Project Report

Date	17 November 2022
Team ID	PNT2022TMID27071
Project Name	Gas leakage monitoring and alerting system for industries.
Team Members	Kumaran N T (Lead) Abija Mercy J A Kaviya M Lijitha Aswi A

1. INTRODUCTION

1.1 Project Overview

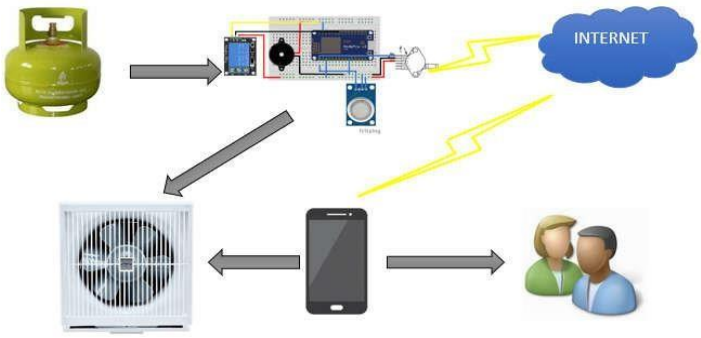
The Internet of Things is an emerging topic of technical, social, and economic significance. Consumer products, durable goods, cars and trucks, industrial and utility components, sensors, and other everyday objects are being combined with Internet connectivity and powerful data analytic capabilities that promise to transform the way we work, live, and play.

Internet of Things aim towards making life simpler by automating every small task around us. As much is IoT helping in automating tasks, the benefits of IoT can also be extended for enhancing the existing safety standards. Safety has always been an important criterion while designing home, buildings, industries as well as cities. The increased concentration of certain gases in the atmosphere can prove to be extremely dangerous. These gases might be flammable at certain temperature and humidity conditions, toxic after exceeding the specified concentrations limits or even a contributing factor in the air pollution of an area leading to problems such as smog and reduced visibility which can in turn cause severe accidents and also have adverse effect on the health of people.

Most of the societies have fire safety mechanism. But it can use after the fire exists. In order to have a control over such conditions we proposed system that uses sensors which is capable of detecting the gases such as LPG, CO2, CO and CH4.

This system will not only able to detect the leakage of gas but also alerting through audible alarms. Presence of excess amounts of harmful gases in environment then this system can notify the user.

System can notify to society admin about the condition before mishap takes place through a message.



1.2 Purpose

The Internet of things (IoT) is a futuristic technology where interconnection of devices and the internet is proposed. As the safety keeps an important concern, the proposed gas detection system makes use of **IoT to detect the leakage and alert the user for preventing the leakage.**

The purpose of this project is to detect the presence of LPG leakage as a part of a safety system and save the workers in the gas industries and causalities in the houses.

2. LITERATURE SURVEY

2.1 Existing problem

The gas leaked by an LPG cylinder if inhaled can lead to suffocation, as well as cause difficulty in walking or speaking. Your nervous system can get affected, while you can experience heart attack and rise in your blood pressure. Hence, it is important to be careful if you detect a LPY cylinder leak.

It may lead to suffocation when inhaled and may lead to explosion. Due to the explosion of LPG, the number of deaths has been increased in recent years. To avoid this problem there is a need for a system to detect the leakage of LPG.

2.2 References

[1] Shital Imade, Priyanka Rajmanes, Aishwarya Gavali , Prof. V. N. Nayakwadi “GAS LEAKAGE DETECTION AND SMART ALERTING SYSTEM USING IOT” https://www.pramanaresearch.org/gallery/22.%20feb%20ijirs%20-%20d539.pdf

[2] Kumar Keshamoni and Sabbani Hemanth. "Smart Gas Level Monitoring, Booking & Gas Leakage Detector over IoT " International Advance Computing Conference IEEE, 2017.

[3] Babuprasanth.V. “Cloud Connected Smart Gas Leakage Detection And Safety Precaution System" International Journal of MC Square Scientific Research Vol.6, No.1 Nov 2014.

[4] Asmita Varma, Prabhakar S, Kayalvizhi Jayavel. “Gas Leakage Detection and Smart Alerting and Prediction Using IoT." *Internet of Things and Applications (IOTA), International Conference on*. IEEE, 2017.

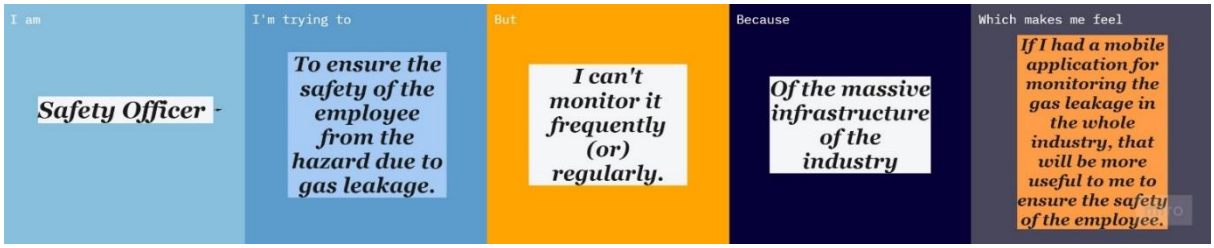
2.3 Problem Statement Definition

The Problem statement Comprises set of questions which the project seeks to address. It identifies the current state and future state and any gaps between the two.

The Problem arises here in this project is:

Problem 1:

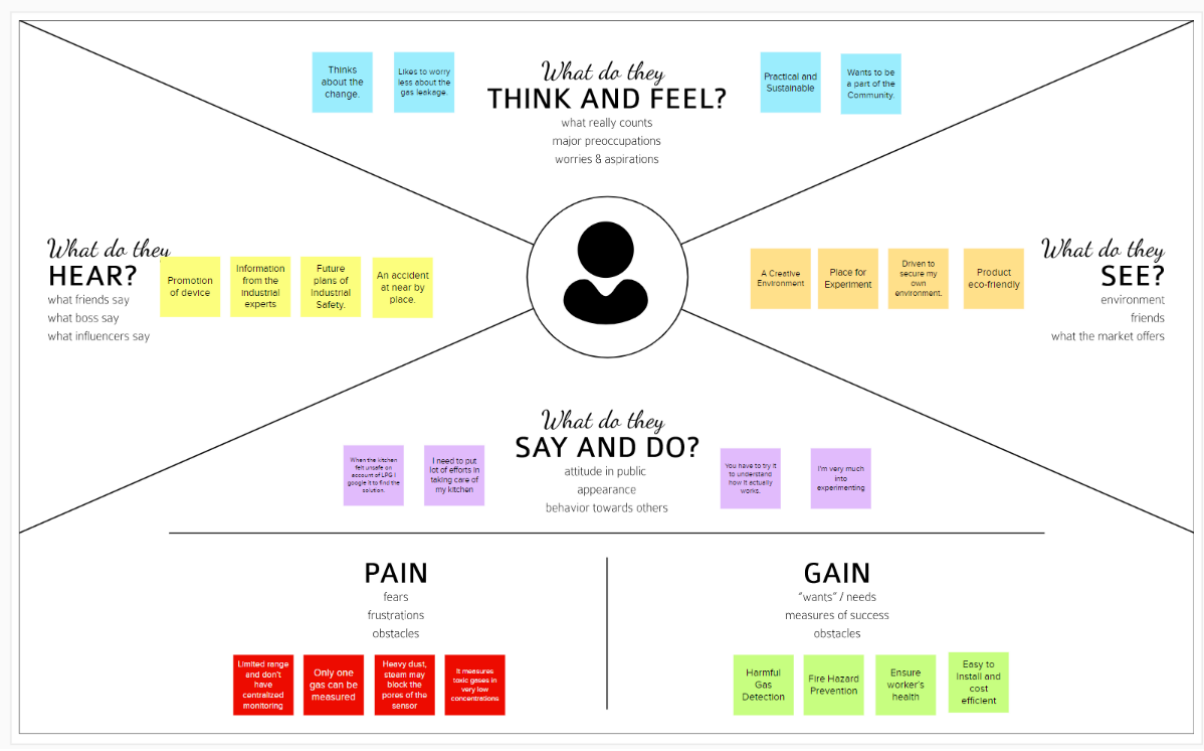
Problem2:



3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

An empathy map is a collaborative tool teams can use to gain a deeper insight into their customers.

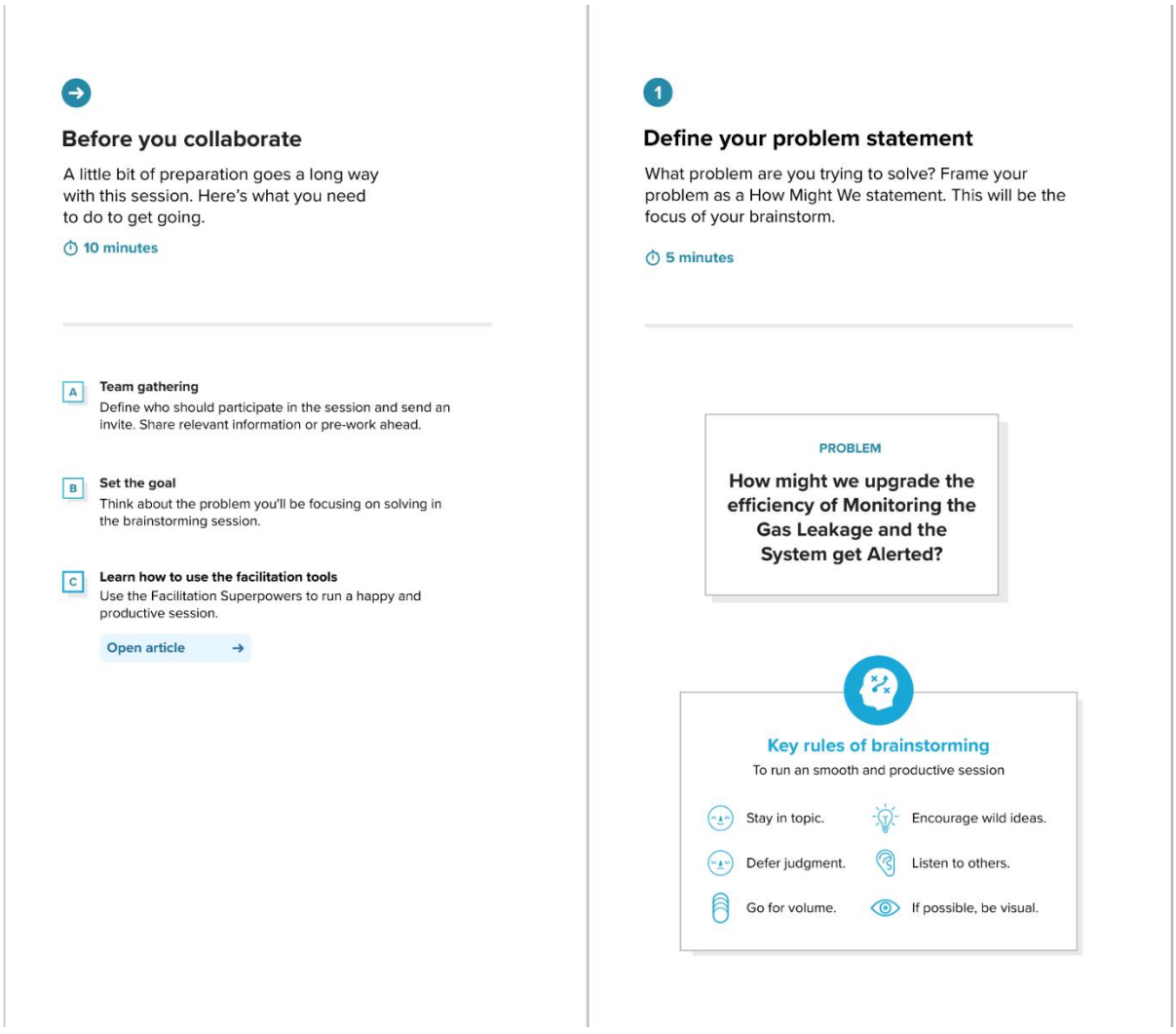


3.2 Ideation & Brainstorming

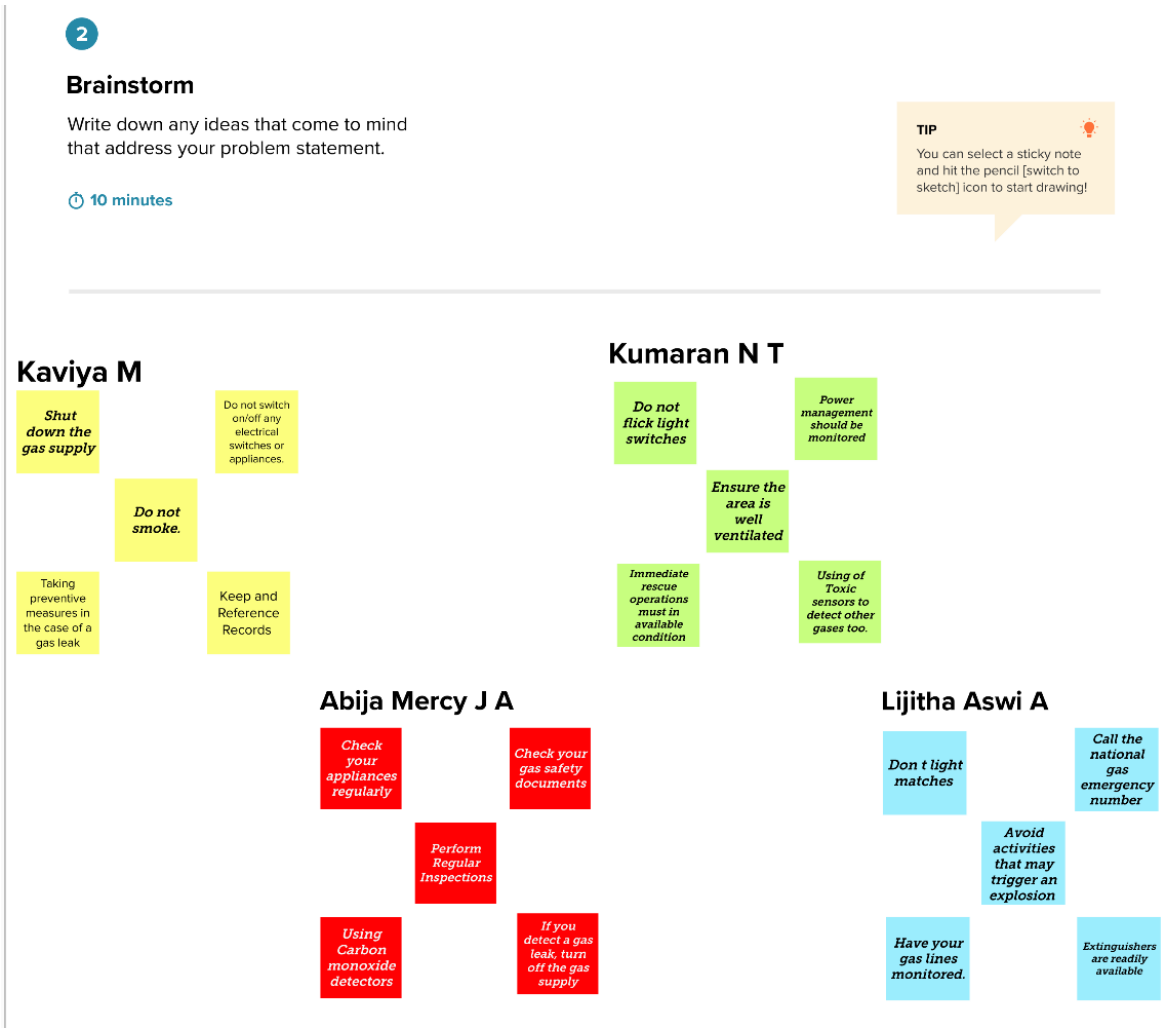
Ideation is often closely related to the practice of brainstorming, a specific technique that is utilized to generate new ideas. A principal difference between ideation and brainstorming is that ideation is commonly more thought of as being an individual pursuit, while brainstorming is almost always a group activity.

Brainstorm & Idea Prioritization:

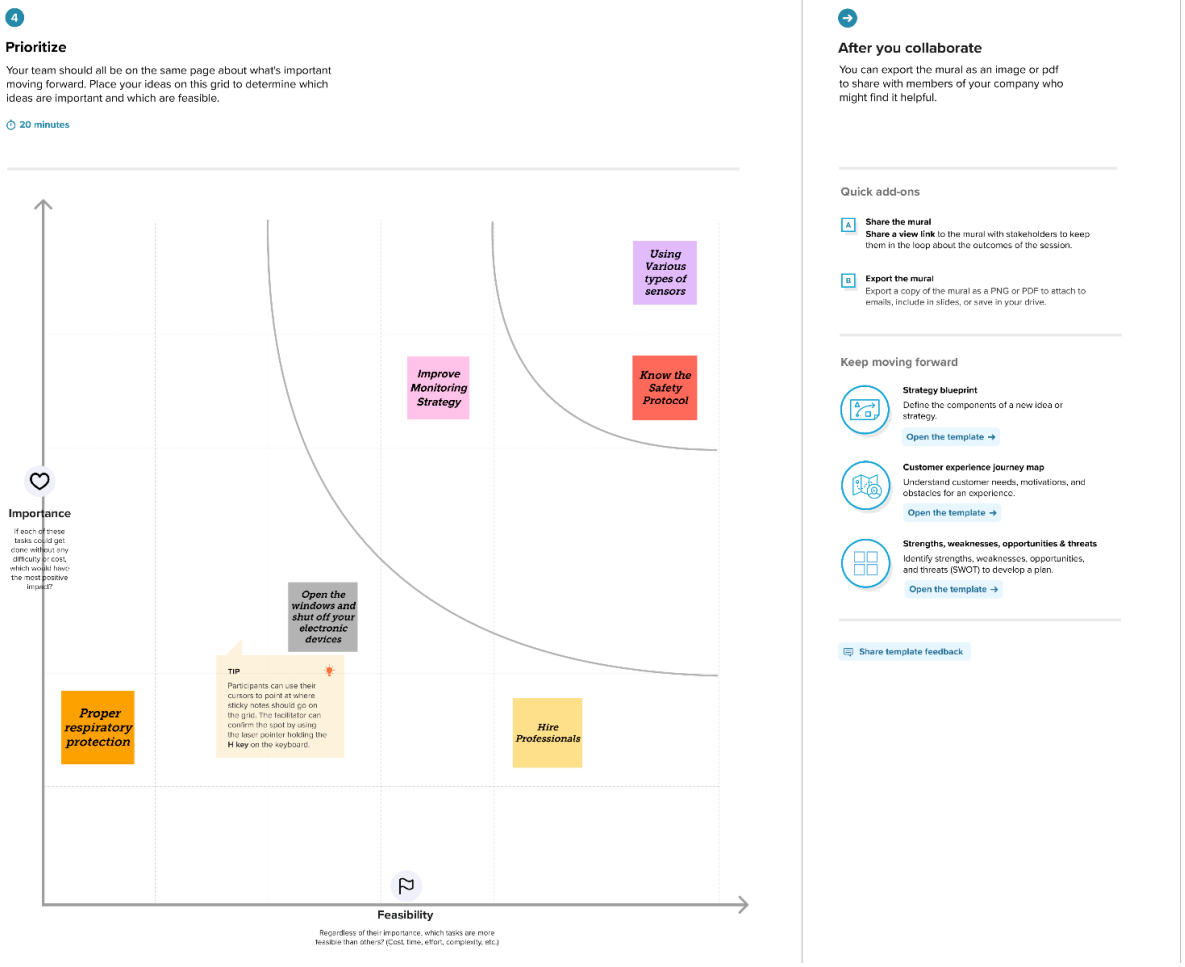
Step-1: Team Gathering, Collaboration and Select the Problem Statement:



Step-2: Brainstorm, Idea Listing and Grouping:



Step-3: Idea Prioritization:



3.3 Proposed Solution

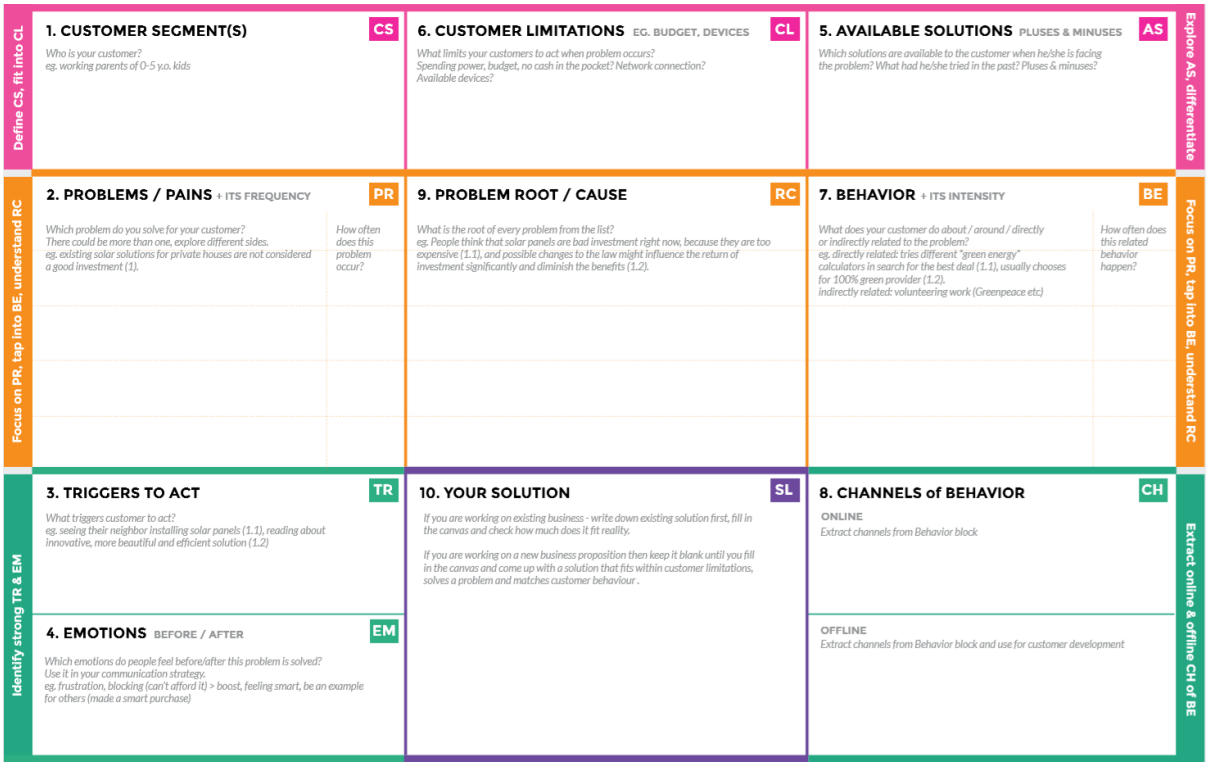
The proposed solution should relate the current situation to a desired result and describe the benefits that will accrue when the desired result is achieved. So, begin your proposed solution by briefly describing this desired result.

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	The purpose of this project is to detect the presence of LPG leakage as a part of a safety system and save the workers in the gas industries and causalities in the houses.
2.	Idea / Solution description	If the gas leaks, the sensor will send its data wirelessly to Arduino. Then, explosion prevention system will be activated.
3.	Novelty / Uniqueness	The system will turn the alarm/buzzer on, automatically releases gas regulator, and neutralizes the air with the exhaust fan and also intimate the user.
4.	Social Impact / Customer Satisfaction	The sensor-enabled solution helps prevent the high risk of gas explosions and affecting any casualties within and outside the premises. The gas sensors help detect the concentration of the gases present in the atmosphere to avoid hazardous consequences like fire breakouts.
5.	Business Model (Revenue Model)	Gas leakage leads to various accidents resulting into both financial loss as well as human injuries. In human's daily life, environment gives the most significant impact to their health issues.

6.	Scalability of the Solution	The result of this project is that the leakage is detected and stopped within 2 seconds, after the leakage starts. This system can detect even 0.001% of leakage. This is an efficient method for automatically detecting and controlling the LPG gas leakage. Moreover, the fire accidents are also prevented by switching off the power supply.

3.4 Problem Solution fit

Problem-Solution canvas is a tool for entrepreneurs, marketers and corporate innovators, which helps them identify solutions with higher chances for solution adoption, reduce time spent on solution testing and get a better overview of current situation.



4. REQUIREMENT ANALYSIS

4.1 Functional requirement

Functional requirements may involve calculations, technical details, data manipulation and processing, and other specific functionality that define what a system is supposed to accomplish. Behavioural requirements describe all the cases where the system uses the functional requirements, these are captured in use cases.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Objective	The purpose of this system is to detect gas leakage, neutralize it, and prevent the explosion.
FR-2	Focus	The user shall be able to receive warning message as quickly as possible.
FR-3	Features	Gas detectors measure the level of different gases within the air, and are used to prevent anyone from being exposed to toxic gases that could poison or kill. You may recognise them as fire alarms or carbon monoxide detectors in your home (or) Industry.
FR-4	Essentiality	To prevent anyone from being exposed to toxic gases and explosion.

4.2 Non-Functional requirements

A Non-functional requirement (NFR) is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviours.

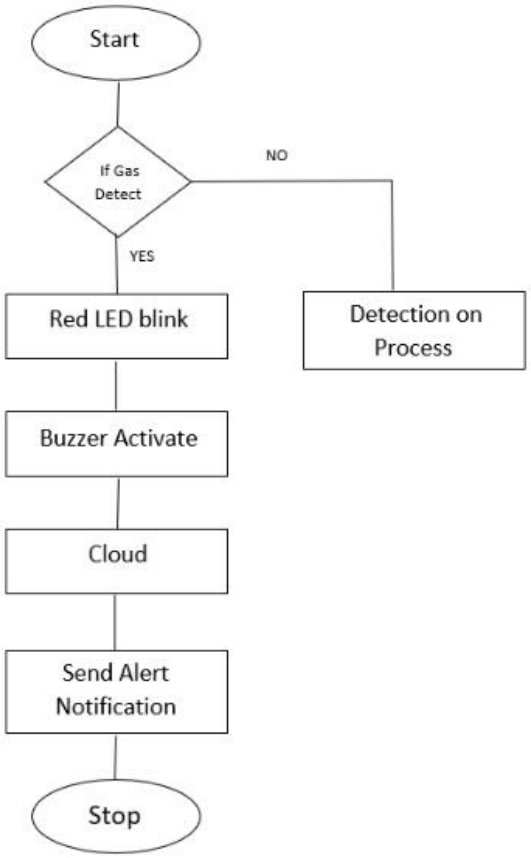
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	The system interface should be easy and effective. (User-friendly)
NFR-2	Security	The communication between the Arduino and the GLDS should be secure by encryption. The system should not display the homeowner personal information to anyone.

NFR-3	Performance	The system should response immediately to any leakage situation. The system should update the local database in real time. The homeowner information should be modified easily
NFR-4	Availability	The system should work 24 hours 7 days a week.

5. PROJECT DESIGN

5.1 Data Flow Diagrams

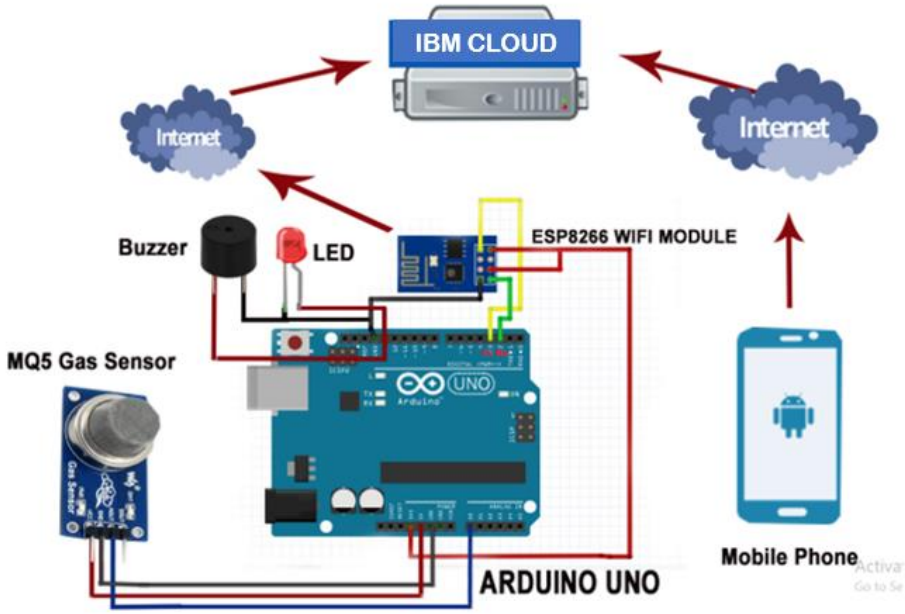
A data flow diagram shows the way information flows through a process or system. It includes data inputs and outputs, data stores, and the various subprocesses the data moves through. DFDs are built using standardized symbols and notation to describe various entities and their relationships.



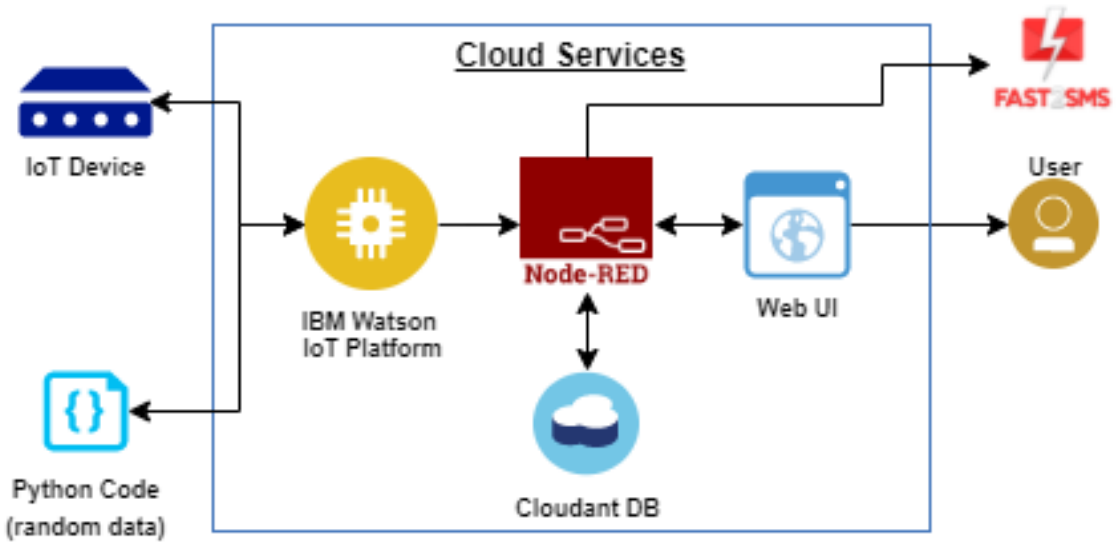
5.2 Solution & Technical Architecture

A solution architecture (SA) is architectural description idea of a specific solution. SA's combine guidance from different enterprise architecture viewpoints (business, information and technical), as well as from the enterprise solution architecture (ESA).

Solution Architecture Diagram



Technical Architecture



5.3 User Stories

A user story is an informal, general explanation of a software feature written from the perspective of the end user or customer. The purpose of a user story is to articulate how a piece of work will deliver a particular value back to the customer.

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

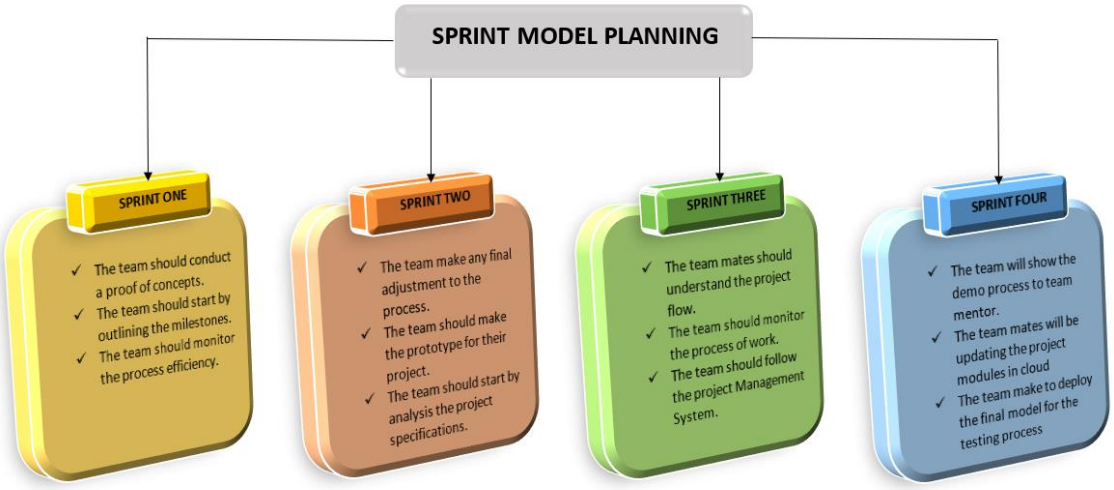
The objective of the Estimation would be to consider the User Stories for the Sprint by Priority and by the Ability of the team to deliver during the Time Box of the Sprint.

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Preventing from explosion	USN-1	The safety officer of the industry needs to prevent anyone from being exposed to toxic gases that could poison or kill.	10	Medium	Abija Mercy J A
Sprint-1	Analysing the gas leakage	USN-2	The safety officer of the industry who wants to save his employees from explosion must take necessary actions.	10	High	Abija Mercy J A
Sprint-2	To detect the gas leakage	USN-3	The safety officer of industry should take certain steps by installing gas detectors in their industry.	20	High	Kaviya M

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-3	Testing and training of the model device	USN-4	The programmer can design a gas leakage detection model by training the dataset.	20	High	Lijitha Aswi A
Sprint-4	Notification	USN-5	The gas leakage in the industry is detected by the device which is further notified by using SMS or alarming systems.	20	High	Kumaran N T

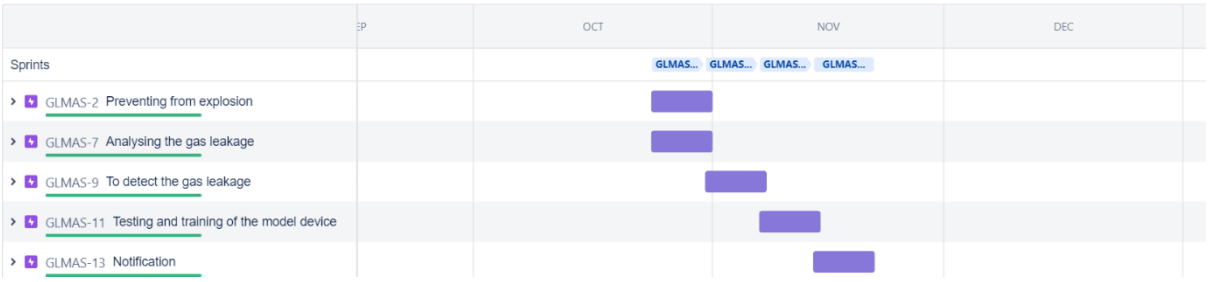
6.2 Sprint Delivery Schedule

Delivery Plan



6.3 Reports from JIRA

Jira Software is part of a family of products designed to help teams of all types manage work. Originally, Jira was designed as a bug and issue tracker. But today, Jira has evolved into a powerful work management tool for all kinds of use cases, from requirements and test case management to agile software development.



7. CODING & SOLUTIONING

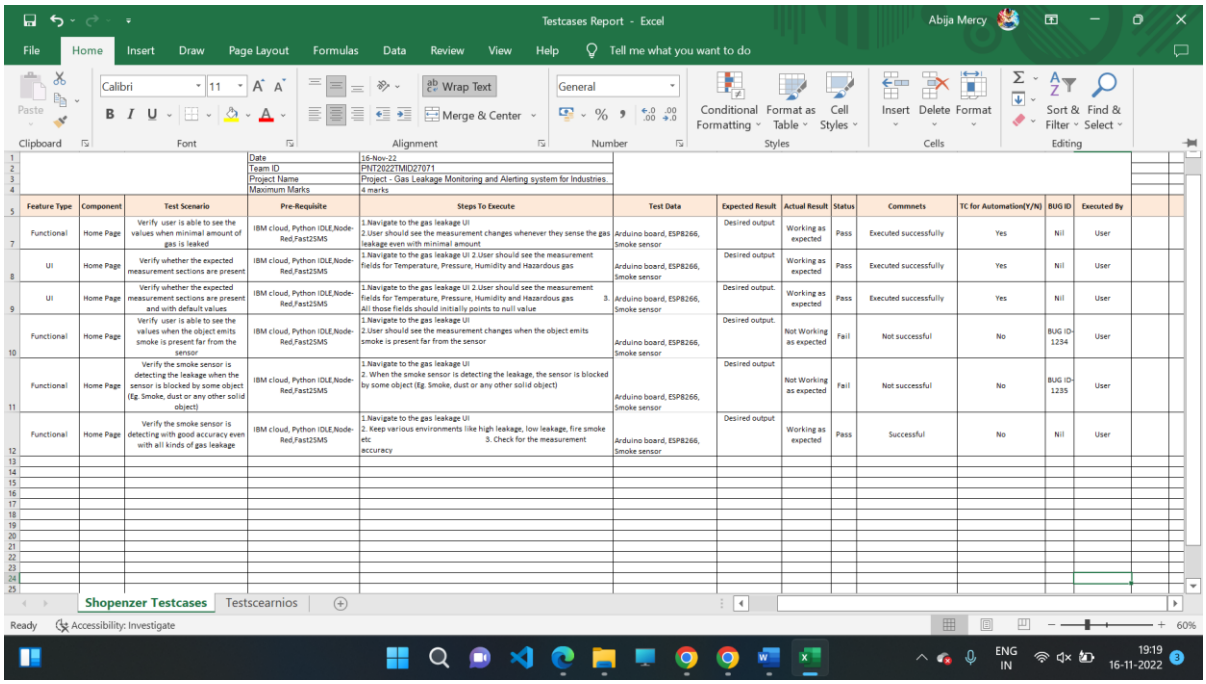
7.1 Python Code

```
#IBM Watson IOT Platform
#pip install wiotp-sdk
import wiotp.sdk.device
import time
import random


#Provide your IBM Watson Device Credentials
myConfig = {
    "identity": {
        "orgId": "yf0dyy",
        "typeId": "Kumaran",
        "deviceId":"12345"
    },
    "auth": {
        "token": "VJTDPRX@f&4Vuox8ms"
    }
```

```
}

def myCommandCallback(cmd):
    print("Message received from IBM IoT Platform: %s" % cmd.data['command'])
    m=cmd.data['command']



client = wiotp.sdk.device.DeviceClient(config=myConfig, logHandlers=None)
client.connect()

#Conditions
while True:
    temp=random.randint(0,100)
    hum=random.randint(0,100)
    pre=random.randint(0,100)
    haz=random.randint(0,100)

    myData={'Temperature':temp,
            'Humidity':hum,
            'Pressure':pre,
            'HazardousGas':haz
            }
    client.publishEvent(eventId="status", msgFormat="json", data=myData, qos=0,
onPublish=None)
    print("Published data Successfully: %s", myData)
    if(haz>90):
        print("Exhaust Fan is ON")
    else:
        print("Exhaust Fan is OFF")
    client.commandCallback = myCommandCallback
    time.sleep(2)
client.disconnect(
```

8. TESTING

8.1 Test Cases

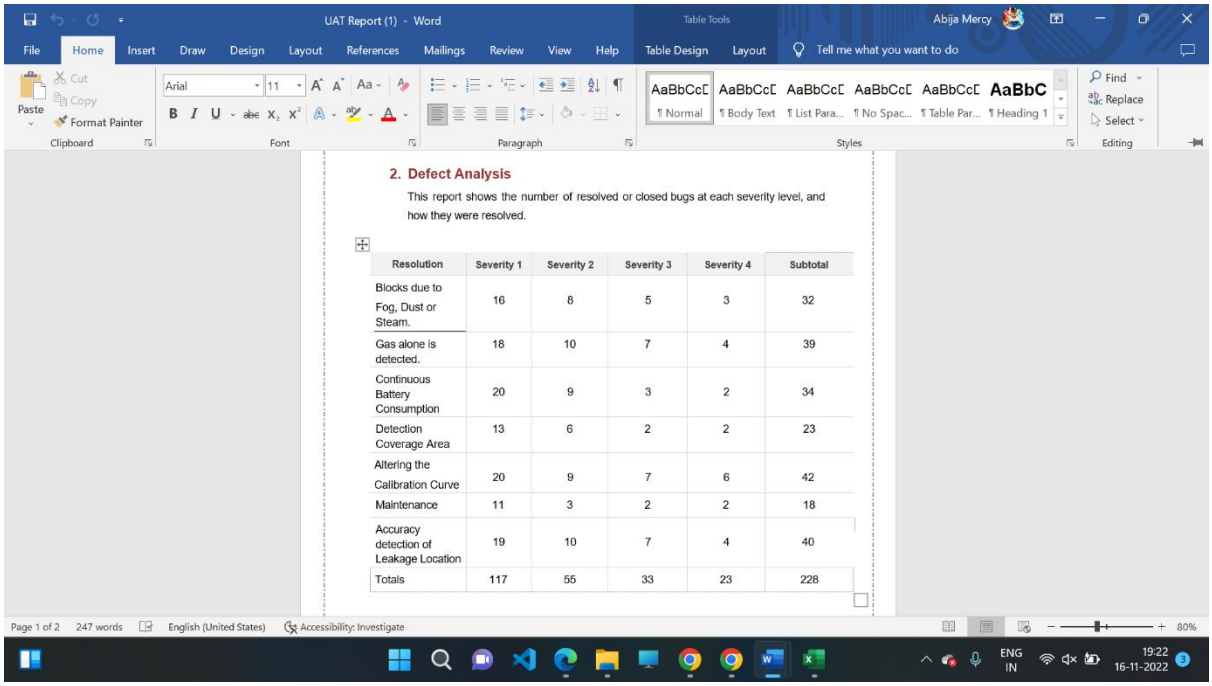


Testcases Report - Excel

			Date	16-Nov-22								
			Team ID	PNT2022TMID27071								
			Project Name	Project - Gas Leakage Monitoring and Alerting system for Industries.								
			Maximum Marks	4 marks								
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
Functional	Home Page	Verify user is able to see the values when minimal amount of gas is leaked	IBM cloud, Python IDLE,Node-Red,Fast2SMS	1.Navigate to the gas leakage UI 2.User should see the measurement changes whenever they sense the gas leakage even with minimal amount	Arduino board, ESP8266, Smoke sensor	Desired output	Working as expected	Pass	Executed successfully	Yes	Nil	User
UI	Home Page	Verify whether the expected measurement sections are present	IBM cloud, Python IDLE,Node-Red,Fast2SMS	1.Navigate to the gas leakage UI 2.User should see the measurement fields for Temperature, Pressure, Humidity and Hazardous gas	Arduino board, ESP8266, Smoke sensor	Desired output	Working as expected	Pass	Executed successfully	Yes	Nil	User
UI	Home Page	Verify whether the expected measurement sections are present and with default values	IBM cloud, Python IDLE,Node-Red,Fast2SMS	1.Navigate to the gas leakage UI 2.User should see the measurement fields for Temperature, Pressure, Humidity and Hazardous gas 3. All those fields should initially points to null value	Arduino board, ESP8266, Smoke sensor	Desired output.	Working as expected	Pass	Executed successfully	Yes	Nil	User
Functional	Home Page	Verify user is able to see the values when the object emits smoke is present far from the sensor	IBM cloud, Python IDLE,Node-Red,Fast2SMS	1.Navigate to the gas leakage UI 2.User should see the measurement changes when the object emits smoke is present far from the sensor	Arduino board, ESP8266, Smoke sensor	Desired output.	Not Working as expected	Fail	Not successful	No	BUG ID-1234	User
Functional	Home Page	Verify the smoke sensor is detecting the leakage when the sensor is blocked by some object (Eg. Smoke, dust or any other solid object)	IBM cloud, Python IDLE,Node-Red,Fast2SMS	1.Navigate to the gas leakage UI 2. When the smoke sensor is detecting the leakage, the sensor is blocked by some object (Eg. Smoke, dust or any other solid object)	Arduino board, ESP8266, Smoke sensor	Desired output	Not Working as expected	Fail	Not successful	No	BUG ID-1235	User
Functional	Home Page	Verify the smoke sensor is detecting with good accuracy even with all kinds of gas leakage	IBM cloud, Python IDLE,Node-Red,Fast2SMS	1.Navigate to the gas leakage UI 2. Keep various environments like high leakage, low leakage, fire smoke etc. 3. Check for the measurement accuracy	Arduino board, ESP8266, Smoke sensor	Desired output	Working as expected	Pass	Successful	No	Nil	User

8.2 User Acceptance Testing

User Acceptance Testing (UAT), which is performed on most UIT projects, sometimes called beta testing or end-user testing, is a phase of software development in which the software is tested in the "real world" by the intended audience or business representative.

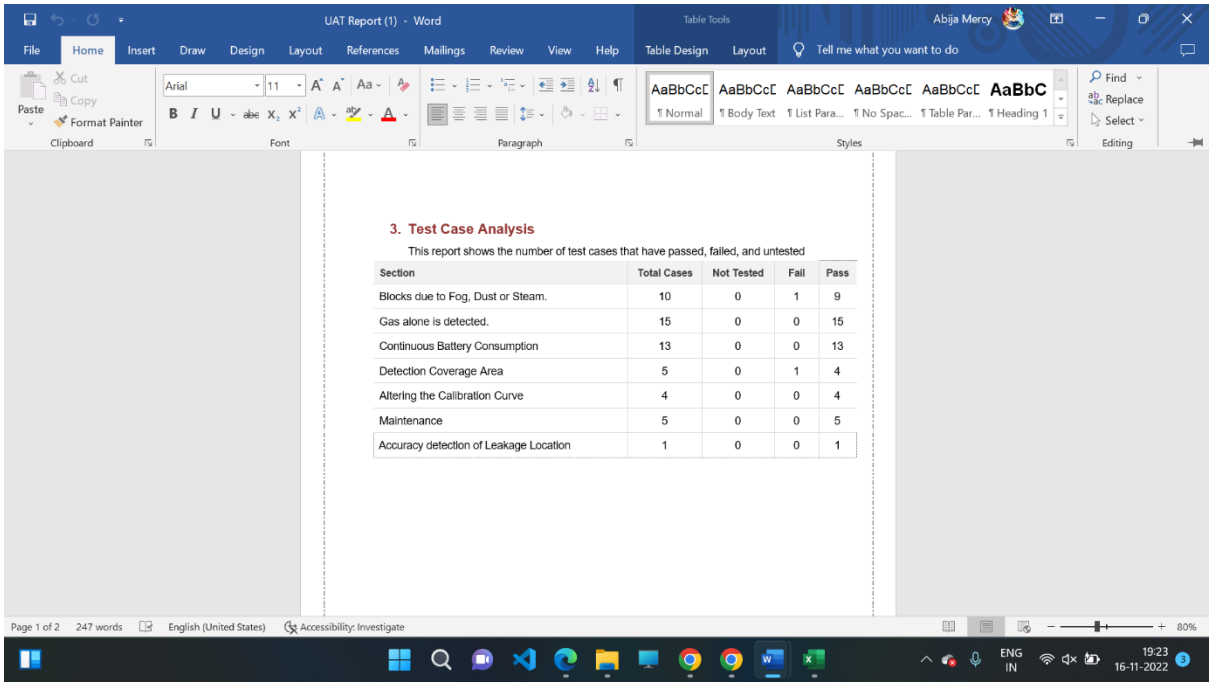


UAT Report (1) - Word

2. Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved.

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
Blocks due to Fog, Dust or Steam.	16	8	5	3	32
Gas alone is detected.	18	10	7	4	39
Continuous Battery Consumption	20	9	3	2	34
Detection Coverage Area	13	6	2	2	23
Altering the Calibration Curve	20	9	7	6	42
Maintenance	11	3	2	2	18
Accuracy detection of Leakage Location	19	10	7	4	40
Totals	117	55	33	23	228



3. Test Case Analysis

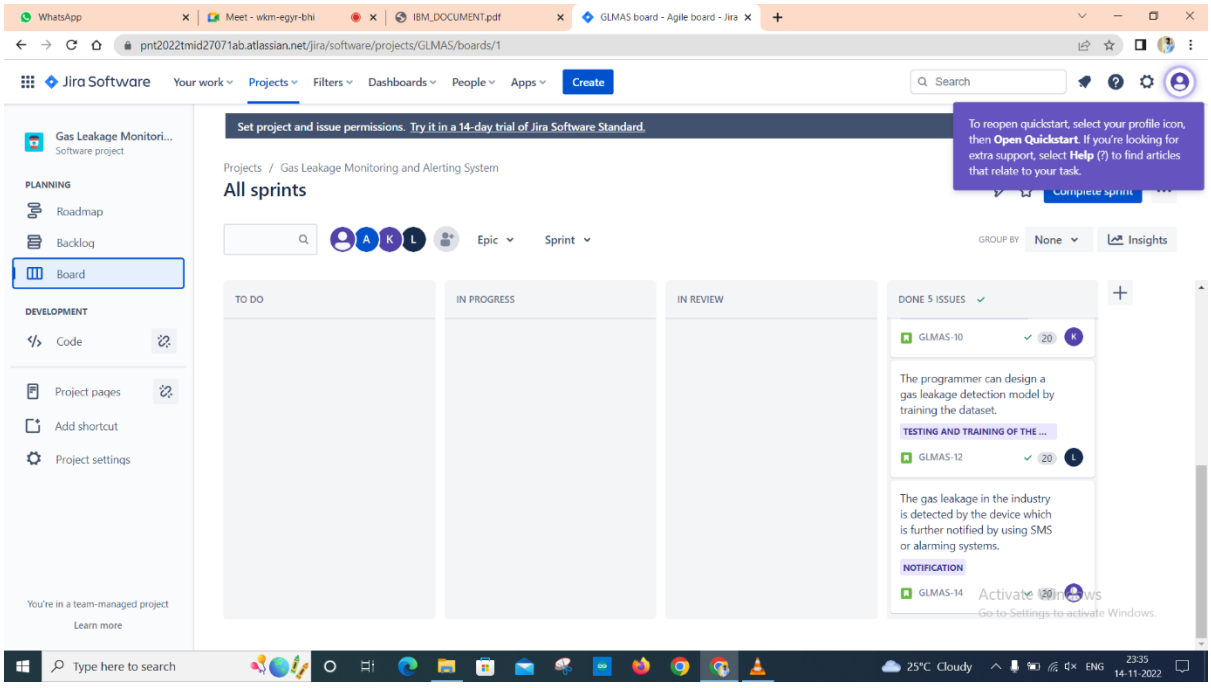
This report shows the number of test cases that have passed, failed, and untested

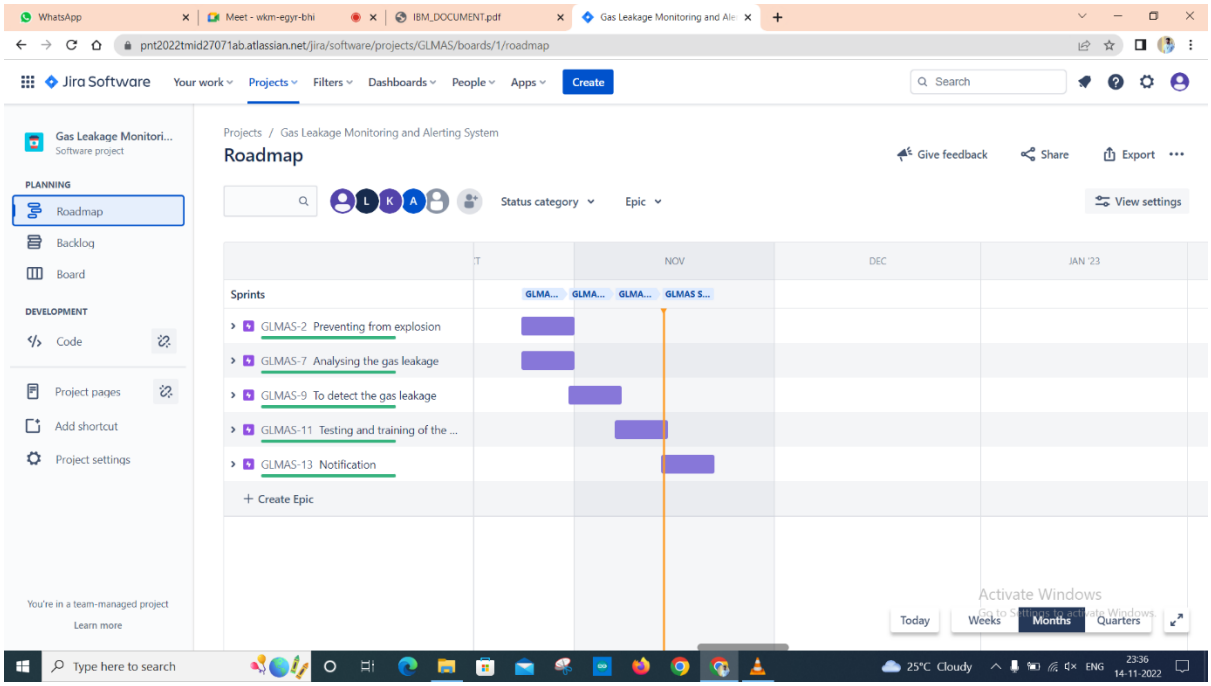
Section	Total Cases	Not Tested	Fail	Pass
Blocks due to Fog, Dust or Steam.	10	0	1	9
Gas alone is detected.	15	0	0	15
Continuous Battery Consumption	13	0	0	13
Detection Coverage Area	5	0	1	4
Altering the Calibration Curve	4	0	0	4
Maintenance	5	0	0	5
Accuracy detection of Leakage Location	1	0	0	1

9. RESULTS

9.1 Performance Metrics

Performance metrics are defined as figures and data representative of an organization's actions, abilities, and overall quality.





10. ADVANTAGES & DISADVANTAGES

Advantages

- ✓ Get real-time alerts about the gaseous presence in the atmosphere.
- ✓ Prevent fire hazards and explosions.
- ✓ Supervise gas concentration levels.
- ✓ Ensure worker's health.
- ✓ Real-time updates about leakage.
- ✓ Cost-effective installation.
- ✓ Data analytics for improved decisions.
- ✓ Measure oxygen level accuracy.

Disadvantages

- ✓ Only one gas can be measured with each instrument.
- ✓ Poor stability leads to greater environmental impact.
- ✓ When heavy dust, steam or fog blocks the input of the sensor.

11. CONCLUSION

In this project we use IOT technology for enhancing the existing safety standards. While making this prototype has been to bring a revolution in the field of safety against the leakage of harmful and toxic gases in environment and hence nullify any major or minor hazard being caused due to them. We have used the IOT technology to make a Gas Leakage Detector for society which having Smart Alerting techniques involving sending text message to the concerned authority and an ability performing data analytics on sensor. This system will be able to detect the gas in environment using the gas sensors. This will prevent form the major harmful problem

We focus on designing a prototype for IoT based LPG cylinder monitoring system. The proposed system is cost-effective and it is real-time. It monitors gas leakage on continuous basis and displayed the Temperature, Pressure, Humidity, and Gas level on mobile. The customer will get the information about the leakage of LPG and if someone is present near his/her house at that particular time, they will be notified accordingly. IoT based system will send an alert message to users on their phones so that they will be more aware about the gas level & leakage of LPG.

12. FUTURE SCOPE

Major cities of India are pushing Smart Home application, gas monitoring system is a part of Smart Home application. Enhancing Industrial Safety using IoT. IoT turns drone into gas detection sensor. Another major future scope could be including a Automatic Shut-off device which will turn off the gas supply whenever it will detect any gas leakage. This system can be implemented in Industries, Hotels and wherever the LPG cylinders are used. This system can be used in industries involving applications such as Furnace, Boilers, Gas welding, Gas cutting, Steel Plants, Metallurgical industries, Food processing Industries, Glass Industries, Plastic industries, Pharmaceuticals, Aerosol manufacturing. As hospitals require to provide maximum possible safety to patients, this system can be used to keep track of all the cylinders used in it. Some of the cylinders used are Oxygen cylinder, Carbon dioxide cylinder, Nitrous oxide cylinder.

As many students are naïve the risk of causing accidents is high. Hence, our system can also be used in schools, colleges. Many colleges have well established labs including chemistry lab and pharmaceutical labs where gas burners are used. Plenty of medical equipment requires gas cylinders.

13. APPENDIX

The Project deliverables are uploaded in Git repository and in the IBM dashboard.

- ✓ GitHub Link: https://github.com/IBM-EPBL/IBM-Project-886-1658328489
- ✓ Demo Link:

  https://drive.google.com/file/d/1XLlKsc2BlxFpJQUbdZLjoKTmdQfUKQ0Y/view?usp=drivesdk