PROJECT REPORT

PROJECT TITLE: INDUSTRY-SPECIFIC INTELLIGENT FIRE MANAGEMENT SYSTEM.

TEAM ID: PNT2022TMID07157.

TEAM MEMBERS: PRITHIBHA R (TEAMLEAD)
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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

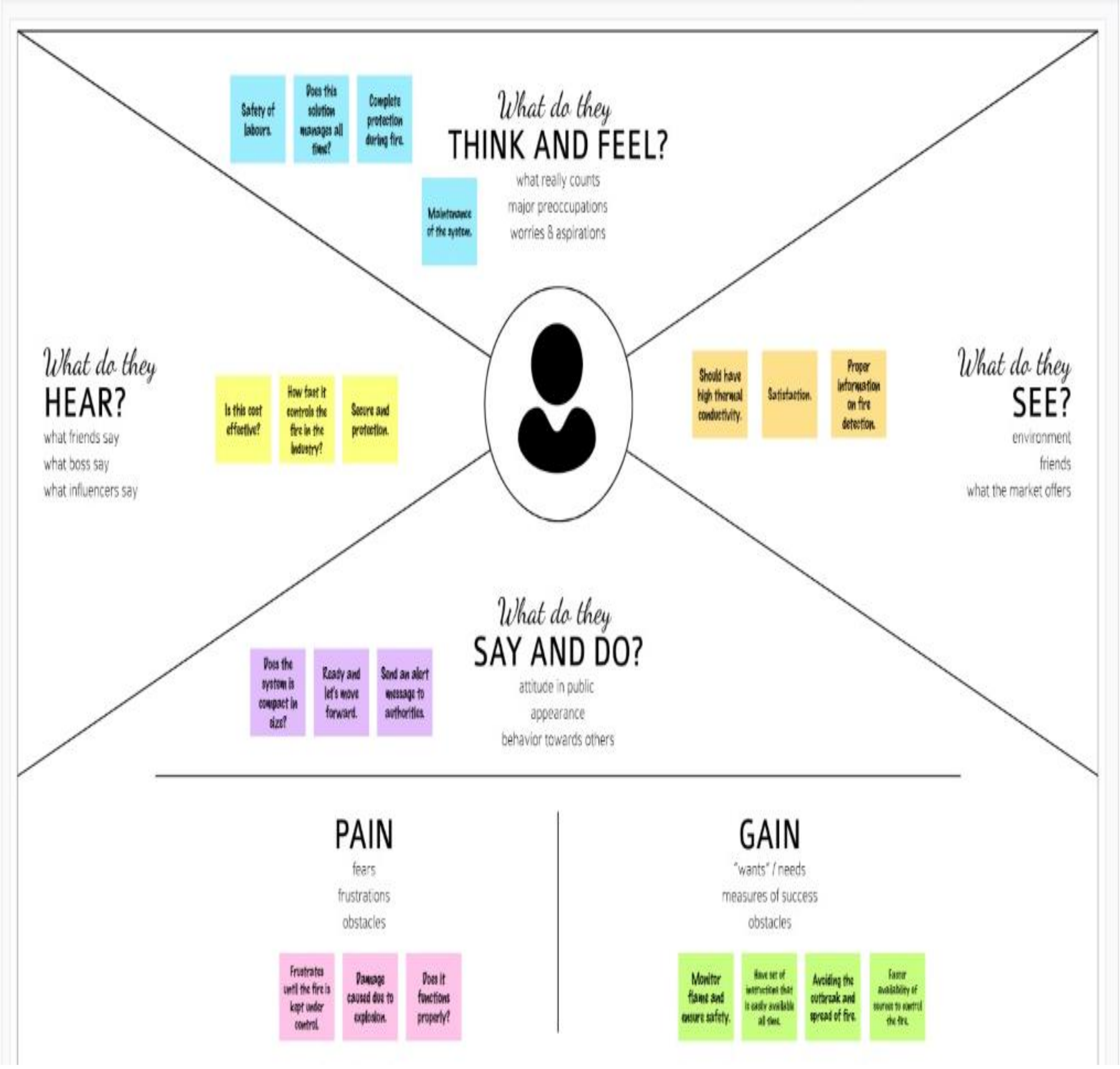
[4] R.A. Sowah, A.R. Ofoli, S.N. Krakani, S.Y. Fiawoo, hardware Design and Web-Based Communication Modules of a Real-Time multisensor Fire Detection and Notification System Using Fuzzy Logic, IEEE Transactions on Industry Applications, 53 (2016) 559-566.

2.3 Problem Statement Definition

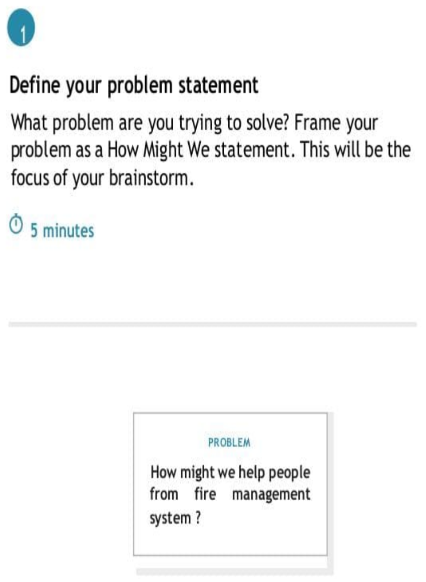
Industry Specific Intelligent fire management system are designed to Prevent fire accidents due to Gas leakage and flame in industry

3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas


Safety of labours.
Does this solution manages all time?
Complete protection during fire.
Maintenance of the system.
What do they
THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations
What do they
HEAR?
what friends say
what boss say
what influencers say
Is this cost effective?
How fast it controls the fire in the industry?
Secure and protection.
Should have high thermal conductivity.
Satisfaction.
Proper information on fire detection.
What do they
SEE?
environment
friends
what the market offers
Does the system is compact in size?
Ready and let's move forward.
Send an alert message to authorities.
What do they
SAY AND DO?
attitude in public
appearance
behavior towards others
PAIN
fears
frustrations
obstacles
Frustrates until the fire is kept under control.
Damage caused due to explosion.
Does it functions properly?
GAIN
"wants" / needs
measures of success
obstacles
Monitor flame and ensure safety.
Have set of instruction that is easily available all time.
Avoiding the outbreak and spread of fire.
Faster availability of sources to control the fire.

3.2 Ideation &Brainstorming



1

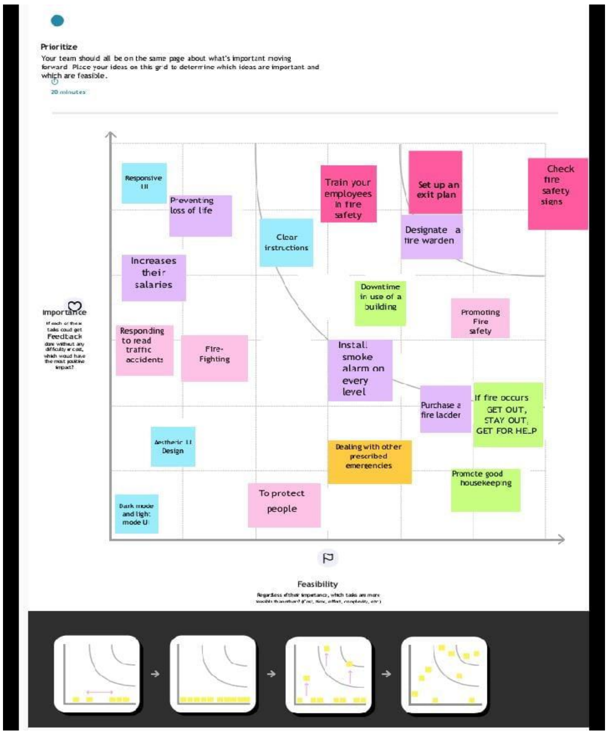
Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

How might we help people from fire management system ?

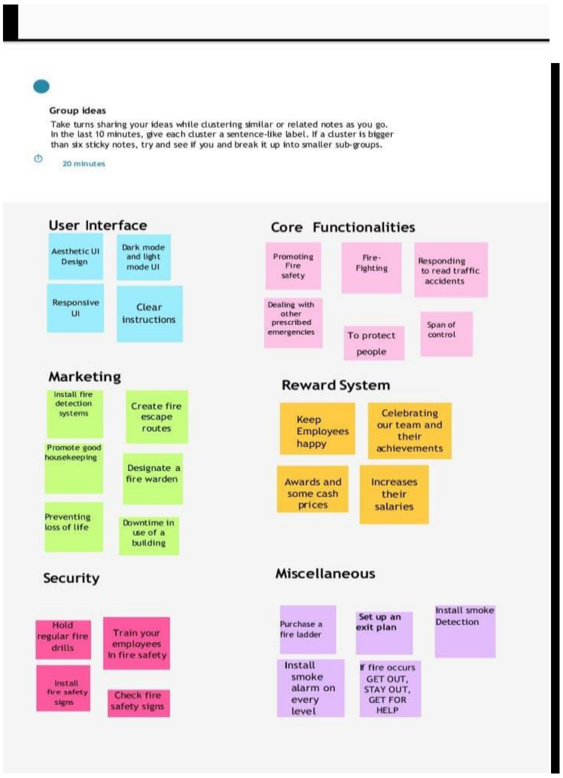


Prioritize

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.

20 minutes

Responsive UI
Preventing loss of life
Train your employees in fire safety
Set up an exit plan
Check fire safety signs
Clear instructions
Designate a fire warden
Increases their salaries
Downtime in use of a building
Promoting Fire safety
Importance
If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?
Feedback
Responding to read traffic accidents
Fire-Fighting
Install smoke alarm on every level
Purchase a fire ladder
If fire occurs GET OUT, STAY OUT, GET FOR HELP
Aesthetic UI Design
Dealing with other prescribed emergencies
Promote good housekeeping
Dark mode and light mode UI
To protect people
Feasibility
Regardless of their importance, which tasks are more feasible than others? (cost, time, effort, complexity, etc.)

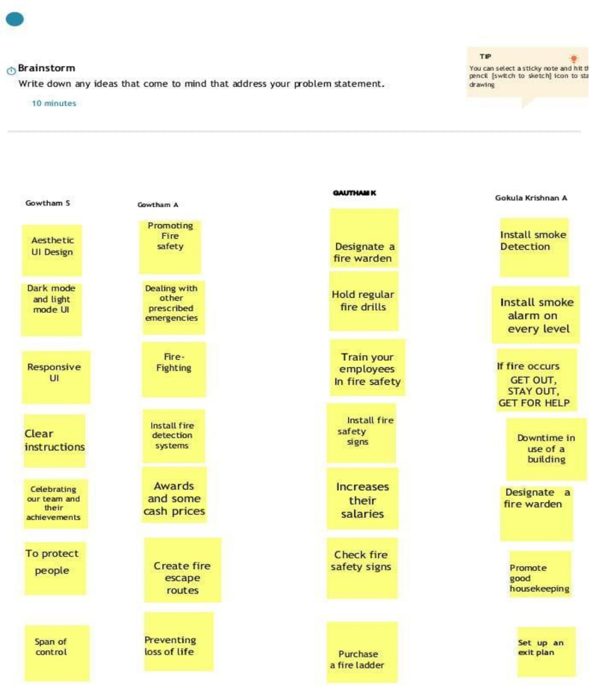


Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. In the last 10 minutes, 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.

20 minutes

User Interface
Aesthetic UI Design
Dark mode and light mode UI
Responsive UI
Clear instructions
Core Functionalities
Promoting Fire safety
Fire-Fighting
Responding to read traffic accidents
Dealing with other prescribed emergencies
To protect people
Span of control
Marketing
Install fire detection systems
Create fire escape routes
Promote good housekeeping
Designate a fire warden
Preventing loss of life
Downtime in use of a building
Reward System
Keep Employees happy
Celebrating our team and their achievements
Awards and some cash prices
Increases their salaries
Security
Hold regular fire drills
Train your employees In fire safety
Install fire safety signs
Check fire safety signs
Miscellaneous
Purchase a fire ladder
Set up an exit plan
Install smoke Detection
Install smoke alarm on every level
If fire occurs GET OUT, STAY OUT, GET FOR HELP



Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

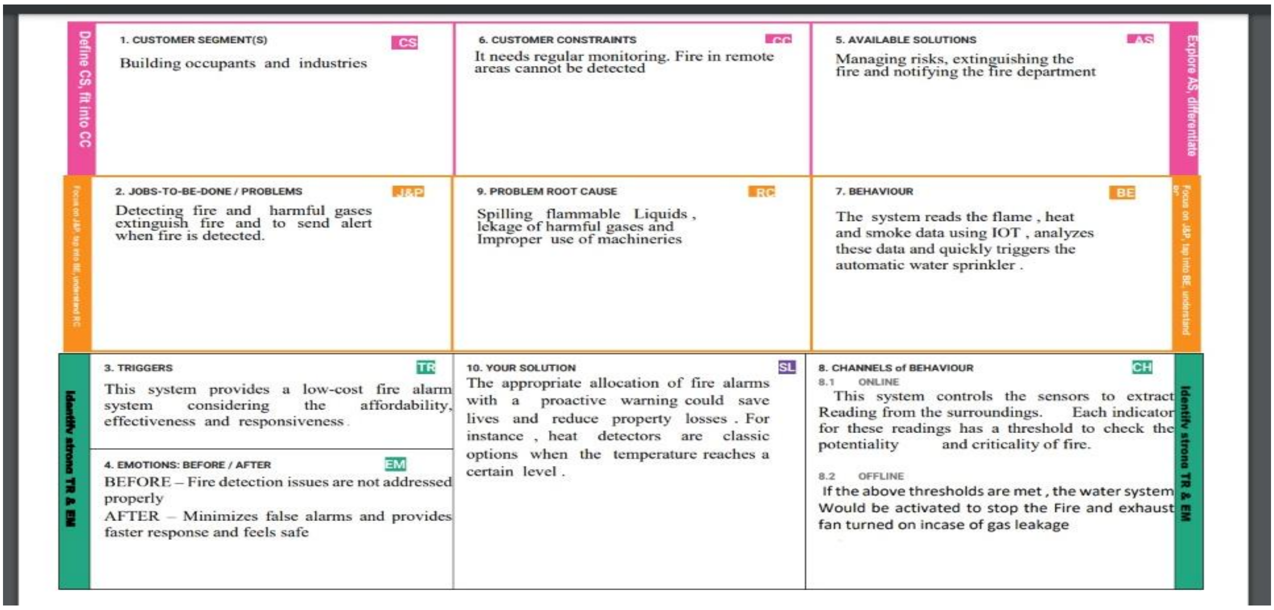
You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing

Gowtham S
Aesthetic UI Design
Dark mode and light mode UI
Responsive UI
Clear instructions
Celebrating our team and their achievements
To protect people
Span of control
Gowtham A
Promoting Fire safety
Dealing with other prescribed emergencies
Fire-Fighting
Install fire detection systems
Awards and some cash prices
Create fire escape routes
Preventing loss of life
GAUTHAM K
Designate a fire warden
Hold regular fire drills
Train your employees In fire safety
Install fire safety signs
Increases their salaries
Check fire safety signs
Purchase a fire ladder
Gokula Krishnan A
Install smoke Detection
Install smoke alarm on every level
If fire occurs GET OUT, STAY OUT, GET FOR HELP
Downtime in use of a building
Designate a fire warden
Promote good housekeeping
Set up an exit plan

3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To develop a safety management system for industries for protecting against the fire incidents in industries.
2.	Idea / Solution description	To implement the fire safety system in industries based on IOT using Arduino uno with fire detection and fire extinguisher system using sensors like gas sensor, Flame sensor, temperature sensor .
3.	Novelty / Uniqueness	The integrated system detects fire and gas in the atmosphere and extinguish it automatically. It also send alert via sms when gas and fire are detected.
4.	Social Impact / Customer Satisfaction	The system detects and senses the fire using sensors that we use and it helps the customers to access with the immediate notification and the timely access and helps in early prevention of fire accidents in industries.
5.	Business Model (Revenue Model)	This model is used to calculate the probability of the ignition and spread across a landscape of industries and help in rescuing people and machine from the fire accident.
6.	Scalability of the Solution	This is completely modular system makes it easily expandable and business efficient for the customized fire detection, with the significant cost , Easy operatability and management.

3.4 Problem Solution Fit



Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Building occupants and industries

6. CUSTOMER CONSTRAINTS CC

It needs regular monitoring. Fire in remote areas cannot be detected

5. AVAILABLE SOLUTIONS AS

Managing risks, extinguishing the fire and notifying the fire department

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

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

Detecting fire and harmful gases extinguish fire and to send alert when fire is detected.

9. PROBLEM ROOT CAUSE RC

Spilling flammable Liquids , lekage of harmful gases and Improper use of machineries

7. BEHAVIOUR BE

The system reads the flame , heat and smoke data using IOT , analyzes these data and quickly triggers the automatic water sprinkler .

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TR

This system provides a low-cost fire alarm system considering the affordability, effectiveness and responsiveness .

4. EMOTIONS: BEFORE / AFTER EM

BEFORE – Fire detection issues are not addressed properly

AFTER – Minimizes false alarms and provides faster response and feels safe

10. YOUR SOLUTION SL

The appropriate allocation of fire alarms with a proactive warning could save lives and reduce property losses . For instance , heat detectors are classic options when the temperature reaches a certain level .

8. CHANNELS of BEHAVIOUR CH

8.1 ONLINE

This system controls the sensors to extract Reading from the surroundings. Each indicator for these readings has a threshold to check the potentiality and criticality of fire.

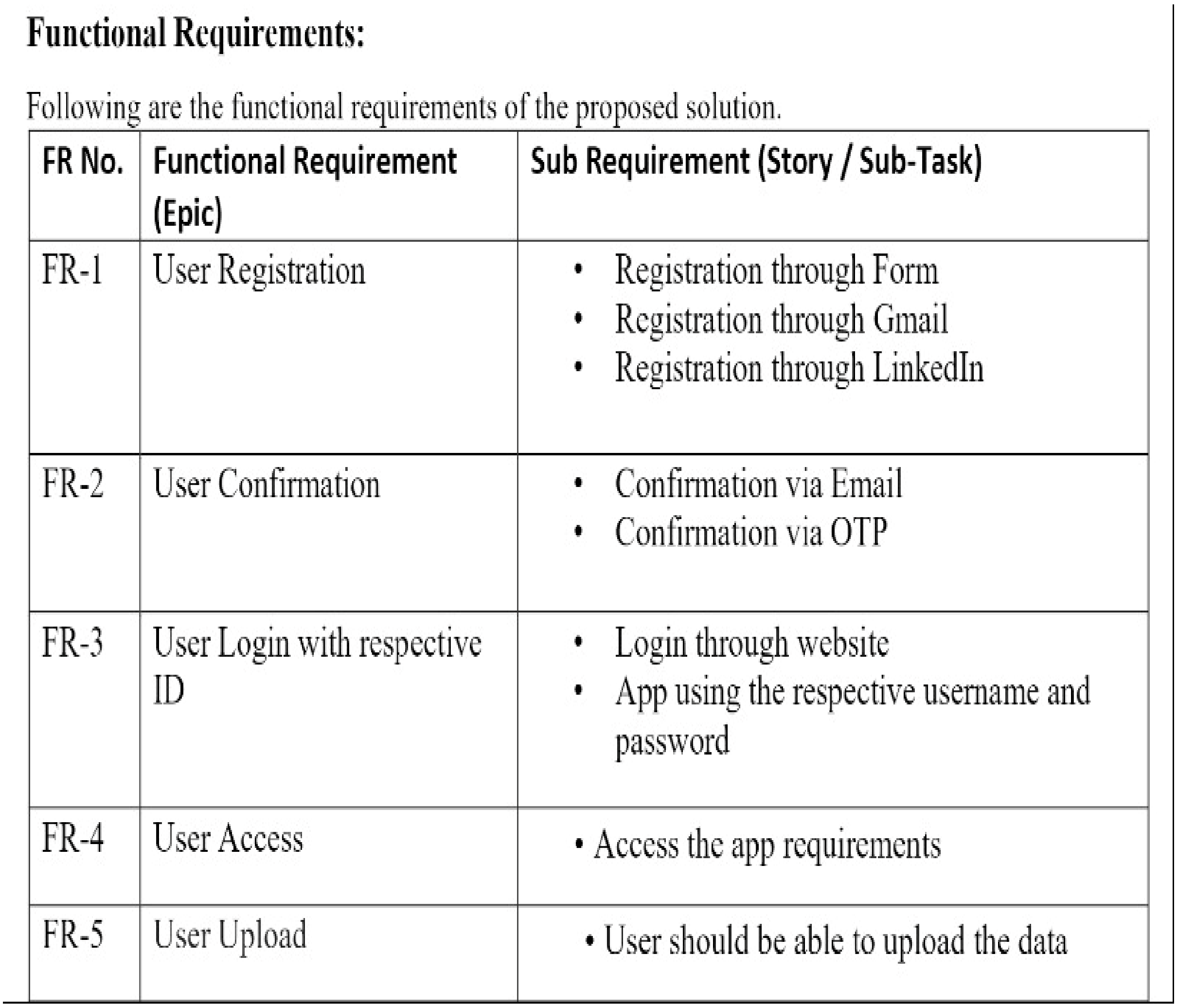
8.2 OFFLINE

If the above thresholds are met , the water system Would be activated to stop the Fire and exhaust fan turned on incase of gas leakage

Identify strong TR & EM

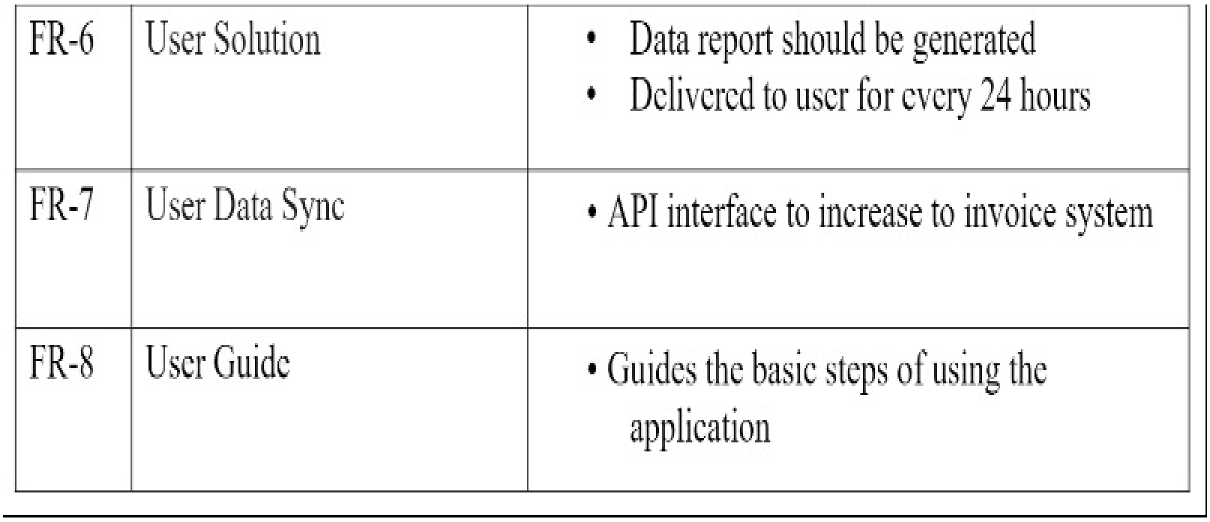
4.REQUIREMENT ANALYSIS

4.1Functional requirement



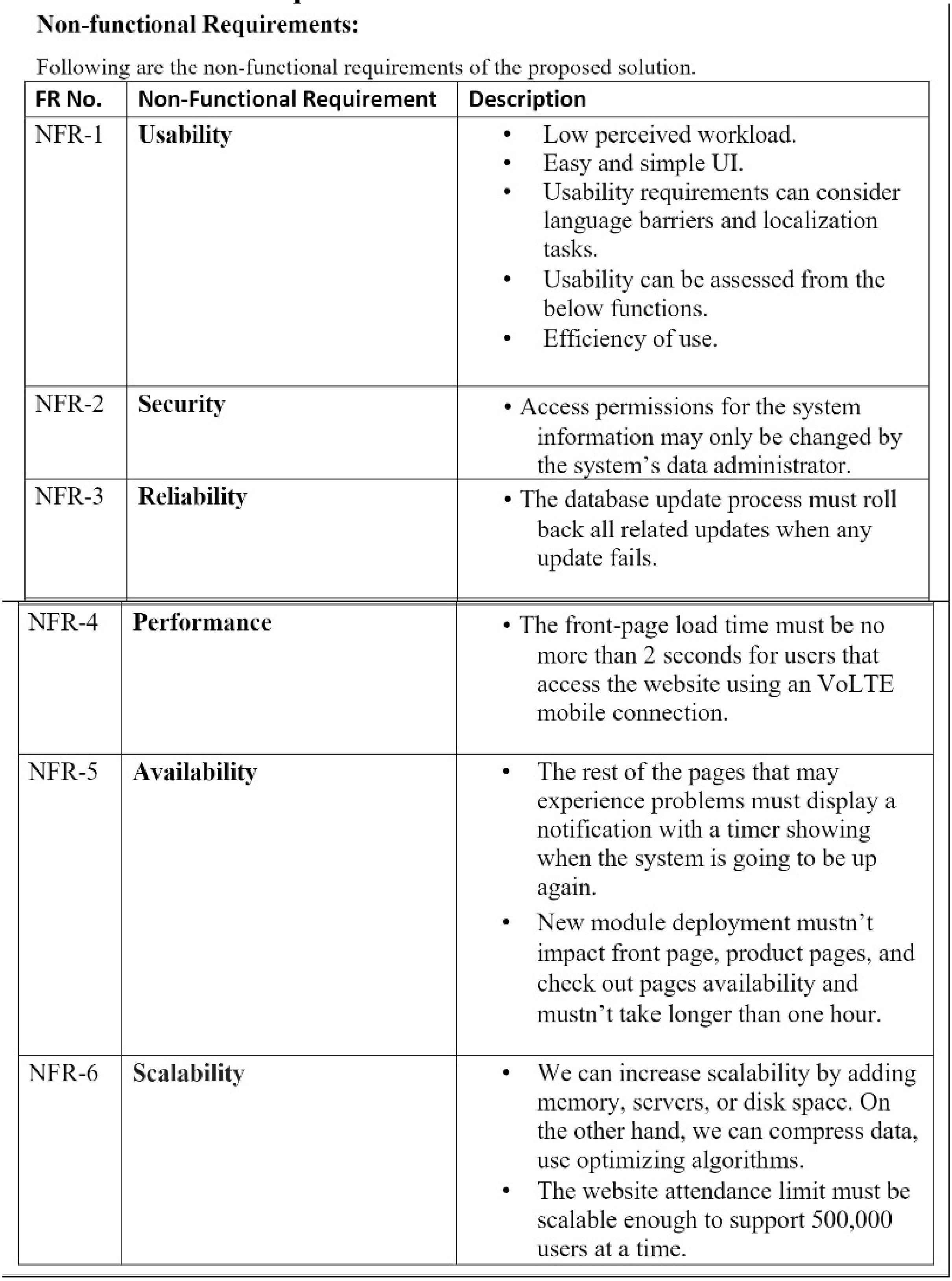
Functional Requirements:

Following are the functional requirements of the proposed solution.



FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	• Registration through Form • Registration through Gmail • Registration through LinkedIn
FR-2	User Confirmation	• Confirmation via Email • Confirmation via OTP
FR-3	User Login with respective ID	• Login through website • 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 • Delivered to user for every 24 hours
FR-7	User Data Sync	• API interface to increase to invoice system
FR-8	User Guide	• Guides the basic steps of using the application

4.2 Non-Functional requirement



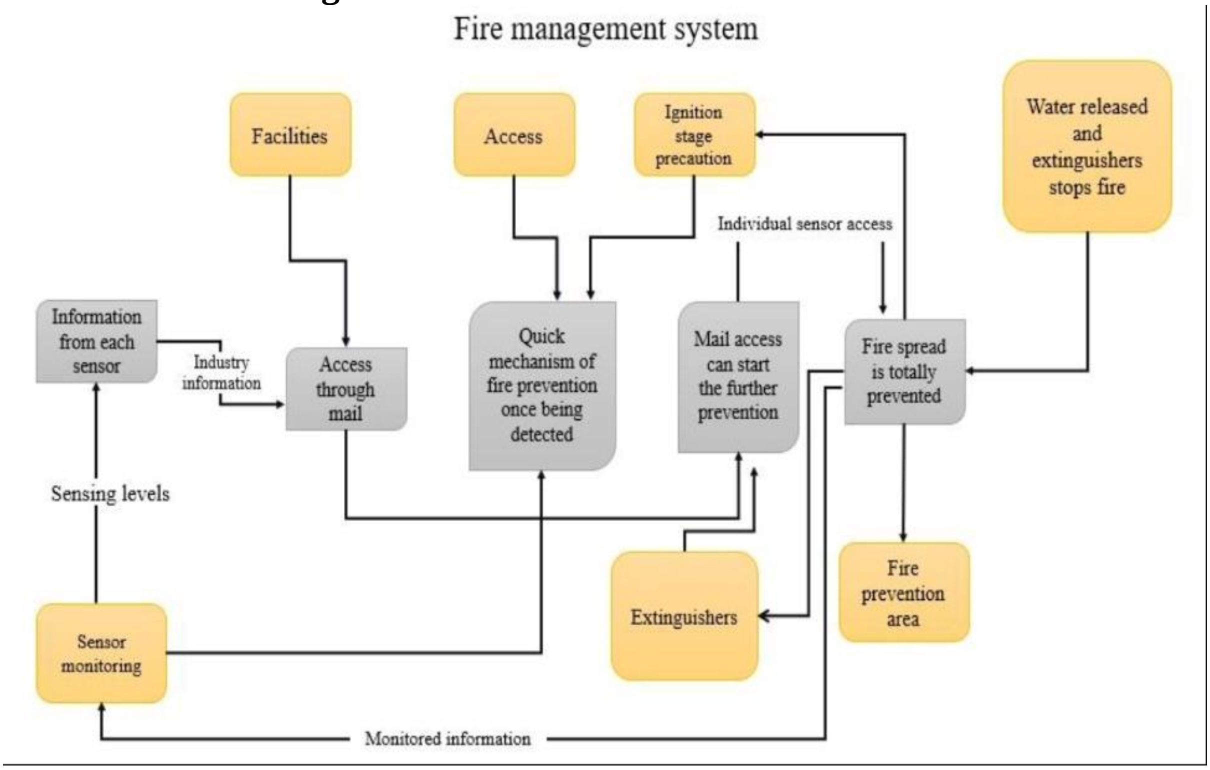
Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	• Low perceived workload. • Easy and simple UI. • Usability requirements can consider language barriers and localization tasks. • Usability can be assessed from the below functions. • Efficiency of use.
NFR-2	**Security**	• Access permissions for the 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 than 2 seconds for users that access the website using an VoLTE mobile connection.
NFR-5	**Availability**	• The rest of the pages that may experience problems must display a notification with a timer showing when the system is going to be up again. • New module deployment mustn't 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. • The website attendance limit must be scalable enough to support 500,000 users at a time.

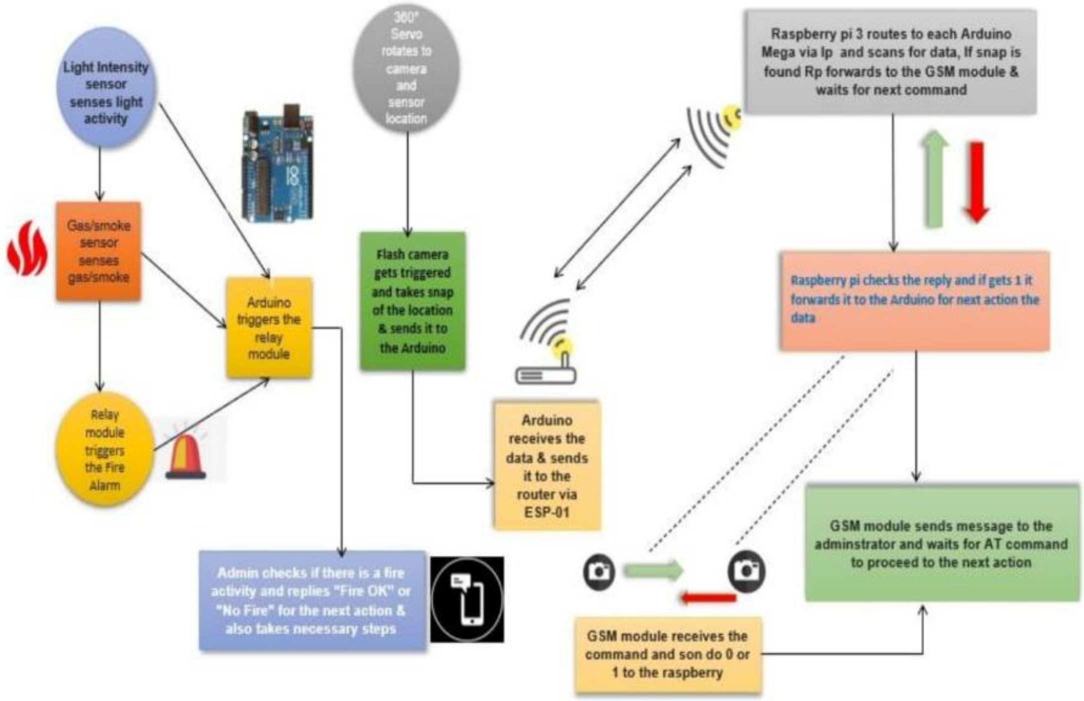
5.PROJECT DESIGN

5.1 Data Flow Diagram

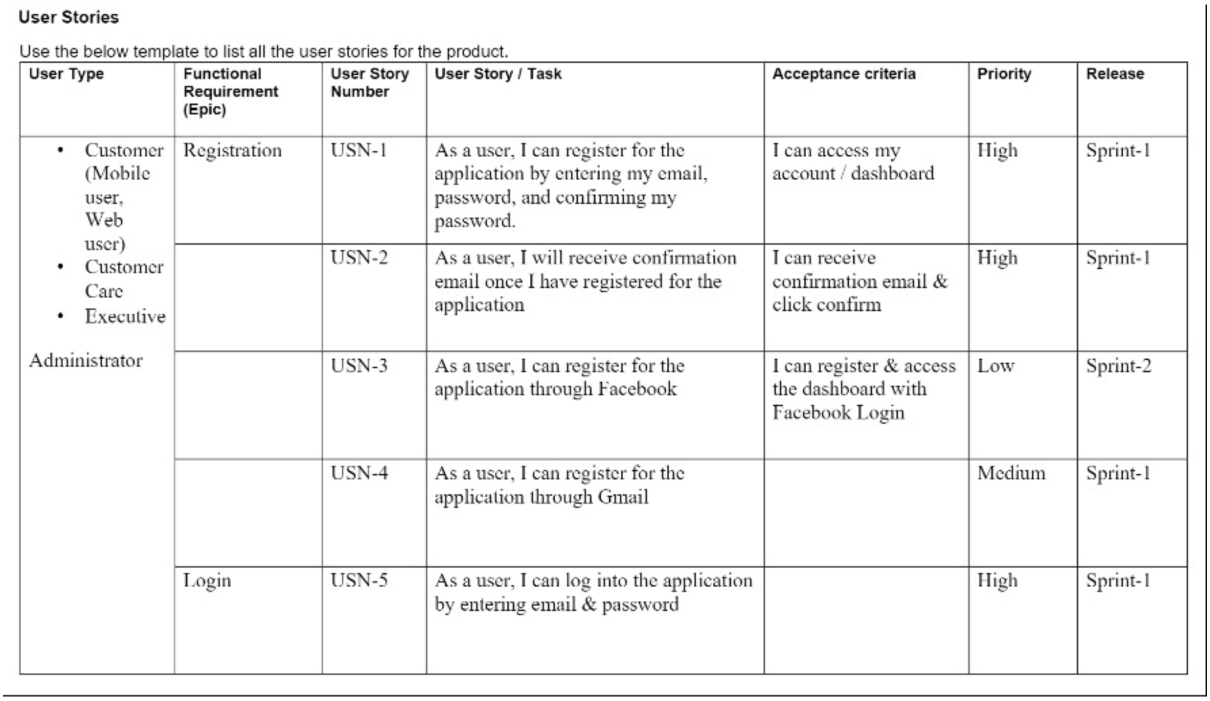

Fire management system
Facilities
Access
Ignition stage precaution
Water released and extinguishers stops fire
Individual sensor access
Information from each sensor
Industry information
Access through mail
Quick mechanism of fire prevention once being detected
Mail access can start the further prevention
Fire spread is totally prevented
Sensing levels
Extinguishers
Fire prevention area
Sensor monitoring
Monitored information

5.2Solution Architecture

Solution Architecture Diagram:


Light Intensity sensor senses light activity
360° Servo rotates to camera and sensor location
Raspberry pi 3 routes to each Arduino Mega via Ip and scans for data, If snap is found Rp forwards to the GSM module & waits for next command
Gas/smoke sensor senses gas/smoke
Arduino triggers the relay module
Flash camera gets triggered and takes snap of the location & sends it to the Arduino
Raspberry pi checks the reply and if gets 1 it forwards it to the Arduino for next action the data
Relay module triggers the Fire Alarm
Arduino receives the data & sends it to the router via ESP-01
GSM module sends message to the adminstrator and waits for AT command to proceed to the next action
Admin checks if there is a fire activity and replies "Fire OK" or "No Fire" for the next action & also takes necessary steps
GSM module receives the command and son do 0 or 1 to the raspberry

5.3 User Stories



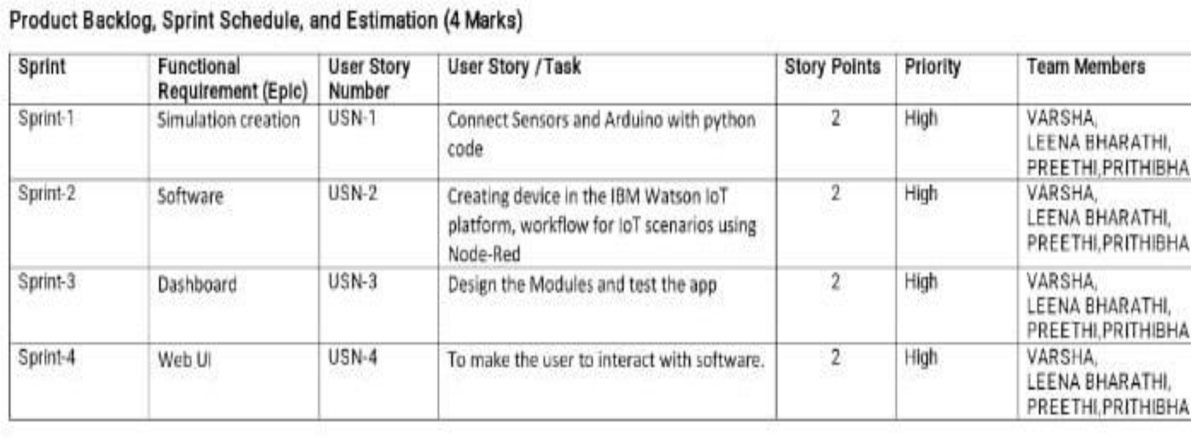
User Stories

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, Web user) • Customer Care • Executive Administrator	Registration	USN-1	As a user, I can register for the application by entering my email, 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
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail		Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Sprint-1

6.PROJECT PLANNING &SCHEDULING

6.1 Sprint Planning & Estimation



Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Simulation creation	USN-1	Connect Sensors and Arduino with python code	2	High	VARSHA, LEENA BHARATHI, PREETHI,PRITHIBHA
Sprint-2	Software	USN-2	Creating device in the IBM Watson IoT platform, workflow for IoT scenarios using Node-Red	2	High	VARSHA, LEENA BHARATHI, PREETHI,PRITHIBHA
Sprint-3	Dashboard	USN-3	Design the Modules and test the app	2	High	VARSHA, LEENA BHARATHI, PREETHI,PRITHIBHA
Sprint-4	Web UI	USN-4	To make the user to interact with software.	2	High	VARSHA, LEENA BHARATHI, PREETHI,PRITHIBHA

7.CODING & SOLUTIONING

7.1 Feature 1

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

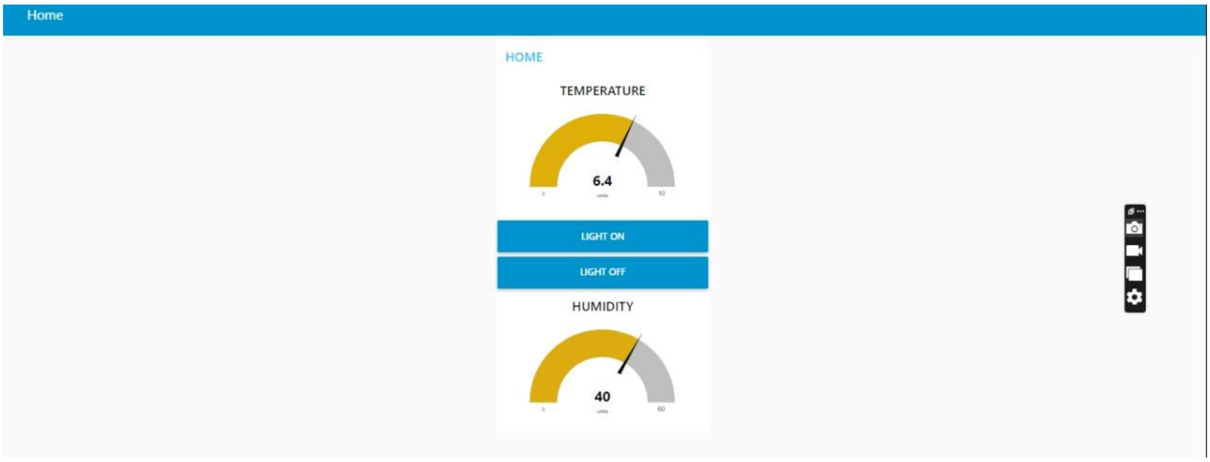
7.2 Feature 2

- Login
- Wokwi

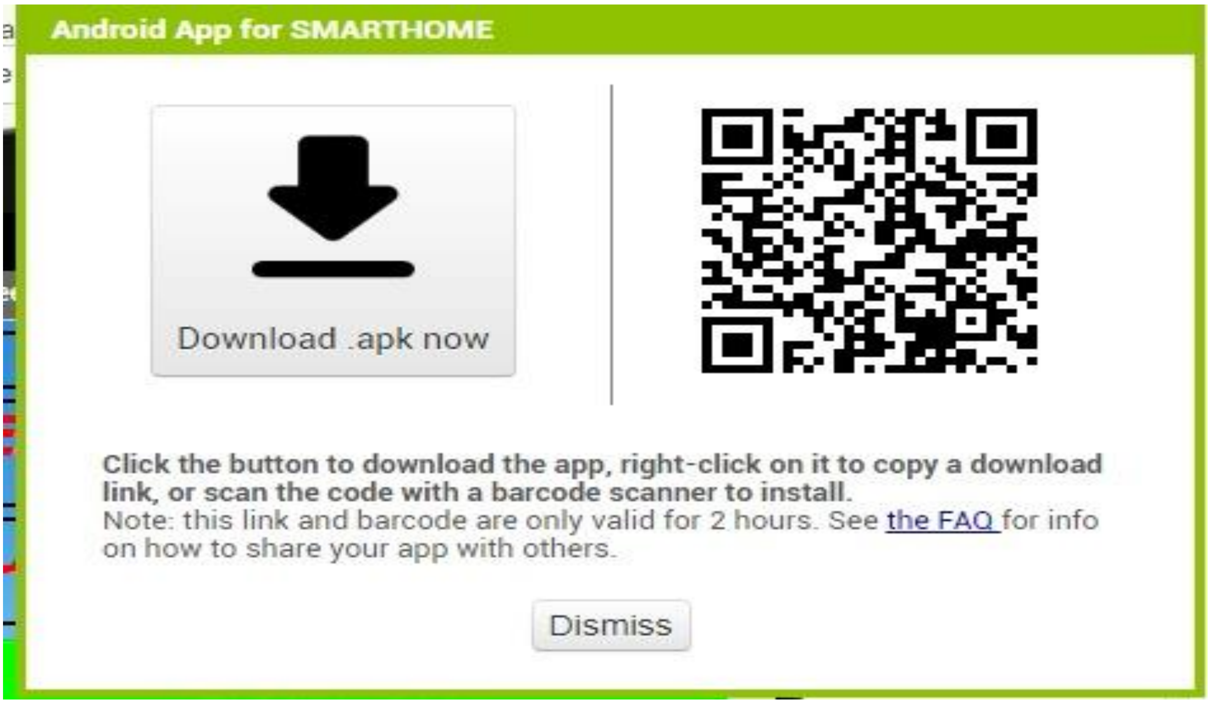
8.TESTING AND RESULTS

8.1 Test Cases

TEST CASE 1



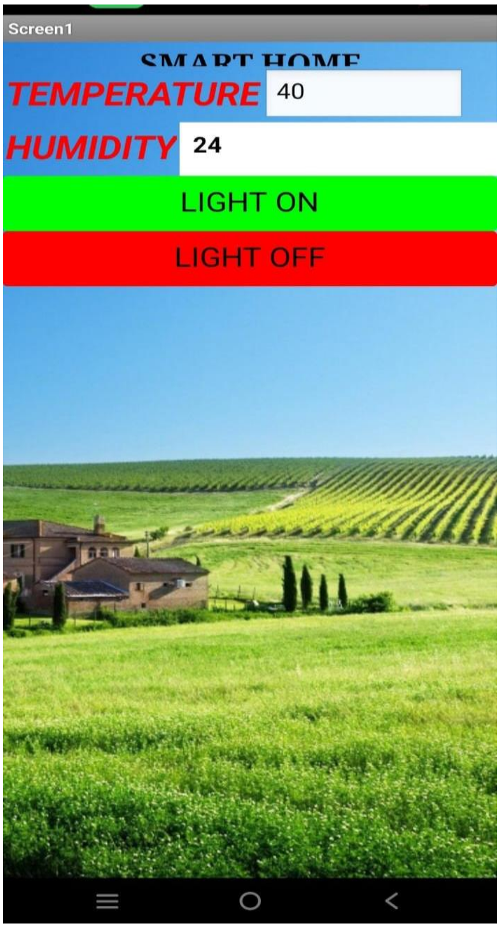
TEST CASE 2



Android App for SMARTHOME

Click the button to download the app, right-click on it to copy a download link, or scan the code with a barcode scanner to install.
Note: this link and barcode are only valid for 2 hours. See the FAQ for info on how to share your app with others.

TEST CASE 3



TEMPERATURE 40

HUMIDITY 24

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

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

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

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

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

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

#define LED 2


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 "i3869j"//IBM ORGANITION ID
#define DEVICE_TYPE "abcd"//Device type mentioned in ibm watson IOT Platform
#define DEVICE_ID "1234"//Device ID mentioned in ibm watson IOT Platform
#define TOKEN "12345678"     //Token
String data3;
float h, t;



//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// Server Name
char publishTopic[] = "iot-2/evt/Data/fmt/json";// topic name and type of event perform and format in which data to be send
char subscribetopic[] = "iot-2/cmd/command/fmt/String";// cmd  REPRESENT command type AND COMMAND IS TEST OF FORMAT STRING
char authMethod[] = "use-token-auth";// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;//client id



//--------------------------------------
WiFiClient wifiClient; // creating the instance for wificlient
```

```
PubSubClient client(server, 1883, callback ,wifiClient); //calling the predefined client id by passing parameter like server id,portand wificredential



void setup()// configureing the ESP32
{
  Serial.begin(115200);
  dht.begin();
  pinMode(LED,OUTPUT);
  delay(10);
  Serial.println();
  wificonnect();
  mqttconnect();
}

void loop()// Recursive Function
{

  h = dht.readHumidity();
  t = dht.readTemperature();
  Serial.print("temp:");
  Serial.println(t);
  Serial.print("Humid:");
  Serial.println(h);

  PublishData(t, h);
  delay(1000);
  if (!client.loop()) {
    mqttconnect();
  }
}




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

void PublishData(float temp, float humid) {
  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 += "," "\"Humid\":";
  payload += humid;
  payload += "}";



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



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

}



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

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

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

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

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

  Serial.print("callback invoked for topic: ");
  Serial.println(subscribetopic);
  for (int i = 0; i < payloadLength; i++) {
    //Serial.print((char)payload[i]);
    data3 += (char)payload[i];
  }
  Serial.println("data: "+ data3);
  if(data3=="lighton")
  {
Serial.println(data3);
digitalWrite(LED,HIGH);
  }
  else
  {
Serial.println(data3);
digitalWrite(LED,LOW);
  }
data3="";
}
```

13.2 GitHub

GitHub Link:

https://github.com/IBM-EPBL/IBM-Project-19673-1659703909