Professional Readiness for

Innovation, Employability, and

Entrepreneurship

# PROJECT REPORT

| | |
|---|---|
| **Title** | Hazardous Area Monitoring for Industrial Plant powered by IoT |
| **Team ID** | PNT2022TMID18041 |
| **Industry Mentor** | Bharadwaj |
| **Faculty Mentor** | Priyanka G |
| **Team Lead** | Kaushik Balaji M S (9517201904070) |
| **Members** | Ramkumar K ()<br>Ramkumar K (9517201904122)<br>Karthick Raja S (9517201904067) |

## *Table of Contents*

# 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.

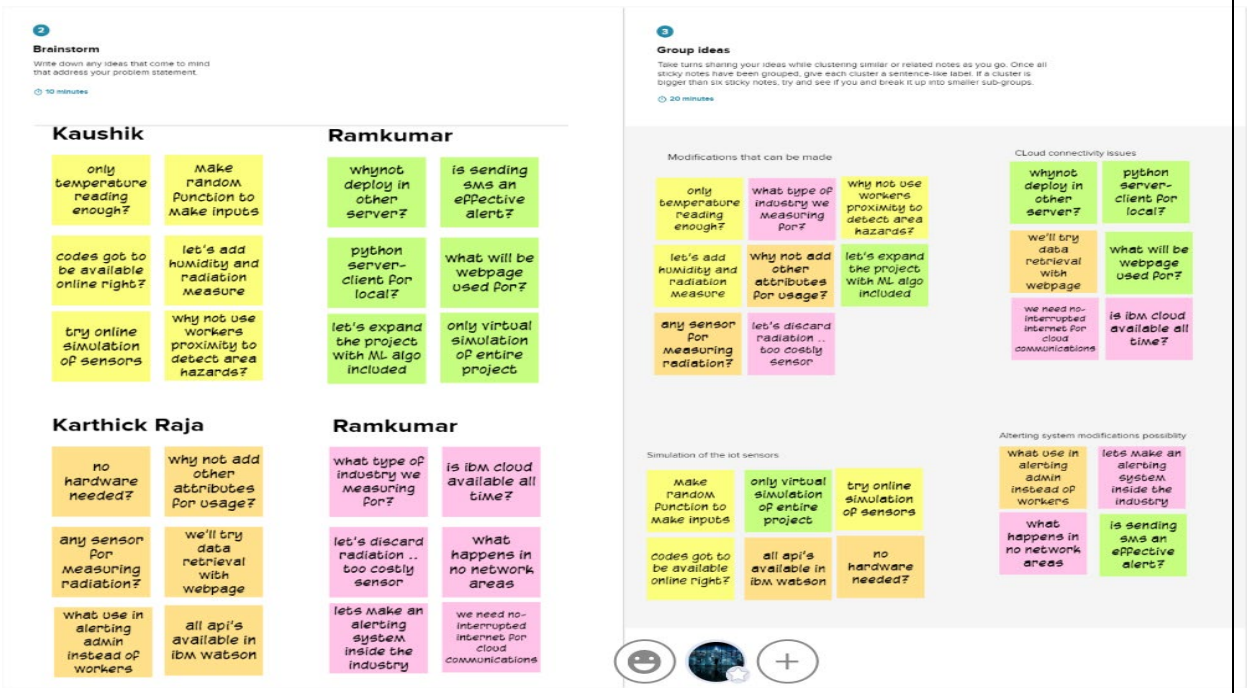
2.2.2 Sureshkumar A (2015). A Study On Computer Based Monitoring SystemFor Hazardous Area Safety Measurement Using Virtual Instrumentation. International Conference on Inter Disciplinary Research in Engineering and Technology [ICIDRET], ICIDRET.2015.030. The basic idea of this paper is to provide a way to virtualize all the sensor automations instead of manually reading the data from sensors, to get the desired results from the environment

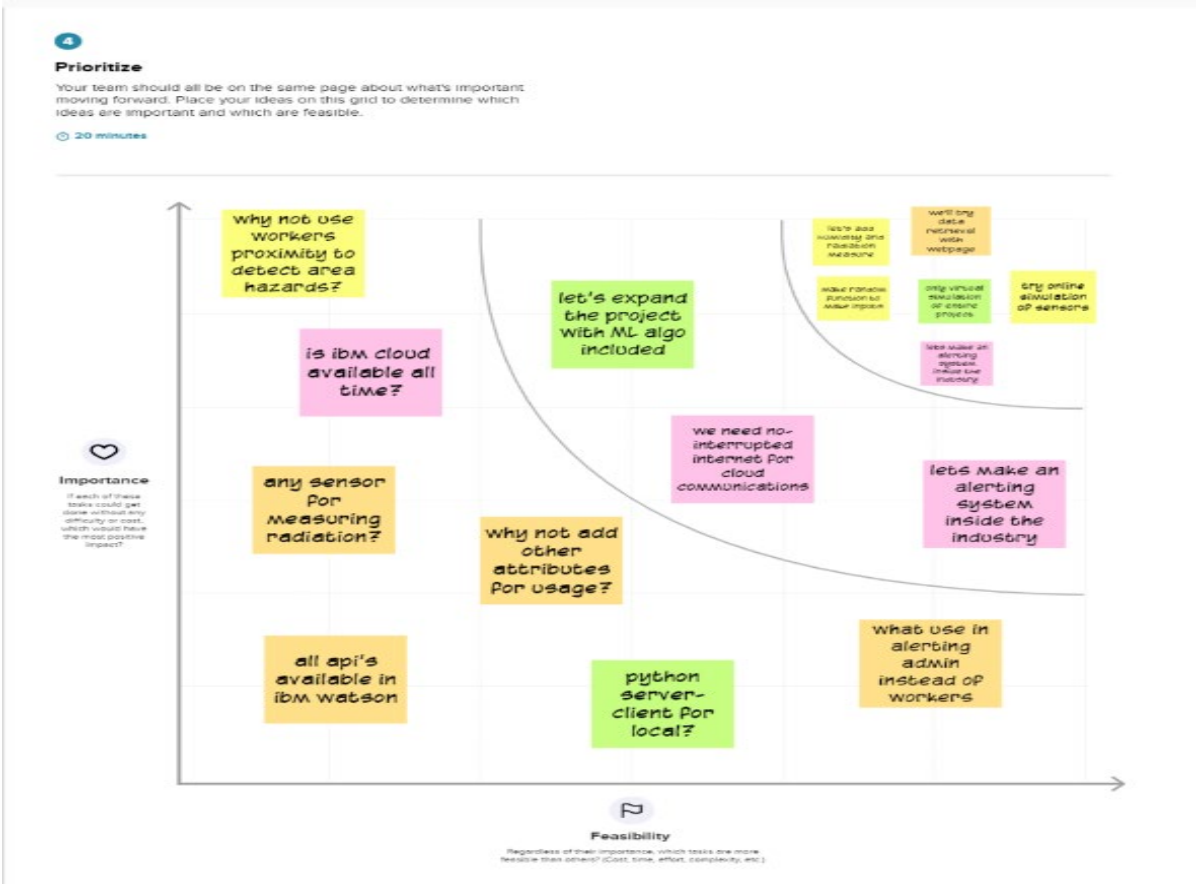
2.2.3 Somnath, Paul., T.V. Sarath., (2018). End to End IoT Based Hazard Monitoring System. International Conference on Inventive Research in Computing Applications (ICIRCA) 10.1109/ICIRCA.2018.8597430. This paper uses various IoT devices and messaging protocols to monitor parameters like temperature, humidity, presence or absence of objects.

## 3. IDEATION & PROPOSED SOLUTION

### 3.1 Empathy map


### 3.2 Brainstorming Session






3.3 **Proposed Solution**

| S.No. | Parameter | Description |
|---|---|---|
| 1. | Problem Statement (Problem to be solved) | ○ Hazardous Area Monitoring for Industrial Plant Powered by IoT |
| 2. | Idea / Solution description | ○ Using a variety of sensor, the environmental parameters such as |

| | | |
|---|---|---|
| | | temperature, humidity can be monitored<br>o If the conditions exceeds safety limits, message is sent to users sms. |
| 3. | Novelty / Uniqueness | o Device being developed can monitor a wide range temperature and accurate humidity measurements.<br>o Apart from notifying the user, an alert can be made in the hazardous area.<br>o Reduces unwanted manpower. |
| 4. | Social Impact / Customer Satisfaction | o As the device is small, it is easy to install them in various locations based on necessity. |
| 5. | Business Model (Revenue Model) | o Device can be obtained by paying for the IBM clou/Watson subscription.<br>o It can be yearly or monthly.<br>o Based on the term of subscription 5 – 8% discount shall be made available. |
| 6. | Scalability of the Solution | o 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<br><br>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<br><br>Gets alert alarm in the working area. |

### 4.2 **Non-Functional Requirements**

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

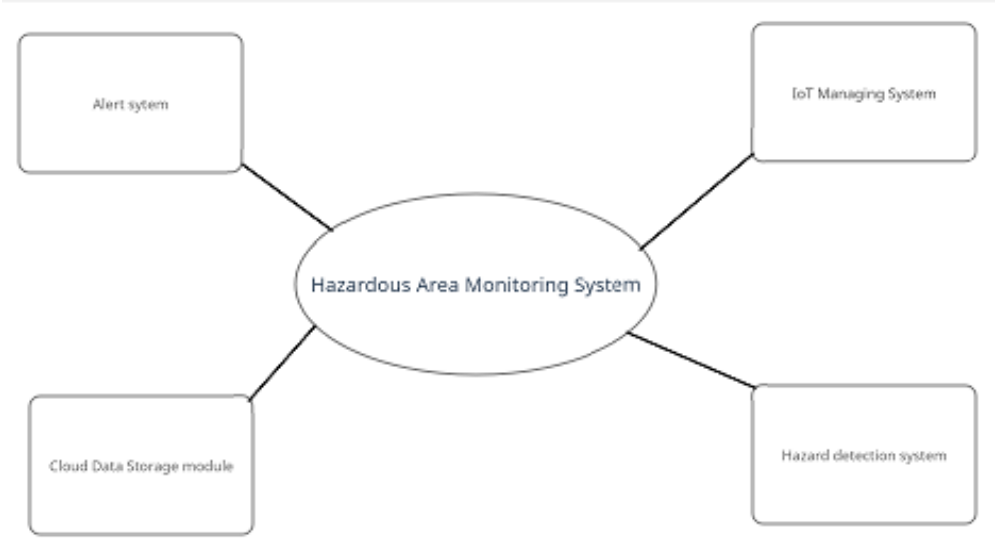
| **FR No.** | **Non-Functional Requirement** | **Description** |
|---|---|---|
| NFR-1 | Usability | The device must be usable by the customer anywhere |
| NFR-2 | Security | Data from the sensors are stored securely and away from other data |
| NFR-3 | Reliability | Data can be retrieved anytime and 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.<br><br>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

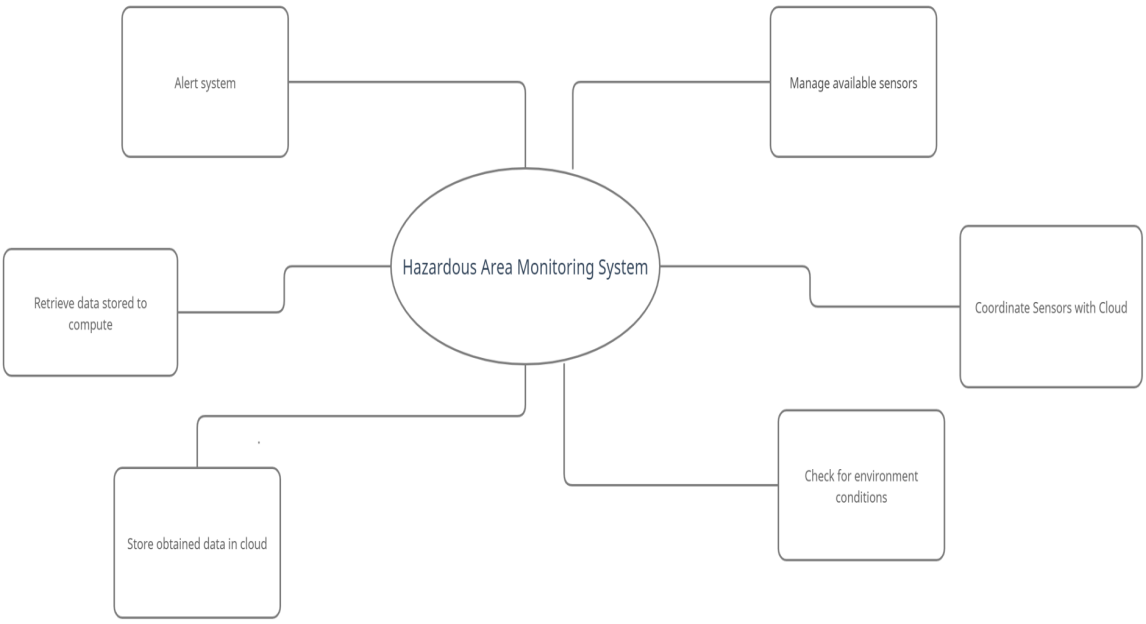
### 5.1 Dataflow Diagrams

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.

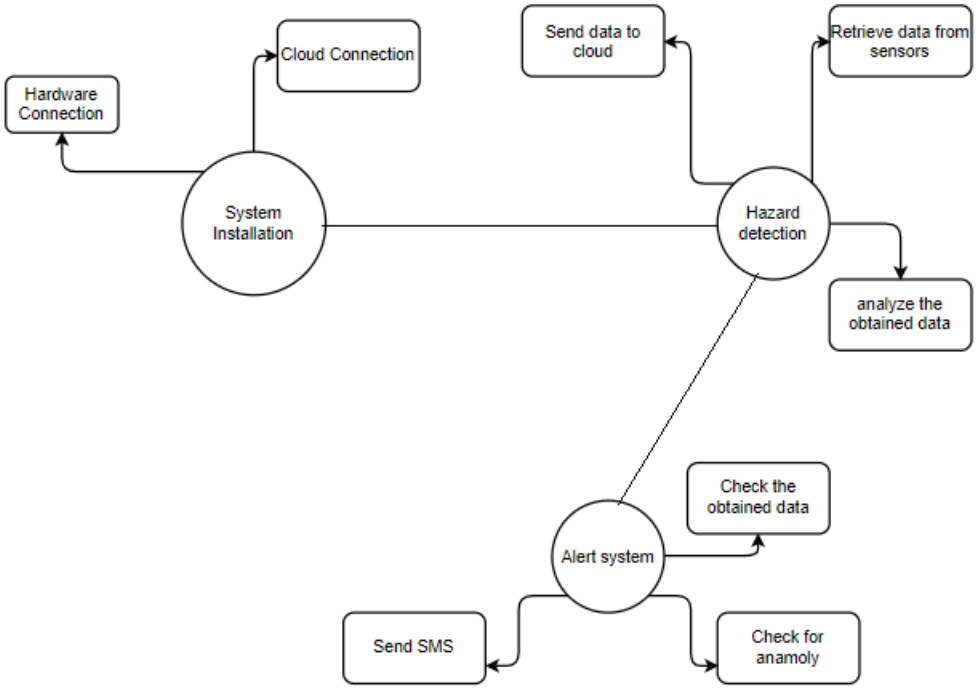
#### 5.1.1 DFD Level 0



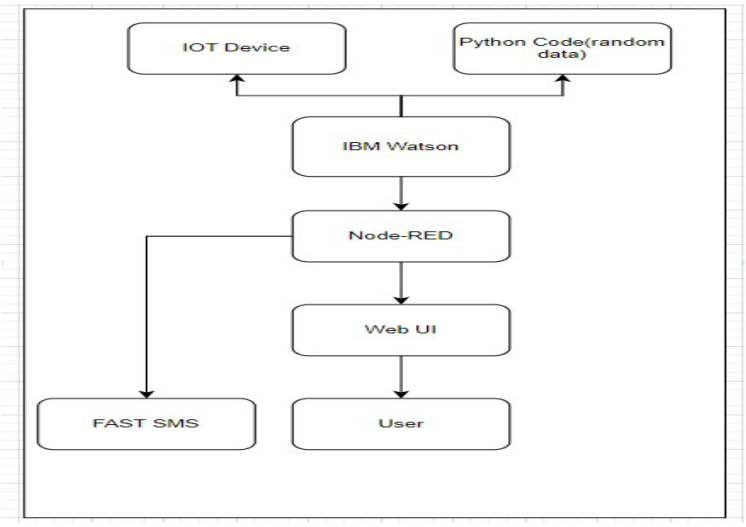

#### 5.1.2. DFD Level 1




### 5.1.3 **DFD Level 2**



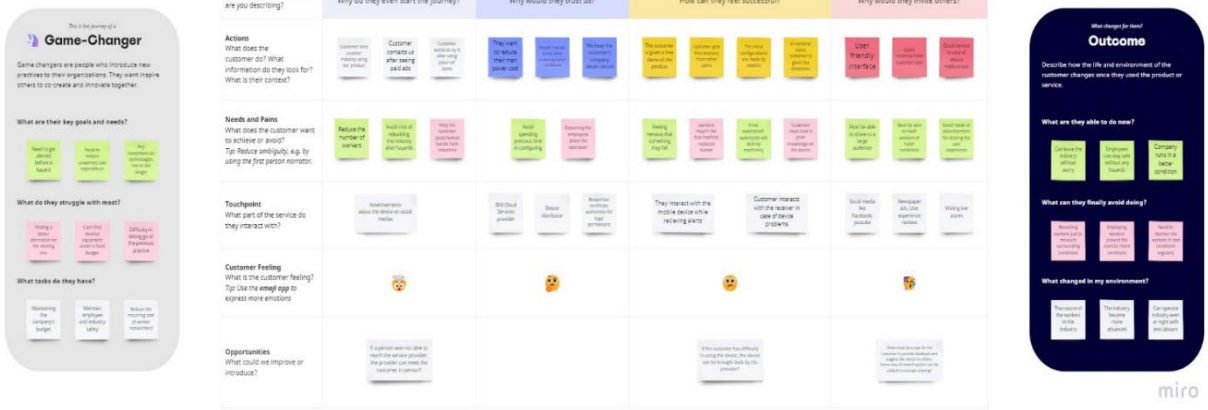
## 5.2 **Solution and Technical Architecture**




## 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 |

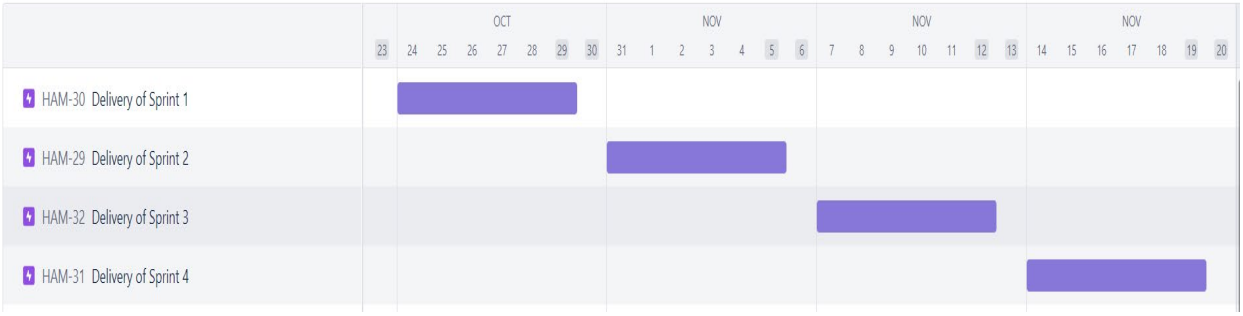
| | | | | | | |
|---|---|---|---|---|---|---|
| Sprint-2 | Focus | USN-6 | Alert SMS must be sent to the registered phone number | 2 | Low | Ram kumar , Kaushik Balaji |
| Sprint-2 | Features | USN-8 | Whether the malfunction is rectified or emergency measures needed | 5 | Medium | Ram kumar |
| Sprint-3 | 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 |

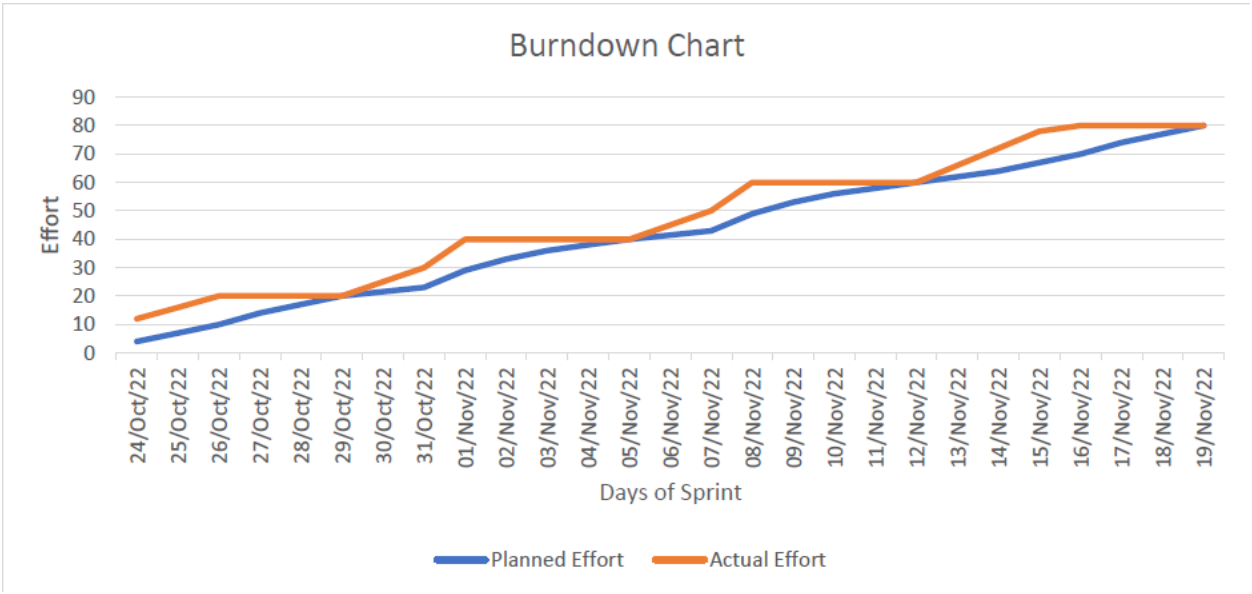
## 6.2 **Sprint Delivery Schedule**

| **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 ov 2022 |

### 6.3 **Reports from JIRA**




### 6.4 **Burnout Chart**




## 7. **CODING & SOLUTIONING**

### 7.1 **Python Script**

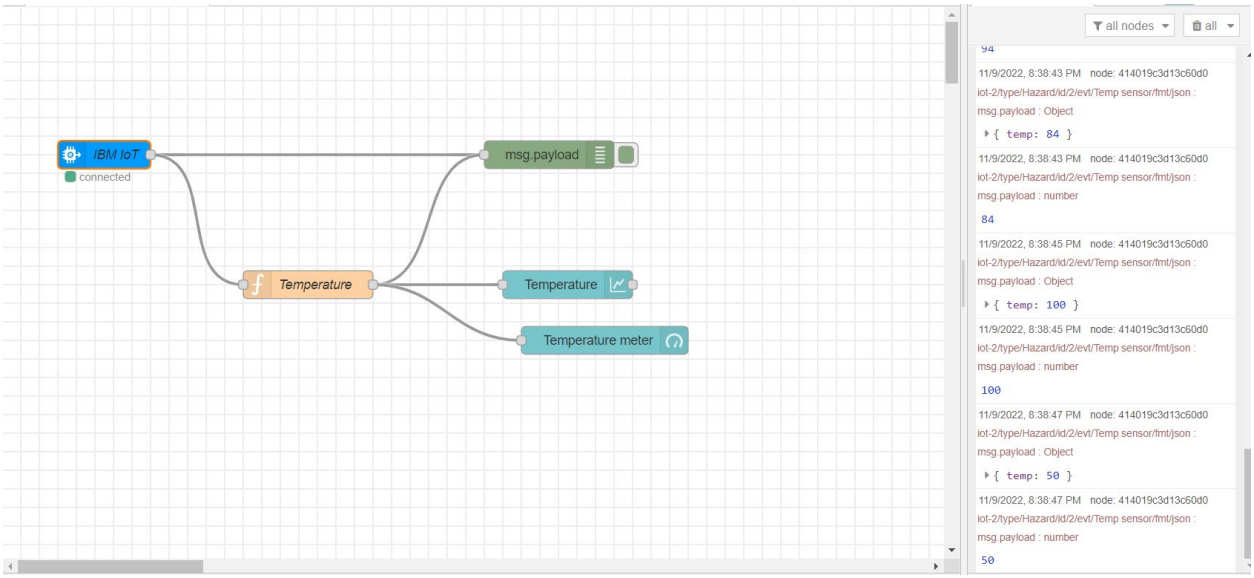
```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random
```

```
# 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)
```

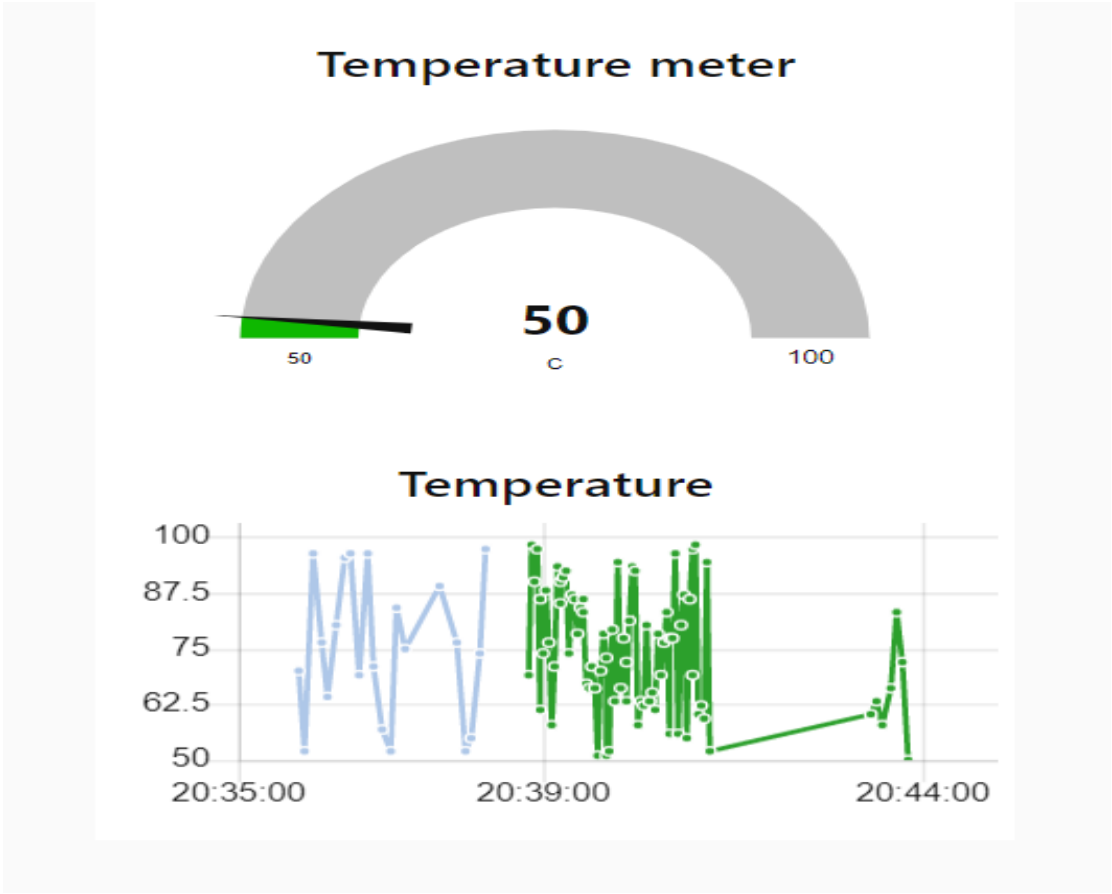
```
mydata = {'temp': temp}


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


success = deviceCli.publishEvent("Temp sensor", "json", mydata, qos=0,
  on_publish=on_publish)
if not success:
   print("Not connected to IoTF")
deviceCli.commandCallback = myCommandCallback
time.sleep(5)

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

## 7.2 **Web application**

### 7.2.1 **Node-RED data flow**

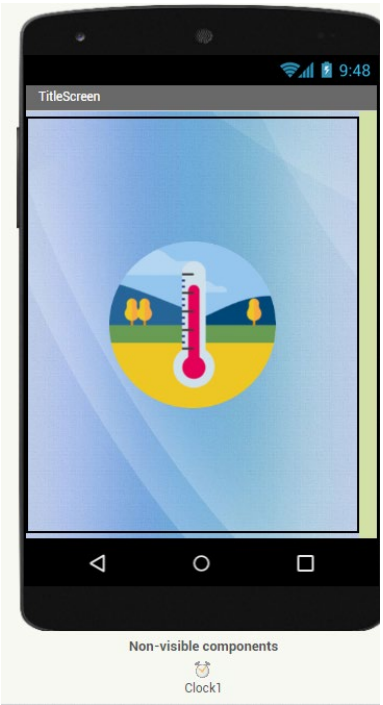


### 7.2.2 **Web application data visualization**

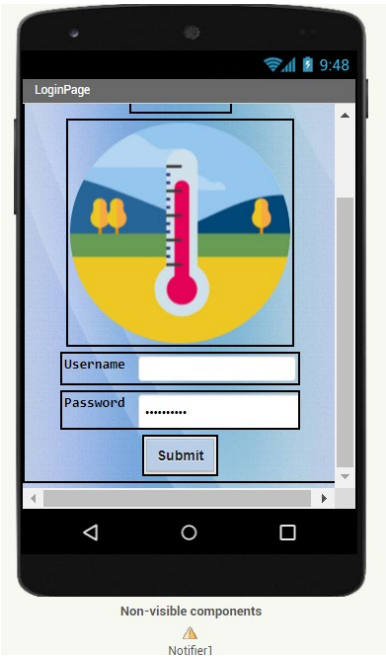


## 7.3 **Mobile application**

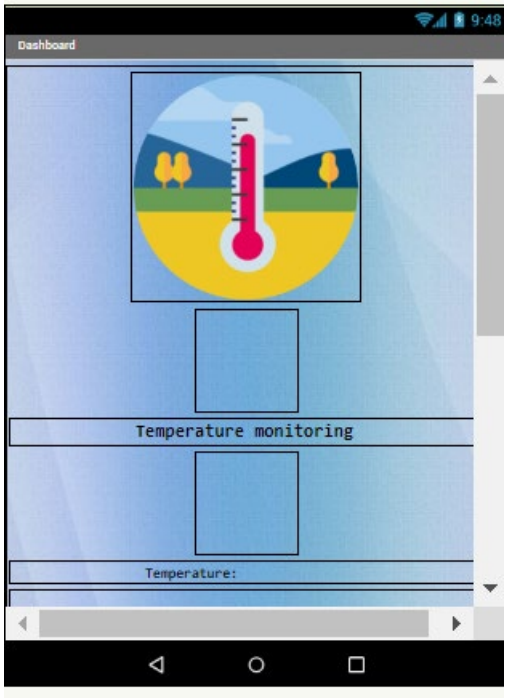
### 7.3.1 **Screen 1**




### 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-Requisite | Steps To Execute | Test Data | Expected Result | Actual Result | Status | Commnets | 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 te 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 sensord | Log into the user's vaid account | Log into the user's account and wait for a few seconds to establish connectiion. | | The Temperature field must display new data for every 2 seconds and the user must get "High Temperature alert .. " popup message during anamoly | 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.

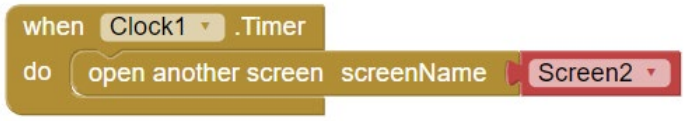
## 12. **FUTURE SCOPE**

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

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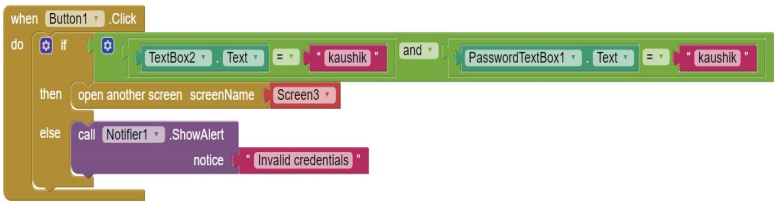
#### Mit application Screen 2 Code block

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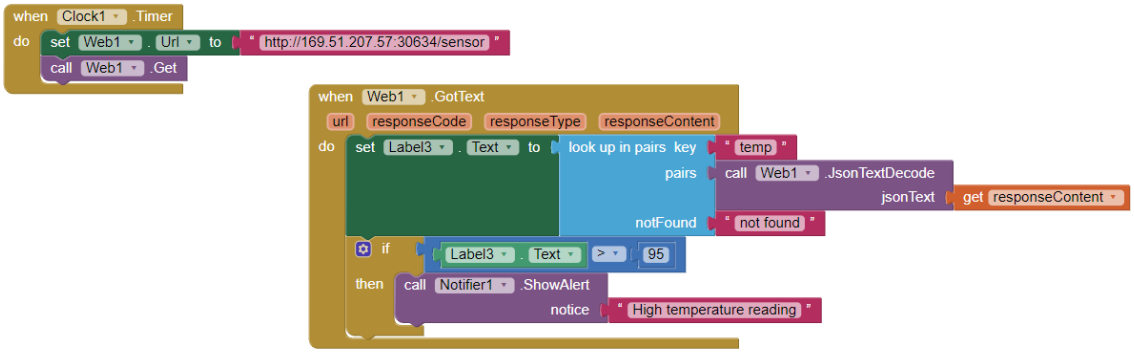
**Mit application Screen 3 code block**




**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]