IBM PROJECT REPORT

GAS LEAKAGE MONITORING AND ALERTING SYSTEM FOR INDUSTRIES

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Team Members: AKSHITHA. B

DURAI ASHWATH. M

ELAVARASAN. V

CONTENTS

1. INTRODUCTION

1.1 Project Overview:

This project helps the industries in monitoring the emission of harmful gases. In several areas, the integration of gas sensors helps in monitoring the gas leakage. If any gas leakage is detected the admins will be notified along with the location. In the web application, admins can view thesensor parameters.

1.2 Purpose:

Inhaling concentrated gas can lead to asphyxia and possible death. To overcome these disasters, we designed a system for monitoring and alerting the leakage of those harmful gases. This makes the industrialists get rid of the fear of any disasters caused by the gases.

2. LITERATURE SURVEY

2.1 Existing Problem:

The number of sensors is unpredictable and the positioning of equipment is improper and also the affordable of the system is high and the systems are sometimes causing heavydisasters.

2.2 References:

NAME: Wireless gas sensor network for detection and monitoring of harmful gases inutility areas and industries
AUTHOR: P. C. Jain, Rajesh Kushwaha
CONTENT: This work was carried out as a part of project "Development of low-cost real-time monitoring system for detection of harmful gases".

NAME: Gas Leakage Detection Based on IOT
AUTHOR: V Suma, Ramya R, Shekhar Kumar, A Akshay
CONTENT: This paper puts forth a new proposed system which is a microcontroller-based application of gas booking and gas detection systems using IOT. Themain intention of this work is to ensure a safe and easier way of gas booking and leakage detection toavoid disasters that may occur due to negligence.

NAME: Smart Gas Leakage Detection with Monitoring and Automatic Safety System
AUTHOR: S.M. Zinnuraain Mahmudul Hasan, Md. Akramul Hakque,

Mir Mohammad Nazmul Arefin
CONTENT: The proposed system is mainly aimed for household purposes, where the user can be notified of the amount of LPG remaining in the cylinder so that necessary actions can be taken to pre-book a new cylinder without any hassle. Also, itnotifies the user about any LPG leakage to take preventive action to avoid an explosion by sending data with the help of Wi-Fi communication system and with an automatic safety system.

NAME: IOT Device forSewage Gas Monitoring andAlert System
AUTHOR: Nitin Asthana, Ridhima Bahl
CONTENT: This project aims at providing smart solutions to monitor poisonous sewage gases and works on a system of live sewage level detection and monitoring. Whenever a certain threshold is crossed, an alert is sent to the observer who is examining the conditions from a remote location. The information is then forwarded along with different gas ppm values indicating whether it is safe for the worker to clean or work in that environment or not.

NAME: Sleep Scheduling in Industrial Wireless Sensor Networks for Toxic Gas Monitoring
AUTHOR: Mithun Mukherjee, Lei Shu Likun Hu Gerhard P. Hancke Chunsheng Zhu
CONTENT: This article proposes a sleep scheduling scheme based on the hazardous classification of a gas leakage area in a petrochemical plant. The proposed scheme wakes up a minimum number of sleep nodes in a gas leakage area compared to the well-known CKN algorithm that considers the entireregion to meet the threshold zone coverage degree.

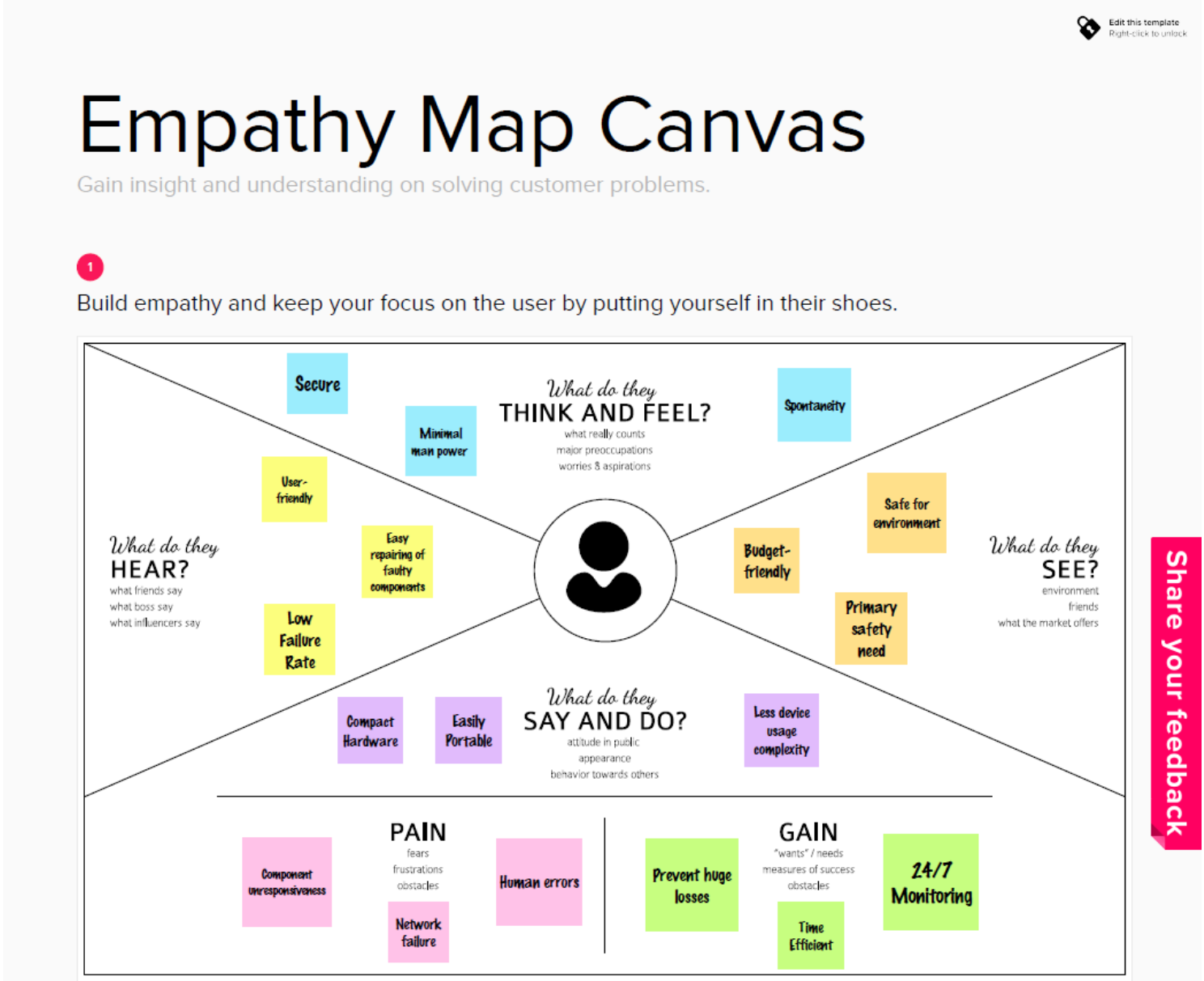
NAME: Embedded System for Hazardous Gas Detection and Alerting
AUTHOR: V Ramya, B Palaniappan
CONTENT: It is necessary that good safety systems are to be implemented in places of education and work. This work modifies the existing safety model installed in industries etc. It is a designed microcontroller basedtoxic gas detecting and alerting system.

2.3 Problem statement definition:

Since the number of sensors is unpredictable, the industrialists feel in secured in handling the gases. Also, the cost price of the products and the complications in installing the systems are high. This makes the customers feel disappointed sometimes.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas:



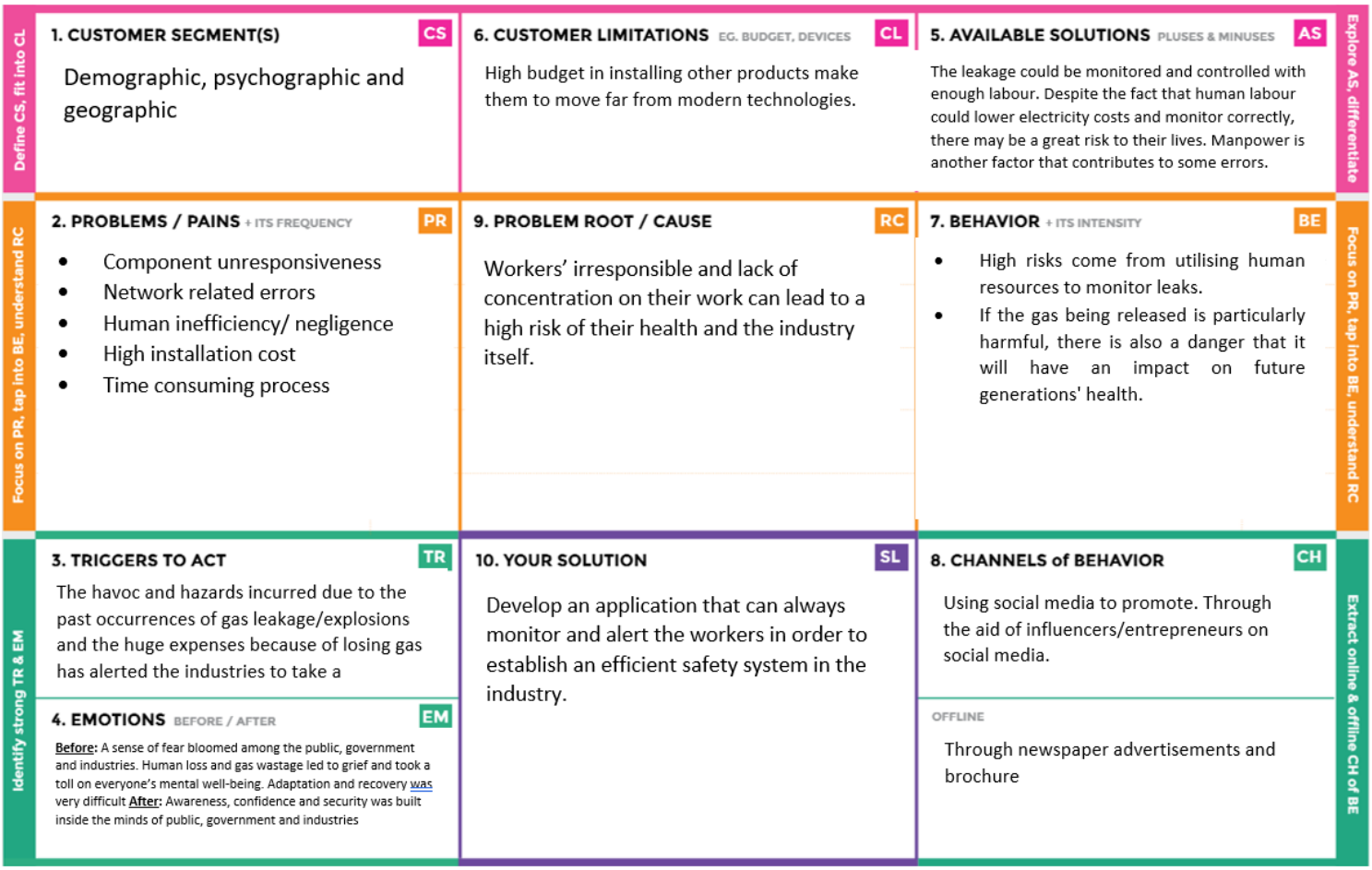
3.2 Ideation & Brainstorming:

3.3 Proposed Solution:

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Continuous industrial development gives rise to harmful gas releases. Often these emissions are controlled. Lapses in preventive maintenance led to faulty pipelines & equipment. Such operational negligence to detect gas leaks is damaging the environment. Apart from polluting the atmospheric air, such leaks create potential hazards for the workers in the industry. Consequently, breathing even with low concentration can lead to many diseases and increase fatality. This project presents a gas leakage alerting and monitoring system to detect leakage in industries and to alarm the people onboard.
2.	Idea / Solution description	The key research objectives are as follows: • This project helps the industries in monitoring the emission of harmful gases • In several areas, the gas sensors will be integrated to monitor the gas leakage • 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.
3.	Novelty / Uniqueness	In the instance of a gas leak inside a secluded area, the workers must be evacuated immediately. Just in case there are people unable to get out, a night vision camera could be installed to monitor their presence and help them. Once gas is detected, the main power supply will be cut off to prevent fires. Also, DC - operated alarming and exit mechanisms will be installed since the power supply is cut off.
4.	Social Impact / Customer Satisfaction	From the public perception as worst impacts of present the uneconomical cost, the system failure, the employee's negligence, the structure mismanagement.
5.	Business Model (Revenue Model)	Gas leakage monitoring and Alerting System organises its operations into two reportable business segments:

		The petroleum industry is just one of the numerous industries that make up a company's strategy. Other components include the detection of the gas kind and leaking quantity, the primary switching off mechanism, and the battery-operated night vision camera that records, and adding on to it a sensor can be installed to detect motion. The method to lead out while in dark and an alerting sound.
6.	Scalability of the Solution	It can be monitored, and preventive measures can be taken to avoid any disaster. The suggested system makes use of sensor and communication technologies, which enable quick detection of the gas type. Suppose corrective steps are taken promptly after it is reported over the IoT devices. In that case, that can help save the loss of lives, alleviate any mishaps from happening, and cut down on business expenses. The gas leakage detection system can be optimized for detecting toxic gasses along with upgrading them with smoke and fire detectors to identify the presence of smoke and fire. Ensuring worker safety is important but making using of the right technology is even more vital.

3.3 Problem Solution Fit:



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4. REQUIREMENT ANALYSIS

4.1 Functional Requirement:

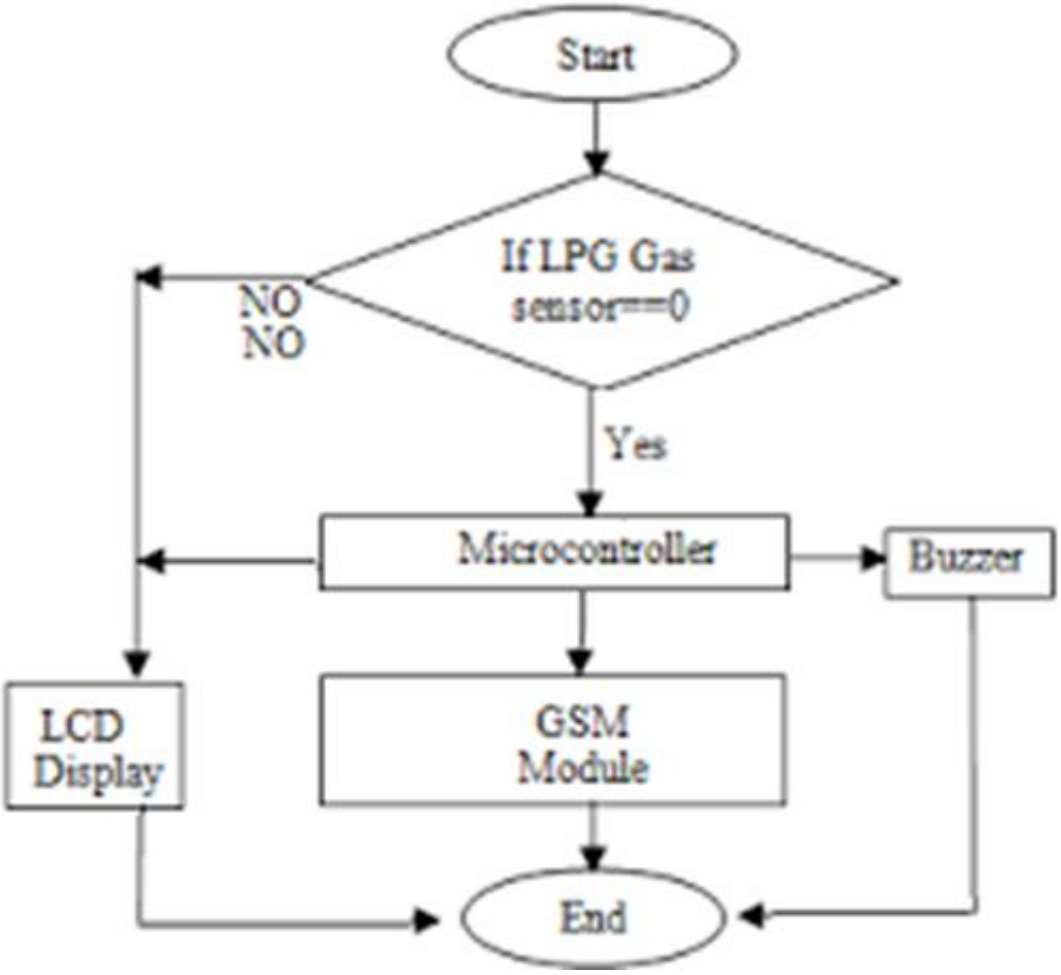
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Visibility	There must be a sound alarming system, to caution the people working in the plant.
FR-2	User Reception	The data like the level of gas should be sent through alerting messages.
FR-3	User Understanding	An emergency alert message must be passed on to the user through SMS or app. The message must notify the amount at gas leaked. The system should update the local database in real time.
FR-4	User Convenience	The system must provide an instantaneous sensor response as soon as the gas leaks. A night-mode camera must be used to capture footage of employees trapped in the environment. There must be a ventilation mechanism to let out the leaked gas. A battery-operated recovery system should be installed in case of power loss.
FR-5	User Performance	The system should make rapid intimating process. There must be an automatic hose to spray water to put out fire, if encountered.

Non-Functional Requirement:

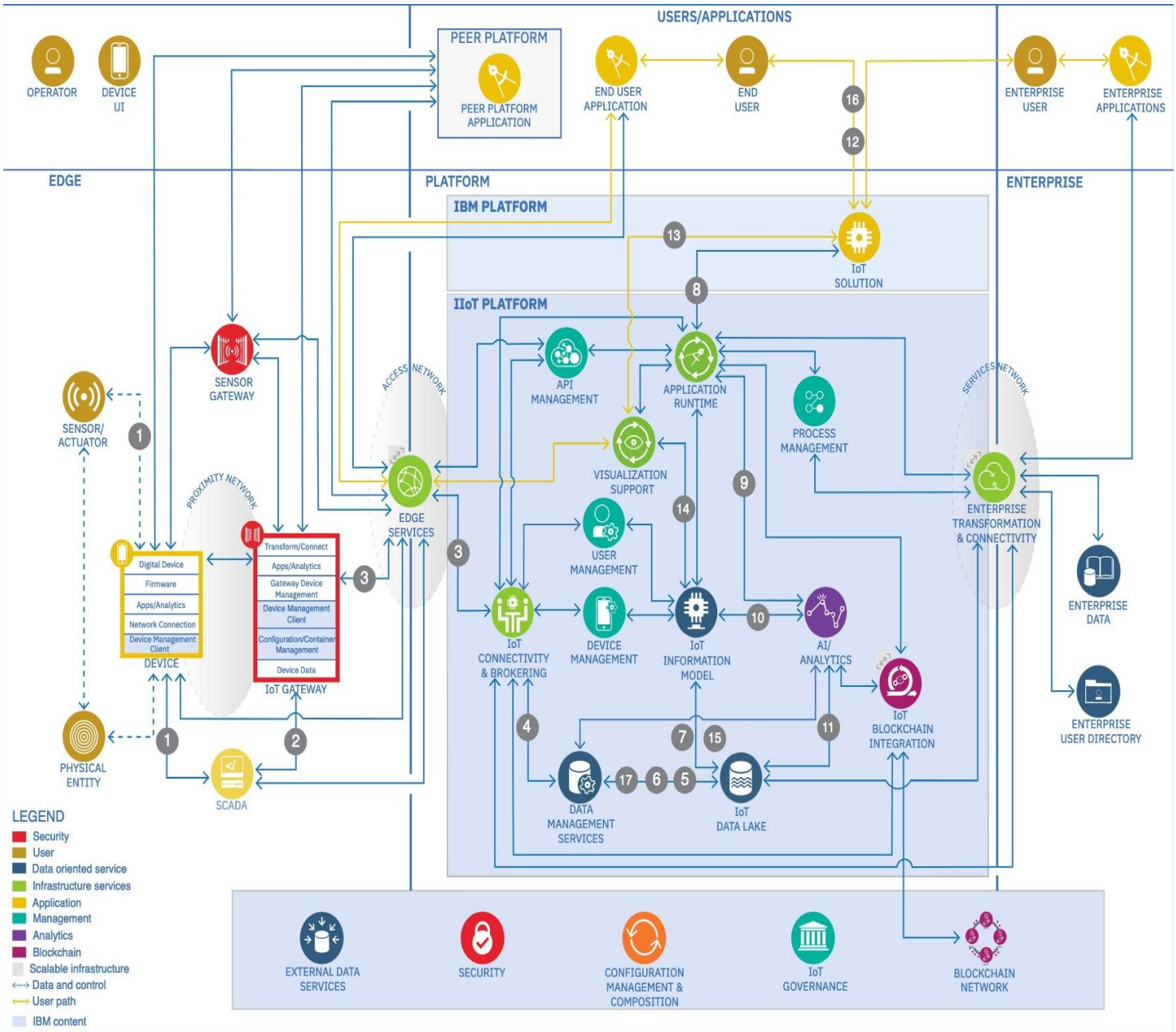
Business Requirements	User Requirements	Product Requirements
The said system can be deployed in homes, hotels, factory units, LPG cylinder storage areas, and so on. The main advantage of this IoT and Arduino-based application is that it can determine the leakage and send the data over to a site. It can be monitored, and preventive measures can be taken to avoid any disaster.	The gas leakage detection system can be optimized for detecting toxic gasses along with upgrading them with smoke and fire detectors to identify the presence of smoke and fire. Ensuring worker safety is important but making using of the right technology is even more vital.	Detecting gasses is necessary regardless of your business role or individual purpose. Certain technologies at play make such IoT devices what they are, and if you want to indulge in IoT application development, you must know what they are and what purpose they can fulfil.

5. PROJECT DESIGN

5.1 Data Flow Diagrams:



5.2 Solution & Technical Architecture:



5.3 User Stories:

6. PROJECT PLANNING AND SCHEDULING

6.1 Sprint Planning & Estimation:

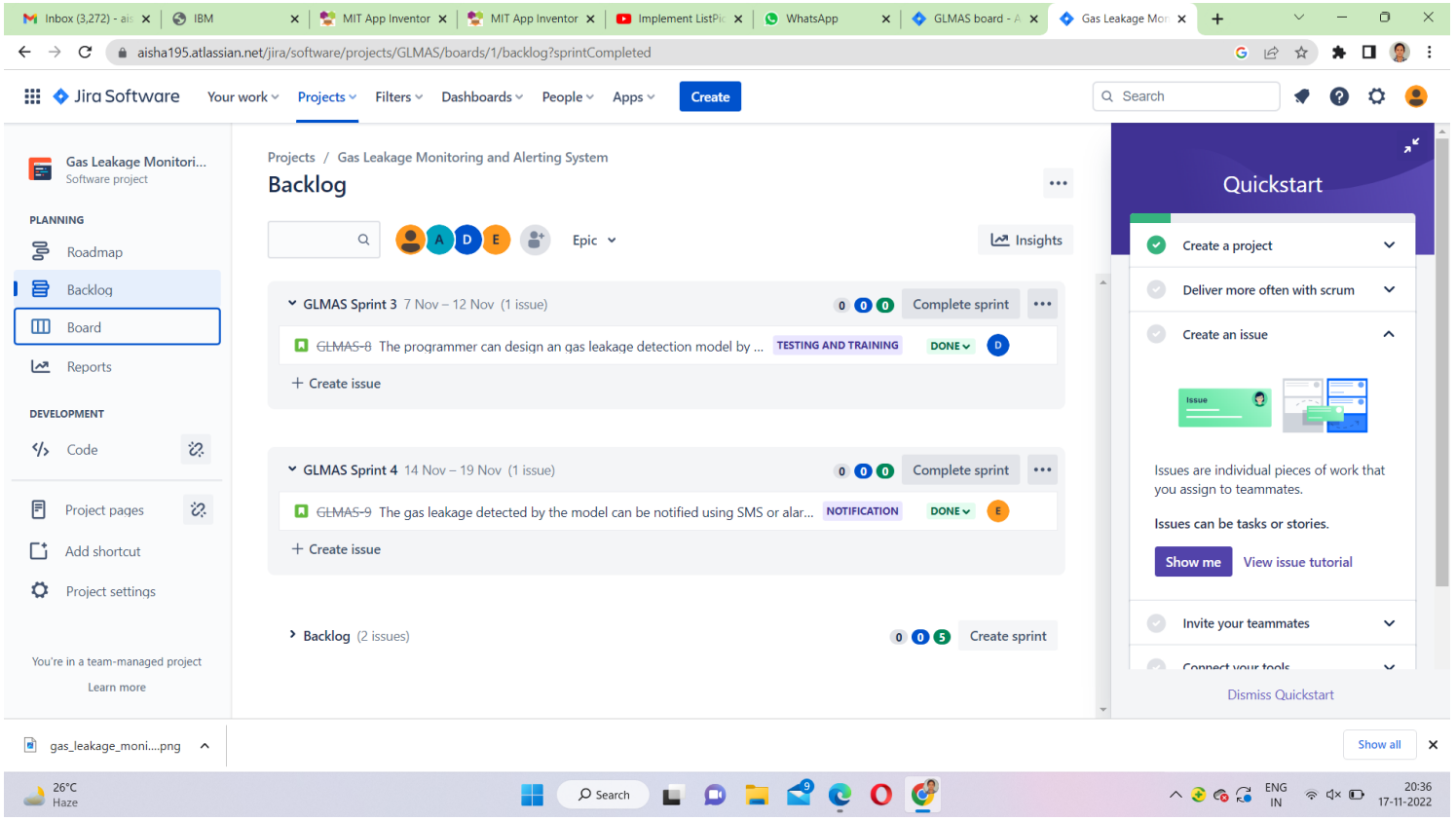
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Analyzing the gas leakage	USN-1	The owner who wants to save his employees or a person who wants to savetheir family from explosiontakes necessary actions	2	High	Aishwarya. R Akshitha. B Elavarasan. V Durai Ashwath.M
Sprint-1	Prevent from explosion	USN-2	The fire officers worry about any explosions dueto gas leakage which may cause many death	1	High	Aishwarya. R Akshitha. B Elavarasan. V Durai Ashwath.M
Sprint-2	To detect the gas leakage	USN-3	The owner can take necessary steps by deploying gas detectors intheir surroundings	2	Low	Aishwarya. R Akshitha. B Elavarasan. V Durai Ashwath. M
Sprint-3	Testing and training of the model device	USN-4	The programmer can design a gas leakagedetection model by training the dataset	2	Medium	Aishwarya. R Akshitha. B Elavarasan. V Durai Ashwath. M
Sprint-4	Notification	USN-5	The gas leakage detected by the model can be notified using SMS or alarming system	1	High	Aishwarya. R Akshitha. B Elavarasan. V Durai Ashwath. M

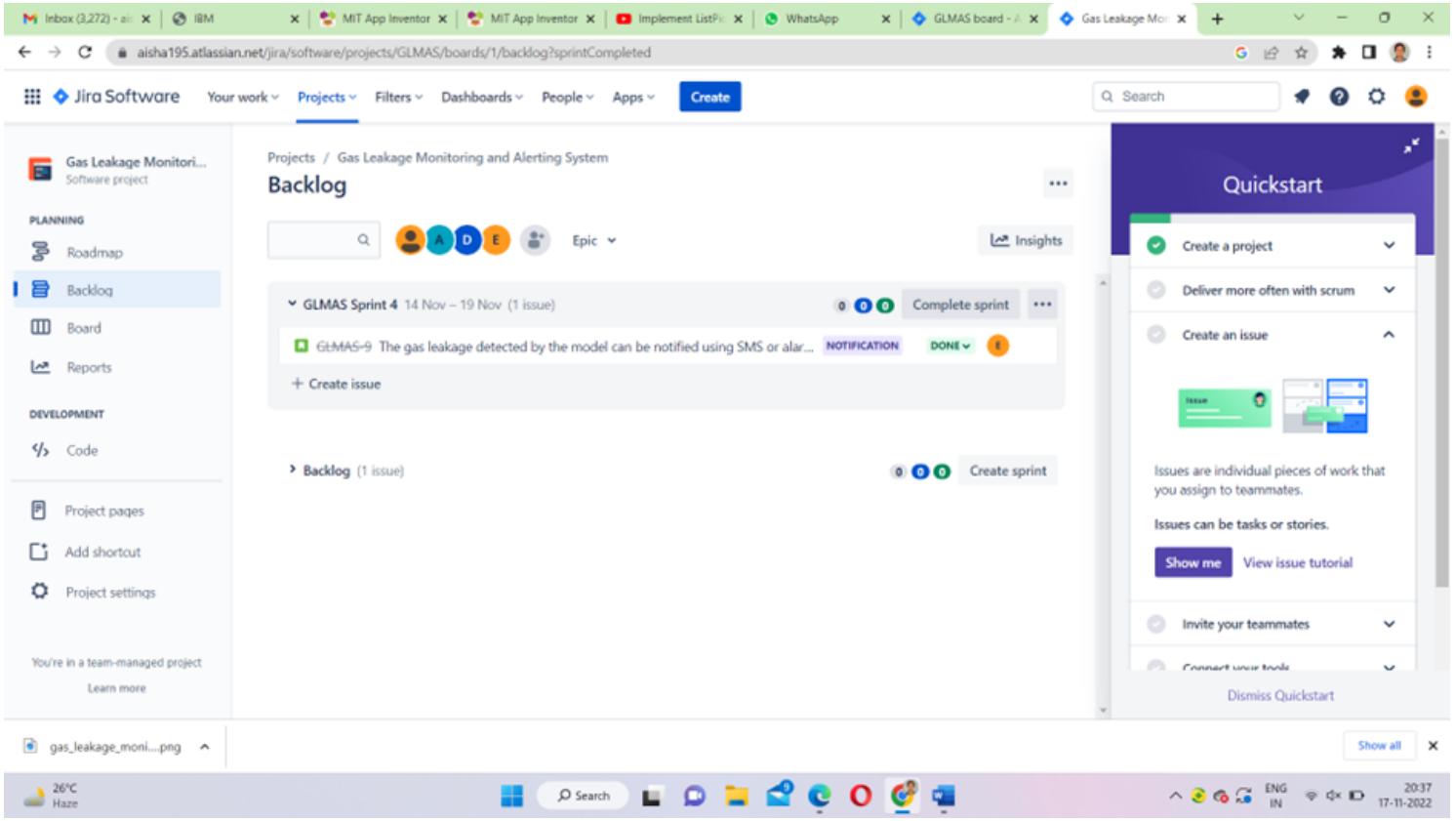
6.2 Sprint Delivery Schedule:

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	17 Nov 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	17 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	18 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.3 Reports From JIRA:

BACKLOG & ROADMAP




Jira Software
Your work
Projects
Filters
Dashboards
People
Apps
Create
Search
Gas Leakage Monitori...
Software project
PLANNING
Roadmap
Backlog
Board
Reports
DEVELOPMENT
Code
Project pages
Add shortcut
Project settings
You're in a team-managed project
Learn more
Projects / Gas Leakage Monitoring and Alerting System
Backlog
Epic
Insights
GLMAS Sprint 4 14 Nov – 19 Nov (1 issue)
Complete sprint
GLMAS-9 The gas leakage detected by the model can be notified using SMS or alar...
NOTIFICATION
DONE
Create issue
Backlog (1 issue)
Create sprint
Quickstart
Create a project
Deliver more often with scrum
Create an issue
Issues are individual pieces of work that you assign to teammates.
Issues can be tasks or stories.
Show me
View issue tutorial
Invite your teammates
Dismiss Quickstart
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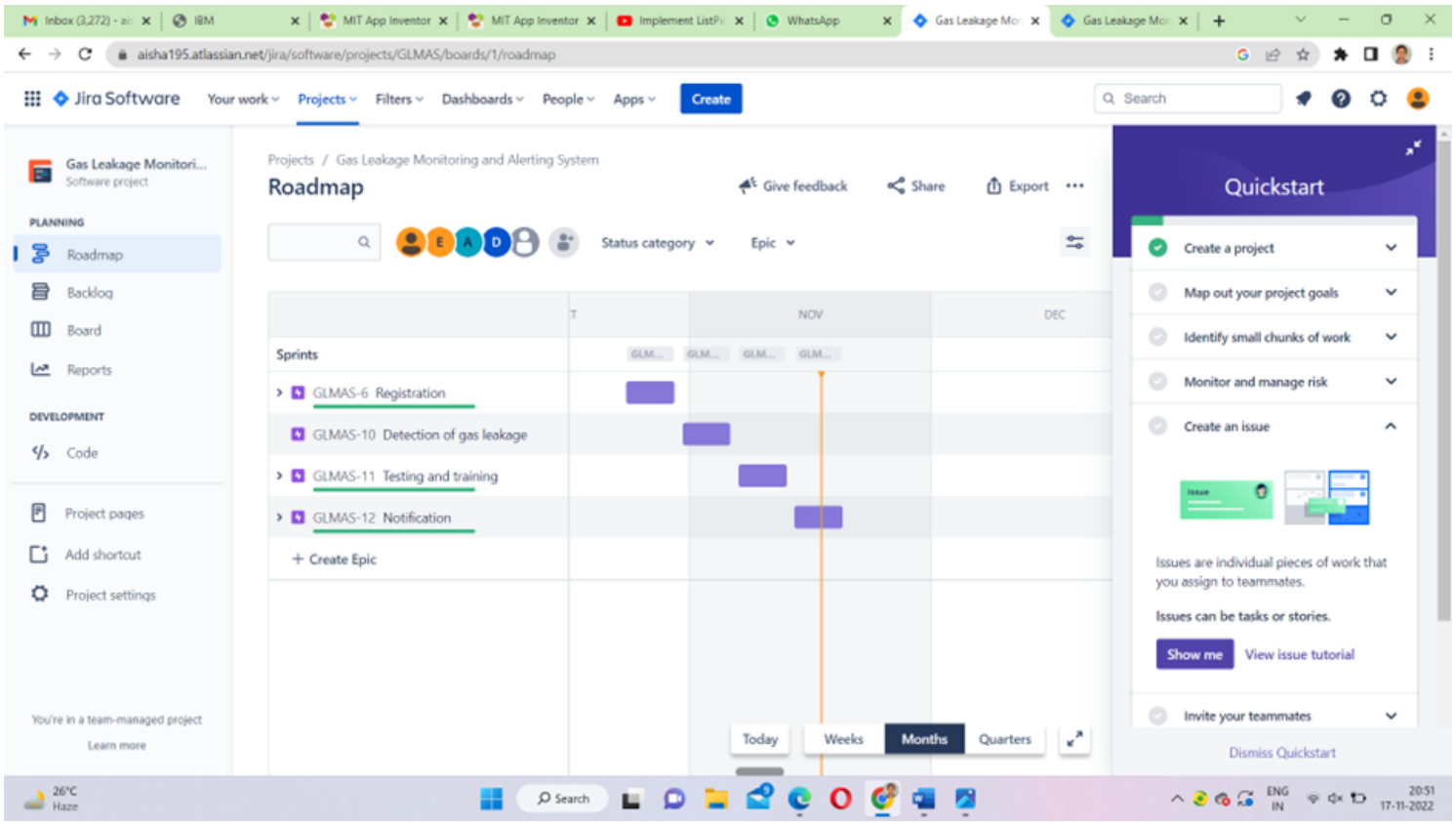
Show all


Jira Software
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Software project
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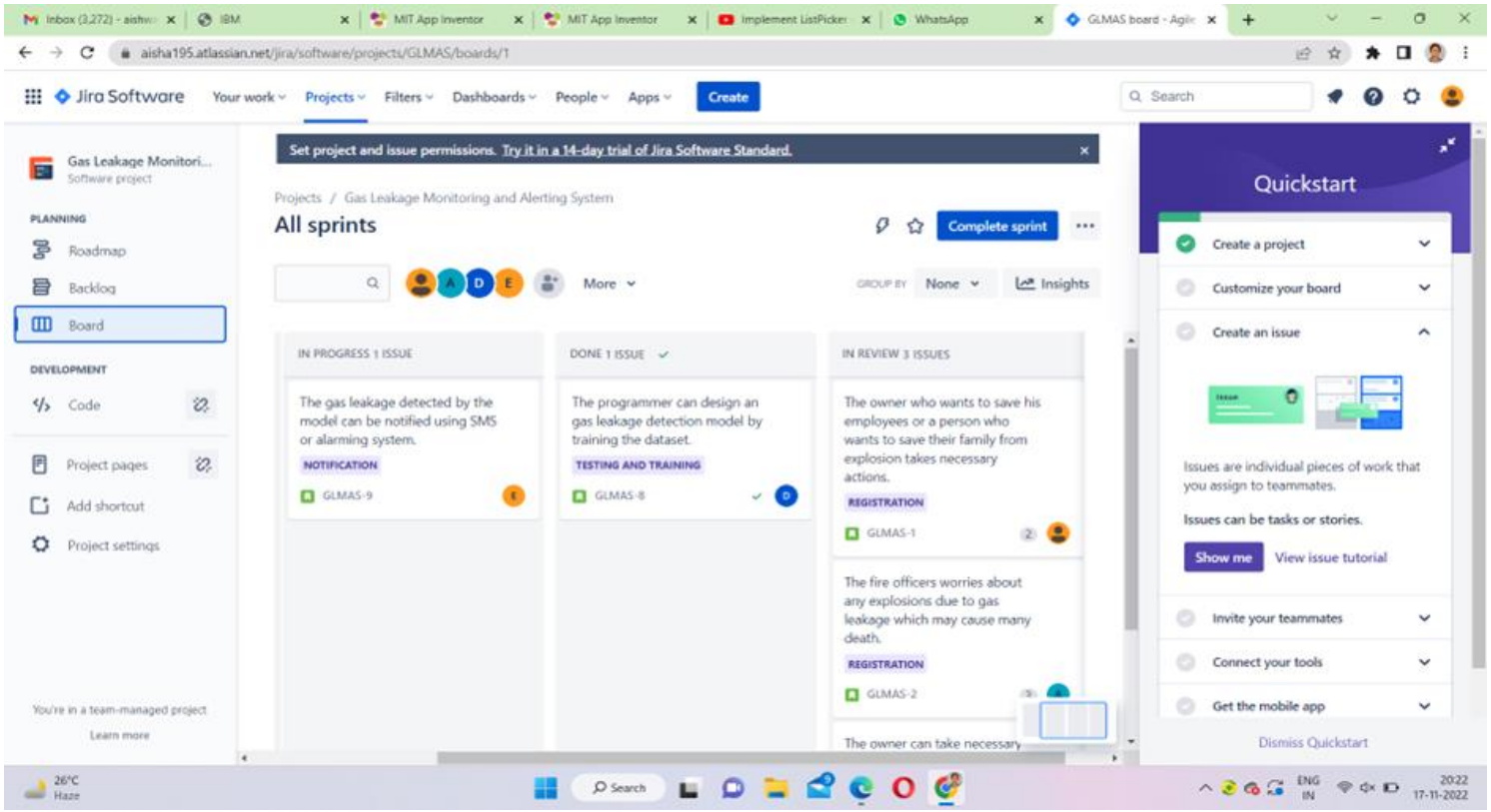
Learn more
Projects / Gas Leakage Monitoring and Alerting System
Roadmap
Give feedback
Share
Export
Status category
Epic
NOV
DEC
Sprints
GLMAS-6 Registration
GLMAS-10 Detection of gas leakage
GLMAS-11 Testing and training
GLMAS-12 Notification
Create Epic
Today
Weeks
Months
Quarters
Quickstart
Create a project
Map out your project goals
Identify small chunks of work
Monitor and manage risk
Create an issue
Issues are individual pieces of work that you assign to teammates.
Issues can be tasks or stories.
Show me
View issue tutorial
Invite your teammates
Dismiss Quickstart

SCRUM BOARD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Your work
Projects
Filters
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People
Apps
Create
Search
Gas Leakage Monitori...
Software project
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Code
Project pages
Add shortcut
Project settings
You're in a team-managed project
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Set project and issue permissions. Try it in a 14-day trial of Jira Software Standard.
Projects / Gas Leakage Monitoring and Alerting System
All sprints
Complete sprint
More
GROUP BY None
Insights
IN PROGRESS 1 ISSUE
The gas leakage detected by the model can be notified using SMS or alarming system.
NOTIFICATION
GLMAS-9
DONE 1 ISSUE
The programmer can design an gas leakage detection model by training the dataset.
TESTING AND TRAINING
GLMAS-8
IN REVIEW 3 ISSUES
The owner who wants to save his employees or a person who wants to save their family from explosion takes necessary actions.
REGISTRATION
GLMAS-1
The fire officers worries about any explosions due to gas leakage which may cause many death.
REGISTRATION
GLMAS-2
The owner can take necessary
Quickstart
Create a project
Customize your board
Create an issue
Issues are individual pieces of work that you assign to teammates.
Issues can be tasks or stories.
Show me
View issue tutorial
Invite your teammates
Connect your tools
Get the mobile app
Dismiss Quickstart
26°C
Haze
Search
ENG
IN
20:22
17-11-2022

7. CODING AND SOLUTIONING

7.1 Feature 1:

Cut-off power supply and turn on fans – When there is any gas detected by the sensors, the complete power supply of the building is cut off and there is a ventilation mechanism to automatically turn on the exhaust fans. It is done using battery-operated mode in order to prevent catching of fires. Just in case fire emerges unfortunately, there is also a method to put off fire, where the water hose sprays/sprinkles water on the burning fire.

7.1 Feature 2:

Night mode cameras – Night vision cameras are placed at specified places to monitor the safety of working staff and ensure they are evacuated safely out of the building. A display board for caution that says “EXIT” is also displayed at exit ways to guide the workers to get out of the location. The location of the gas leakage is also clearly specified such that the gas leakage can be detected and rectified easily within a short duration of time.

8. TESTING

8.1 User Acceptance Test:

Date	19-Nov-22
Team ID	PNT2022TMID27861
Project Name	Project - Gas Leakage Monitoring And Alerting System For Industries
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)	Executed By
TC_001	Functional	IBM cloud	Create the IBM Cloud services which are being used in this project.	IBM Cloud Login ID & Password	1.Go to IBM Cloud signup page 2.Enter e-mail id and other credentials 3.Enter a password	https://cloud.ibm.com/login	User should sign up IBM cloud and details should be verified	Working as expected	Pass	Results verified	No	AISHWARYA.R & AKSHITHA.B
TC_002	Functional	IBM Cloud	Configure the IBM Cloud services which are being used in completing this project.	IBM Cloud Login ID & Password	1.Go to Cloud login 2.Enter user ID & Password 3.Verify login by the popup display	https://cloud.ibm.com/login	User login to IBM Cloud and should be navigated to IBM Cloud dashboard page	Working as expected	Pass	Results verified	No	AISHWARYA.R
TC_003	Functional	IBM Watson IoT Platform	IBM Watson IoT platform acts as the mediator to connect the web application to IoT devices, so create the IBM Watson IoT platform.	IBM Watson IoT Platform Login ID & Password	1.Login to IBM Cloud 2.Click Catalog 3.Search IoT and click create 4.Go to resource list and search Internet of Things platform 5.Press Launch and click Sign in IBM Watson Platform	https://vq4nsy.internetofthings.ibmcloud.com/dashboard/	User should be navigated to IBM IoT Watson Platform	Working as expected	Pass	Results verified	No	AISHWARYA.R
TC_004	Functional	IBM Watson	In order to connect the IoT device to the IBM cloud, create a device in the IBM Watson IoT platform and get the device credentials.	IBM Watson IoT Platform Login ID & Password	1.Login to IBM Watson Platform 2. Click Add Device 3.Enter the details and click Finish. Create Device ID & Device type 4.Turn on Device Simulator and click simulation running. Enter the values of gas, temperature & humidity level 5.Click Send & Save. Verify the displayed result of the levels	Temperature, Humidity and Gas sensor values are generated randomly in simulation	Temperature, Humidity and Gas sensor values should be randomly generated	Working as expected	Pass	Results verified	No	AKSHITHA.B
TC_005	Functional	IBM Cloud(Node Red)	Configure the connection security and create API keys that are used in the Node-RED service for accessing the IBM IoT Platform.	Node Red Installation	1.Install node red and open node red in command prompt 2.Select IBM input in IoT	https://cloud.ibm.com/developer/appservice/create-app?starterKit=59c9d5bd-4d31-3611-897a-f94eea80dc9f&defaultLan	User should be able to see the Node Red page	Working as expected	Pass	Results verified	No	AKSHITHA.B
TC_006	Functional	Node Red	Create a Node-RED service.	Node Red Installation	1.Select IBM IoT input in Node. In IBM IoT Watson Platform, go to apps and click on generate API keys. 2.Copy & paste generated API key and token in the IBM IoT input. After entering all details, click the done button. 3.Add debug to the IBM IoT and rename as Msg.payload and click on done. Click gauge from the dashboard and fill the details & add functions to the gauge. Check the generated values from the debug message. 4.Edit function node, connect them, add another gauge and functions, name them as "Temperature", "Gas" &"Humidity" 5.Finally add alarm ON/OFF and Sprinkler ON/OFF buttons to the IBM	Values of sensors and button for Alarm & Sprinkler ON/OFF is displayed	Values of sensors and button for Alarm & Sprinkler ON/OFF should be displayed	Working as expected	Pass	Results verified	No	AKSHITHA.B

TC_007	Functional	Python 3.7.0	Develop a python script to publish random sensor data such as temperature, humidity level and Gas level to the IBM IoT platform	Python 3.7.0(64 bit) installation	1.Download and install Python 3.7.0 2.Develop python code	https://www.python.org/downloads/release/python-370/	User should be able to develop a python code	Working as expected	Pass	Results verified	No	DURAI ASHWATH.M
TC_008	Functional	Python 3.7.0	After developing python code, commands are received just print the statements which represent the control of the devices.	Python 3.7.0(64 bit) installation	1.Downlinstall Python 3.7.0 2.After python code	Get the output from the cod	User should be able to get the results from the developed code	Working as expected	Pass	Results verified	No	ELAVARASAN.V
TC_009	Functional	IBM Cloudant DB	Publish Data to The IBM Cloud	IBM Cloud Login ID & Password	1.Run the python code 2.Verify the displayed output	Publishment of python code	User should be able to publish th	Working as expected	Pass	Results verified	No	AISHWARYA.R
TC_010	Web UI	Node Red & MIT Inventor	Create Web UI in Node- Red	MIT Inventor Login ID & password	1.Go to Node Red. Select http in & http response. Add functions and select another http in and http response. Connect them to IBM IoT output and function.Print the command statements such as Sprinkler ON/OFF, Alarm ON/OFF and sensor 2.Go to MIT app inventor and create frontend using buttons,horizontal arrangement, text bar, etc. Add blocks and so on to create back end. Verify the output	Sensors values and command values can be seen in the mobile application	Sensors values and command values should be seen in the mobile application	Working as expected	Pass	Results verified	No	AKSHITHA.B & AISHWARYA.R
TC_011	Functional	IBM Cloudant DB	Configure the Node-RED flow to receive data from the IBM IoT platform and also use Cloudant DB nodes to store the received sensor data in the	IBM Cloud Login ID & Password	1.Go to IBM cloud, search Cloudant in Catalog, Add new dashboard, go to Node Red 2.Connect to cloudant and verify the results	Cloudant is connected by NODE RED	User should be able to connect the Cloudant and Node Red	Working as expected	Pass	Results verified	No	AKSHITHA.B

9. RESULTS

9.1 Performance Testing Report:

Date : 19-11-2022

Team ID : PNT2022TMID27861

Project Name : Gas Leakage Monitoring and Alerting System

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	Fan 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/Risks
1	Python script	Python coding	https://www.python.org/psf/sponsors/#heroku	Depend on the delivered code
2	Node Red	Sensor & command values	https://node-red-bwjcz-2022-11-10.eu-gb.mybluemix.net/red/#flo	Sensor values
3	MIT Inventor	Light/Sprinkler/Sensors notification	http://ai2.appinventor.mit.edu/#5253023233061632	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	https://www.python.org/psf/sponsors/#heroku
2	Node Red	Sensors&command values	Met	Pass	GO	Closed	Sensing the values perfectly	https://node-red-bwjcz-2022-11-10.eu-gb.mybluemix.net/red/#flc
3	MIT APP Inventor	Light/Sprinkler/Sensors notification	Met	Pass	GO	Closed	Notifies the users at correct time	http://ai2.appinventor.mit.edu/#5253023233061632

10. ADVANTAGES AND DISADVANTAGES

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
- Supervise gas concentration levels
- Ensure worker's health
- Real-time updates about leakages
- Cost-effective installation
- Data analytics for improved decisions
- Measure oxygen level accuracy
- Get immediate gas leak alert

Disadvantages:

- Only one gas can be measured with each instrument.
- When heavy dust, steam or fog blocks the laser beam, the system will not be able to take measurements.

11. CONCLUSION

Gas leakage leads to severe accidents resulting in material losses and human injuries. Gas leakage occurs due to poor maintenance of equipment and inadequate awareness of thepeople. Hence, gas leakage detection is essential to prevent accidents and to save human lives. This paper presented LPG leakage detection and alert system. This system triggers buzzer and notification to alert people when gas leakage isdetected.

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. 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, Food processing Industries, Glass Industries, Plastic industries, Pharmaceuticals, Aerosol manufacturing. As hospitals require to provide maximum possible safetyto 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 chemistry lab and pharmaceutical labs where gas burners are used. Several medical equipment requires gas cylinders.

12. APPENDIX

Source Code:

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(6, 7, 8, 9, 10, 11);
float gasPin = A0;
float gasLevel;
int ledPin = 2;
int buttonPin = 3;
int buzzPin = 4;
int buttonState;
int fan = 5;

void setup(){
  pinMode(ledPin, OUTPUT);
  pinMode(buttonPin, INPUT);
  pinMode(gasPin,INPUT);
  pinMode(fan,OUTPUT);
  Serial.begin(9600);
  lcd.begin(16, 2);
  lcd.setCursor(0,0);
```

```
  lcd.print(" Welcome");
  lcd.setCursor(0,2);
  lcd.print("PNT2022TMID51246");
  delay(500);
  lcd.clear();
}

void loop(){
  // Read the value from gas sensor and button
  gasLevel = analogRead(gasPin);
  buttonState = digitalRead(buttonPin);

  // call the function for gas detection and button work
  gasDetected(gasLevel);
  buzzer(gasLevel);
  exhaustFanOn(buttonState);
}

// Gas Leakage Detection & Automatic Alarm and Fan ON
void gasDetected(float gasLevel){
  if(gasLevel >= 200){
   digitalWrite(buzzPin,HIGH);
    digitalWrite(ledPin,HIGH);
    digitalWrite(fan,HIGH);
    lcd.setCursor(0,0);
   lcd.print("GAS:");
    lcd.print(gasLevel);
   lcd.setCursor(0,2);
   lcd.print("FAN ON");
   delay(1000);
   lcd.clear();
  }else{
   digitalWrite(ledPin,LOW);
    digitalWrite(buzzPin,LOW);
    digitalWrite(fan,LOW);
    lcd.setCursor(0,0);
   lcd.print("GAS:");
    lcd.print(gasLevel);
   lcd.setCursor(0,2);
   lcd.print("FAN OFF");
   delay(100);
```

```
   lcd.clear();
  }
}
//BUZZER
void buzzer(float gasLevel){
if(gasLevel>=200)
  {
  for(int i=0; i<=30; i=i+10)
  {
  tone(4,i);
  delay(400);
  noTone(4);
  delay(400);
  }
  }
}
// Manually Exhaust FAN ON
void exhaustFanOn(int buttonState){
  if(buttonState == HIGH){
    digitalWrite(fan,HIGH);
    lcd.setCursor(0,0);
   lcd.print("Button State:");
    lcd.print(buttonState);
    lcd.setCursor(0,2);
    lcd.print("FAN ON");
    delay(10000);
    lcd.clear();
  }
}
```

GitHub and Project Demo Link:

Github Link -

https://github.com/IBM-EPBL/IBM-Project-21805-1659791852

Project Demo Link -

https://drive.google.com/file/d/18hoo_3UpG2tG258dYIs9WV4BMwS9JF6s/view?usp=drivesdk