FINAL PROJECT REPORT

Team ID	40785-1660634822 / PNT2022TMID54319
Project Name	**Gas leakage Monitoring & Alerting system for Industries**

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1. INTRODUCTION

1.1 Project Overview

The Internet of Things (IoT) is a network of devices, cars, and household appliances that includes hardware, software, actuators, and a network, allowing them to communicate, operate together, and exchange information. IoT entails extending the Internet's network beyond regular devices like desks, workstations, smartphones, and tablets to any variety of often unintelligent or web-unaware physical objects and everyday objects.
These devices can communicate and link through the Internet, and they may be remotely watched and controlled thanks to innovation.The Internet of Things' meaning has evolved as a result of the convergence of multiple technologies, continuous research, artificial intelligence, wearable sensors, and implanted systems.The Internet of things is made more powerful by traditional areas such as established frameworks, remote sensor systems, control framework computerization (counting home and building mechanisation), and others. A gas leak refers to the release of petroleum gas or any vaporous substance from a pipeline or other regulator into an area where it is not intended for such release. Spills are dangerous because even a little hole might eventually turn into a dangerous confluence of gas. In addition to posing a risk of fire and explosion, holes can decimate nearby flora, even large trees, and release very ozone-harming compounds.

1.2 Purpose

A growing trend of specialised, social, and financial centrality is the Internet of Things. Customers' products, durable goods, automobiles, contemporary and utility components, sensors, and other common objects are being combined with Internet accessibility and fantastic information system capabilities that promise to transform how we work, live, and play. Amazing predictions have been made about the impact of IoT on the Internet and economy; some predict that by 2025, there will be upwards of 100 billion connected IoT devices and a global financial impact of more than $11 trillion. The Internet of Things (IoT) is a key topic in the design, strategy, and innovation industries.This technology is embedded in a broad variety of structured things, frameworks, and sensors that take use of advances in processor speed, device downsizing, and organised interconnections to provide new capabilities. The widespread use of IoT devices is expected to affect many aspects of the way we live. Customers are being pushed toward a future fantasy by new IoT products like Internet-enabled equipment, home automation components, and vitality the executive's devices "Smart homes provide higher security and energy efficiency. We are getting closer thanks to IoT frameworks like organised automobiles, clever traffic frameworks, and sensors embedded in roadways and scaffolds "Brilliant urban places" help reduce congestion and energy use.By increasing the accessibility of data along the value chain of generation using positioned sensors, internet of things technology offers the potential to change horticulture, industry, and the creation and distribution of energy.

2.LITERATURE SURVEY

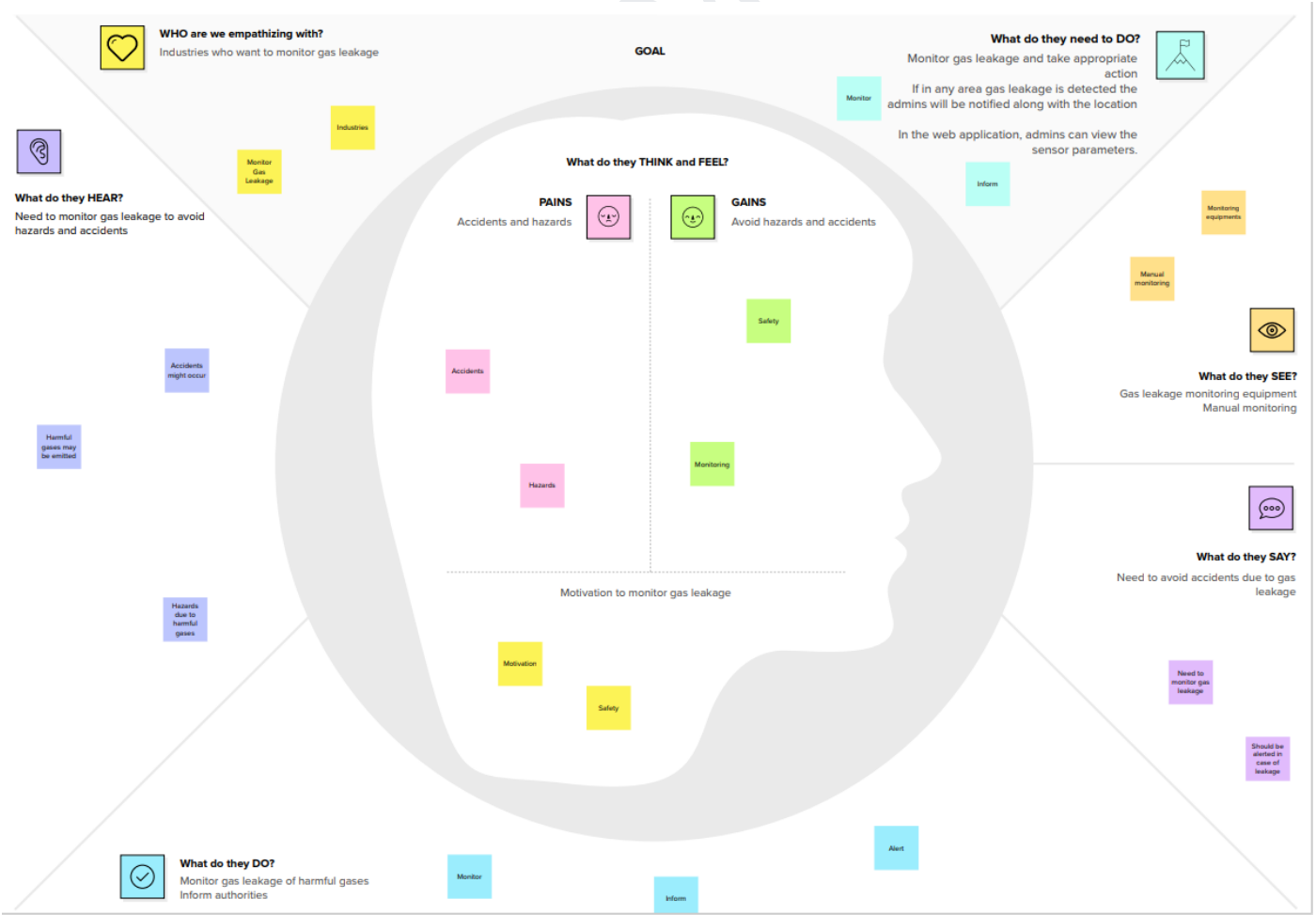
S no.	Journal Details	Inference
1.	Makiko Kawada, Tadao Minagawa, Eiichi Nagao, Mitsuhito Kamei, Chieko Nishida and Koji Ueda, "Advanced monitoring system for gas density of GIS," 2008 International Conference on Condition Monitoring and Diagnosis, 2008, pp. 363- 368, doi: 10.1109/CMD.2008.4580302.	This paper describes a state-of-the-art gas leakage detection system, which consists of a high-performance gas pressure sensor and a new algorithm improving accuracy of the leakage rate calculation. The gas pressure sensor has enough properties, resolution of 20 Pa and the stability of 0.004 % per year. Furthermore, in order to achieve high accuracy of leakage detection in the actual field, the new algorithm of the leakage rate calculation has been developed to cancel the interference due to solar radiation and weather.

2.	A. Banik, B. Aich and S. Ghosh, "Microcontroller based low cost gas leakage detector with SMS alert," 2018 Emerging Trends in Electronic Devices and Computational Techniques (EDCT), 2018, pp. 1-3, doi: 10.1109/EDCT.2018.8405094.	The system detects the leakage of the LPG (Liquefied Petroleum Gas) using a gas sensor and uses the GSM to alert the person about the gas leakage via SMS. When the LPG concentration in the air exceeds a predetermined level, the gas sensor senses the gas leakage and the output of the sensor goes LOW. This is detected by the microcontroller and the LED and buzzer are turned ON simultaneously. The system then alerts the customerby sending an SMS to the specified mobile-phone.
3.	A. M. Anika, M. N. Akter, M. N. Hasan, J. F. Shoma and A. Sattar, "Gas Leakage with Auto Ventilation and Smart Management System Using IoT," 2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS), 2021, pp. 1411-1415, doi: 10.1109/ICAIS50930.2021.9395774.	In this paper, Arduino UNO microcontroller was utilized to build a smart gas detection system with many usable sensors (MQ2, IR Fire Sensor) and actuators (air fan, buzzer). When gas spillage is recognized, the client will be intimated through SMS and at the same time they will receive notification via blynk application. The proposed system can detect fire, gas leakage and it also has the ability to take further steps and decrease gas concentration via auto air ventilation and extinguish fire with water.

4.	S. Jamadagni, P. Sankpal, S. Patil, N. Chougule and S. Gurav, "Gas Leakage and Fire Detection using Raspberry Pi," 2019 3rd International Conference on Computing Methodologies and Communication (ICCMC), 2019, pp. 495- 497, doi: 10.1109/ICCMC.2019.8819678.	This paper presents the growth in the industrial monitoring system's design using Internet of Things (IoT). The sensor used for the development of this system is MQ-2 which detects the leakage of gas at any atmos pheric condition and fire sensor as a simple and compact device for protection against fire. In gas sensor system, Ras pberry pi plays an important role such that all the components are interfaced to it. This avails the observer to notice the changes from anywhere in the world.

3. IDEATION & PROPOSED SOLUTION

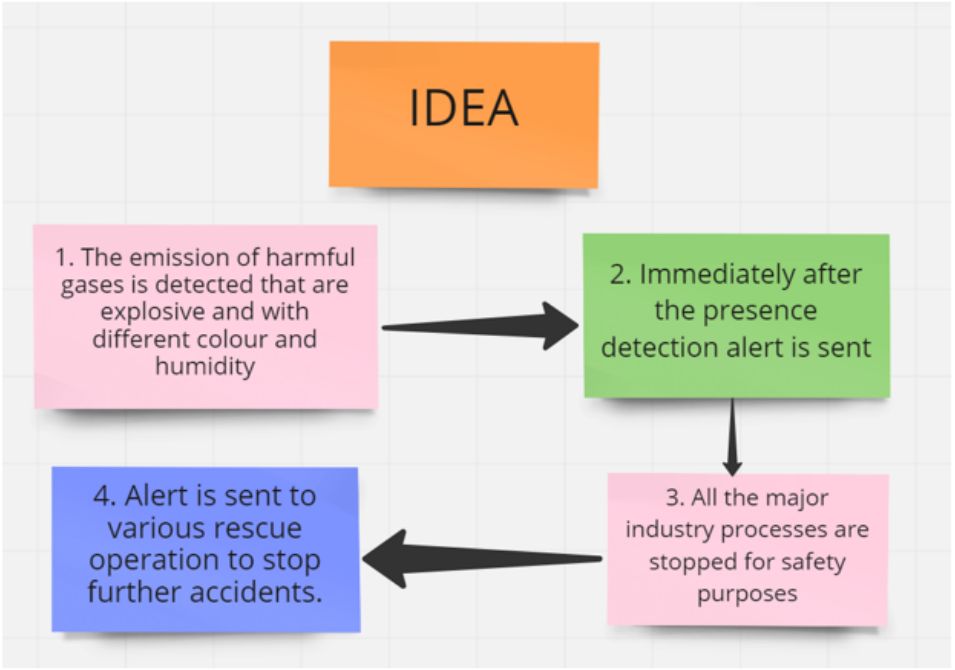
3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

Customer Problem Statement:

Ideation:



3.3 Proposed Solution

S.No	Parameter	Description
1.	**Problem Statement (Problem to be solved)**	In order to work effectively on major crises rather than worrying about monitoring or gas leakage, workers in busy industries that are packed with gas—whether harmful or harmless—need a way to continuously monitor their gas pipelines and detect early if there is any leakage of gas in their surroundings. This will indeed reduce the manpower of that industry and foster peace.

2.	**Idea / Solution description**	• The gas sensors will be fitted at different locations to track gas leaks. • The proposed scheme initiates an automated control response upon 0.001% LPG leakage detection • By employing a relay and stepper motor in tandem to cut off the house's electricity, we are able to increase human security.Additionally, by utilizing a GSM module, we are sending an alarm message through SMS (Short Messaging Services) to inform the users of the LPG leak, and a buzzer is available to notify the neighbors in the event that the users are not there • The key benefit of this system over the manual approach is that it completes every step automatically and responds quickly.

3.	**Novelty / Uniqueness**	Although there are several current solutions to this issue, none have been able to meet client demands. Some methods only detect certain gases, while others fail to notify the primary department, and yet others experience delays. Our system will inform the employees even if there is a little gas leak, notifying the industry person as well as the fire fighters so they can take care of the issue.

4.	**Social Impact / Customer Satisfaction**	For the employees and the community that surrounds or is affiliated with the industry, our solution will be highly beneficial. Our method will save major catastrophes like the Bhopal Gas Tragedy, saving countless lives. This project will lower the mental stress of the workers so they can focus on other tasks or by relaxing them.
5.	**Business Model (Revenue Model)**	• Energy security is currently one of the objectives in practice due to the broad deployment of the urban natural gas sector. • The analysis of the pressure, temperature, and flow rate of gas leakage over time under steady-state and dynamic settings was done using the gas leakage model. • Since everyone can understand how to utilize the product, it is simple for them to do so for their safest organization.
6.	**Scalability of the Solution**	• In order to have the quickest reaction in the event of an accident, setting up quick communication equipment with the nearby fire station and other relief stations is essential. • Even when the gas leakage is more severe, the product senses the precise values and efficiently warns the employees.

Problem-Solution fit canvas 2.0

40785-1660634822 : Gas Leakage monitoring & Alerting system for Industries

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) — CS

Who is your customer?

Industry who want to monitor gas leakage in their production sites

6. CUSTOMER — CC

What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices.

Need of costly equipment, accurate sensors and skilled labor

5. AVAILABLE SOLUTIONS — AS

Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons dothese solutions have? i.e. pen and paper is an alternative to digital notetaking

Gas leakage sensors, manual monitoring

Explore AS, differentiate

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

2. JOBS-TO-BE-DONE / PROBLEMS — J&P

Which jobs-to-be-done (or problems) do you address for your customers?There could be more than one; explore different sides.

Need to monitor leakage of harmful gases

Alert the stakeholders in case of gas leakage and take appropriate action

9. PROBLEM ROOT CAUSE — RC

What is the real reason that this problem exists? What is the back story behind the need to do this job?
i.e. customers have to do it because of the change in regulations.

Leakage of gases at production sites cause health hazards and accidents

7. BEHAVIOUR — BE

What does your customer do to address the problem and get the job done?
i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)

Install an appropriate IoT system to monitor gas leakage

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

Identify strong TR & EM

3. TRIGGERS — TR

What triggers customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news.

The hazard of accidents due to leakage of harmful gases

4. EMOTIONS: BEFORE / AFTER — EM

How do customers feel when they face a problem or a job and afterwards?
i.e. lost, insecure > confident, in control - use it in your communication strategy & design.

Scare of accidents and unsafe environment for workers. -> Safe environment for workers

10. YOUR SOLUTION — SL

If you are working on an existing business, write down your current solution first,fill in the canvas, and check how much it fits reality.
If you are working on a new business proposition, then keep it blank until you fill inthe canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.

Monitor gas leakage and take appropriate action.
If in any area gas leakage is detected the admins will be notified along with the location
In the web application, admins can view the sensor parameters.

8. CHANNELS of BEHAVIOUR — CH

8.1 ONLINE

What kind of actions do customers take online? Extract online channels from #7

In the web application, admins can view the sensor parameters.

8.2 OFFLINE

What kind of actions do customers take offline? Extract offline channels from #7and use them for customer development.

Take immediate action in case of gas leakage

Extract online & offline CH of BE

AMALTAMA

3.4 Problem Solution fit

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Visibility	Level of gas can be monitored by users if there is any leakage, alerts can be sent to the stakeholders through messages.
FR-2	User Reception	The data indicating the level of gas can be informed through messages and a website
FR-3	User Understanding	The user can monitor the level of gas with the help of the data. If there is an increase in gas level, then the alert will be given. They also get notified through a message and alarm
FR-4	User Convenience	Through message we can easily get indication of gas level and in case of gas leakage, it can directly send notifications to nearby fire station, local centre and hospital.
FR-5	User Performance	When the user gets notified, he/she could turn on the exhaust fan/sprinkler

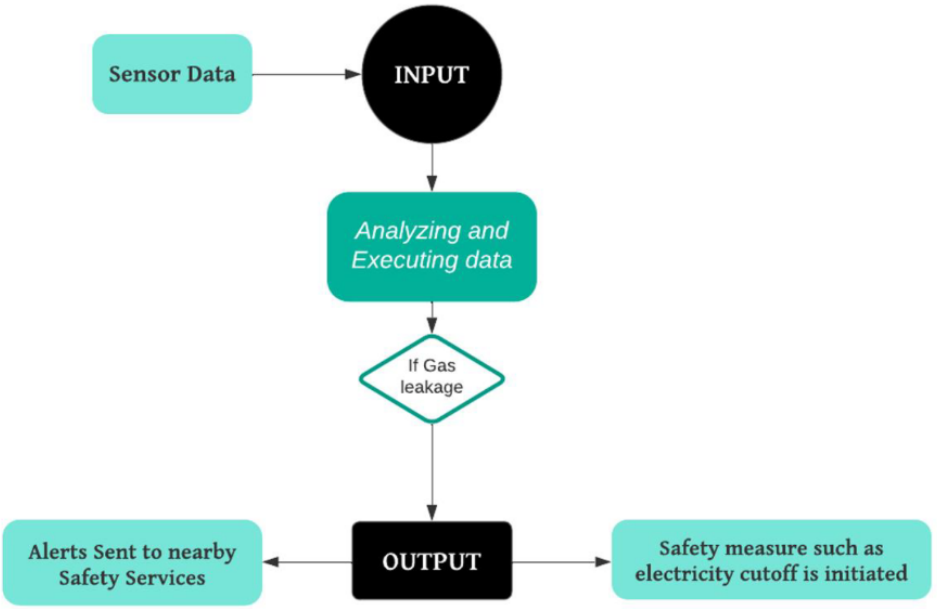
4.2 Non-Functional requirements

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

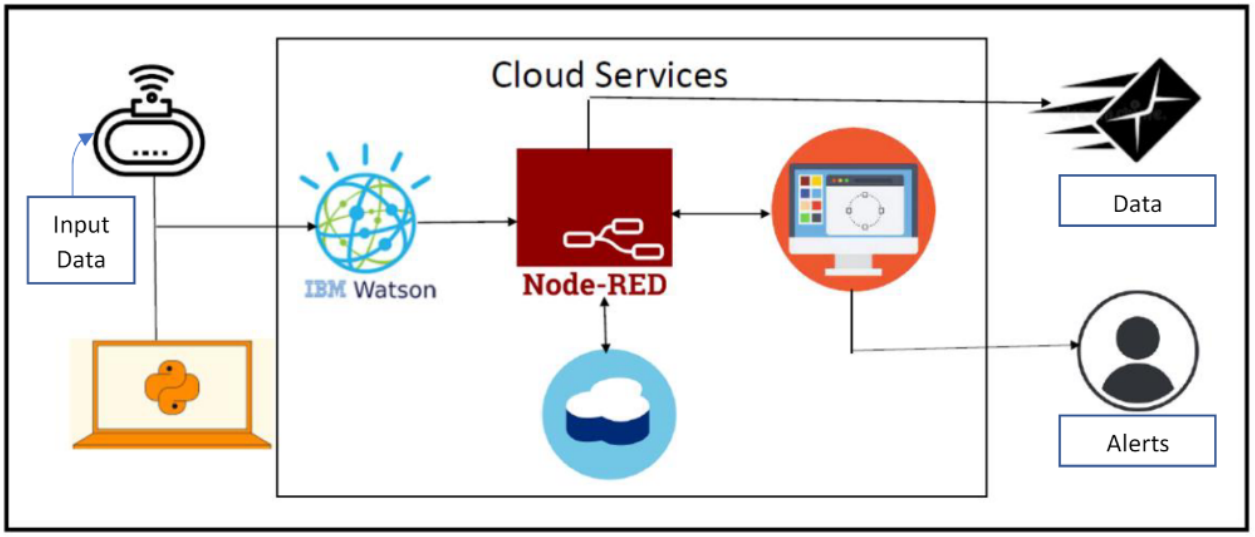
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	It updates the sensory data regularly as well as protects the workers.
NFR-2	**Security**	As a result of emergency alert, protection of both the humans and properties is ensured.
NFR-3	**Reliability**	Can provide accurate values and alerts. Has the capacity to recognize the smoke accurately and does not give a false alarm
NFR-4	**Performance**	Sprinklers and exhaust fans are used in case of emergency.
NFR-5	**Availability**	Can be used around the clock
NFR-6	**Scalability**	Setup can extend to include multiple sensors for a wider coverage

5. PROJECT DESIGN

5.1 Data Flow Diagrams



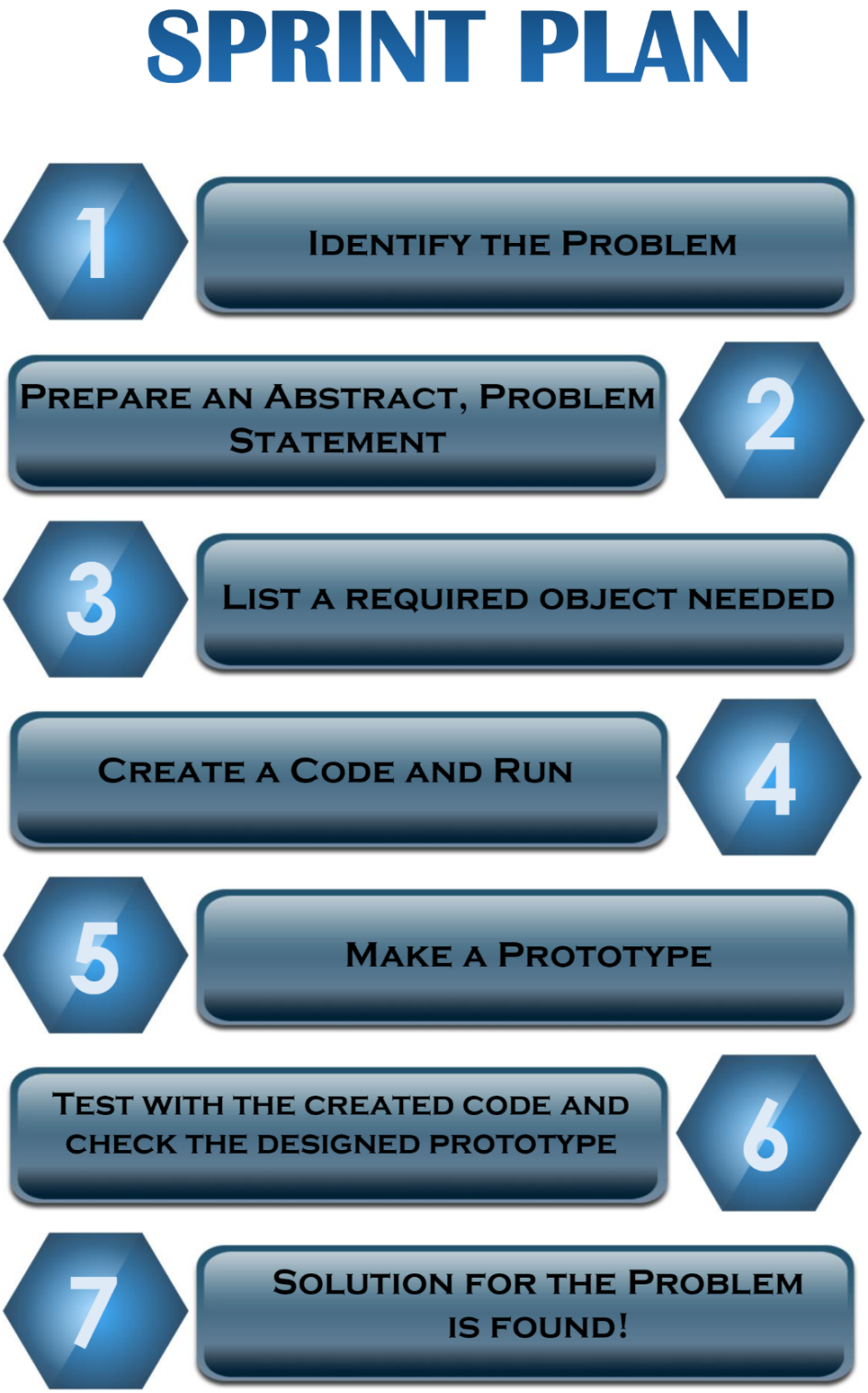
5.2 Solution & Technical Architecture



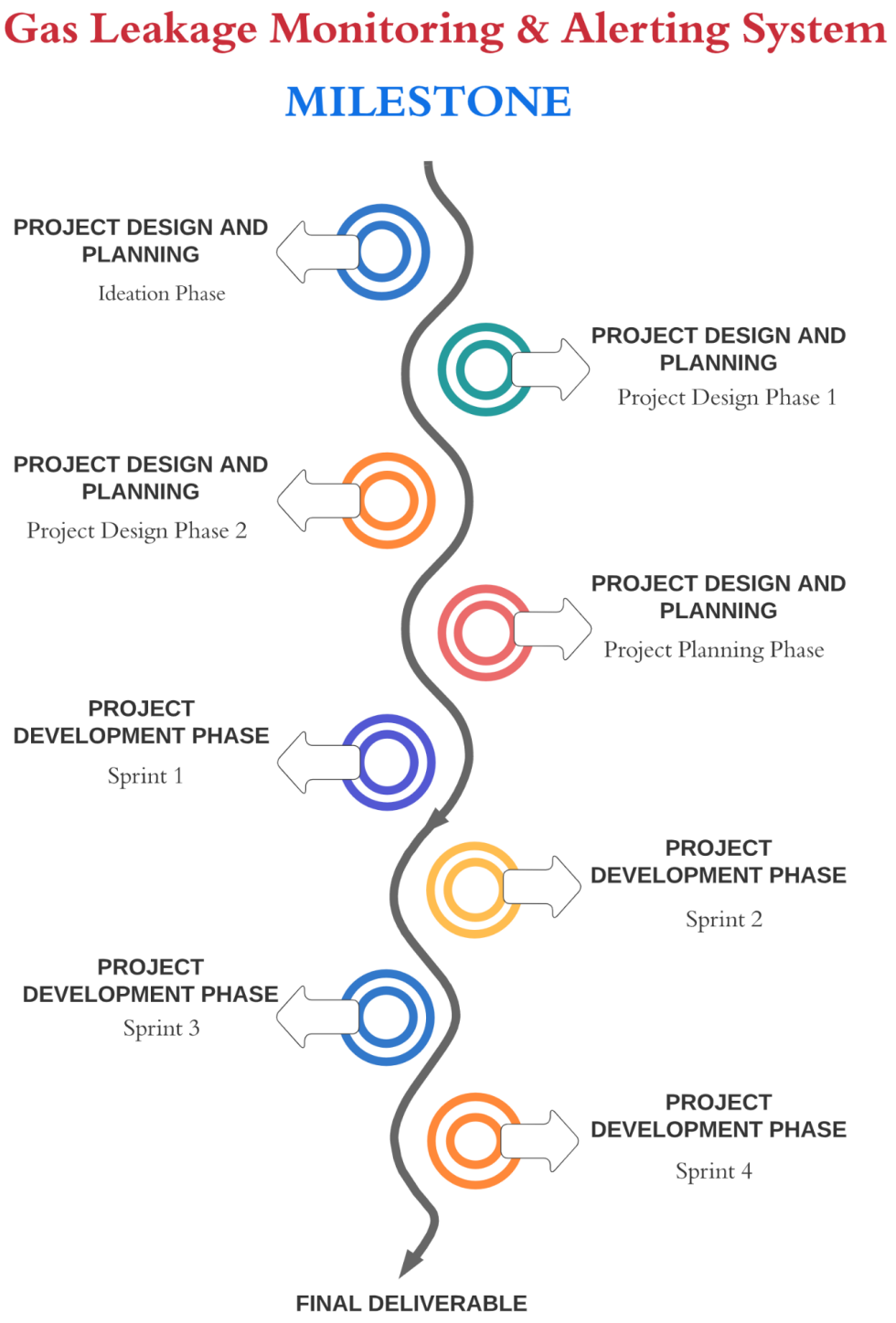
Journey Steps Which step of the experience are you describing?	**Discovery** Why do they even start the journey?	**Registration** Why would they trust us?	**Onboarding and First Use** How can they feel successful?	**Sharing** Why would they invite others?
Actions What does the customer do? What information do they look for? What is their context?	Detecting the leakage of gas	To fill up their information in the application/ website for registering	To connect the device with the system/ mobile And also to check the efficiency of device	When they get fulfilled with the product, they can recommend to other industrialists
Needs and Pains What does the customer want to achieve or avoid?	To avoid leakage of gas To decrease the disasters caused by the leakage of toxic gases	To have enough knowledge on using the devices	Workers have to check it regularly and work according to the procedures	If they have more contacts, they could share the experience of the product to them
Touchpoint What part of the service do they interact with?	Through their mobiles and systems which is connected with the device through IoT	Website Mobile app In-store employees	Speakers Video demos Mobile notifications Mobile/ PC	Social media Newspapers Sponsorship and collaborations
Customer Feeling What is the customer feeling? *Tip: Use the **emoji app** to express more emotions*	😊	😍	🤩	🥳
Process ownership Who is in the lead on this?	Industrialists	Industrialists	Workers / Industrialists	Industrialists

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

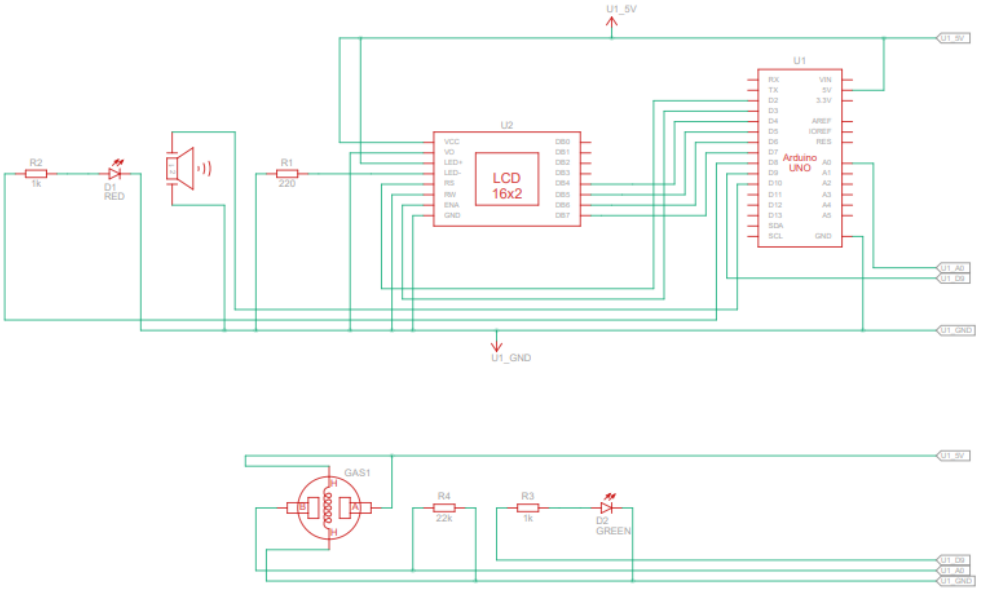


6.2 Sprint Delivery Schedule

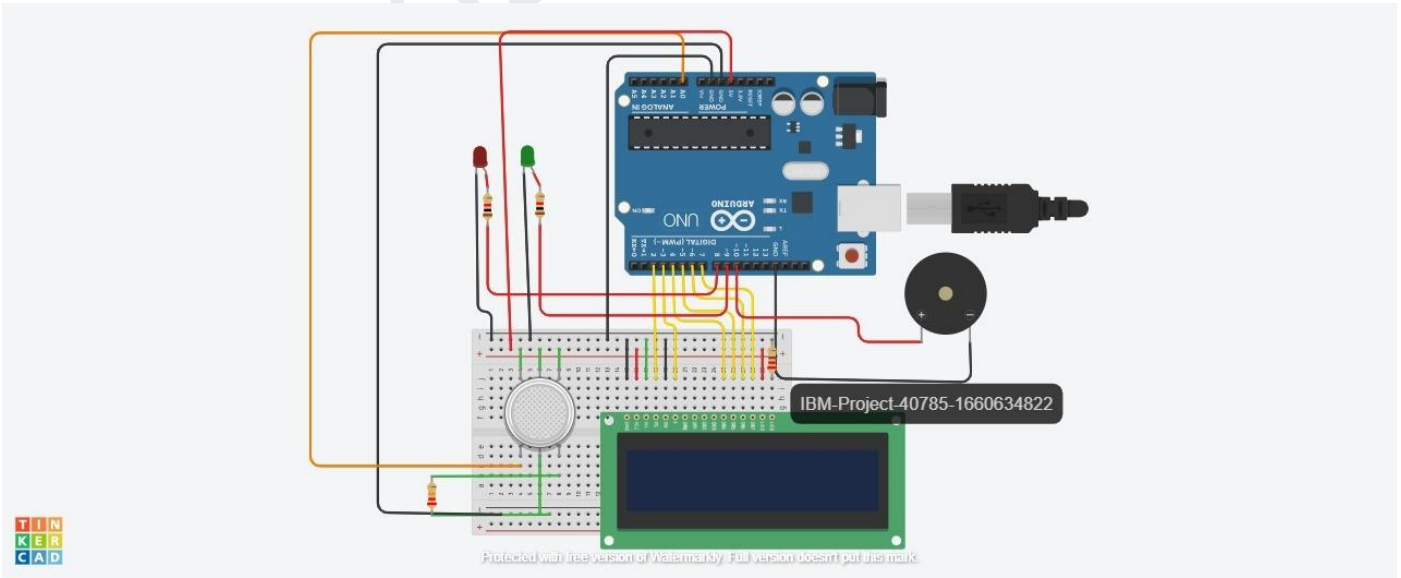


7. CODING & SOLUTIONING

7.1 Schematic Diagram



7.2 Circuit Diagram:



7.3 Components:

S. No.	Name of the Component	Quantity
1.	Arduino UNO R3	1
2.	Breadboard	1
3.	LED	2
4.	Resistor	5
5.	Piezo	1
6.	Gas Sensor	1
7.	LCD (16x2)	1

7.4 Source Code:

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(5,6,8,9,10,11);


int redled = 2;

int greenled = 3;

int buzzer = 4;

int sensor = A0;

int sensorThresh = 400;


void setup()

{

pinMode(redled, OUTPUT);

pinMode(greenled,OUTPUT);

pinMode(buzzer,OUTPUT);

pinMode(sensor,INPUT);

Serial.begin(9600);
```

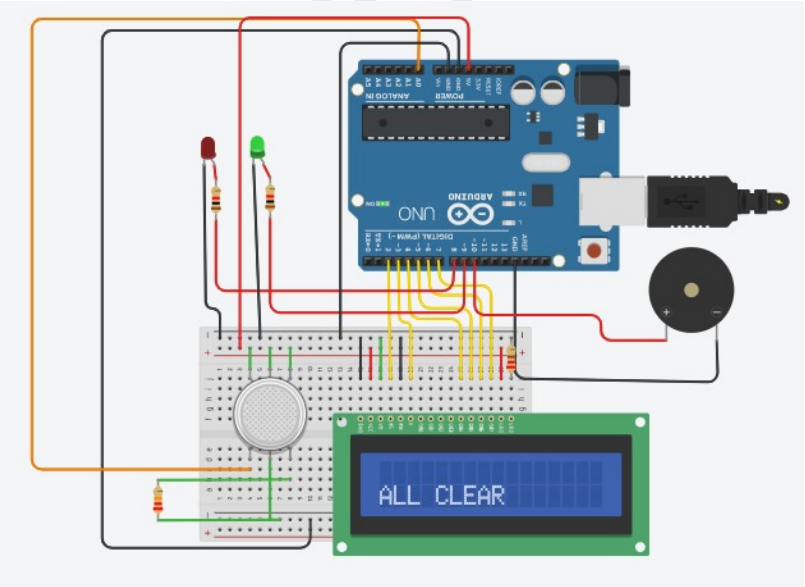
```
lcd.begin(16,2);
}

void loop()
{
 int analogValue = analogRead(sensor);
 Serial.print(analogValue);
 if(analogValue>sensorThresh)
 {
  digitalWrite(redled,HIGH);
  digitalWrite(greenled,LOW);
  tone(buzzer,1000,10000);
  lcd.clear();
  lcd.setCursor(0,1);
  lcd.print("ALERT");
  delay(1000);
  lcd.clear();
  lcd.setCursor(0,1);
  lcd.print("EVACUATE");
  delay(1000);
 }
 else
 {
  digitalWrite(greenled,HIGH);
  digitalWrite(redled,LOW);
  noTone(buzzer);
```

```
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("SAFE");
    delay(1000);
    lcd.clear();
    lcd.setCursor(0,1);
    lcd.print("ALL CLEAR");
    delay(1000);
  }
}
```

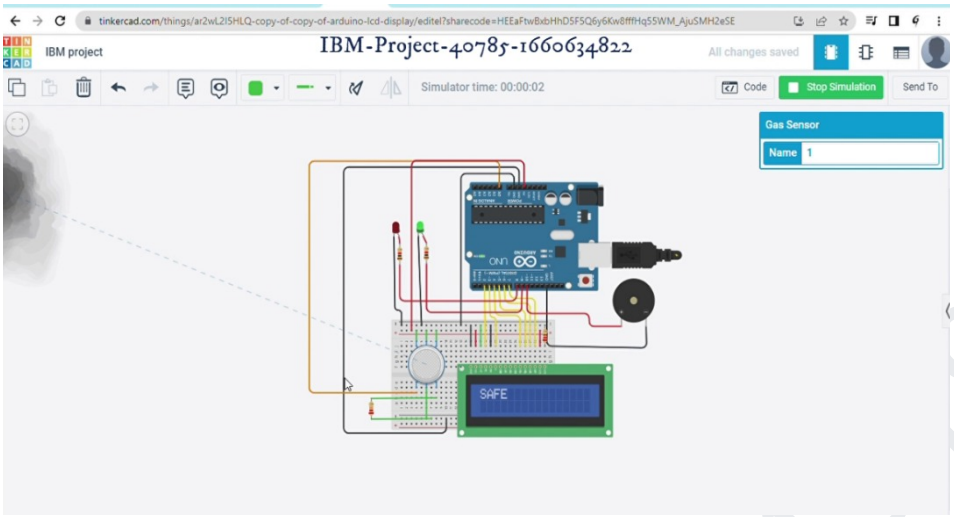
8. Testing

8.1 Test Cases

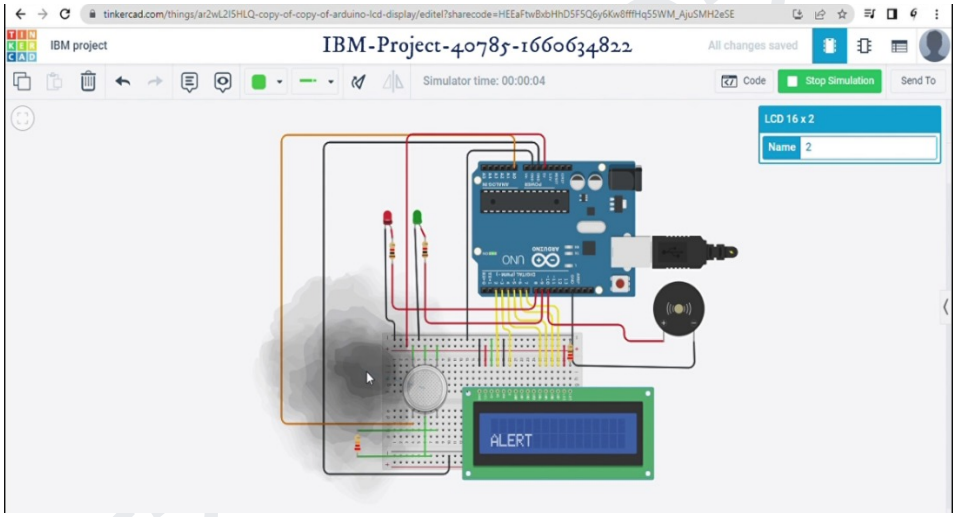
8.1.1 All Clear State



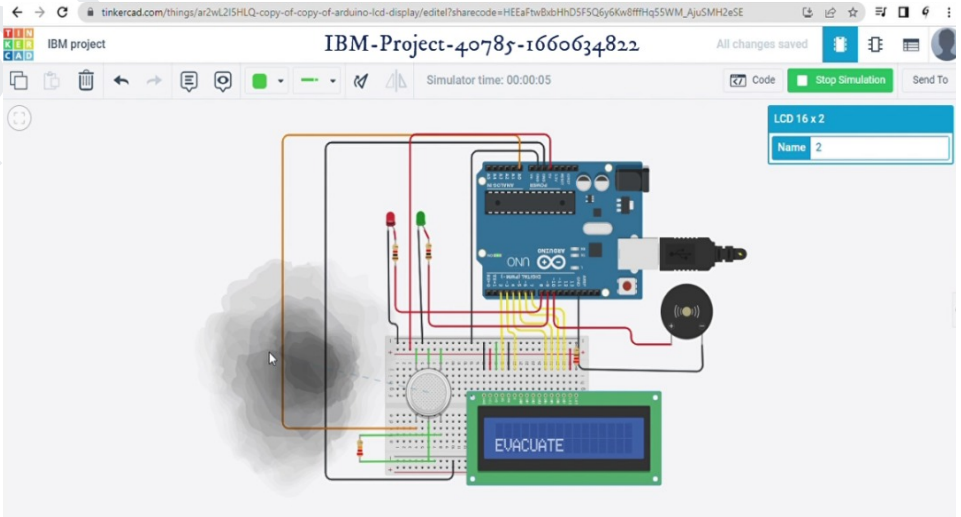
8.1.2 Safe State



8.1.3. Alert State



8.1.4 Evacuate State



9.Results

Thus the Gas leakage and Monitoring system has been detected to be working optimally. The system is able to detect the leakage of harmful gases around the sensor's surrounding and is working efficiently to alert the people around for immediate evacuation.

10. Advantages and Disadvantages

Advantages: Easy user interface, Compact design.

Disadvantages: Less range, Connectivity issues, Security Issues.

11.Conclusion

Thus the Project execution can be concluded that the performance of the gas leakage detection and monitoring system works splendidly as anticipated. The Project has been designed to be useful and applicable at industrial and domestic purposes. The system thus works at helping the lives at risk during a gas leakage emergency situation by alerting them and giving the required time to evacuate safely. The gases being detected here are CO2, Propane, Methane etc,. With the combined components of Arduino, Microcontroller is used to build the overall gas detection system.

12.Future Scope

The main future scope of the project is to integrate the overall system with industrial automation such as to control and communicate the alerts under one shelter. It focuses on initiating the rescue service immediately by integrating under one structure such as clearing the way, opening the doors, exhaust systems etc. The future scope also aims to introduce more machine learning algorithms for increased efficiency.

13.Appendix

Video link :

https://drive.google.com/file/d/1-hiIYg9cGmtkpqB9D19XBlsSmjfJLWhN/view?usp=sharing

Github link:

https://github.com/IBM-EPBL/IBM-Project-40785-1660634822