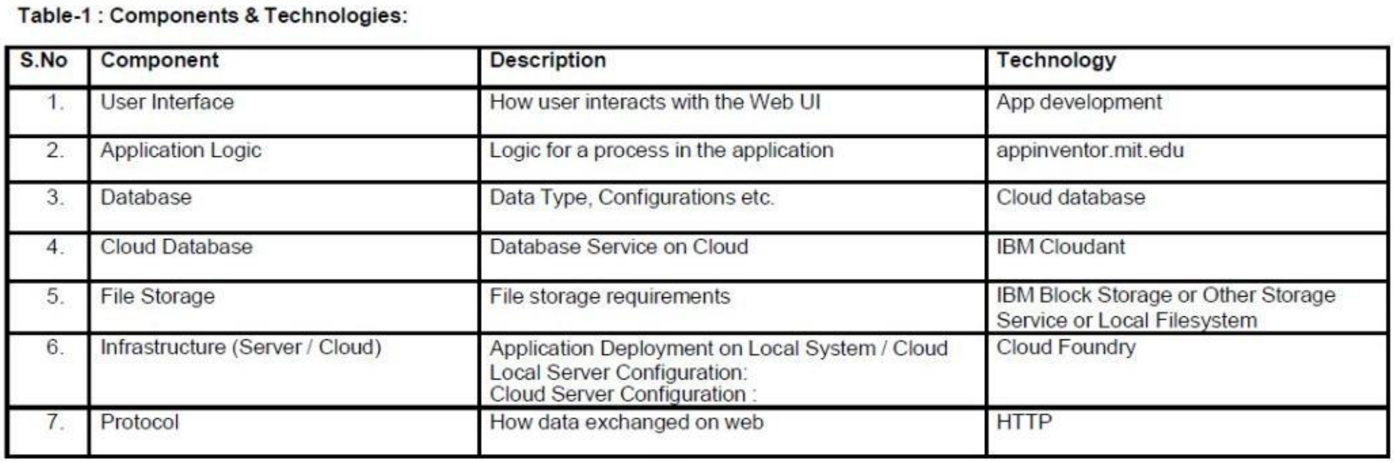


Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	How user interacts with the Web UI	App development
2.	Application Logic	Logic for a process in the application	appinventor.mit.edu
3.	Database	Data Type, Configurations etc.	Cloud database
4.	Cloud Database	Database Service on Cloud	IBM Cloudant
5.	File Storage	File storage requirements	IBM Block Storage or Other Storage Service or Local Filesystem
6.	Infrastructure (Server / Cloud)	Application Deployment on Local System / Cloud Local Server Configuration: Cloud Server Configuration :	Cloud Foundry
7.	Protocol	How data exchanged on web	HTTP

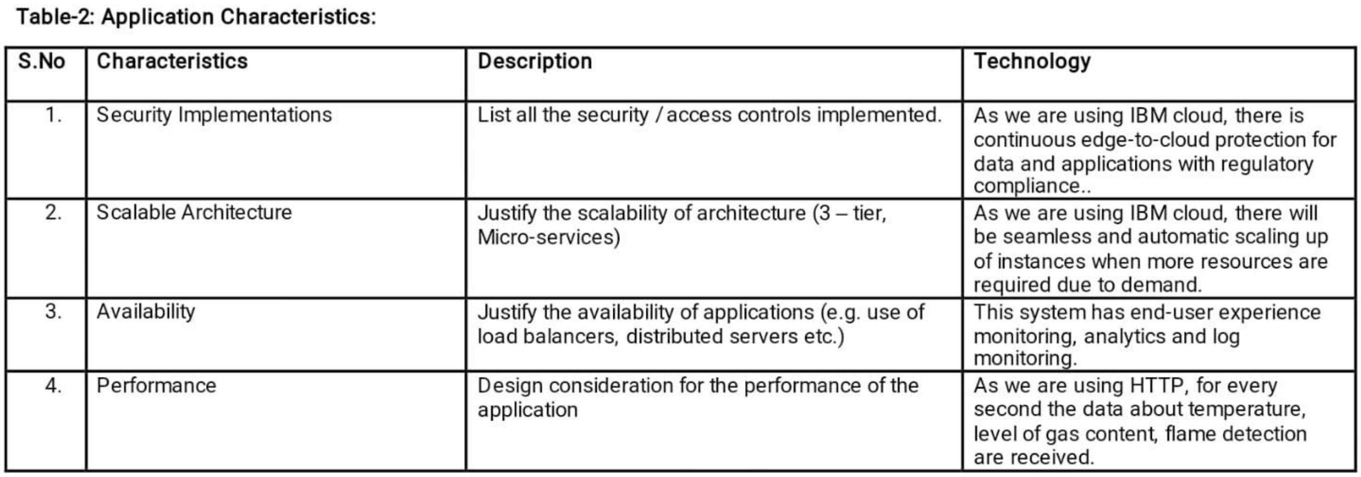
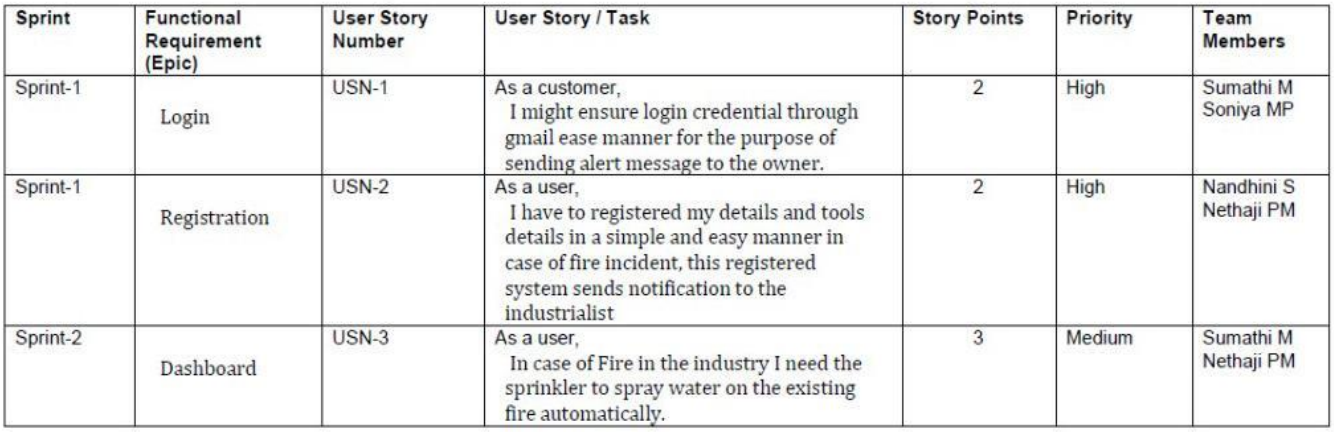


Table-2: Application Characteristics:

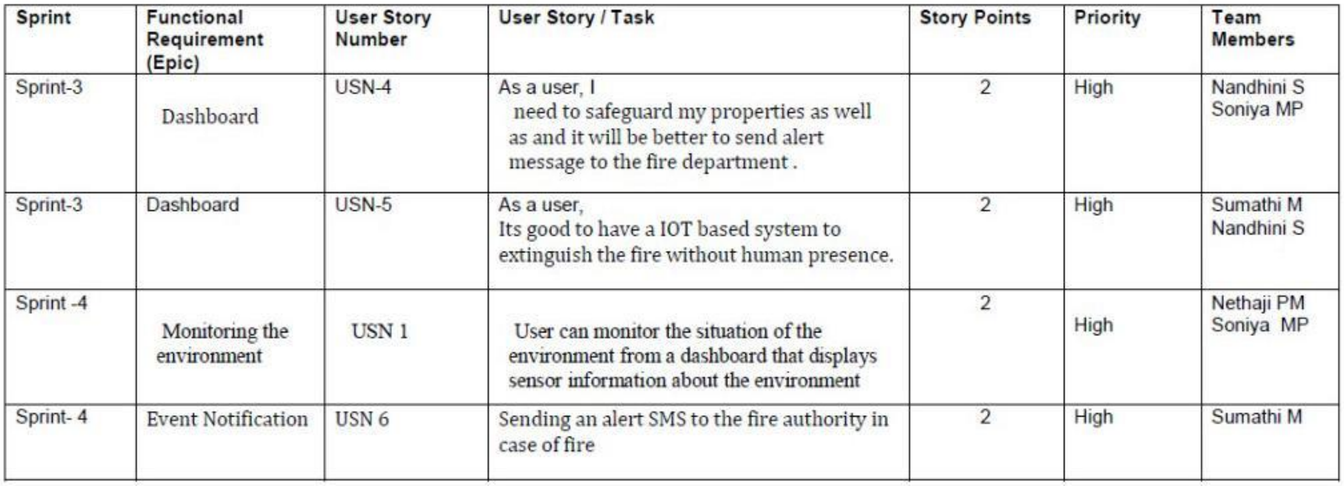
S.No	Characteristics	Description	Technology
1.	Security Implementations	List all the security / access controls implemented.	As we are using IBM cloud, there is continuous edge-to-cloud protection for data and applications with regulatory compliance..
2.	Scalable Architecture	Justify the scalability of architecture (3 – tier, Micro-services)	As we are using IBM cloud, there will be seamless and automatic scaling up of instances when more resources are required due to demand.
3.	Availability	Justify the availability of applications (e.g. use of load balancers, distributed servers etc.)	This system has end-user experience monitoring, analytics and log monitoring.
4.	Performance	Design consideration for the performance of the application	As we are using HTTP, for every second the data about temperature, level of gas content, flame detection are received.

6 . Project design and planning

Sprint planning and estimation

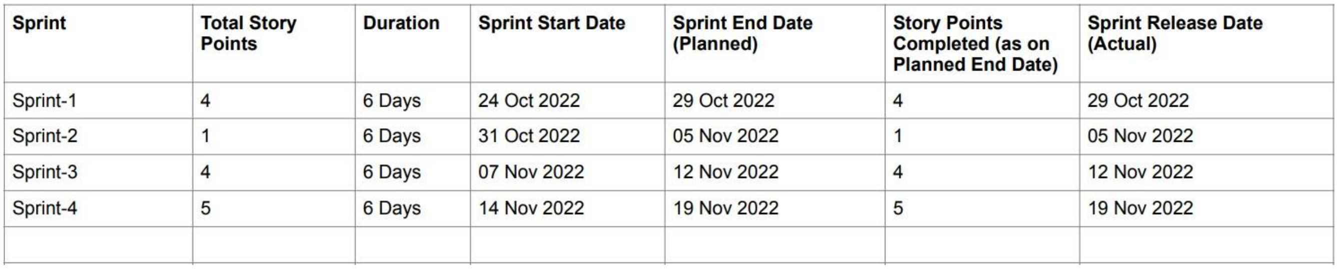


Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Login	USN-1	As a customer, I might ensure login credential through gmail ease manner for the purpose of sending alert message to the owner.	2	High	Sumathi M Soniya MP
Sprint-1	Registration	USN-2	As a user, I have to registered my details and tools details in a simple and easy manner in case of fire incident, this registered system sends notification to the industrialist	2	High	Nandhini S Nethaji PM
Sprint-2	Dashboard	USN-3	As a user, In case of Fire in the industry I need the sprinkler to spray water on the existing fire automatically.	3	Medium	Sumathi M Nethaji PM



Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-3	Dashboard	USN-4	As a user, I need to safeguard my properties as well as and it will be better to send alert message to the fire department .	2	High	Nandhini S Soniya MP
Sprint-3	Dashboard	USN-5	As a user, Its good to have a IOT based system to extinguish the fire without human presence.	2	High	Sumathi M Nandhini S
Sprint -4	Monitoring the environment	USN 1	User can monitor the situation of the environment from a dashboard that displays sensor information about the environment	2	High	Nethaji PM Soniya MP
Sprint- 4	Event Notification	USN 6	Sending an alert SMS to the fire authority in case of fire	2	High	Sumathi M

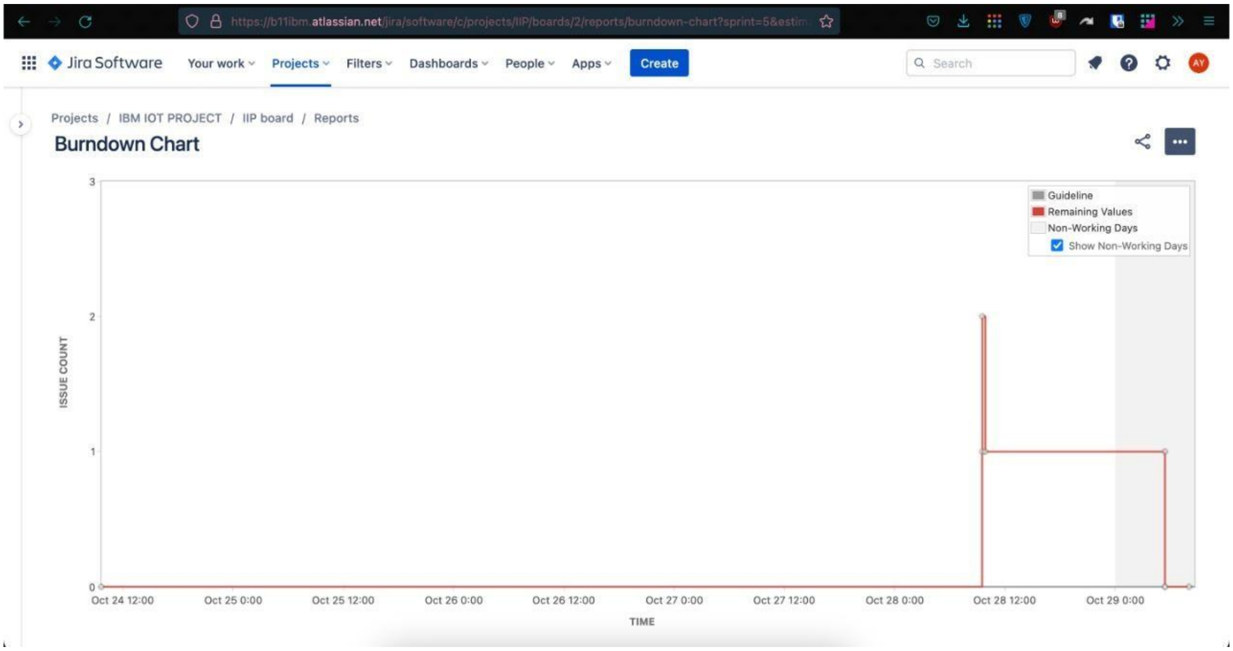
Sprint delivery schedule



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	4	6 Days	24 Oct 2022	29 Oct 2022	4	29 Oct 2022
Sprint-2	1	6 Days	31 Oct 2022	05 Nov 2022	1	05 Nov 2022
Sprint-3	4	6 Days	07 Nov 2022	12 Nov 2022	4	12 Nov 2022
Sprint-4	5	6 Days	14 Nov 2022	19 Nov 2022	5	19 Nov 2022

Reports from JIRA

Sprint 1

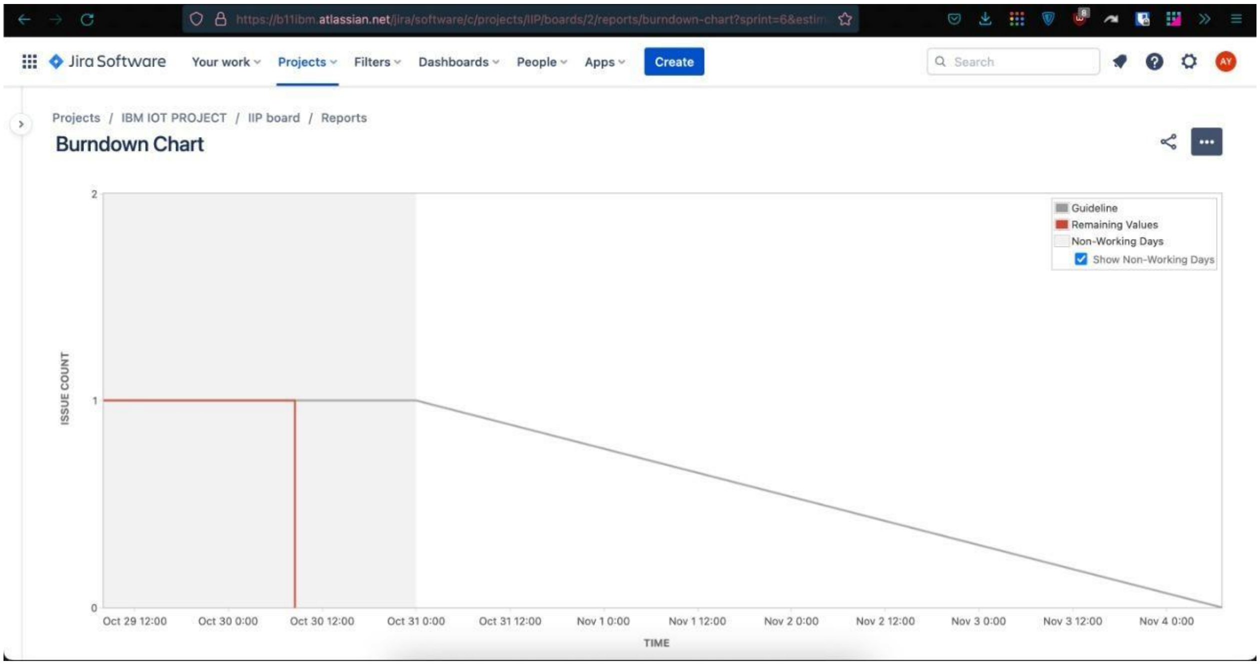


https://b11ibm.atlassian.net/jira/software/c/projects/IIP/boards/2/reports/burndown-chart?sprint=5&estim

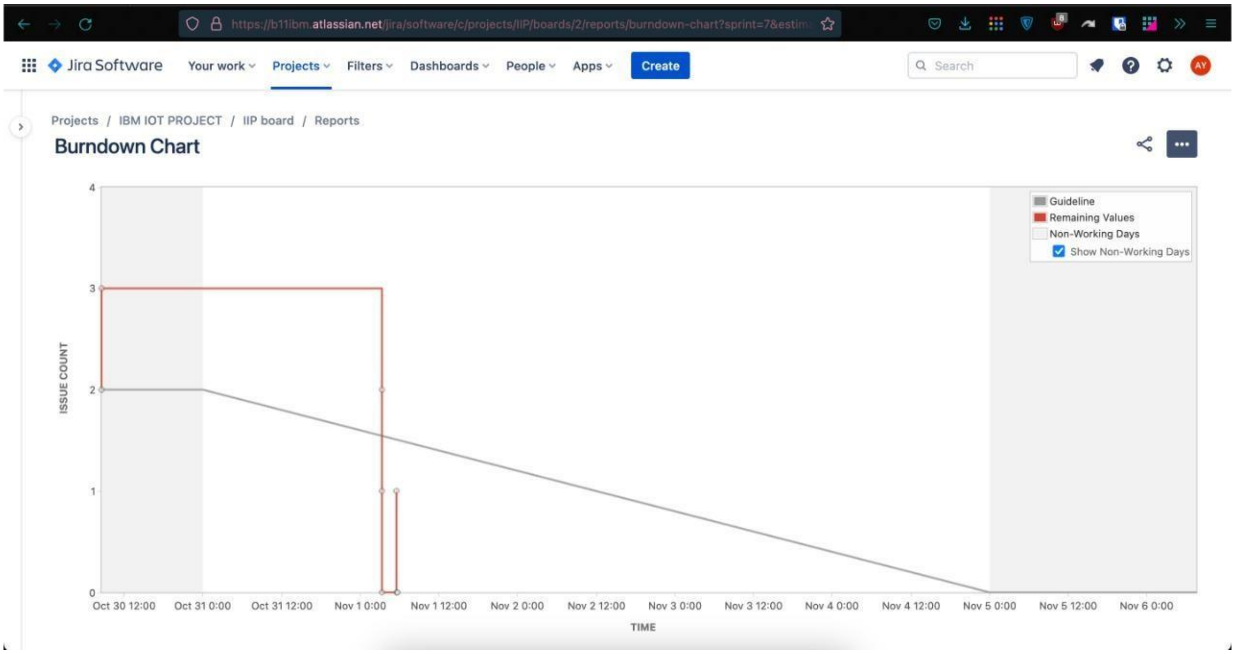
Projects / IBM IOT PROJECT / IIP board / Reports

Burndown Chart

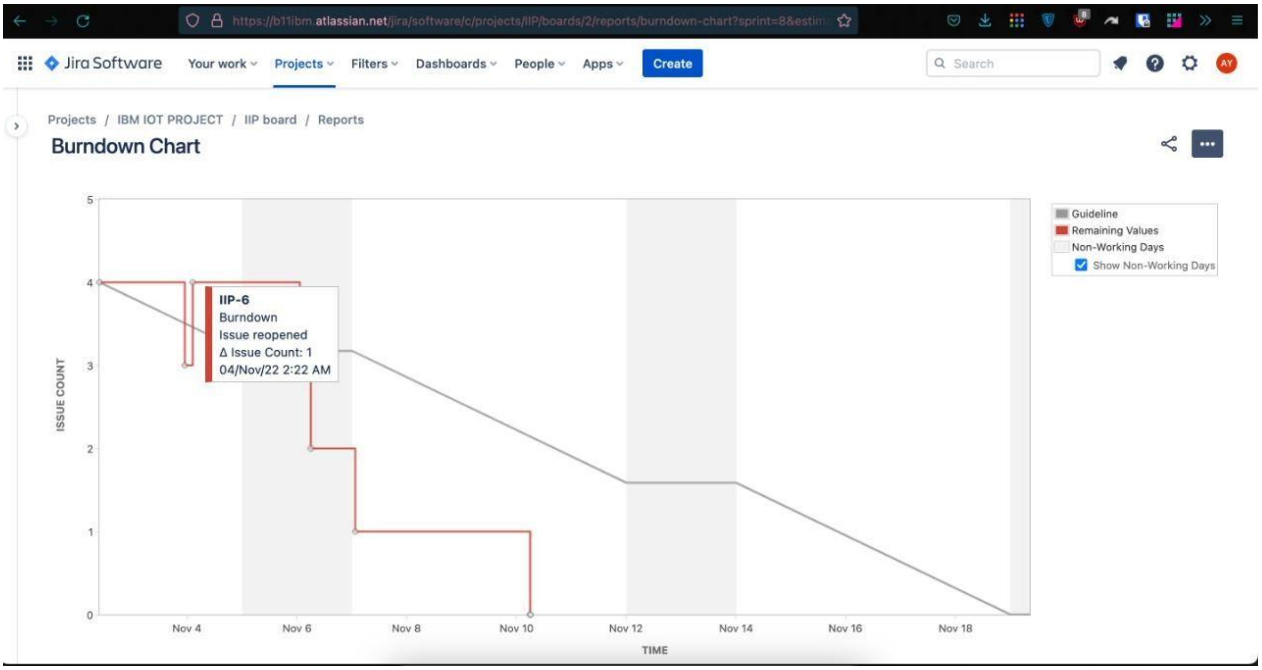
Sprint 2



Sprint 3



Sprint 4



https://b11ibm.atlassian.net/jira/software/c/projects/IIP/boards/2/reports/burndown-chart?sprint=8&estim

Projects / IBM IOT PROJECT / IIP board / Reports

Burndown Chart

IIP-6
Burndown
Issue reopened
Δ Issue Count: 1
04/Nov/22 2:22 AM

7.Coding and Solutioning

Feature 1 : False alarm checking

```
    if(temp < 45 ){

        if(flame > 650 ){

          accidentstatus = "Need Auditing";

          if(canfanoperate)

            isfanon = true;

          else

            isfanon = false;

          issprinkon = false;

}
```

```
  else if(flame <= 10){
    accidentstatus = "nothing happened";
    isfanon = false;
    issprinkon = false;
  }

}else if(temp >= 45 && temp <= 55 ){
  if(flame <=650 && flame >100  ){

    if(cansprinkoperate)
      issprinkon = true;
    else
      issprinkon = false;
    accidentstatus = "moderate";
    if(gas > 160 && canfanoperate ){
      isfanon = true;
    }
    else{
      isfanon = false;
    }
  }
  else if(flame <= 100 && flame > 10){
   if(cansprinkoperate)
      issprinkon = true;
    else
      issprinkon = false;
    isfanon = false;
```

```
        accidentstatus = "moderate";
      }

    }else if(temp > 55){
      if(flame > 650){
        gas = 500 + rand()%500;
        accidentstatus = "severe";
        if(cansprinkoperate)
          issprinkon = true;
        else
          issprinkon = false;
        if(canfanoperate)
          isfanon = true;
        else
          isfanon = false;
      }
      else if(flame < 650 && flame > 400 ){
        gas = 300 + rand()%500;
        accidentstatus = "severe";
        if(cansprinkoperate)
          issprinkon = true;
        else
          issprinkon = false;

        if(canfanoperate)
          isfanon = true;
        else
          isfanon = false;

      }
    }
    else {
      accidentstatus = "Need moderate Auditing";
      isfanon = false;
      issprinkon = false;
    }



    if(issprinkon){
      if(flow){
        sprinkstatus = "working";
      }
      else{
        sprinkstatus = "not working";
      }
    }
    else if(!issprinkon){
      sprinkstatus = "ready";
    }
    else {
      sprinkstatus = "something's wrong";
    }
```

Explanation

- This set of code checks for false alarm
- It also sets the current status
- This also handles the permission management of whether a device would work or not

Feature 2

```
void PublishData(float temp, int gas ,int flame ,int flow,bool
isfanon,bool issprinkon) {

  mqttconnect();

  String payload = "{\"temp\":";

  payload += temp;

  payload += "," "\"gas\":";

  payload += gas;

  payload += "," "\"flame\":";

  payload += flame;

  payload += "," "\"flow\":";

  payload += ((flow)?"true":"false");

  payload += "," "\"isfanon\":";

  payload += ((isfanon)?"true":"false");

  payload += "," "\"issprinkon\":";

  payload += ((issprinkon)?"true":"false");

  payload += "," "\"cansentalert\":";

  payload += ((cansentalert)?"true":"false");

  payload += "," "\"accidentstatus\":";

  payload += "\""+accidentstatus+"\"";

  payload += "," "\"sprinkstatus\":";

  payload += "\""+sprinkstatus+"\"";

  payload += "}";
  if (client.publish(publishTopic, (char*) payload.c_str())) {

    Serial.println("Publish ok");// if it sucessfully upload data on the

  } else {

    Serial.println("Publish failed");

  }


}
```

Explanation

- It sends the data to IBM IoT Watson platform

Feature 3

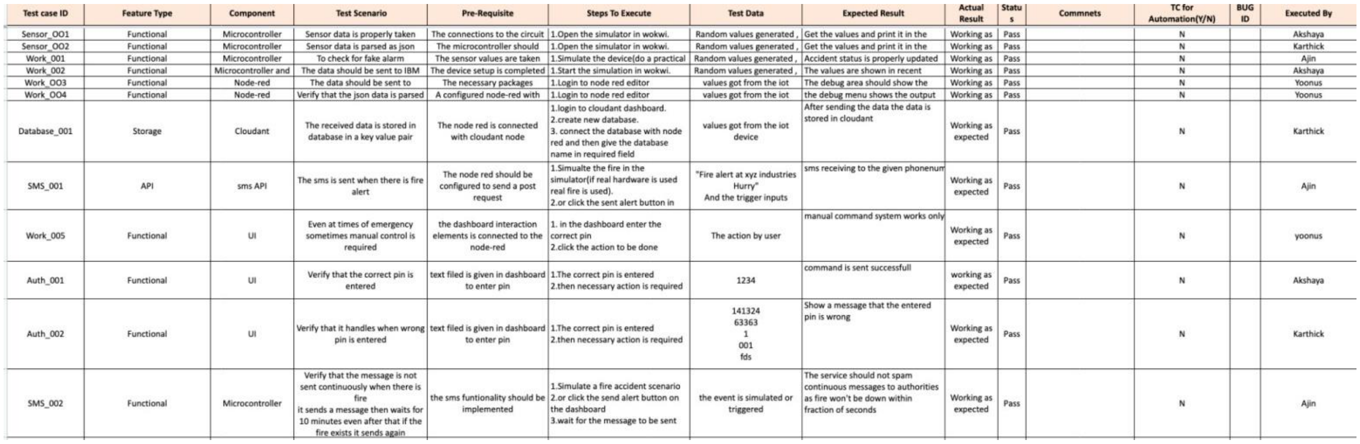
```
void callback(char* subscribetopic, byte* payload, unsigned int
payloadLength)

{

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

  Serial.println(subscribetopic);

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

    data3 += (char)payload[i];

  }

  Serial.println("data: "+ data3);

  const char *s =(char*) data3.c_str();double pincode = 0;

  if(mjson_get_number(s, strlen(s), "$.pin", &pincode)){

    if(((int)pincode)==137153){

        const char *buf;

        int len;
        if (mjson_find(s, strlen(s), "$.command", &buf, &len))

        {

          String command(buf,len);

          if(command=="\"cantfan\""){

                      canfanoperate = !canfanoperate;

          }

          else if(command=="\"cantsprink\""){

            cansprinkoperate = !cansprinkoperate;

          }else if(command=="\"sentalert\""){

            resetcooldown();

          } }  } }

  data3="";

;

}
```

Explanation

- The action taken by the user is received as a command and stored in a buffer
- The event in the device is done according to the command
- It checks for a secret encrypted pin for performing that event

8. TESTING

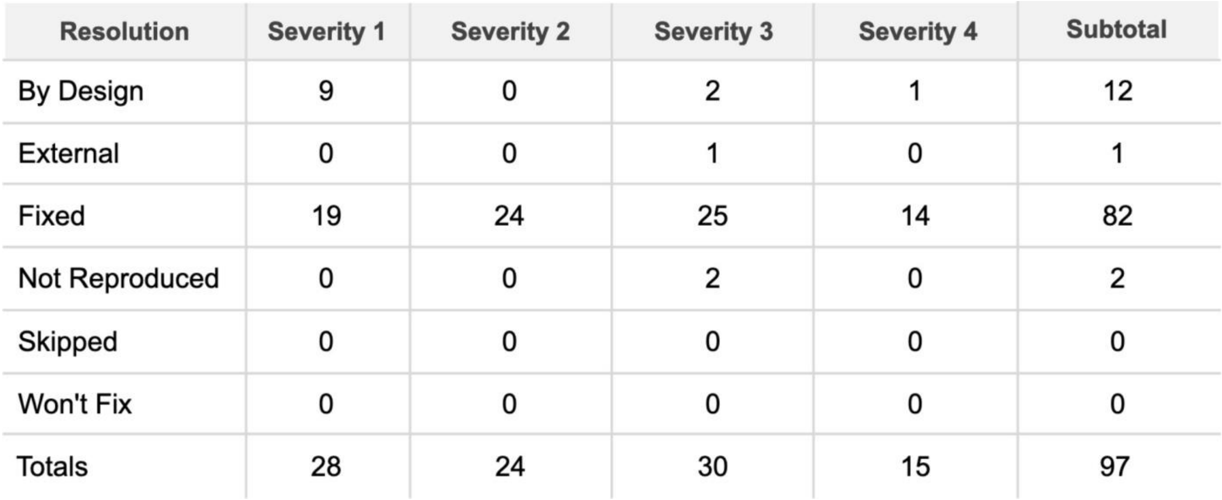
a. Testcases



Test case ID	Feature Type	Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Commnets	TC for Automation(Y/N)	BUG ID	Executed By
Sensor_OO1	Functional	Microcontroller	Sensor data is properly taken	The connections to the circuit	1.Open the simulator in wokwi.	Random values generated ,	Get the values and print it in the	Working as	Pass		N		Akshaya
Sensor_OO2	Functional	Microcontroller	Sensor data is parsed as json	The microcontroller should	1.Open the simulator in wokwi.	Random values generated ,	Get the values and print it in the	Working as	Pass		N		Karthick
Work_001	Functional	Microcontroller	To check for fake alarm	The sensor values are taken	1.Simulate the device(do a practical	Random values generated ,	Accident status is properly updated	Working as	Pass		N		Ajin
Work_002	Functional	Microcontroller and	The data should be sent to IBM	The device setup is completed	1.Start the simulation in wokwi.	Random values generated ,	The values are shown in recent	Working as	Pass		N		Akshaya
Work_OO3	Functional	Node-red	The data should be sent to	The necessary packages	1.Login to node red editor	values got from the iot	The debug area should show the	Working as	Pass		N		Yoonus
Work_OO4	Functional	Node-red	Verify that the json data is parsed	A configured node-red with	1.Login to node red editor	values got from the iot	the debug menu shows the output	Working as	Pass		N		Yoonus
Database_001	Storage	Cloudant	The received data is stored in database in a key value pair	The node red is connected with cloudant node	1.login to cloudant dashboard. 2.create new database. 3. connect the database with node red and then give the database name in required field	values got from the iot device	After sending the data the data is stored in cloudant	Working as expected	Pass		N		Karthick
SMS_001	API	sms API	The sms is sent when there is fire alert	The node red should be configured to send a post request	1.Simualte the fire in the simulator(if real hardware is used real fire is used). 2.or click the sent alert button in	"Fire alert at xyz industries Hurry" And the trigger inputs	sms receiving to the given phonenum	Working as expected	Pass		N		Ajin
Work_005	Functional	UI	Even at times of emergency sometimes manual control is required	the dashboard interaction elements is connected to the node-red	1. in the dashboard enter the correct pin 2.click the action to be done	The action by user	manual command system works only	Working as expected	Pass		N		yoonus
Auth_001	Functional	UI	Verify that the correct pin is entered	text filed is given in dashboard to enter pin	1.The correct pin is entered 2.then necessary action is required	1234	command is sent successfull	working as expected	Pass		N		Akshaya
Auth_002	Functional	UI	Verify that it handles when wrong pin is entered	text filed is given in dashboard to enter pin	1.The correct pin is entered 2.then necessary action is required	141324 63363 1 001 fds	Show a message that the entered pin is wrong	Working as expected	Pass		N		Karthick
SMS_002	Functional	Microcontroller	Verify that the message is not sent continuously when there is fire it sends a message then waits for 10 minutes even after that if the fire exists it sends again	the sms funtionality should be implemented	1.Simulate a fire accident scenario 2.or click the send alert button on the dashboard 3.wait for the message to be sent	the event is simulated or triggered	The service should not spam continuous messages to authorities as fire won't be down within fraction of seconds	Working as expected	Pass		N		Ajin

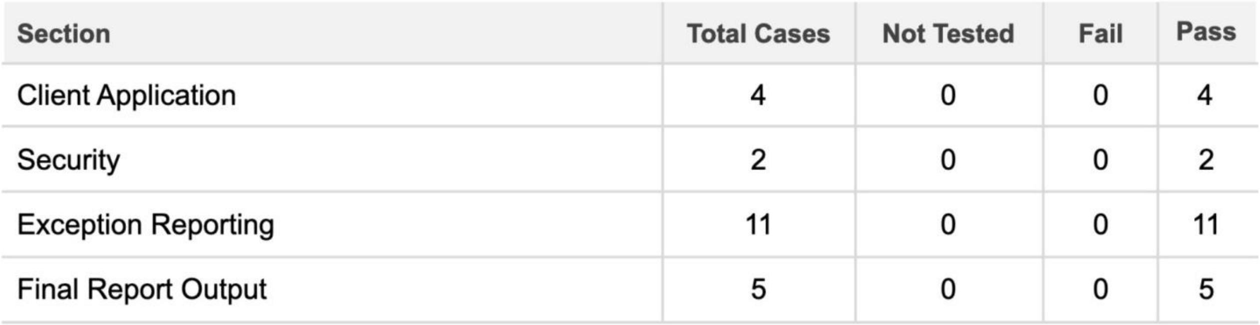
b. UAT

Defect analysis



Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	9	0	2	1	12
External	0	0	1	0	1
Fixed	19	24	25	14	82
Not Reproduced	0	0	2	0	2
Skipped	0	0	0	0	0
Won't Fix	0	0	0	0	0
Totals	28	24	30	15	97

Test case analysis



Section	Total Cases	Not Tested	Fail	Pass
Client Application	4	0	0	4
Security	2	0	0	2
Exception Reporting	11	0	0	11
Final Report Output	5	0	0	5

9. Results

a. Performance

metricsCPU usage

The micro version of c++ is make the best use of the CPU. For every loop the program runs in O(1) time, neglecting the network and communication. The program sleeps for every 1 second for better communication with MQTT. As the program takes O(1) time and the compiler optimizes the program during compilation there is less CPU load for each cycle. The upcoming instructions are on the stack memory, so they can be popped after execution.

Memory usage :

The sensor values , networking data are stored in sram of the ESP32 . It’s a lot of data because ESP32 has only limited amount of memory (520 KB) .For each memory cycle the exact addresses are overwritten with new values to save memory and optimal execution of the program

Error rates :

The errors rates are very low as the backend and dashboard is handled with node-red.The exceptions are handled in a proper way as it does not affect the usability of the system

Latency and Response Time :

The DOM handling of the received data is optimal and latency is low .After the DOM is loaded the entire site is loaded to the browser

The server also responses quickly . The average time of response is respectable

For the data sent from the IoT device (considering the sleep of one second from the IoT),the response is much quicker .We can easily see the delay caused by the sleep function

The average time is well over optimal value

Average time = $(5ms + 2600ms)/2$

= 1302.5

Garbage collection:

In the server-side garbage collection is done by the Node framework.In the IoT device , c++ does not have any garbage collection features . But it is not necessary in this scenario as the memory is used again for storing the data . Any dangling pointer or poorly handled address space is not allocated.

10. Advantages and Disadvantages

Advantages

- Active monitoring for gas leakage and fire breakout
- Automatic alerting of admin as well as fire authorities using SMS
- Automatically turning on/off sprinkler as well as exhaust fan
- Authentication is required to turn on/off of sprinkler and exhaust fan as well as sendingSMS alert manually
- It automatically detect false fire breakout reducing unnecessary panic
- by using flow sensors we can confirm that the sprinkler system is working as it intended
- All device status can be shown in a dashboard
- Users can see the dashboard using a web application

Disadvantages

- Always need to connect with the internet **[Only to Send the SMS alert]**
- If the physical device is damaged the entire operation is collapsed
- Need large database since many data is stored in cloud database every second

11. CONCLUSION

So in conclusion our problem premise is solved using Iot devices by creating a smart management system that solves many inherent problems in the traditional fire management system like actively monitoring for fire breakouts as well as gas leakage and sending SMS alerts to the admin as well as to the fire authorities .

12. FUTURE SCOPE

The existing devices can be modified to work in different specialized environment as well as scale to house use to big labs[Since fire accidents can cause major loss in human lives in homes to big industries] as well as it can be used in public places , vehicles.

13.APPENDIX

Esp32 - Microcontroller :

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth

Memory: 320 KiB SRAM

CPU: Tensilica Xtensa LX6 microprocessor @ 160 or 240 MHz

Power: 3.3 V DC

Manufacturer: Espressif Systems

Predecessor: ESP8266

Sensors :

DHT22 - Temperature and Humidity sensor

The DHT22 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed).

Flow Sensors

A flow sensor (more commonly referred to as a “flow meter”) is an electronic device that measures or regulates the flow rate of liquids and gasses within pipes and tubes.

MQ5 - Gas sensor

Gas sensors (also known as gas detectors) are electronic devices that detect and identify different types of gasses. They are commonly used to detect toxic or explosive gasses and measure gas concentration.

Flame sensors

A flame-sensor is one kind of detector which is mainly designed for detecting as well as responding to the occurrence of a fire or flame. The flame detection response can depend on its fitting

Source code:

```
#include <WiFi.h>//library for wifi

#include <PubSubClient.h>//library for MQtt

#include "DHT.h"// Library for dht11

#include <cstdlib>

#include <time.h>

#include <mjson.h>

#define DHTPIN 15     // what pin we're connected to

#define DHTTYPE DHT22   // define type of sensor DHT 11

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


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

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

#define ORG "fvs923"

#define DEVICE_TYPE "zenabc"

#define DEVICE_ID "221"

#define TOKEN "12345678"


String data3 = "";
String accidentstatus ="";

String sprinkstatus = "";

float temp =0;

bool isfanon = false;

bool issprinkon = false;

bool cansprinkoperate = true;

bool canfanoperate = true;

bool cansentalert = false;

int gas = 0;

int flame = 0;

int flow = 0;

long int cooldown= 600;

char server[] = ORG ".messaging.internetofthings.ibmcloud.com";

char publishTopic[] = "iot-2/evt/data/fmt/json";

char subscribetopic[] = "iot-2/cmd/command/fmt/String";

char authMethod[] = "use-token-auth";

char token[] = TOKEN;

char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_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();
  //if real gas sensor is used make sure the senor is heated up for acurate readings
  /*
    - Here random values for readings and stdout were used to show the
      working  of the devices as physical or simulated devices are not
      available.
  */
  delay(10);
  Serial.println();
  wificonnect();
  mqttconnect();
}
void loop()
{
  temp = dht.readTemperature();
  //setting a random seed (only for random values not in real life scenarios)
  srand(time(0));
  //initial variable activities like declaring , assigning
  gas = rand()%400;
  int flamereading = rand()%1024;
  flame = map(flamereading,0,1024,0,1024);
  int flow = ((rand()%100)>50?1:0);
  //find the accident status 'cause fake alert may be caused by some mischief activities
  if(temp < 45 ){
    if(flame > 650 ){
      accidentstatus = "Need Auditing";
      if(canfanoperate)
        isfanon = true;
      else
        isfanon = false;
      issprinkon = false;
    }
    else if(flame <= 10){
      accidentstatus = "nothing happened";
      isfanon = false;
      issprinkon = false;
    }

  }else if(temp >= 45 && temp <= 55 ){
    if(flame <=650 && flame >100  ){

      if(cansprinkoperate)
        issprinkon = true;
      else
        issprinkon = false;
      accidentstatus = "moderate";
      if(gas > 160 && canfanoperate ){
        isfanon = true;
      }
      else{
        isfanon = false;
      }
    }
    else if(flame <= 100 && flame > 10){
     if(cansprinkoperate)
        issprinkon = true;
      else
        issprinkon = false;
      isfanon = false;
      accidentstatus = "moderate";
    }

  }else if(temp > 55){
    if(flame > 650){
      gas = 500 + rand()%500;
      accidentstatus = "severe";

      if(cansprinkoperate)

        issprinkon = true;

      else

        issprinkon = false;

      if(canfanoperate)

        isfanon = true;

      else

        isfanon = false;

    }

    else if(flame < 650 && flame > 400 ){

      gas = 300 + rand()%500;

      accidentstatus = "severe";

      if(cansprinkoperate)

        issprinkon = true;

      else

        issprinkon = false;

      if(canfanoperate)

        isfanon = true;

      else

        isfanon = false;



    }
```

```
}
else {
  accidentstatus = "Need moderate Auditing";
  isfanon = false;
  issprinkon = false;
}
if(issprinkon){
  if(flow){
    sprinkstatus = "working";
  }
  else{
    sprinkstatus = "not working";
  }
}
else if(!issprinkon){
  sprinkstatus = "ready";
}
else {
  sprinkstatus = "something's wrong";
}



PublishData(temp,gas,flame,flow,isfanon,issprinkon);
```

```
  //a cooldown period is set as the values and situations are random
in real life sceanarios the time can be reduced or neclected

  if(accidentstatus=="severe" && cooldown >= 600){

    cooldown = 0;

    sendalert();

    PublishData(temp,gas,flame,flow,isfanon,issprinkon);

    cansentalert = false;

  }

  if(cooldown > 999999){

    cooldown = 601;

  }

  delay(1000);

  ++cooldown;

  if (!client.loop()) {

    mqttconnect();

  }

}

/*.....................................retrieving to
Cloud.…………………………………………………………*/

void PublishData(float temp, int gas ,int flame ,int flow,bool
isfanon,bool issprinkon) {

  mqttconnect();//function call for connecting to ibm

  /*

     creating the String in in form JSon to update the data to ibm
cloud
```

```
  */

  String payload = "{\"temp\":";

  payload += temp;

  payload += "," "\"gas\":";

  payload += gas;

  payload += "," "\"flame\":";

  payload += flame;

  payload += "," "\"flow\":";

  payload += ((flow)?"true":"false");

  payload += "," "\"isfanon\":";

  payload += ((isfanon)?"true":"false");

  payload += "," "\"issprinkon\":";

  payload += ((issprinkon)?"true":"false");

  payload += "," "\"cansentalert\":";

  payload += ((cansentalert)?"true":"false");

  payload += "," "\"accidentstatus\":";

  payload += "\""+accidentstatus+"\"";

  payload += "," "\"sprinkstatus\":";

  payload += "\""+sprinkstatus+"\"";

  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);
  while (WiFi.status() != WL_CONNECTED) {
    delay(100);
    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");
  }
}
//handles commands from user side
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++) {
    data3 += (char)payload[i];
  }
  Serial.println("data: "+ data3);

  const char *s =(char*) data3.c_str();

  double pincode = 0;

  if(mjson_get_number(s, strlen(s), "$.pin", &pincode)){

    if(((int)pincode)==137153){

        const char *buf;

        int len;

        if (mjson_find(s, strlen(s), "$.command", &buf, &len))  //
And print it

        {

          String command(buf,len);

          if(command=="\"cantfan\""){

            //this works when there is gas sensor reads high value
and if there should be a

            //manual trigger else it will be automate

            canfanoperate = !canfanoperate;

          }

          else if(command=="\"cantsprink\""){

            cansprinkoperate = !cansprinkoperate;

          }else if(command=="\"sentalert\""){

            //this works when there is accident status is severe and
if there should be a

            //manual trigger else it will be automate

            resetcooldown();

          }
        }
    }
  }
  data3="";
}
void resetcooldown(){
  cooldown = 0;
}
//sent alert request to node-red
void sendalert(){
  cansentalert = true;
  cooldown = 0;
}
```

Github Link : https://github.com/IBM-EPBL/IBM-Project-10534-1659185049

Demo : https://youtu.be/zZnD5GRbDIw