ALAGAPPA CHETTIAR GOVERNMENT COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai)

KARAIKUDI – 630003

PROFESSIONAL READINESS FOR INNOVATION

EMPLOYABLITY AND ENTERPRENEURSHIP

IBM PROJECT REPORT

Submitted by

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ALAGAPPA CHETTIAR GOVERNMENT COLLEGE OF ENGINEERING AND TECHNOLOGY

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BONAFIDE CERTIFICATE

Certified that this PROJECT REPORT **"GAS LEAKAGE MONITORING AND ALERTING SYSTEM FOR INDUSTRIES"** is the bonafide work of **ANDAL ABI A (91761915301), PRIYANKA N (91762015212), ABIKA A** (**91761915001), JAYASHREE S(91762015203)** for **IBM NALAIYATHIRAN** in VII semester of B.E., degree course in Computer Science and Engineering branch during the academic year of 2022 - 2023.

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CHAPTER 1
INTRODUCTION

1.1 Project Overview

Leakage of gas is a major issue in the industrial sector, residential buildings, and gas-powered vehicles, one of the preventive methods to stop accidents associated with gas leakage is to install gas leakage detection devices. The focus of this work is to propose a device that can detect gas leakage and alert the owners to avert problems due to gas leakages. The system is based on a microcontroller that employs a gas sensor as well as a GSM module, an LCD display, and a buzzer. The system was designed for gas leakage monitoring and alerts with SMS via an Arduino microcontroller with a buzzer and an MQ2 gas sensor. The circuit contains a Microcontroller MQ2 gas sensor, buzzer, LCD display, and GSM module, when the sensor detects gas leakage it transmit the information to the Microcontroller while the microcontroller makes a decision and then forwarded a warning message to the user as SMS to a mobile phone for decision to be taken accordingly. The output of

this research will be significant in averting problems associated with gas leakages now and in future.

Index Terms: Gas Leakages, GSM module, Gas Leakage Detector, Gas Sensor, GSM module.

Gas leakage is a major problem within the industrial sector, residential premises, and gas-powered vehicles like CNG (Compressed Natural Gas) buses and cars where the use of gas has become an important source of energy (STET, 2012) to the afore mention area in this era. The issue of Liquefied Petroleum Gas leakage has been so disastrous that it has resulted in serious harm, including the loss of life and property worth millions of dollars around the world. The catastrophic pipeline explosion has happened in different parts of Nigeria in that resulted into death and injure of many people and loss of property [1].

Gas is the most commonly used fuel in Nigerian homes and industry in which some required measures have to be strategized in other to protect against incidents and accidents

such as suffocation and explosion associated with its usage. LPG is a highly inflammable gas made up of a mixture of butane (C4H10) and propane (C3H8) through buthylene and prophylene and another hydrocarbon present in small quantity, due to the odorless of these chemical ethyl mercaptans is added as an odorant to give a powerful scent so that when leakage occurs it can be perceived [2], however in a situation of the minimum quantity of gas leakage, some people have a poor sensing ability to perceive and so, more reliable and effective device use in detecting gas (gas leakage detector) has to be installed in homes, industries, and vehicles of LPG usage to avoid explosion.

LPG leakage refers to several factors such as leakage in the pipe, hose not properly fixed, and hearing of whistling or hissing sound around the cylinder, valve not fitted properly. There are different ways of detecting gas leakage in which there has been existing LPG detector which only sound out an alarm when there is leakage and there is still improvement that could be made to the existing ones, in which a microcontroller activate the alarm and send a message

through SMS to the appropriate personnel. The crux of the paper is to create a device that can detect LPG leakage as part of a safety measure and automatically send an SMS to the appropriate personnel and will activate an alarm immediately after gas leakage is detected in other to prevent wastage of the gas and also explosion which could lead to damaging of properties and other calamities [3].

The focus of this work is to design a system that monitors gas leakage in an enclosed system using an Arduino Uno microcontroller and an alarm system are used to alert people within leakages neighborhood while SMS will be sent to the premises owner or safety organization to towards making 2 decision to avert damages and loss of lives/properties.

1.2 Purpose

The design of a sensor-based automatic gas leakage detector with an alert and control system has been proposed. This is an affordable, less power using, lightweight, portable, safe, user friendly, efficient, multi featured and simple system device for detecting gas.

Gas leakage detection will not only provide us with significance in the health department but it will also lead to raise our economy, because when gas leaks it not only contaminates the atmosphere, but also wastage of gases will hurt our economy. The need for ensuring safety in workplaces is expected to be the key driving force for the market over the coming years.

The objectives among others if the design is implemented are:

i. To prevent loss of lives and properties when gas leakages occur
ii. To enable prompt action by the premises owner and safety organization towards avert problems that may be associated with gas leakages.
iii. To enable people around the gas leakages premises take action to prevent damages escalation.

CHAPTER 2

LITERATURE SURVEY

2.1 Existing problem

Gas leakage is nothing but the leak of any gaseous molecule from a stove, or a pipeline, or cylinder etc. This can occur either purposefully or even unintendedly. As we are aware that these kinds of leaks are dangerous to our health, and when it becomes explosive it could cause great danger to the people, home, workplace, industry and the environment.

2.2 References

2.2.1 Liquid Problem Gas Detection

Liquid problem gas is a flammable mixture of hydrocarbon gases used as fuel in heating appliances, cooking equipment, and specifically as a vehicle fuel (it is often referred to as autogas). It is an odorless gas due to ethyl mercaptan is added as an odorant to be easily detected when leakage occurs for safety precaution. LPG is made by refining petroleum or wet natural gas and is almost entirely derived from fossil fuels sources being manufactured during the refining of crude oil as theory emerged

from the natural state. It was classified as a hazardous material because of its explosive potentials when under pressure, due to this hazardous property leading to fire explosion. The gas detection process was made by the chemically infused paper that change its color when it’s been exposed to gas before the development of the electronics gas detector. The electronics leakage detector was an active approach to initial fault detection in other to achieve the utmost safety of humanity and properties as a whole they introduced an android base automatic gas detection) different approaches have been used alongside several research in the detection of leakage and were also implemented alongside some incident toward some decades. The existing leakage detection is optical sensor method, cable sensor, negative pressure, vapor sampling, signal processing, mass volume, and pressure point analysis, in which have been implemented using a different framework. Some groups of researchers have classified the technology as two fitting categories, which are software and hardware method but research continues and to technical nature research effort which led them to three group methods .

2.2.2 Classification of Leakages Detection

There are different classes of leakage detection which have been used to monitor the leakage, several criteria are classified into their classification, some of which are critical principles and abilities needed from humans. The detection is classified into three, which are automated detection, manual detection, and semi-automated detection. Automated Detection involves monitoring of detecting leakage without the help of the operator, once the detector device is installed and been connected to the display of the personnel in charge and can be automatically shut down from the display unit. (SCADA); Manual Detection - These are methods in which the device can only be operated by humans. Like thermal imager or light detection and ranging (Lidar) devices; Semi-automated detection – solutions that necessitate a certain amount of input or assistance in carrying out certain tasks (e.g., statistical or digital signal processing methods) (Batzias et al., 2011). The technology used in leakages detection can be classified into two categories which are, Direct method and the Indirect method The direct method is making use of a handheld detector by the patrol team along the pipeline and in the aspect of

the very long pipeline, the airplane mounted optical imaging device is used along the pipeline for measuring gas emanation for fast result .

2.2.3 FPGA-GSM Based Gas Leakage Detection

In the work entitled FPGA-GSM Based Gas Leakage Detection Method. They investigated a simple FPGA-based system that detected LPG leakages using the MQ6 sensor. In the event of gas leakage, an automatic warning call is sent to the first response team via GSM to avoid any delays. There is no remote monitoring or any mechanism for mitigating gas leaks, such as automatic shut-off of the gas supply.

2.2.4 Embedded Real-Time System for Gas Leakage Detection

A domestic applications in residential buildings for an Embedded real-time system for gas leakage detection in which sensor nodes are installed in various households and communicate with a single central node. An alarm is triggered in the event of gas leakage. The concerned personnel is identified and alerted via text messages using the assigned MAC address of the RF module in

each sensor unit. The use of exhaust fans is a commonly proposed solution for gas-related accidents, however, this system is only capable of mitigating a possible disaster and not completely averting it, since this approach reduces the risk by expelling gas leakage instead of shutting down the supply .

2.2.5 Wireless modularization of gas safety devices

Smart home gas safety management system based on wireless modularization of gas safety devices was designed to allow safety in the homes in other to reduce damages. The system is based on the commercially available intelligent Micom meters, which have enhanced standard gas meters with a built-in microcontroller and a cutoff valve. The system is primarily concerned with detecting fire breakouts, and the existing gas meter has been upgraded to communicate with an external smoke and CO detecting sensor, as well as fire extinguishing modules, which are used to extinguish the fire when the temperature exceeds the threshold. The requirement for an existing Micom meter to construct the enhanced gas and fire safety method is a disadvantage of this system, as it lacks independent application developed a gas leakage detection and location system based on wireless sensor

networks. They used wireless sensor networks to detect gas leakages and ensure product safety in the petrochemical industry. The system emphasizes the importance of developing centralized location software by collecting data from wireless RF sensors in order to precisely pinpoint the location of gas leakage and aid in the response time reduction In spite of the absence of remote monitoring and automatic shutoff, the study emphasizes the importance of inter-node communication in developing a dependable leakage detection system .

2.2.6 Automatic Safety Gas Stove and liquefied petroleum gas booking and monitoring

An automatic safety gas stove that uses Infrared (IR) sensors to detect the presence of utensils on the stove. In the absence of utensils, the system relies on motors to turn the stove knob to turn off the gas supply. The system presumes that the gas leak is limited to the stove burner and ignores the possibility of a leakage in the gas supply pipe. Its ability to detect gas leaks is limited due to the absence of any sensing units. The disadvantage of this approach is that it does not take into account scenarios such as gas pipe leakage . Automated Unified System for LPG Using

Microcontroller And GSM Module: This was a very cost-effective 4 automated liquified petroleum gas booking and monitoring, which the gas leakage is detected through the weight sensor to detect the level of the gas in the cylinder and an MQ series sensor to monitor leakage through the SMS received by the user and automatically book the cylinder. It also involves an exhaust fan that is switched on and a solenoid valve fitted to the cylinder to close once there is leakage .

2.3 Problem Statement Definition

Few of the major incidents that took place due to gas leakage include the Bhopal Disaster and the Vizag Gas leak. The Bhopal disaster is known to be the worst industrial accident ever.

Approximately 45 tons of Methyl Isocyanate was leaked from this insecticide plant. Methyl Isocyanate is an organic compound and a chemical that could come from the carbamate pesticides. This colorless, poisonous and flammable liquid is something that human beings have to be away from. Vizag Gas leak was a resultant of the escape of styrene that were unattended for a long period.

This colorless oily liquid can spread in fumes. So, a detector must be made in such a way that could detect any kind of gas, fume, leak, smoke etc. However harmful and dangerous it can be, the detector could be attached with certain parameters that could help to prevent the issue.

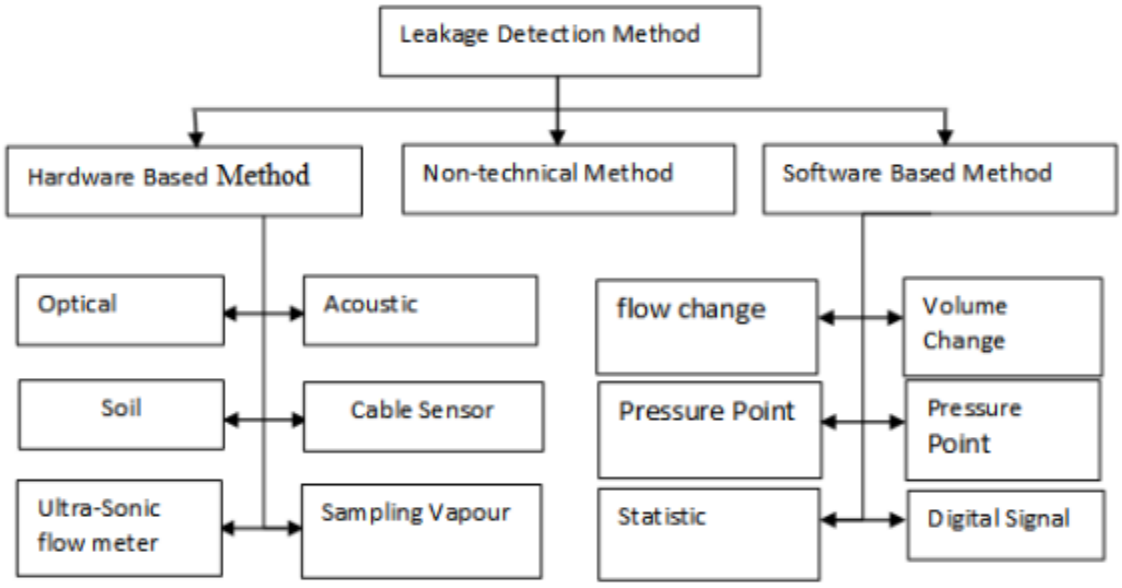


Fig. 2.3.1. Gas Leakage Detection Method Based on Technical Nature

CHAPTER 3

IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

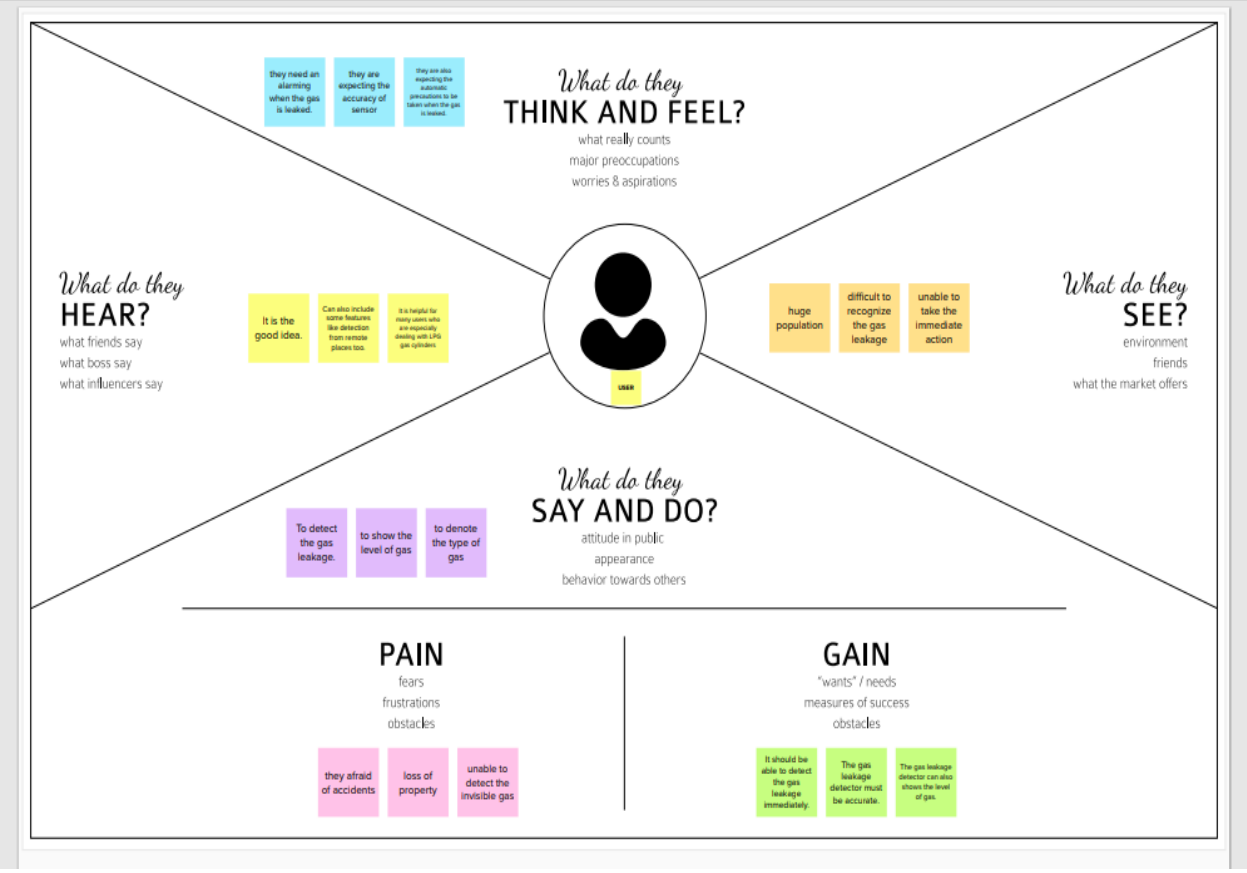


Fig. 3.1.1. Empathy Map Canvas

What do they Think and Feel

- They need an alarm when the gas gets leaked.
- The user expects the accuracy of the setup.

- They expect the system to take automatic decisions when the gas gets leaked.

What do they Hear

- They hear people suggestions about the product.
- People expect some features like detection from remote places too.
- It is helpful for many users who are especially dealing with LPG gas cylinder.

What do they Hear

- The buyer expects huge product demand from the people.
- Immediately recognizing the gas leakage.

What do they Say and Do

- The user expect the product to show the level of gas leaked in the surrounding.
- They also need to denote the type of gas.

Gain and Pain

- It will be able to detect the gas leakage immediately.

- The gas leakage detector must be accurate.
- The gas leakage detector can also shows the level of gas.
- People afraid of accidents because of gas leakage and fire accidents.
- They fear about the loss of property due to Fire accidents and Short circuit of Electricity.
- People cannot detect the leakage of gas by naked eyes only if the gas can be smelled otherwise the leakage of gas causes great damage.

3.2 Ideation & Brainstorming

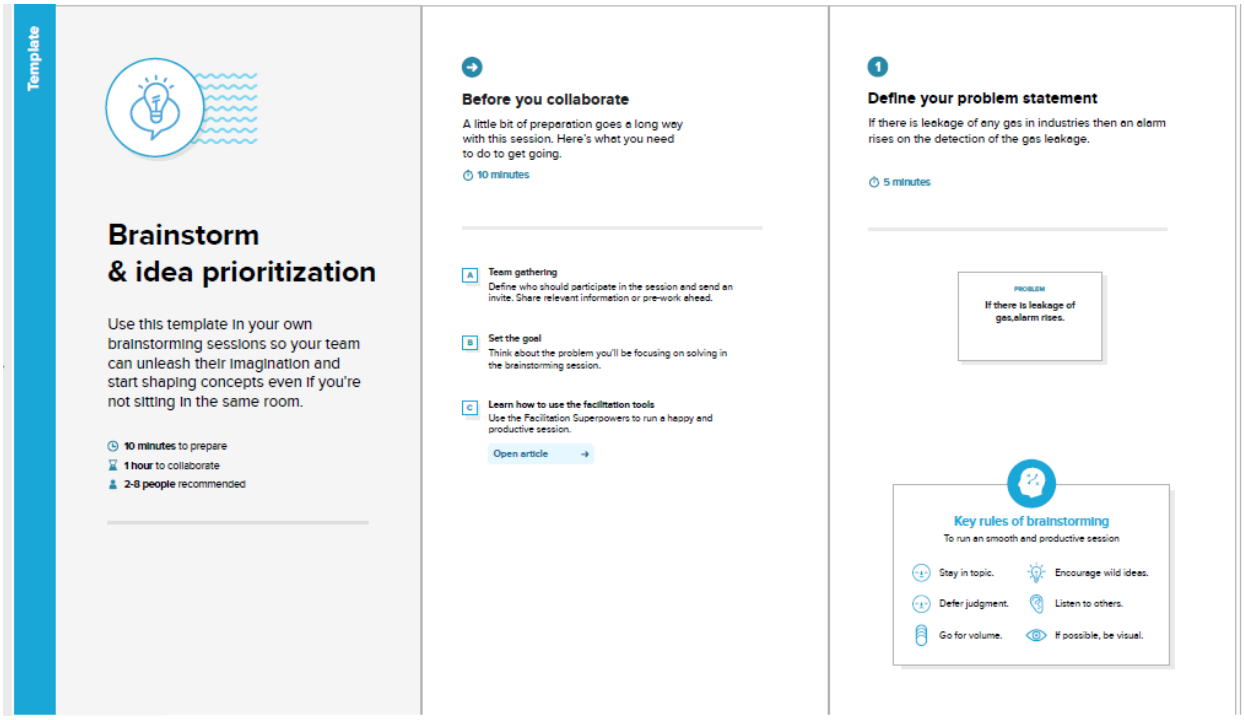


Fig.3.2.1 Ideation and Brainstorming

Brainstorm

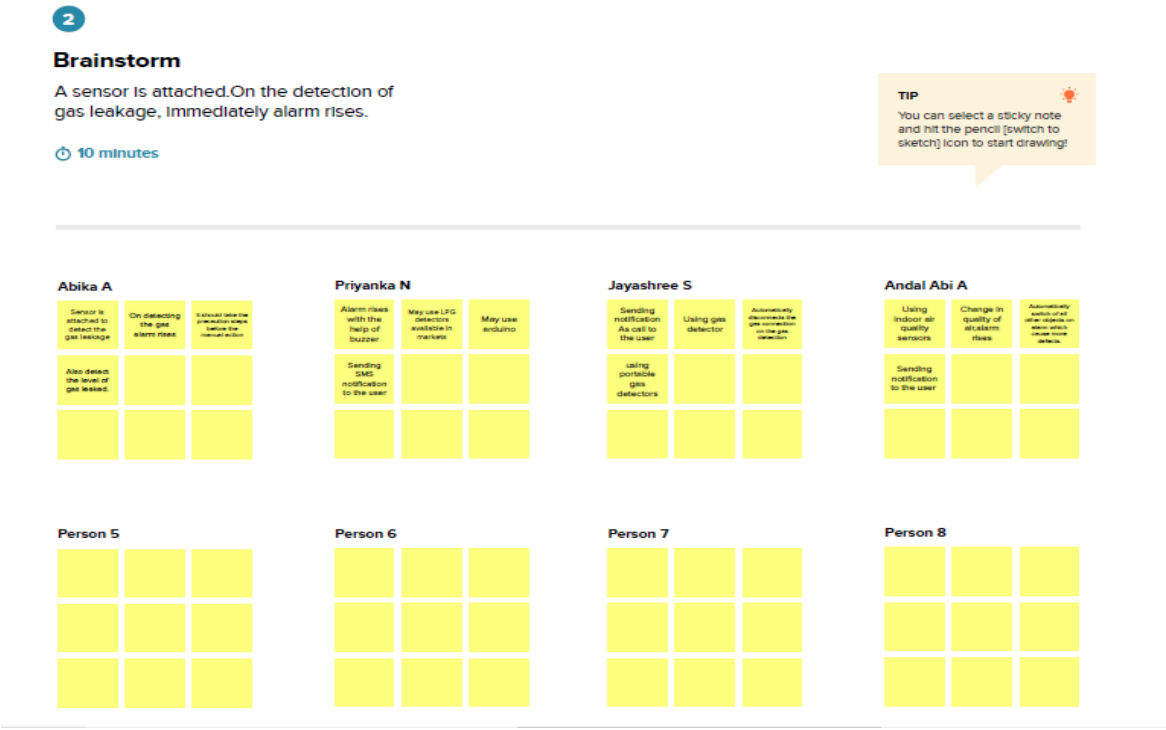


Fig.3.2.2 Brainstorm

Group Ideas

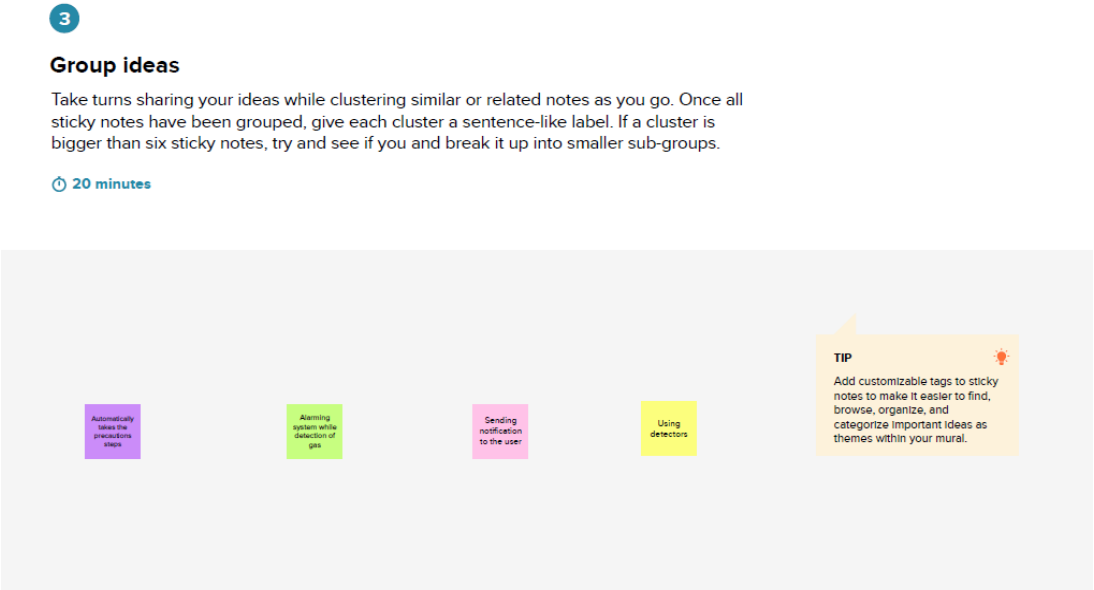


Fig.3.2.3 Group Ideas

Prioritize

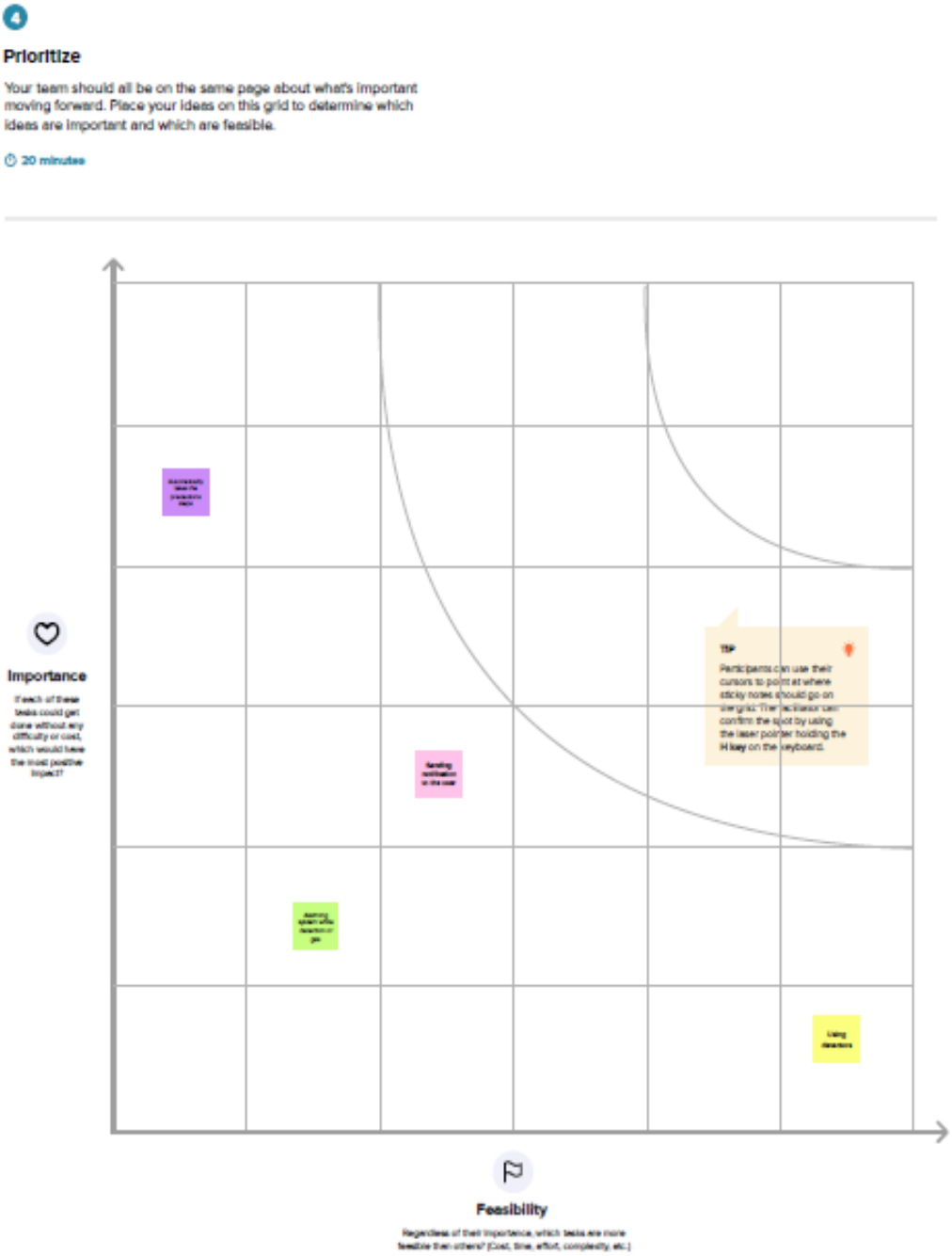


Fig.3.2.4 Prioritize

3.3 Proposed Solution

Proposed Solution Template:

Project team shall fill the following information in proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Leakage of gas in industries.
2.	Idea / Solution description	Detect the gas leakage using gas sensor.
3.	Novelty / Uniqueness	On the detection of gas, alarm rises.
4.	Social Impact / Customer Satisfaction	Customer is satisfied highly if the alarm rises accurately on the detection of gas leakage.
5.	Business Model (Revenue Model)	Gas Leakage Monitoring and alerting System become popular if it detects the gas and rise alarm and send SMS to the user.
6.	Scalability of the Solution	Gas Leakage Monitoring and alerting System works for all types of gas leakage even if the gas is not harmful and this may cause some confusions.

The problem statement of the project is to solve the problem of Leakage of gas in Industries. Idea or Solution description given here is to detect the gas leakage using gas sensor. The Novelty or Uniqueness of the problem solution is that the customer is satisfies highly if the alarm rises accurately on the detection of gas leakage. Here the Business model is the gas Leakage

Monitoring and alerting System become popular if it detects the gas and rise alarm and send SMS to the user. The scalability of the solution is the gas leakage monitoring and alerting system works for all types of gas leakage even if the gas is not harmful and this may cause some confusions.

3.4 Problem Solution fit

Define CS, Fit into CC

Project Title: Gas Leakage Monitoring and Alerting System

Project Design Phase-I - Solution Fit Template **Team ID:** PNT2022TMID06118

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

1. Our customers are the people working in gas agencies and gas distributive vehicles where there is collection of LPG gas cylinders.
2. The people living in residential building who are using the LPG gas cylinders for cooking.
3. The people in the industry sector to detect the gas leakage.
4. In Hospital to detect the gas leakage.

6. CUSTOMER CONSTRAINTS CC

1. Proper alerting system is not available.
2. Detection of gas is difficult in open space.
3. Not able to detect all types of gas.

5. AVAILABLE SOLUTIONS AS

1. Can call 24/7 to gas agency.
2. Proper awareness is needed.
3. Turning off gas cylinders directly.

Explore AS, differentiate

Fig.3.4.1 Customer Segment

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

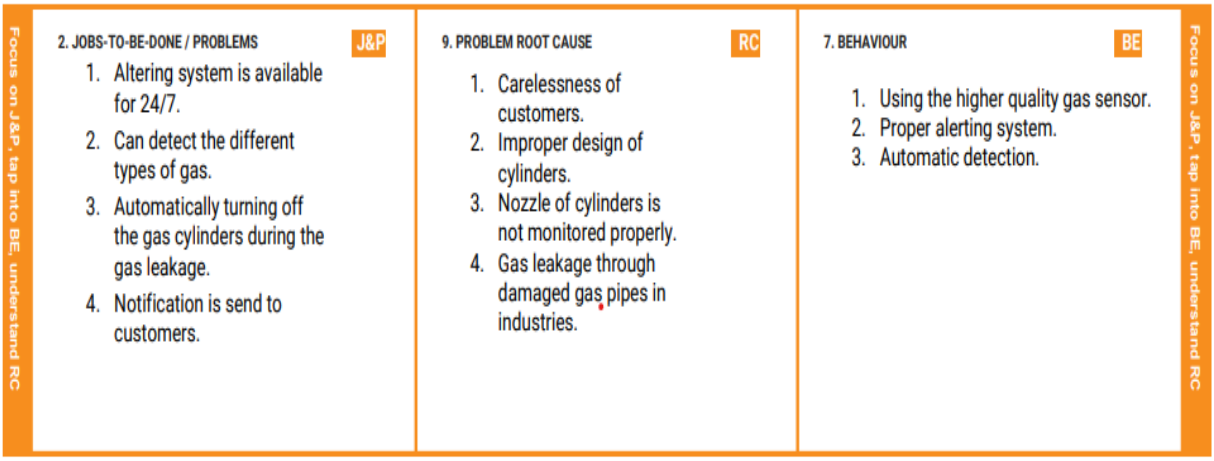


Fig.3.4.2 Focus on J&P

Identify Strong TR & EM

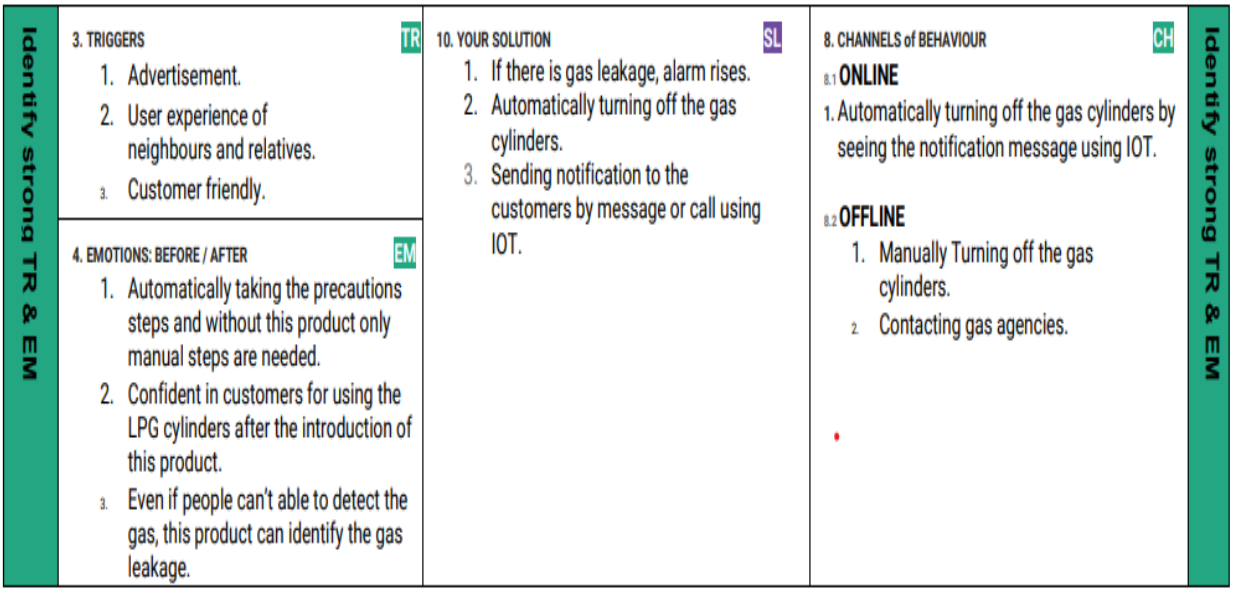


Fig.3.4.3 Identify Strong TR & EM

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 Functional requirement

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Gas Detection	• Gas Detection through Gas sensors
FR-2	Notification	• Notification via Email • Notification via OTP • Notification via Mobile call • Notification via Message
FR-3	Taking Precaution steps	• Automatically turn off the gas knob
FR-4	Rising Alarm	• Rising alarm using the buzzer.
FR-5	Safety of people	• By rising alarm and avoiding disasters
FR-6	Easy to implement	• IOT application with Arduino-UNO

Fig.4.1.1 Functional Requirements

Functional Requirement of the proposed solution is to detect the gas leakage through Gas sensors. The users should get Notification through Email, OTP, Mobile Call, Message.

The system should take precautions steps automatically like Turning off the Gas Knob. After the gas leakage detection the alarm will rise using the buzzer. By the rising of the alarm the people will be exited safely from various places thereby reducing the disasters. By IOT application using Arduino UNO the process is easy to implement.

4.2 Non-Functional requirements

Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	• Can detect the release of gases • Rises alarm • Taking precaution steps • Sending notifications
NFR-2	**Security**	• Ensure the safety of people.
NFR-3	**Reliability**	• Can detect the gases accurately.
NFR-4	**Performance**	• Can detect the release of gases and automatically takes the precaution steps.
NFR-5	**Availability**	• Can be used anywhere where the different gases are involved in work.
NFR-6	**Scalability**	• Can detect the different types of gases even it is non-toxic.

Fig.4.2.1 Non-functional Requirements

Non-Functionality Requirements of the proposed solution are as follows:

- **Usability**- It can detect the release of gases. The alarm will rise after detecting the gases. Precautions steps will be taken by the system. Notifications will be send to the users.
- **Security**- The system will ensure the safety of the people.
- **Reliability**- The system can detect the gases accurately.
- **Performance**- It can detect the release the gases and automatically takes the precaution steps.
- **Availability**- The system can be used anywhere where the different gases are involved in work.
- **Scalability**- It can detect the different types of gases even it is non-toxic.

The system should response immediately to any leakage situation. The system should update the local database in real time. The system should make decision within 5 seconds. The Arduino response time should be fast. The gas detector should be from anywhere at any time. The homeowner information should be modified easily.

CHAPTER 5

PROJECT DESIGN

5.1 Data Flow Diagrams

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.

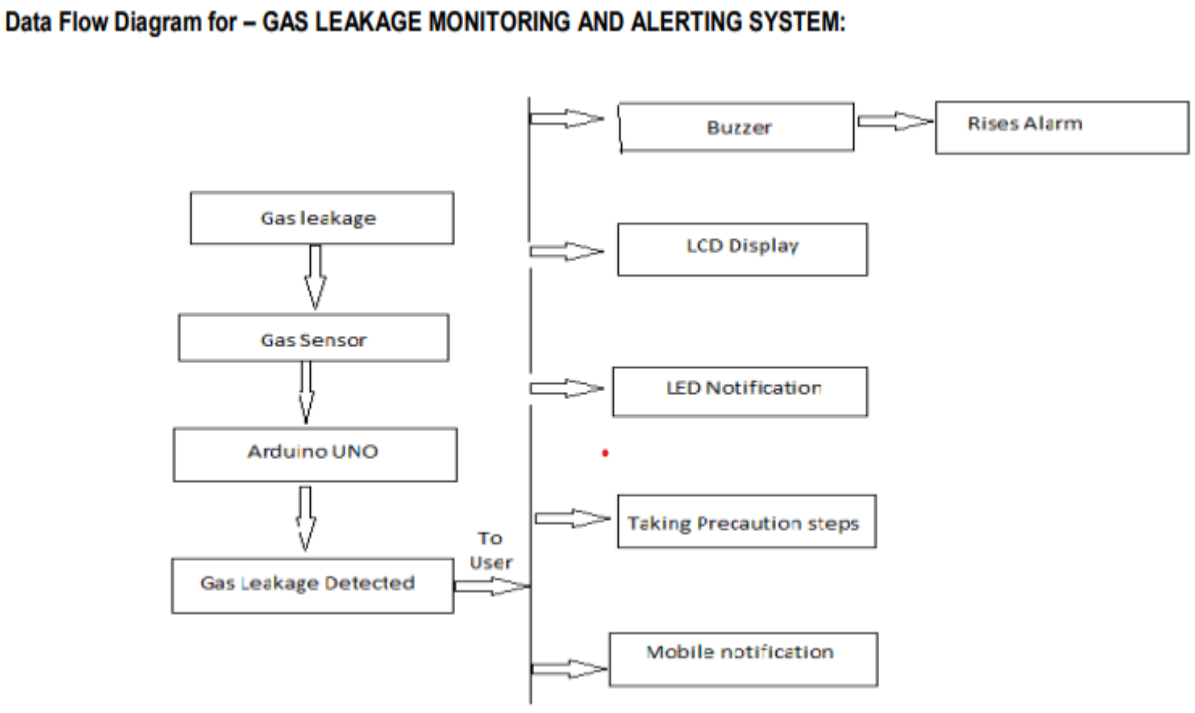


Fig.5.1.1 Data Flow Diagram

5.2 Solution & Technical Architecture

Leakage of gas is a major issue in the industrial sector, residential buildings, and gas-powered vehicles, one of the preventive methods to stop accidents associated with gas leakage is to install gas leakage detection devices. The focus of this work is to propose a device that can detect gas leakage and alert the owners to avert problems due to gas leakages. The system is based on a microcontroller that employs a gas sensor as well as a GSM module, an LCD display, and a buzzer. The system was designed for gas leakage monitoring and alerts with SMS via an Arduino microcontroller with a buzzer and an MQ2 gas sensor. The circuit contains a microcontroller MQ2 gas sensor, buzzer, LCD display, and GSM module, when the sensor detects gas leakage it transmits the information to the microcontroller while the microcontroller makes a decision and then forwarded a warning message to the user as SMS to a mobile phone, glowing of LED bulb, rising of Gas Detection Alarm, and decision to be taken accordingly.

Solution Architecture Diagram

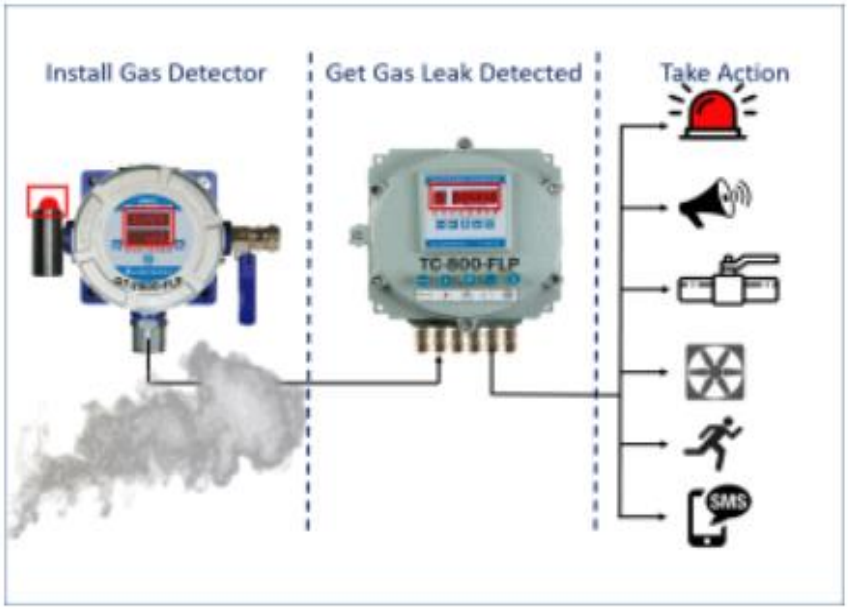


Fig.5.2.2 Solution and Technical Architecture

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 (Home user)	Setup	USN-1	As a user, I need the proper setup of the gas leakage detector.	I can detect the leakage of gas.	High	Sprint-1
		USN-2	As a user, I can detect the gas leakage once the setup is completed.	I can detect the leakage of gas.	High	Sprint-1
Customer (Industrial user)		USN-1	As a user, I need the proper setup of the gas leakage detector.	I can detect the leakage of gas.	High	Sprint-1
		USN-2	As a user, I have to choose the quality products for Gas leakage detector setup.	I can detect the leakage of gas accurately and immediately once the gas is leaked.	High	Sprint-1
		USN-3	As a user, I can check a demo of the Gas leakage detector setup.	I can ensure the safety of workers.	Medium	Sprint-2
Customer (Hospital user)		USN-1	As a user, I need the proper setup of the gas leakage detector.	I can detect the leakage of gas.	High	Sprint-1
		USN-2	As a user, I need the proper accomodation of the gas leakage detector in the hospital.	I can ensure the comfortness of the patients in the hospital.	High	Sprint-1
Customer Care Executive	Creating Awareness	USN-1	As a Customer Care Executive,I can advertise the product to people.	I can ensure the benefit of huge people.	High	Sprint-1
Administrator	Creating product	USN-1	As a Administrator, I will design the gas leakage detector.	I can ensure gas leakage detection accurately.	High	Sprint-1

Fig.5.3.1 User Stories

CHAPTER 6

PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

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

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Proper Setup of gas leakage detector	USN-1	Setting up of the non-defective gas leakage detector with proper equipments.	2	High	Andal Abi A
Sprint-2	Leakage of gas	USN-2	The gas sensor is used to identify the leakage of gas.	2	High	Priyanka N
Sprint-3	Message Alerting System	USN-3	When the gas is leaked, the gas sensors detect the gas and alert messages are send to the users.	2	High	Abika A
Sprint-4	Precaution Measures	USN-4	If the gas leakage is detected, the alarm rises and notifies the user.	2	High	Jayashree S

Fig.6.1.1 Sprint Planning and Estimation

6.2 Sprint Delivery Schedule

Project Tracker, Velocity & Burndown Chart: (4 Marks)

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	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Fig.6.2.1 Sprint Delivery Schedule

Velocity:
Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

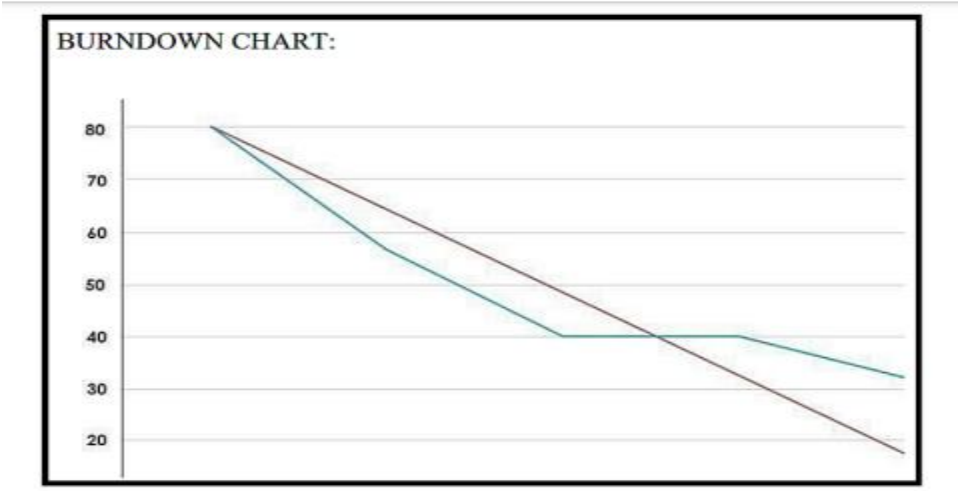


Fig.6.2.2 Burn Down Chart

6.3 Reports from JIRA

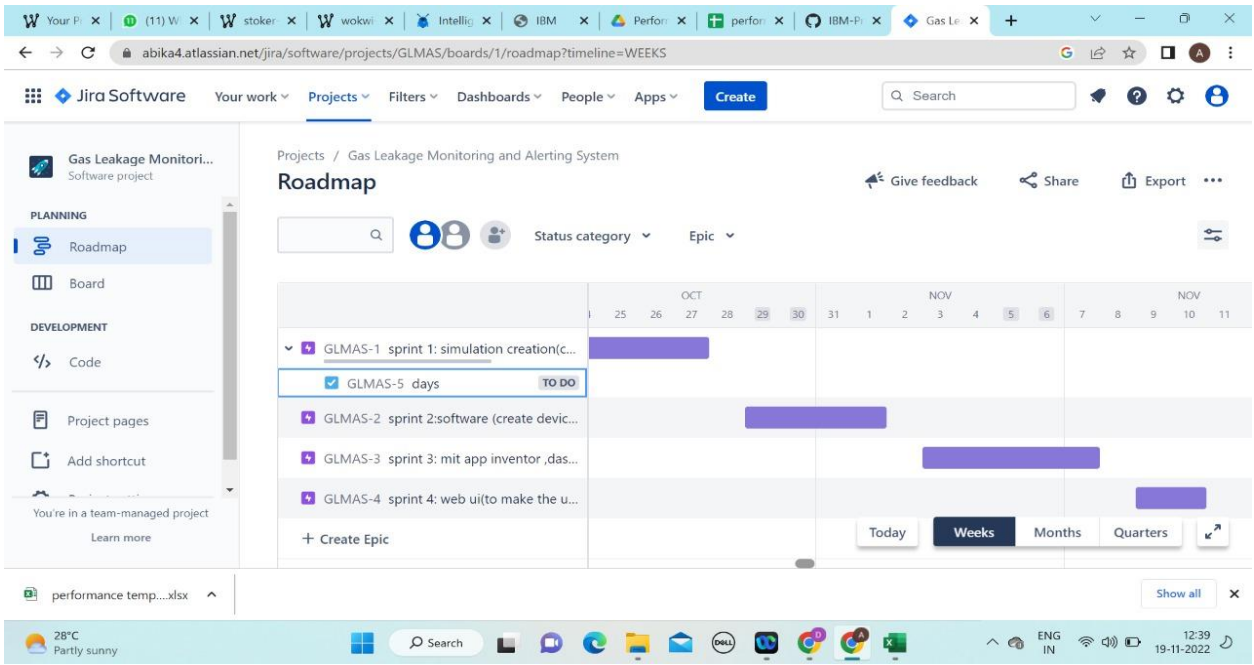


Fig.6.3.1 Report from JIRA

CHAPTER 7
CODING & SOLUTIONING

7.1 Feature 1

Node Red Output

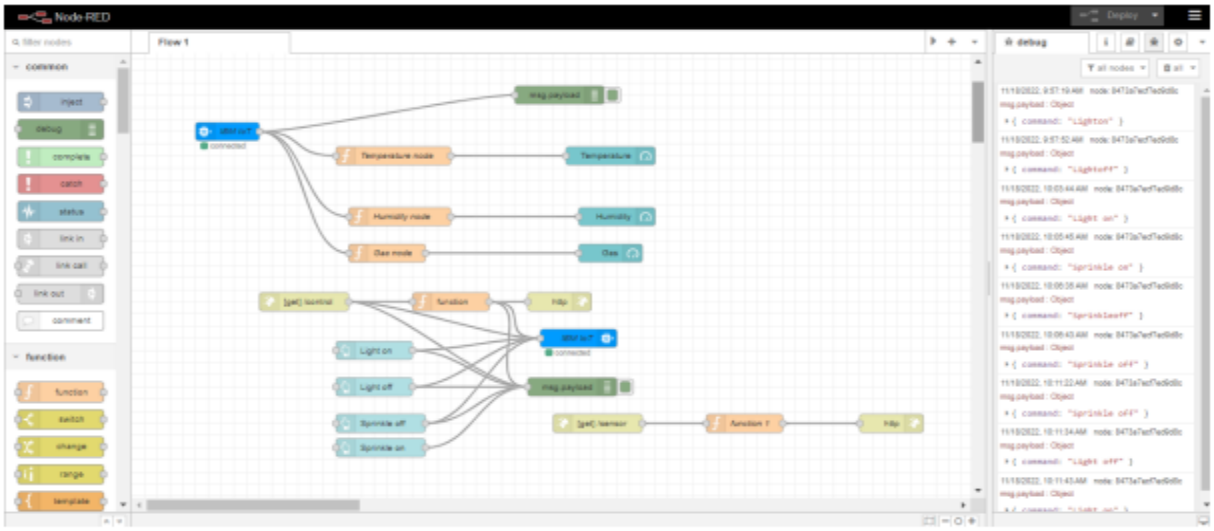


Fig.7.1.1 Node Red Output

7.2 Feature 2

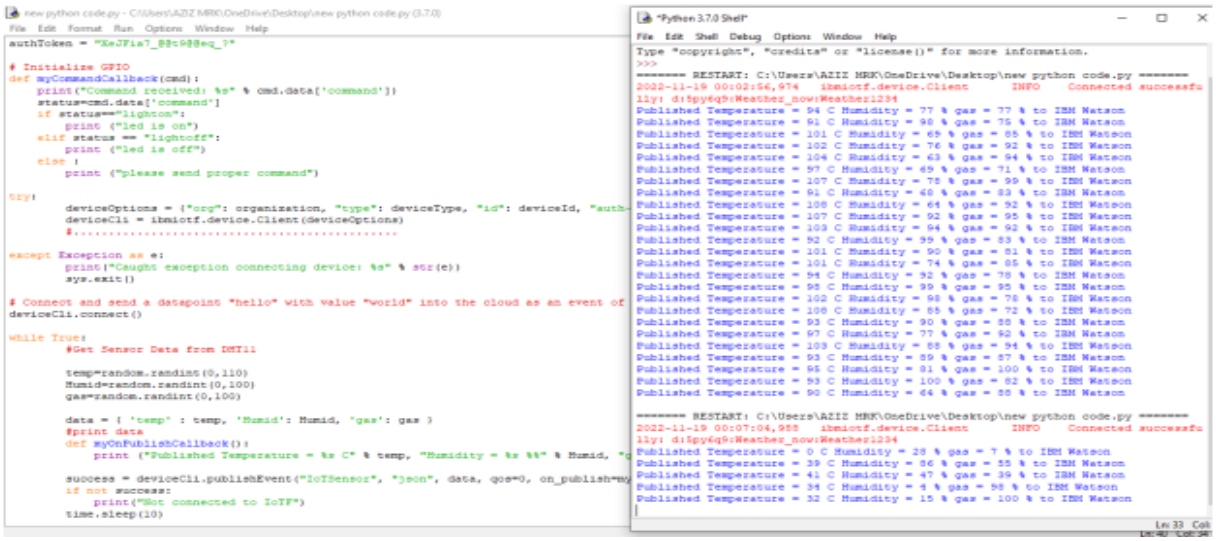


Fig.7.2.1 Python Code

CHAPTER 8
TESTING

8.1 Test Cases

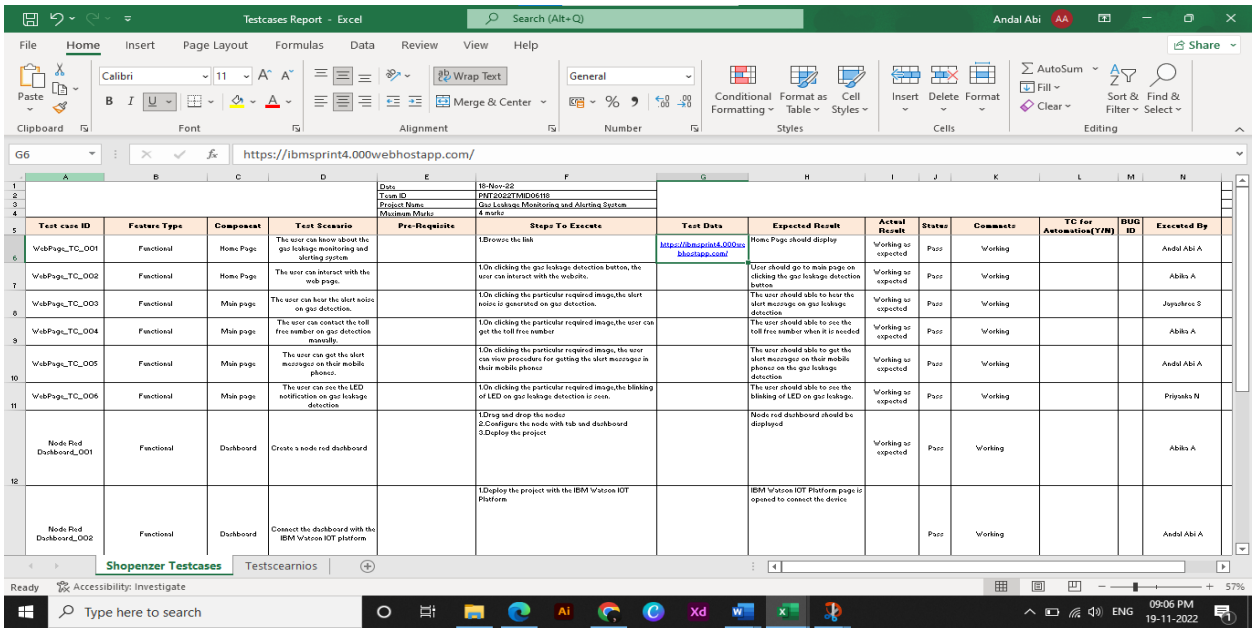


Fig.8.1.1 Test Cases

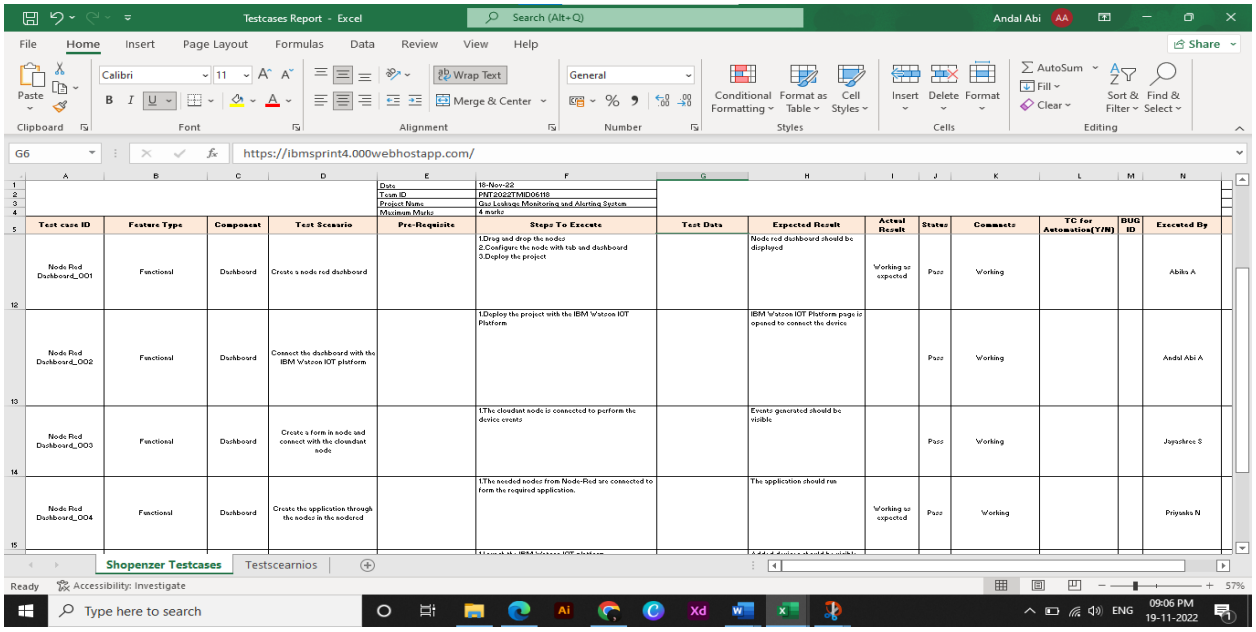
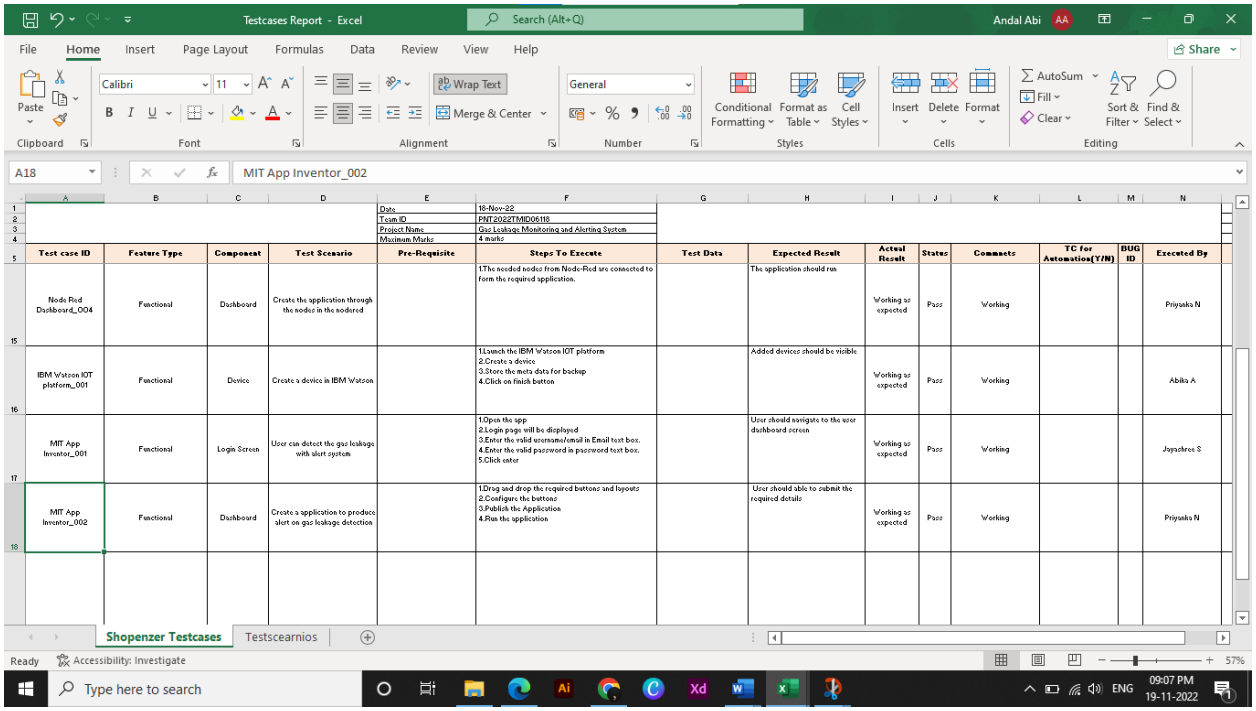


Fig.8.1.2 Test Cases



				Date	18-Nov-22							
				Team ID	PNT2022TMID06118							
				Project Name	Gas Leakage Monitoring and Alerting System							
				Maximum Marks	4 marks							
Test case ID	Feature Type	Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Comments	TC for Automation(Y/N)	BUG ID	Executed By
Node Red Dashboard_004	Functional	Dashboard	Create the application through the nodes in the nodered		1.The needed nodes from Node-Red are connected to form the required application.		The application should run	Working as expected	Pass	Working			Priyanka N
IBM Watson IOT platform_001	Functional	Device	Create a device in IBM Watson		1.Launch the IBM Watson IOT platform 2.Create a device 3.Store the meta data for backup 4.Click on finish button		Added devices should be visible	Working as expected	Pass	Working			Abilla A
MIT App Inventor_001	Functional	Login Screen	User can detect the gas leakage with alert system		1.Open the app 2.Login page will be displayed 3.Enter the valid username/email in Email text box. 4.Enter the valid password in password text box. 5.Click enter		User should navigate to the user dashboard screen	Working as expected	Pass	Working			Jayashree S
MIT App Inventor_002	Functional	Dashboard	Create a application to produce alert on gas leakage detection		1.Drag and drop the required buttons and layouts 2.Configure the buttons 3.Publish the Application 4.Run the application		User should able to submit the required details	Working as expected	Pass	Working			Priyanka N

Fig.8.1.3 Test Cases

8.2 User Acceptance Testing

1. Purpose of Document

The main Purpose of UAT is to validate end to end business flow. It does not focus on cosmetic errors, spelling mistakes or system testing. User Acceptance Testing is carried out in a separate testing environment with production-like data setup. It is kind of black box testing where two or more end-users will be involved.

UAT is performed by :

- Client
- End users

Fig.8.2.1 Purpose of Document

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
By Design	4	3	2	1	10
Duplicate	1	0	3	0	4
External	2	2	1	1	6
Fixed	4	3	5	19	31
Not Reproduced	1	0	1	1	3
Skipped	0	0	1	1	2
Won't Fix	1	3	2	2	8
Totals	13	11	15	25	64

Fig.8.2.1 Defect Analysis

3. Test Case Analysis

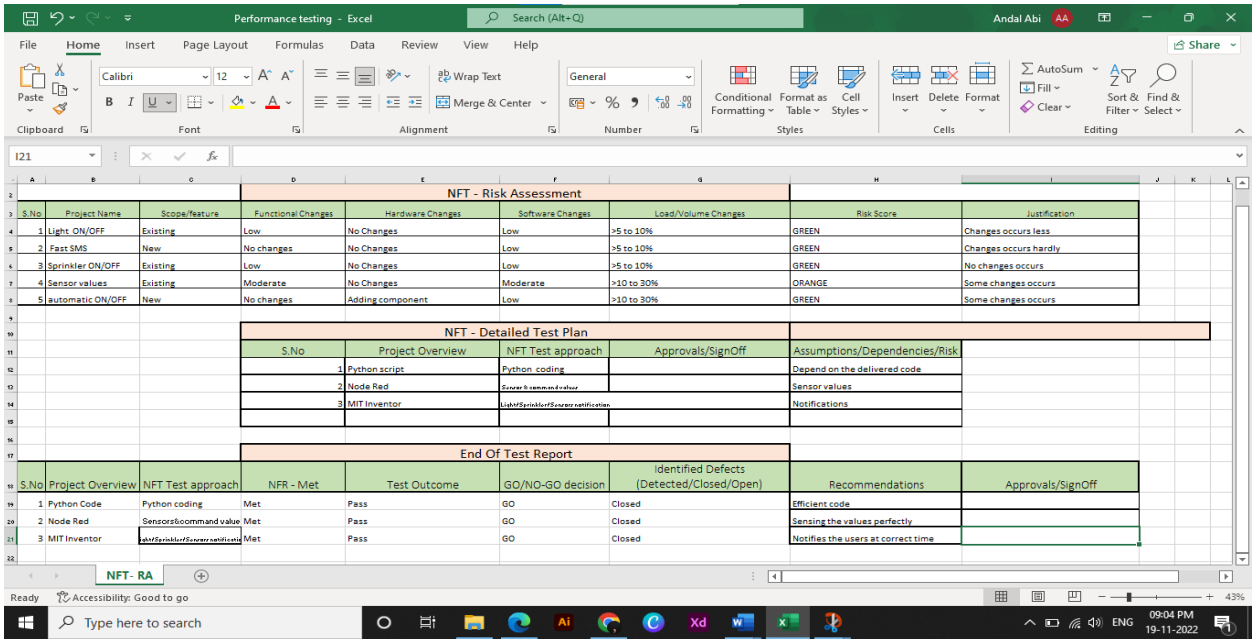
This report shows the number of test cases that have passed, failed, and untested.

Section	Total Cases	Not Tested	Fail	Pass
Web Page	5	0	0	5
Node Red Dashboard	32	0	0	32
IBM Watson IOT platform	2	0	0	2
MIT App Inventor	3	0	0	3

Fig.8.2.3 Test Case Analysis

CHAPTER 9
RESULTS

9.1 Performance Metrics



NFT - Risk Assessment

S.No	Project Name	Scope/feature	Functional Changes	Hardware Changes	Software Changes	Load/Volume Changes	Risk Score	Justification
1	Light_ON/OFF	Existing	Low	No Changes	Low	>5 to 10%	GREEN	Changes occurs less
2	Fast SMS	New	No changes	No Changes	Low	>5 to 10%	GREEN	Changes occurs hardly
3	Sprinkler ON/OFF	Existing	Low	No Changes	Low	>5 to 10%	GREEN	No changes occurs
4	Sensor values	Existing	Moderate	No Changes	Moderate	>10 to 30%	ORANGE	Some changes occurs
5	automatic ON/OFF	New	No changes	Adding component	Low	>10 to 30%	GREEN	Some changes occurs

NFT - Detailed Test Plan

S.No	Project Overview	NFT Test approach	Approvals/SignOff	Assumptions/Dependencies/Risk
1	Python script	Python coding		Depend on the delivered code
2	Node Red	Sensors&command value		Sensor values
3	MIT Inventor	LightSprinklerServernotification		Notifications

End Of Test Report

S.No	Project Overview	NFT Test approach	NFR - Met	Test Outcome	GO/NO-GO decision	Identified Defects (Detected/Closed/Open)	Recommendations	Approvals/SignOff
1	Python Code	Python coding	Met	Pass	GO	Closed	Efficient code	
2	Node Red	Sensors&command value	Met	Pass	GO	Closed	Sensing the values perfectly	
3	MIT Inventor	LightSprinklerServernotificatio	Met	Pass	GO	Closed	Notifies the users at correct time	

Fig.9.1.1 Performance Testing

Web Application Dashboard

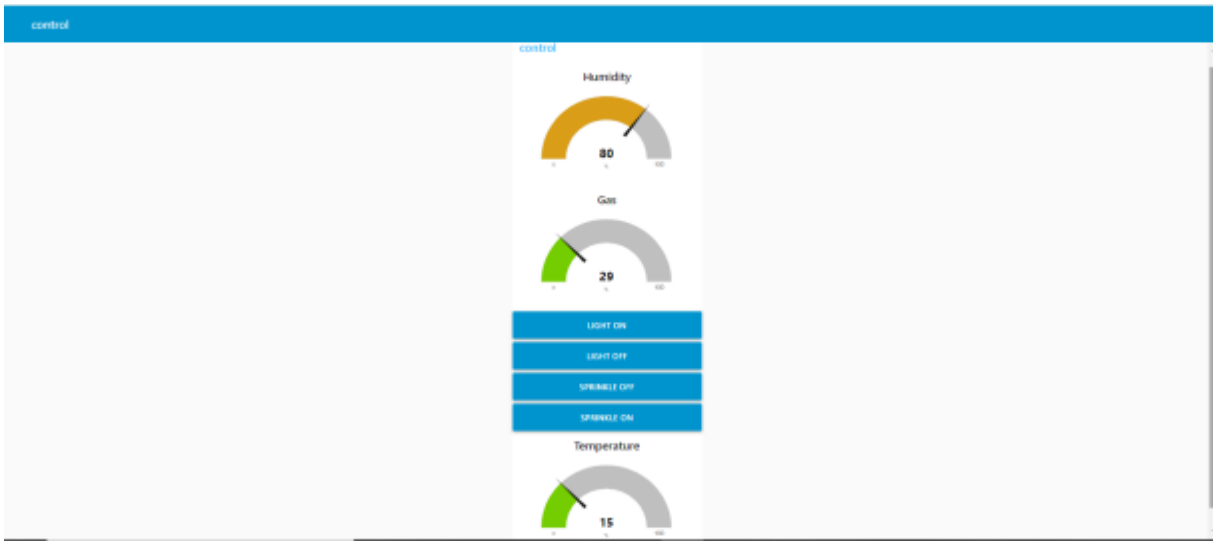


Fig.9.1.2 Web Application Dashboard

CHAPTER 10
ADVANTAGES & DISADVANTAGES

10.1 Advantages

- Detect the concentration of the gases.
- The sensor-enabled solution helps prevent the high risk of gas explosions and affecting any casualties within and outside the premises.
- Get real-time alerts about the gaseous presence in the atmosphere.
- Prevent fire hazards and explosions.
- Ensure worker’s health.
- Real-time updates about leakages.
- Cost-effective installation.
- Measure oxygen level accuracy.
- Get immediate gas leak alerts.

10.2 Disadvantages

- Get immediate gas leak alerts.
- When heavy dust, steam or fog blocks the laser beam, the system will not be able to take measurements.

CHAPTER 11
CONCLUSION

11.1 Conclusion

This work presents the design and implementation of gas leakage detection system. Various works on gas leakages detection system was reviewed and presented. Gas leakage leads to severe accidents resulting in material los -ses and human injuries. Gas Leakage occurs due to poor maintenance of equipment and inadequate awareness of the people. Hence, gas leakage detection is essential to prevent accidents and to save human lives. This research work had advanced in knowledge as it included an embedded system to alert users via multiple mobile phones for further action to be taken when leakage is detected. The device detects gas leakage using a highly sensitive MQ-2 gas sensor to activate a buzzer that alert people of leakages, and also sent an SMS with the information “Gas Leakage Detected” from the SIM800 GSM Module as a backup to alert the appropriate authority or facility owner of a gas leakage. This design could be adopted, funded, and implemented as it has great potential of mitigating against accidents associated with LPG leakage.

CHAPTER 12

FUTURE SCOPE

12.1 Future Scope

Major cities of India are pushing Smart Home application, gas m onitoring system is a part of Smart Home application. Enhancing Industrial Safety using IOT. This system can be implemented in Industries, Hotels, and wherever the gas cylinders are used. This system can be used in industries involving applications such as Furnace, Boilers, Gas welding, Gas cutting, Steel Plants, Metallurgical industries, Plastic 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 naive the risk of causing accidents is high. Hence, our system can also be used in schools. colleges. Many colleges have well established labs including che mistry lab and pharmaceutical labs where gas burners are used Several medical equipment requires gas cylinders.

CHAPTER 13

APPENDIX

13.1 Source Code

```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random


#Provide your IBM Watson Device Credentials
organization = "5py6q9"
deviceType = "Weather_now"
deviceId = "Weather1234"
authMethod = "token"
authToken = "XeJFia7_@@t9@@eq_?"

# Initialize GPIO


def myCommandCallback(cmd):
    print("Command received: %s" %
cmd.data['command'])
    status=cmd.data['command']
    if status=="Lighton":
        print ("Light is on")
    elif (status == "LIghtoff") :
        print ("Light is off")
```

```
    elif status == "sprinkleron":
        print("Sprinkle is OFF")
    elif status == "sprinkleron":
        print("Sprinkle is ON")
    #print(cmd)



try:
        deviceOptions = {"org": organization, "type":
deviceType, "id": deviceId, "auth-method":
authMethod, "auth-token": authToken}
        deviceCli =
ibmiotf.device.Client(deviceOptions)
        #.....................................

except Exception as e:
        print("Caught exception connecting device: %s"
% str(e))
        sys.exit()

# Connect and send a datapoint "hello" with value
"world" into the cloud as an event of type "greeting"
10 times
deviceCli.connect()

while True:
        #Get Sensor Data from DHT11

        temp=random.randint(0,100)
```

```
        Humid=random.randint(0,100)
        gas=random.randint(0,100)
        data = { 'temp' : temp, 'Humid': Humid, 'gas' :
gas }
        #print data
        def myOnPublishCallback():
            print ("Published Temperature = %s C" %
temp, "Humidity = %s %%" % Humid, "Gas_Level =
%s %%" %gas, "to IBM Watson")

        success = deviceCli.publishEvent("IoTSensor",
"json", data, qos=0,
on_publish=myOnPublishCallback)
        if not success:
            print("Not connected to IoTF")
        time.sleep(1)

        deviceCli.commandCallback =
myCommandCallback

# Disconnect the device and application from the
cloud
deviceCli.disconnect()
```

13.2 GitHub & Project Demo Link

GitHub

https://github.com/IBM-EPBL/IBM-Project-15720-1659603533