

Professional Readiness for Innovation, Employability, and Entrepreneurship

PROJECT REPORT

Title	Hazardous Area Monitoring for Industrial Plant powered by IoT
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1. INTRODUCTION

1.1 Project Overview

Any heat escaping the machinery, burners, furnaces, etc. are ultimate sources of temperature increase. This happens either accidentally or out of negligence. This may not affect individuals directly, but can in-turn trigger another event of catastrophic nature, thus ensuring precautionary measures is essential. These temperature increases can be monitored regularly using various detectors containing sensors to detect any abnormal changes and trends in heat production and temperature increase, thereby allowing the concerned officials to act on it before anything happens to those working in that environment. This system solely aims on monitoring the temperature of the industry, thereby ensuring the safety of the workers and the industry.

1.2 Purpose

- This project helps the industries in monitoring the rise and fall of temperatures.
- The alert system will be triggered when the temperature exceeds normal bounds.
- In case of emergencies, the admins will be notified in the same instant the workers are alerted.
- In the web application, admins can view the sensor parameters.

2. LITERATURE SURVEY

2.1 Existing Problem

Most of the industries have large machineries that produce heat due to friction. Many industries operate solely on the idea of heat production. They include smelting plants, recycling hubs, waste treatment facilities and even nuclear power generators. So, when these industries produce temperature that they can't control, the result is catastrophic. This

system solely aims on monitoring the temperature of the industry, thereby ensuring the safety of the workers and the industry.

2.2 References

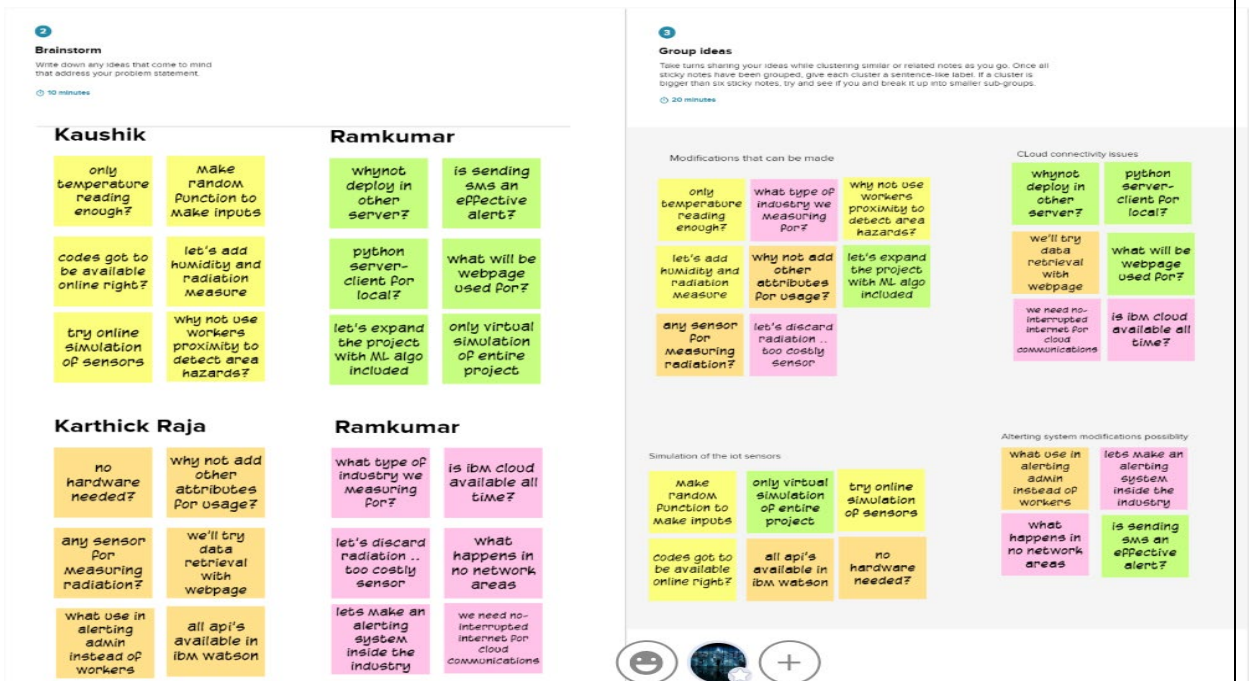
- 2.2.1 Kang, H., Sung, S., Hong, J., Jung, S., Hong, T., Park, H. S., & Lee, D.-E. (2020). Development of a real-time automated monitoring system for managing the hazardous environmental pollutants at the construction site. *Journal of Hazardous Materials*, 123483. doi:10.1016/j.jhazmat.2020.123483. This paper presents a way to monitor the noise and dust in industries using vibrations and sensors to measure vibrations, dust and noise.
- 2.2.2 Sureshkumar A (2015). A Study On Computer Based Monitoring System For Hazardous Area Safety Measurement Using Virtual Instrumentation. *International Conference on Inter Disciplinary Research in Engineering and Technology [ICIDRET]*, ICIDRET.2015.030. The basic idea of this paper is to provide a way to virtualize all the sensor automations instead of manually reading the data from sensors, to get the desired results from the environment
- 2.2.3 Somnath, Paul., T.V. Sarath., (2018). End to End IoT Based Hazard Monitoring System. *International Conference on Inventive Research in Computing Applications (ICIRCA)* 10.1109/ICIRCA.2018.8597430. This paper uses various IoT devices and messaging protocols to monitor parameters like temperature, humidity, presence or absence of objects.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy map



3.2 Brainstorming Session



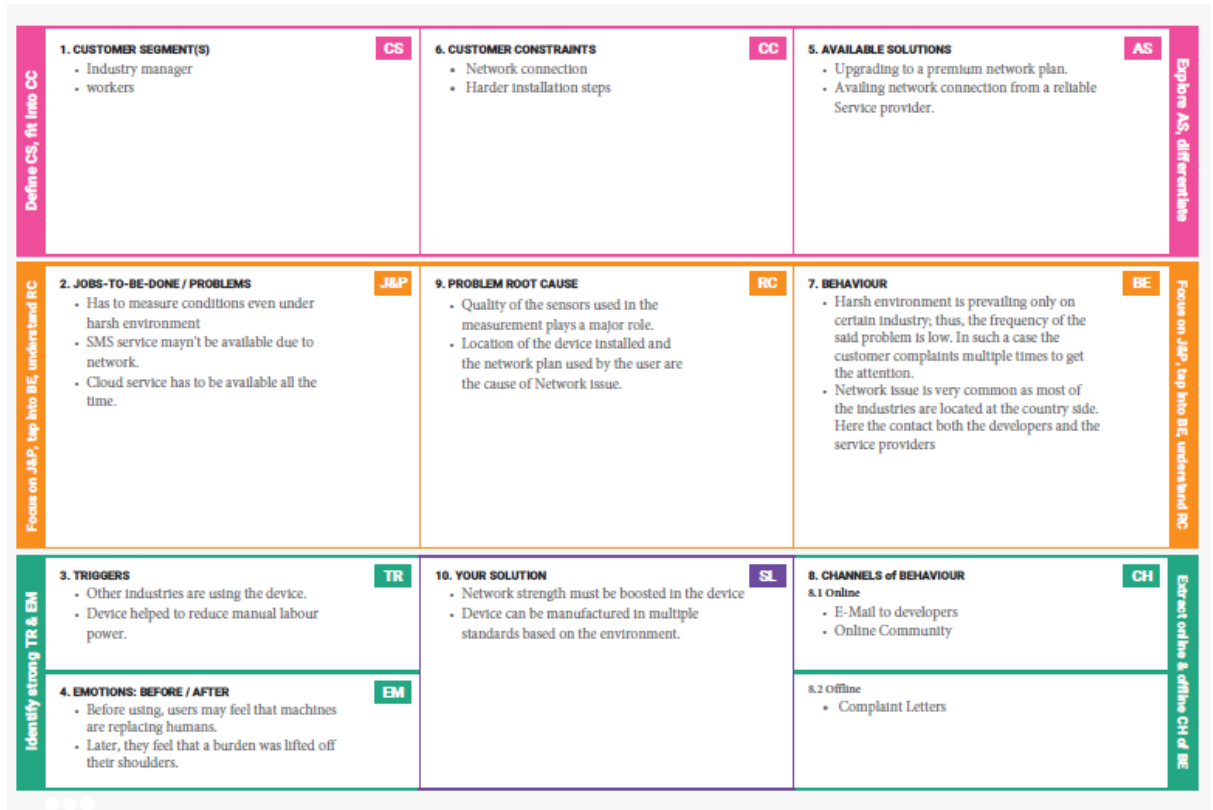
Ⓢ 20 minutes



S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	<ul style="list-style-type: none"> Hazardous Area Monitoring for Industrial Plant Powered by IoT
2.	Idea / Solution description	<ul style="list-style-type: none"> Using a variety of sensor, the environmental parameters such as

		<p>temperature, humidity can be monitored</p> <ul style="list-style-type: none"> ○ If the conditions exceeds safety limits, message is sent to users sms.
3.	Novelty / Uniqueness	<ul style="list-style-type: none"> ○ Device being developed can monitor a wide range temperature and accurate humidity measurements. ○ Apart from notifying the user, an alert can be made in the hazardous area. ○ Reduces unwanted manpower.
4.	Social Impact / Customer Satisfaction	<ul style="list-style-type: none"> ○ As the device is small, it is easy to install them in various locations based on necessity.
5.	Business Model (Revenue Model)	<ul style="list-style-type: none"> ○ Device can be obtained by paying for the IBM clou/Watson subscription. ○ It can be yearly or monthly. ○ Based on the term of subscription 5 – 8% discount shall be made available.
6.	Scalability of the Solution	<ul style="list-style-type: none"> ○ In future additional attributes like radiation can be included for safety measurements to expand industrial coverage.

3.4 Proposed Solution fit



4. REQUIREMENT ANALYSIS

4.1 Functional Requirements

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Online Payment for the service
FR-2	User Access	Access the details using web browser

		Access the details using mobile application
FR-3	User alert	Gets alert as an SMS message Gets alert alarm in the working area.

4.2 Non-Functional Requirements

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

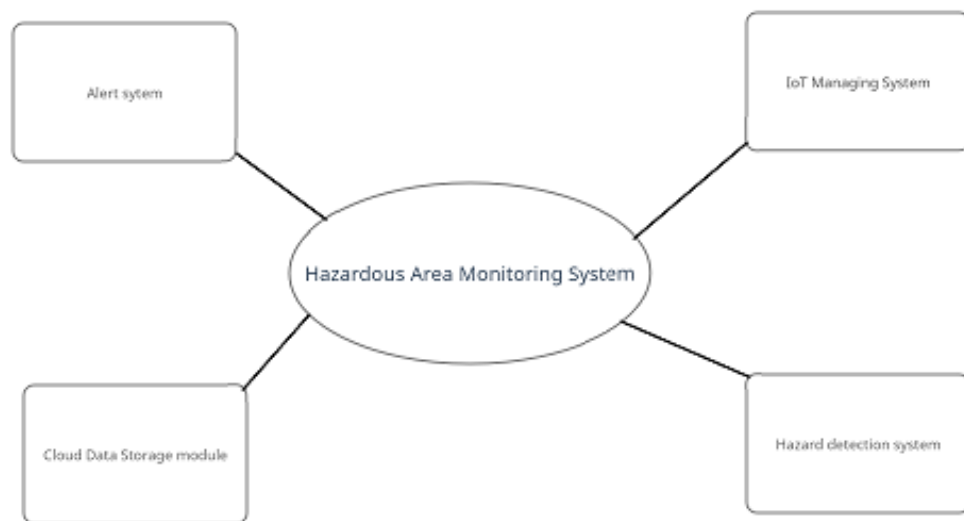
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	The device must be usable by the customer anywhere
NFR-2	Security	Data from the sensors are stored securely and away from other data
NFR-3	Reliability	Data can be retrieved anytime and no data is discarded without customer knowledge
NFR-4	Performance	No performance delay in case of large number of data or more parameters
NFR-5	Availability	The device doesn't fail even under harsh conditions. Device continues to send parameters, even after an alert situation.
NFR-6	Scalability	Device must be capable of measuring conditions even in a larger industry

5. PROJECT DESIGN

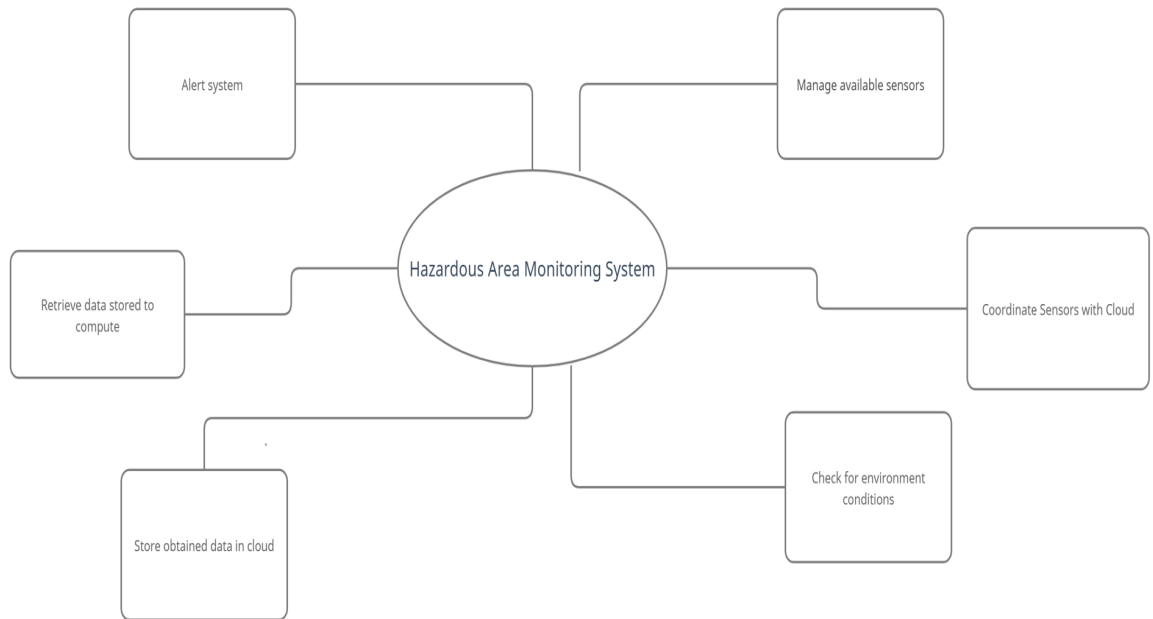
5.1 Dataflow Diagrams

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.

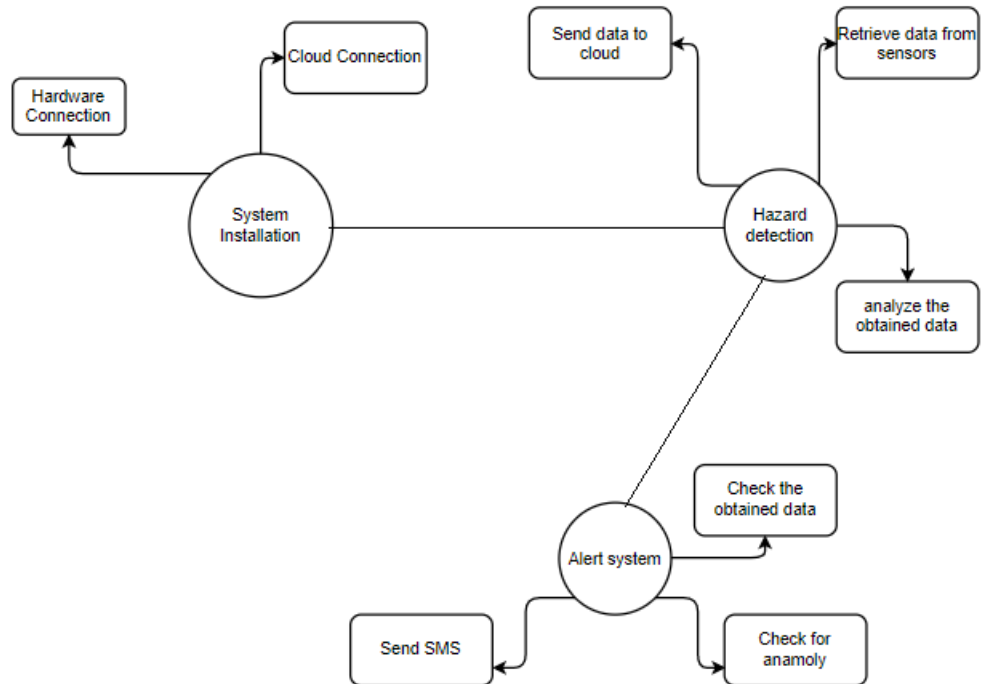
5.1.1 DFD Level 0



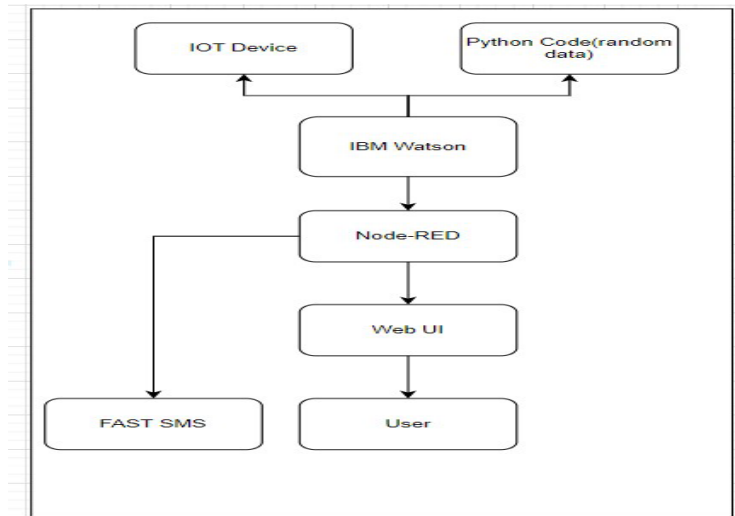
5.1.2. DFD Level 1



5.1.3 DFD Level 2



5.2 Solution and Technical Architecture



5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Technician	Installation	USN-1	The technician must install the smart beacons at points to ensure the entire area of the plant is covered.	A beacon can be found in every area of the plant.	High	Sprint-1
	Data Gathering	USN-2	The beacons obtain the temperature of their respective area using sensors.	The temperature of areas within the plant is obtained.	High	Sprint-1
	Data Sync	USN-3	The beacons send their data to the cloud in the real time which is in turn sent to nearby wearable devices and the administrators dashboard.	Data is sent to the cloud successfully and synced with other devices.	High	Sprint-1
Worker	Wearable device display	USN-4	The wearable devices should display the data sent by beacons within the area.	The user can see the temperature of the area on their device.	High	Sprint-1
	Wearable device adjustments	USN-5	The user can adjust the size of the wearable device to better suit them.	The user can make adjustments to the device to make working with it more comfortable.	Low	Sprint-2
	Wearable display customization	USN-6	The user can adjust the device display to suit their needs on the device itself.	The user can modify the display of the device to increase readability.	Medium	Sprint-2
	SMS Notifications	USN-7	The user is sent a notification to their phone from the wearable device through an API when the area they are in reaches dangerous temperatures.	The user is informed of potential danger via SMS as soon as it is detected by the beacons.	High	Sprint-1
Administrator	Admin Dashboard	USN-8	The beacons send the data through the cloud to a dashboard which is run by the administrator.	The data of all the beacons can be viewed by the administrator of the plant.	High	Sprint-1
	Dashboard Customization	USN-9	The dashboard can be customized by the admin to suit their personal requirements and priorities.	The admin can customize the UI for their dashboard.	Medium	Sprint-2

5.4 Customer Journey



6. PROJECT PLANNING & SCHEDULING

6.1 Sprint planning and Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Objective	USN-1	The sensor must detect the humidity	7	High	Kaushik Balaji, Ram kumar
Sprint-1	Features	USN-2	The values must be displayed	2	Low	Kaushik Balaji, Karthick Raja
Sprint-1	Features	USN-3	Based on threshold, alert has to be sent	5	High	Ram kumar, Karthick Raja
Sprint-1	Features	USN-4	Based on threshold, Buzzer and other alerting system must be turned ON	5	High	Ram kumar, Karthick Raja

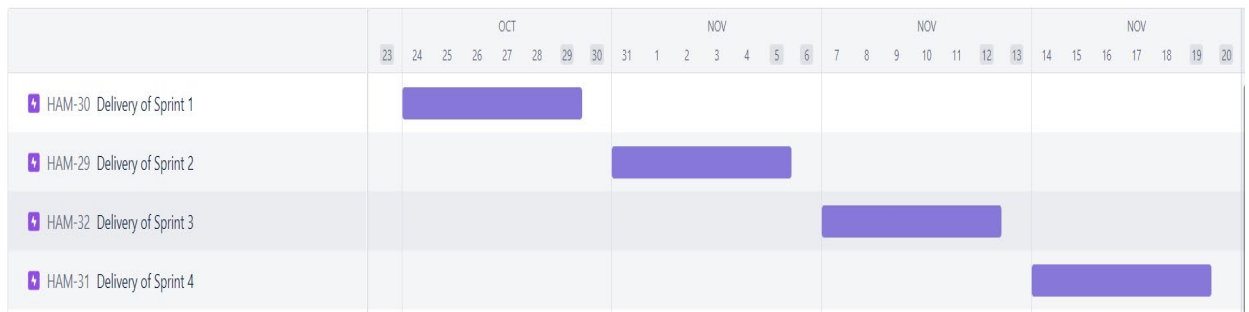
Sprint-2	Focus	USN-6	Alert SMS must be sent to the registered phone number	2	Low	Ram kumar , Kaushik Balaji
Sprint-2	Features	USN-8	Whether the malfunction is rectified or emergency measures needed	5	Medium	Ram kumar
Sprint-3	Data Transfer	USN-9	API key must be retrieved to transfer the data to IBM Cloud	2	Low	Karthick Raja, Ram Kumar
Sprint-3	Data Transfer	USN-10	Data of sensor must be sent to IBM Cloud	5	Medium	Ram kumar,Karthick Raja
Sprint-3	Data Transfer	USN-11	IBM Cloud should send data to Node Red	2	Medium	Ram kumar, Kaushik Balaji
Sprint-3	Data Transfer	USN-12	Data obtained in Node Red must be forwarded to MIT App	3	Medium	Ram kumar, Karthick Raja
Sprint-3	Data Transfer	USN-13	Data must be displayed in the application developed using MIT.	8	High	Ram kumar,Kaushik Balaji
Sprint-4	Registration	USN-14	User must register an account using Email and Mobile Number in the website	2	High	Ram kumar,Kaushik Balaji
Sprint-4	Registration	USN-15	Confirmation mail must be received to the registered Mail-ID	2	Medium	Kaushik Balaji,Ram kumar
Sprint-4	Login	USN-16	User can login into web application through email and password.	3	High	Karthick Raja, Ram kumar

Sprint-4	Dashboard	USN-17	User can access the dashboard and make use of available resources.	2	Medium	Ram Kumar
Sprint-4	Focus	USN-18	User must receive an SMS once an abnormal condition is detected	5	High	Kaushik Balaji
Sprint-4	Allocation	USN-19	Admin must receive information about the situation and can alert the concerned authorities	3	High	Kaushik Balaji, Ram kumar
Sprint-4	Allocation	USN-20	Admin must allot particular person to look after the atmospheric changes.	3	High	Ram kumar, Karthick Raja

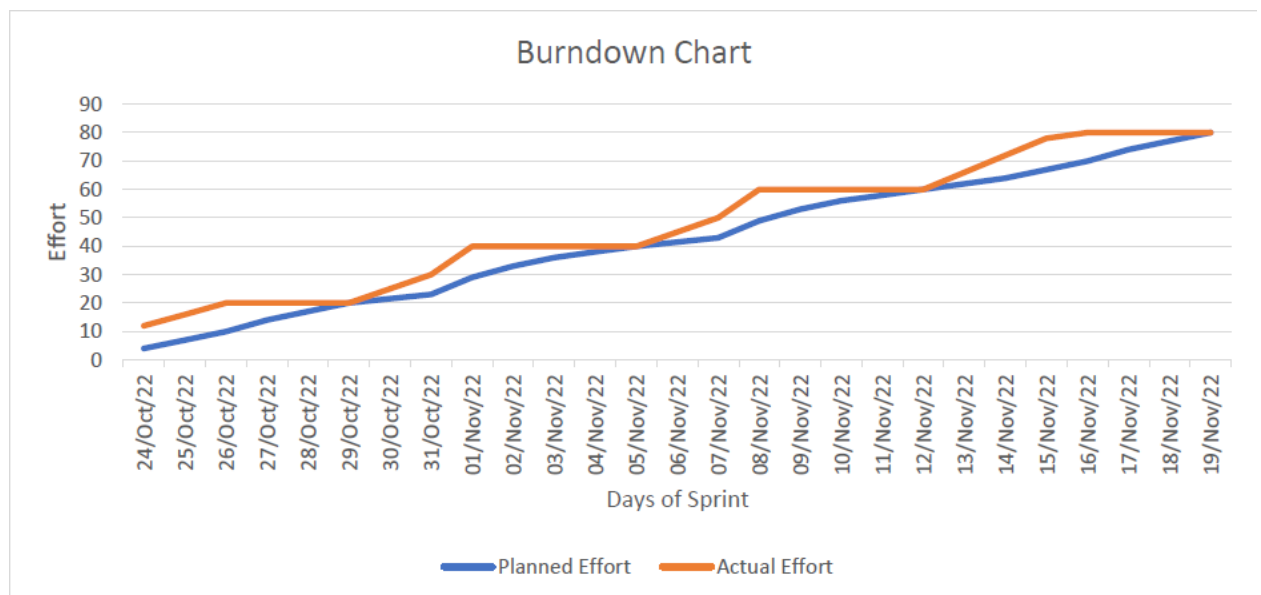
6.2 Sprint Delivery Schedule

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

6.3 Reports from JIRA



6.4 Burnout Chart



7. CODING & SOLUTIONING

7.1 Python Script

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

```

# Provide your IBM Watson Device Credentials
organization = "c1n0yk"
deviceType = "Hazard"
deviceId = "2"
authMethod = "token"
authToken = "123456789"

# Initialize GPIO
def myCommandCallback(cmd):
    print(cmd)
    print("Command received: %s" % cmd.data['command'])
    status = cmd.data['command']
    if status == "lighton":
        print("led is on")
    elif status == "lightoff":
        print("led is off")
    else:
        print("please send proper command")

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

except ibmiotf.ConnectionException as e:
    print("Caught exception connecting device: %s" % str(e))
    sys.exit()
deviceCli.connect()

while True:
    # Get Sensor Data from DHT11

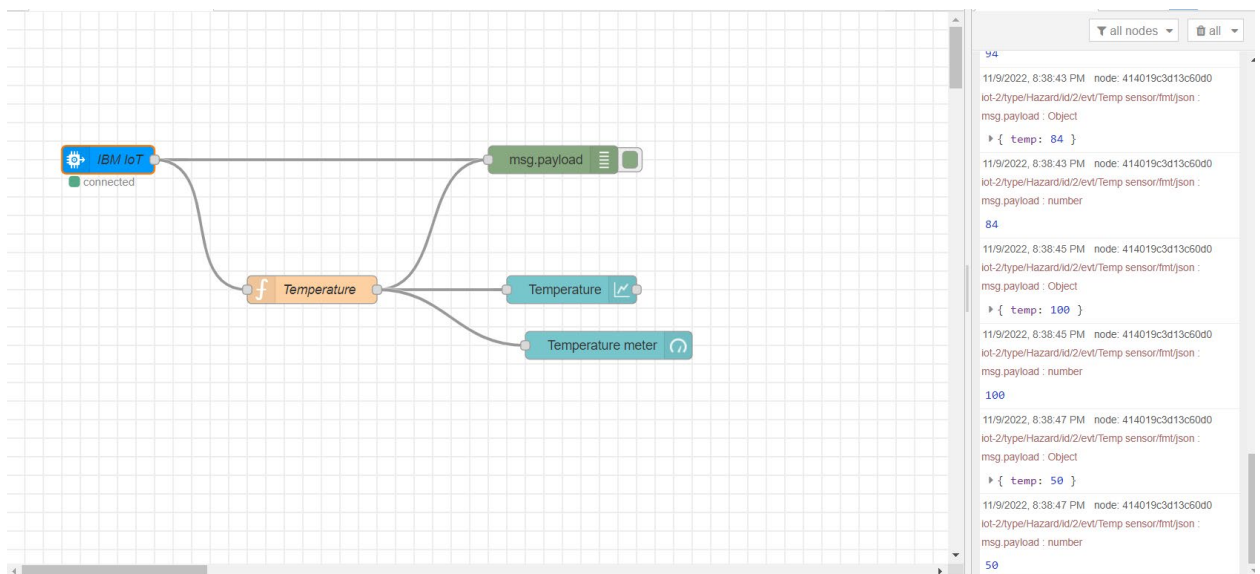
    temp = random.randint(50, 100)

```

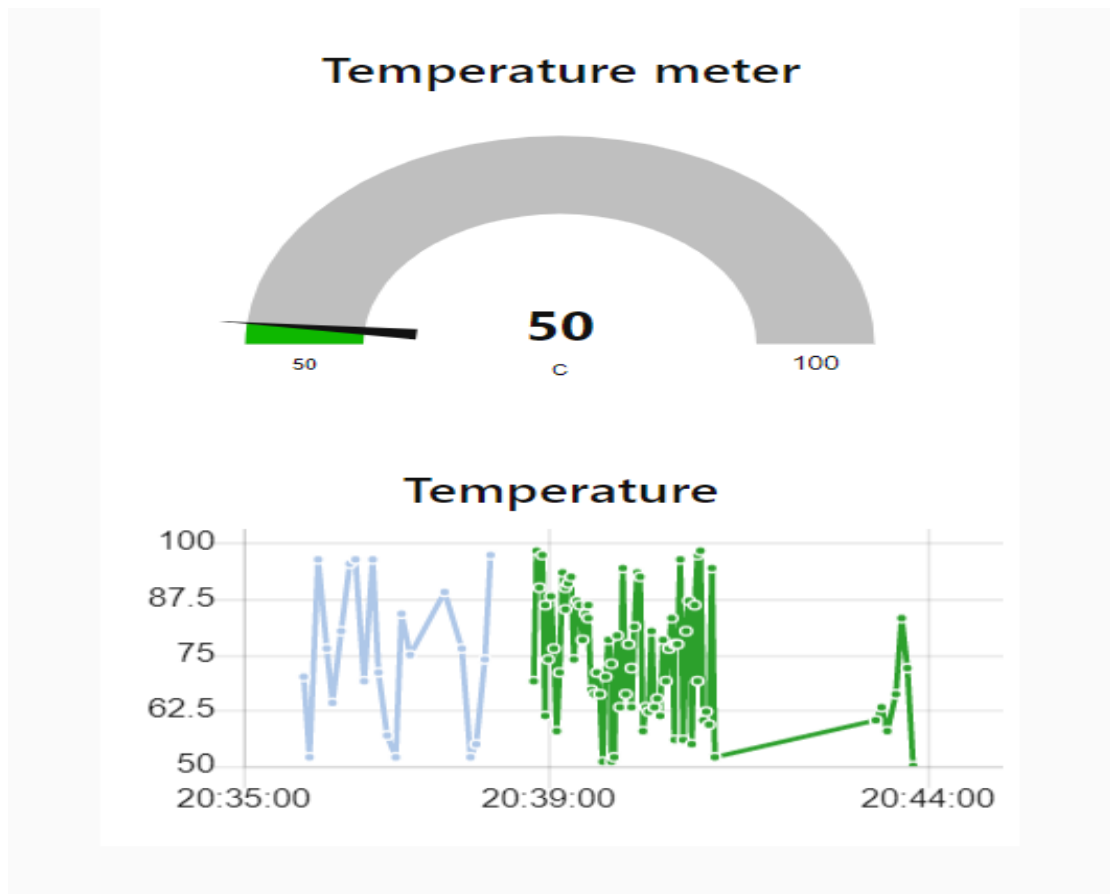
```
def on_publish():
    print("Published Temperature = %s C" % temp, "to IBM Watson")
```

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

7.2.1 Node-RED data flow

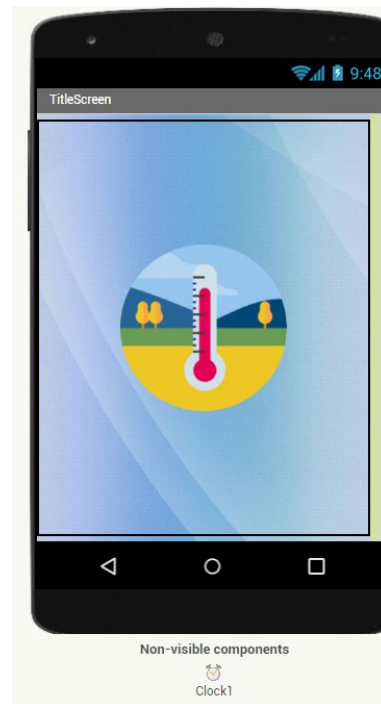


7.2.2 Web application data visualization

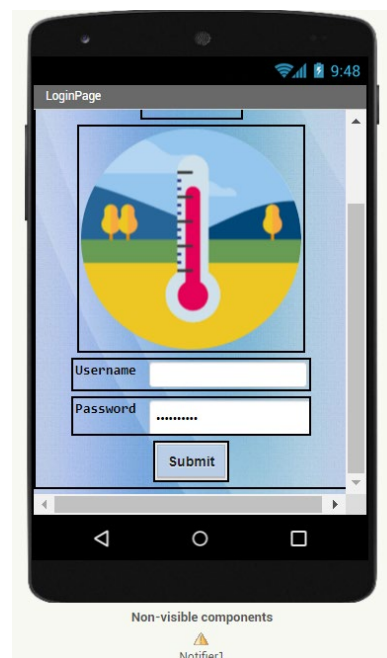


7.3 Mobile application

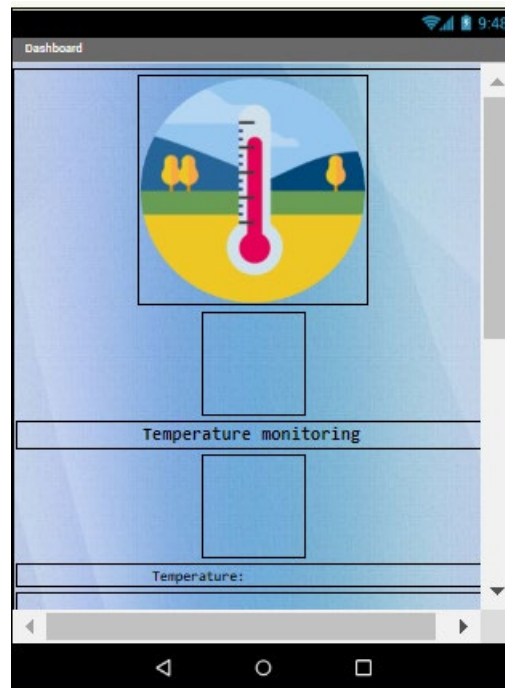
7.3.1 Screen 1



7.3.2 Screen 2



7.3.3 Screen 3



8. TESTING

8.1 Test Cases

Section	TotalCases	Not Tested	Fail	Pass
PrintEngine	3	0	0	3
ClientApplication	43	0	0	43
Security	2	0	0	2
OutsourceShipping	3	0	0	3
ExceptionReporting	8	0	0	8
FinalReportOutput	4	0	0	4
VersionControl	2	0	0	2

8.2 User Acceptance Testing (UAT)

Test case ID	Feature Type	Component	Test Scenario	Pre-Requlite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Comments	BUG ID
LoginPage_TC_001	Functional	Home Page	Verify whether the user is able to see the login page after opening the mobile app	Download the mobile app for viewing the data	Click the app that was previously installed. Wait for the log to be displayed and wait for 2 more seconds for the login screen to load		Login page should display	Working as expected	Pass		
LoginPage_TC_002	UI	Home Page	Verify if all the UI elements in the application is in its place even if used on a mobile of different dimensions		Download the app on 2 different mobile devices. Open the application on both these devices. Observe the layout of the components in both these devices.		Both devices must contain the following components: Logo of the company, Name of the company, and the Username and password fields along with the submit button	Working as expected	Fail	Layout changes with mobile dimensions	bug_001
LoginPage_TC_003	Functional	Home page	Verify user is able to log into application with Valid credentials		Open the application and wait for the app to load the login page. Enter the correct credentials	Username: kaushik password: kaushik	User should navigate to user account homepage	Working as expected	Pass		
LoginPage_TC_004	Functional	Login page	Verify user is able to log into application with Invalid credentials		Open the application and wait for the app to load the login page. Enter the correct credentials	Username: kaushik password: 1234	Application should show 'Incorrect email or password' popup message.	Working as expected	Pass		
LoginPage_TC_004	Functional	Login page	Verify user is able to log into application without credentials		Open the application and wait for the app to load the login page. Enter the correct credentials	Username: password:	Application should show 'Enter username and password' popup message.	Working as expected	Pass		
LoginPage_TC_005	Functional	Home Page	Verify user is able to view the data obtained from the sensor	Log into the user's valid account.	Log into the user's account and wait for a few seconds to establish connection.		The Temperature field must display new data for every 2 seconds and the user must get "High Temperature alert ..." popup message during anomaly	Working as expected	Pass		

Resolution	Severity_1	Severity_2	Severity_3	Severity_4	Subtotal
By Design	11	4	2	3	21
Duplicate	1	0	2	0	3
External	2	3	0	0	5
Fixed	9	4	5	23	41
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	23	16	14	28	81

9. RESULTS

9.1 Performance Metrics

The conclusion from this project's performance that the project system's detection of hazardous condition is remarkable. Useful for both domestic and professional needs. We can use this technology to save lives in risky situations. The hazard monitoring system indicates an alert when the area's temperature crosses a safety limit. Power usage and transmission range estimates are made. The sensor was constructed using straightforward techniques and an Arduino UNO Micro controller.

10. ADVANTAGES & DISADVANTAGES

Advantages

- Fast-pace communication:

In the case an automated system for monitoring the temperature changes in the environment, this is very accurate. We get the required data from the sensors, and send it to the central system for data storage and computation. As the central system does the most computation, the device has more than average performance, when equipped with a good internet connection.

- Round-the-clock support:

Because the data gathering is done by sensors, a little power supply is enough to keep the device running and provide protection to the area round the clock.

- Convenient mode of communication:

The main mode communication between the central device is a mobile application, made to show the constant changes in the data from the required area. As a mobile application is used, it is easier to see the conditions whenever needed. Also, as the alert system is based on SMS service, no internet connection is required to view the new data.

Disadvantages

- Lack of intelligence:

As the device is purely based on alerting the user based on predefined safety limit, the system cannot learn about any

upcoming changes in the safety limit. Lack of an intelligent system will reduce its effectiveness in the long run.

- Unsuitable for some customers:

In case the customer is someone who believes that human labor is better than machines, it becomes a hassle to convince these customers otherwise. Any small technical errors can create a large misunderstanding between the device and these customer, thus can heavily influence the coverage of the device to such customers.

- Requires technical expertise:

Although the device is designed to be user friendly, it is difficult to maintain the device without technical knowledge. The users need to have a basic knowledge of the components of the device, so that they need not wait for the professionals to arrive in case of technical glitches.

11. CONCLUSION

It is always better to have preventive measure, rather than taking actions after a disaster. Having a system to monitor the changes in the surroundings should help the owners of the industry to keep their industries safe and also keep their workers safe. Though the initial cost of installation of the device is higher, it is always better to spend on precaution, than spending on fixing any harmful situation.

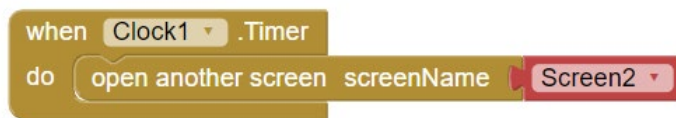
12. FUTURE SCOPE

As the device uses only temperature as its measuring quantity, our device is limited to industries that are in harm's way due to temperature increase. In future we can make the device include parameters like smoke, dust, vibrations, and even radiations. Industries that use atomic radiations have been increasing and our device can help these industries stay on the safer side by helping them monitor the conditions regularly.

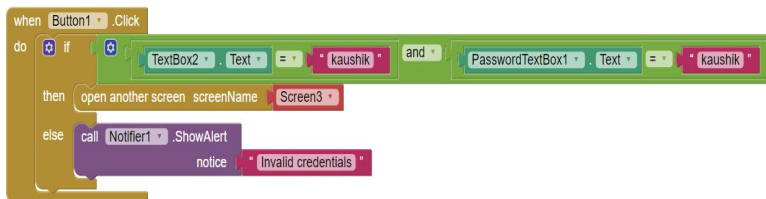
13. APPENDIX

Source Code

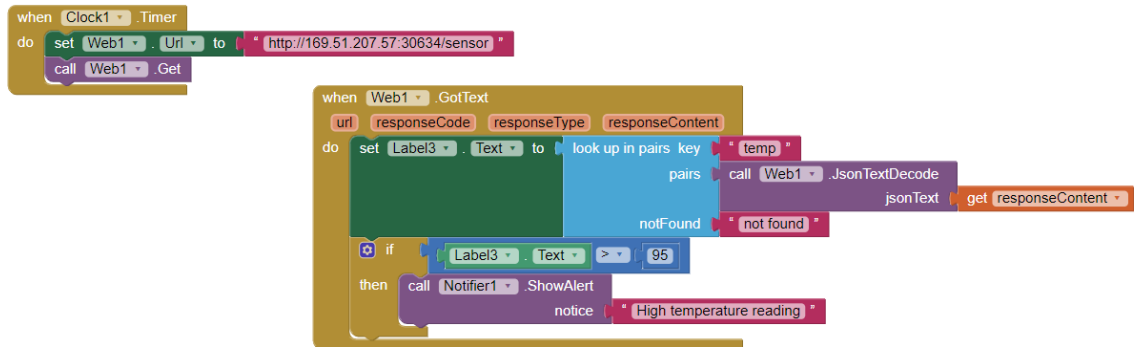
Mit application Screen 1 Code block



Mit application Screen 2 Code block



Mit application Screen 3 code block



Code for event generation in IBM Watson

```
{  
  "temp": random(50, 100)  
}
```

Node-RED Temperature (function) node

```
msg.payload = msg.payload.temp  
global.set("t", msg.payload)  
return msg;
```

Node-RED value (function) node

```
msg.payload = {"temp" : global.get("t")}  
return msg;
```

Project links

[Project demo video link](#)

[Project Google drive link](#)

[Project github link](#)