SIGNS WITH SMART CONNECTIVITY FOR BETTER ROAD SAFETY

IBM PROJECT REPORT

TEAM ID - PNT2022TMID23925

SUBMITTED BY

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1. INTRODUCTION

1.1 Project Overview

- To replace the static signboards, smart connected signboards are used.
- These smart connected sign boards get the speed limitations from a web app using weather API and update automatically.
- Based on the weather changes the speed may increase or decrease.
- Based on the traffic and fatal situations the diversion signs are displayed.
- Guide (Schools), Warning and Service (Hospitals, Restaurants) signs are also displayed accordingly.
- Different modes of operations can be selected with the help of buttons.

1.2 Purpose

- Smart Traffic Management is a system to monitor and control traffic signals using sensors to regulate the flow of traffic and to avoid congestion for a smooth flow of traffic.
- Prioritizing traffic like ambulances, police etc. is also one application comes under smart traffic management.

2. LITERATURE SURVEY

2.1 Existing Problem

- Analysis of crash data has suggested a link between roadside advertising signs and safety.
- Research suggests that crash risk increases by approximately 25–29% in the presence of digital roadside advertising signs compared to control areas.
- On the other hand, static roadside advertising signs have not been linked with differences in the crash count.
- However, this finding is contrary to previous research that suggests differences in crash counts exist in the presence of static roadside advertising.
- The quantity and quality of available evidence limit our conclusion.

▪ Fixed object, side swipe and rear end crashes are the most common types of crashes in the presence of roadside advertising signs.

▪ In addition, drivers showed increased eye fixations and increased drifting between lanes on the road.

2.2 References

▪ Cairney and Gunatillake, 2000; Sisiopiku et al., 2015

▪ Islam, 2015; Sisiopiku et al., 2015

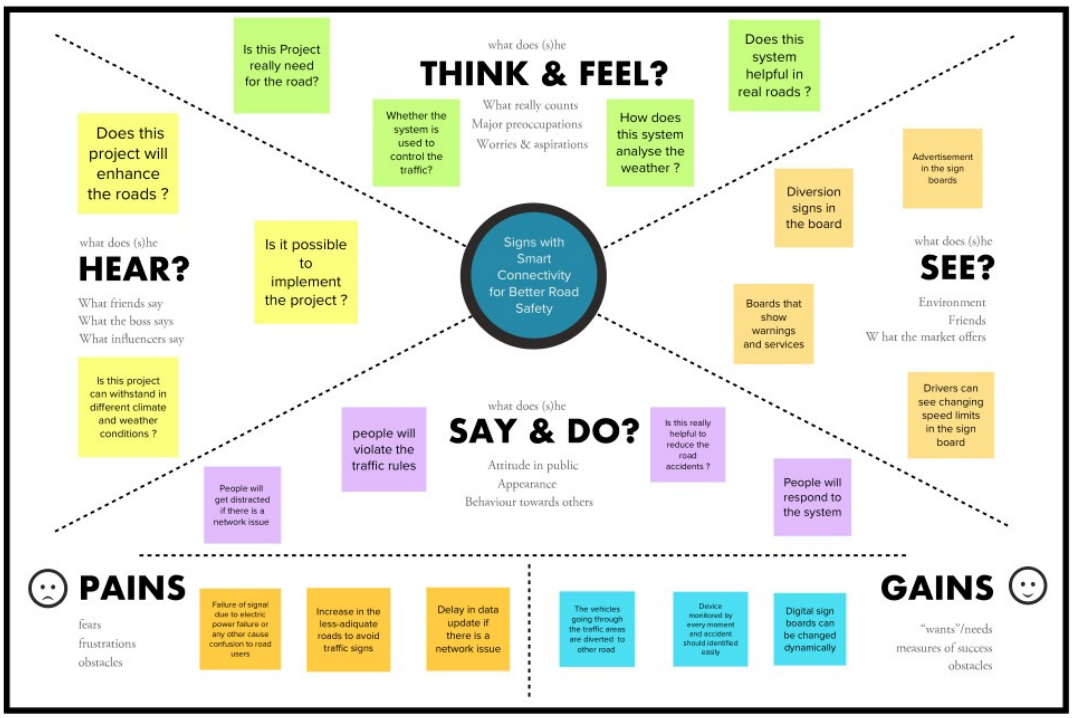
▪ Yannis et al., 2013, Staffeld (1953) and Ady (1967)

2.3 Problem Statement Definition

This project will replace the static boards to smart signed boards that will change the speed limits according to the weather climate and show diversion messages if there are accidents in the road and alert messages if there is hospital, schools or any roadworks.

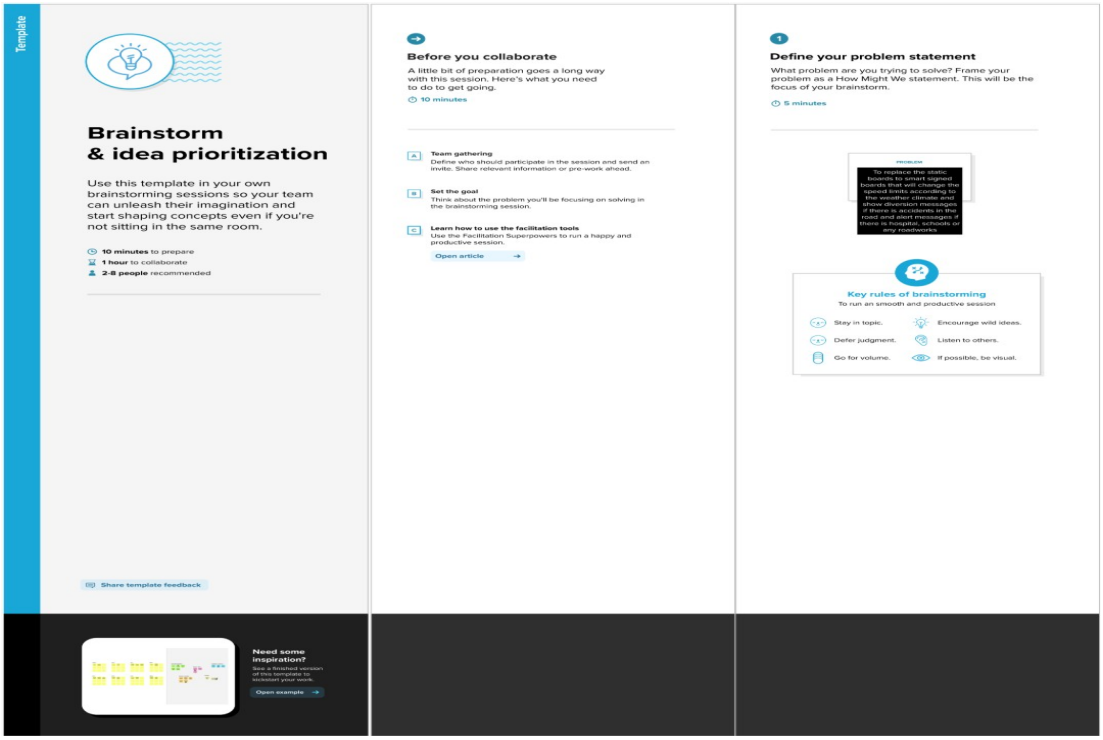
3. IDEATION AND PROPOSED SOLUTION

3.1 Empathy Map Canvas

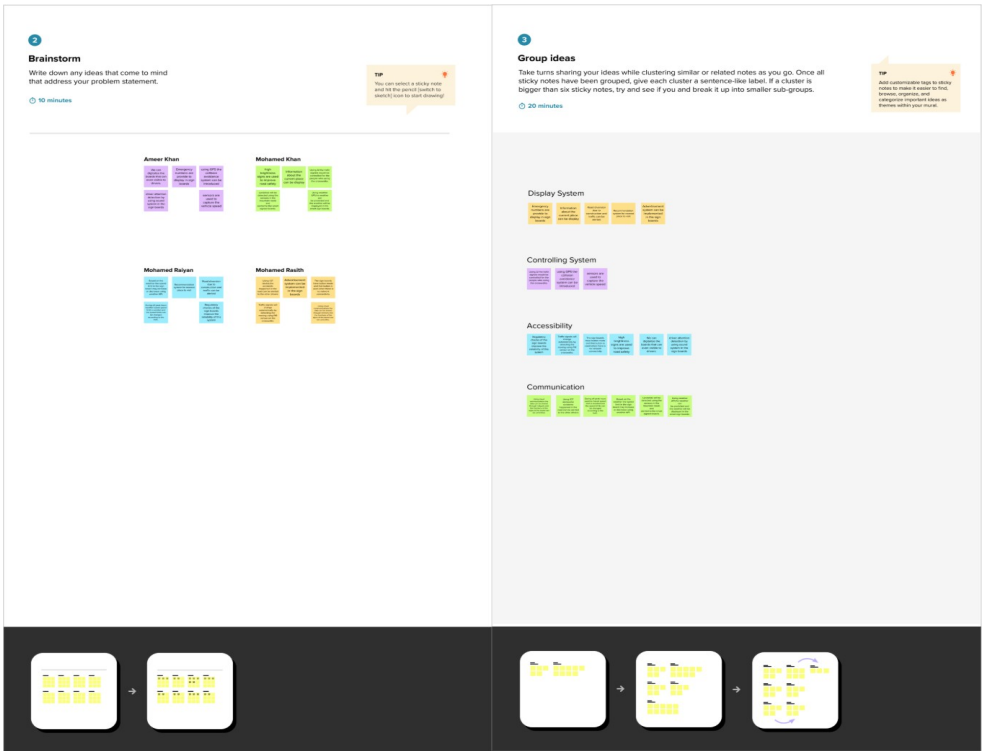


3.2 Ideation & Brainstorming Map

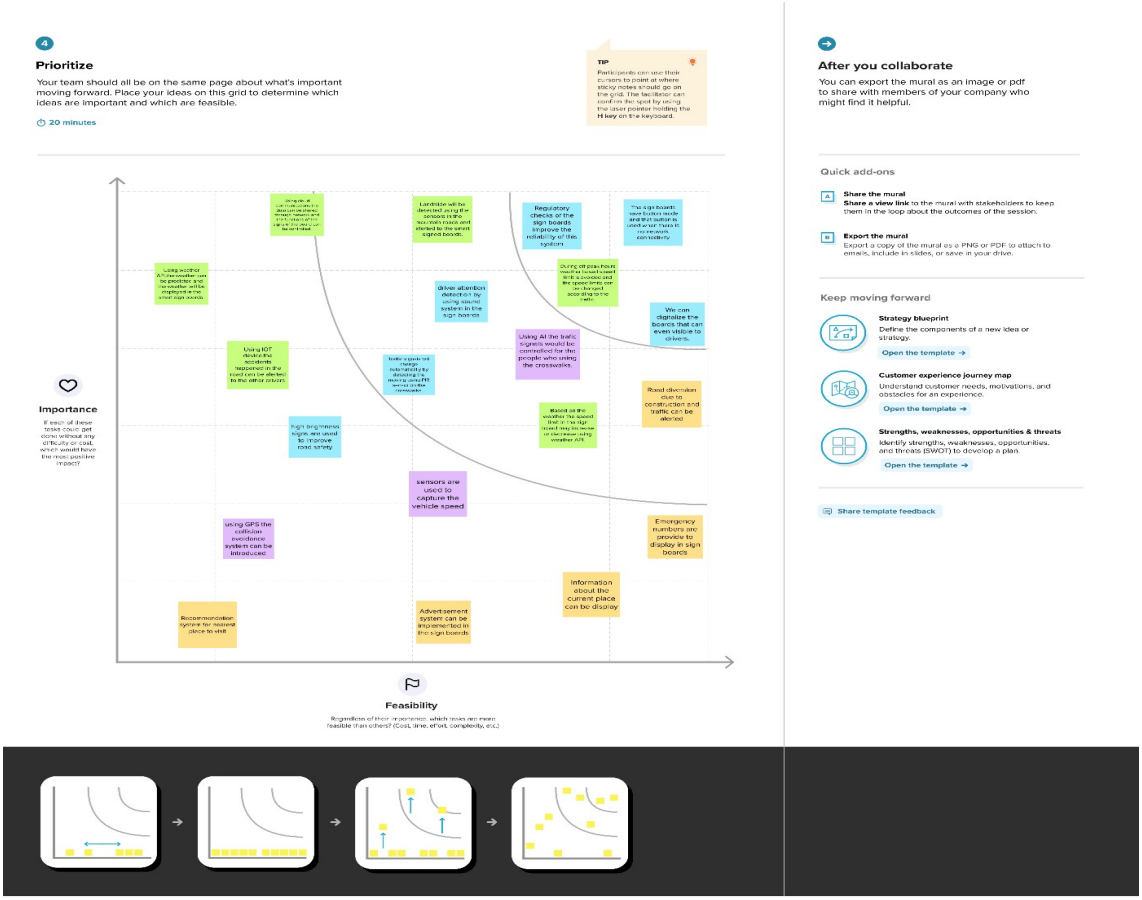
Step-1: Team Gathering, Collaboration and Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization



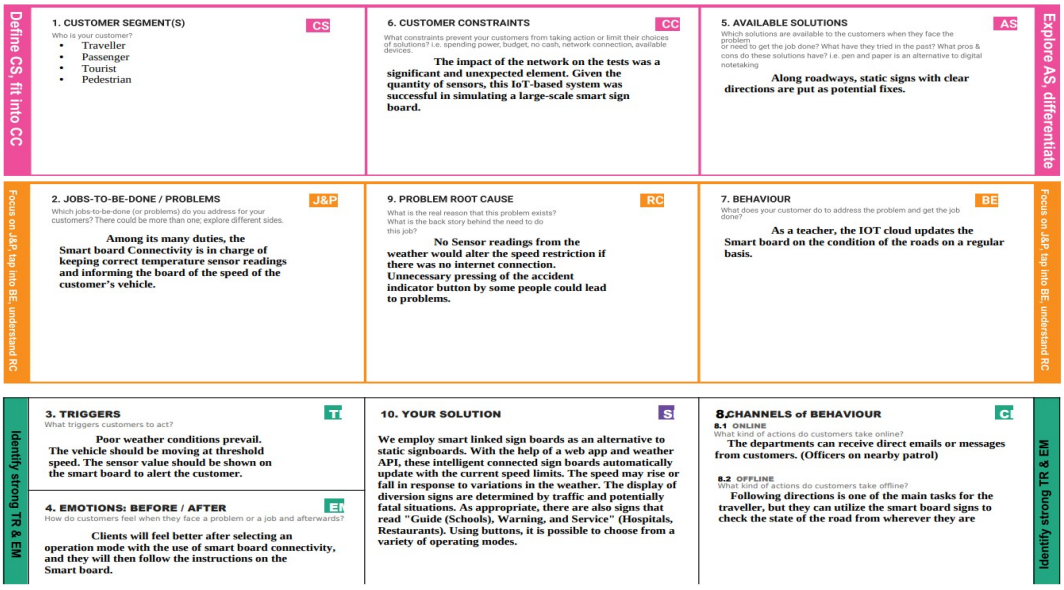
3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To replace the static signboards, smart connected sign boards are used. To get the speed limitations from a web app using weather API and update automatically on the smart connected sign boards. Based on the weather changes the speed may increase or decrease Based on the traffic and fatal situations the diversion signs are displayed.

		To display Guide(Schools), Warning and Service(Hospitals, Restaurant) signs accordingly. To provide different modes of operations that can be selected with the help of buttons.
2.	Idea / Solution description	The weather and temperature details are obtained from the OpenWeatherMap API. Using these details, the speed limit will be updated automatically in accordance with the weather conditions. Also, the details regarding any accidents and traffic congestion faced on the particular road are obtained. Based on this, the traffic is diverted followed by a change in map path and the traffic is cleared. So in the traffic sign board, some buttons will be placed which will be used to make it generic; where each button will be given a functionality such as changing the warning signs, which are predefined and separate signs will be present for both school and hospital zones. By activating this button, either through the web application or the physical buttons, sign of the board can be changed accordingly, and the speed limit will also be set depending upon the zones. Also, the pedestrians are given an option to change the traffic signs if they want to cross the road. If the pedestrian presses the button that is present on the post at the end of the road, then the traffic will be analysed immediately. Accordingly, the sign of the traffic signal will be changed. This reduces the frequent changing of the traffic signs even if the pedestrians are not present.
3.	Novelty / Uniqueness	Generic Sign board for all applications that uses both buttons and web service. Pedestrians are given the access to request the sign change of the signal to cross the road.
4.	Social Impact / Customer Satisfaction	Diversion reasons will be displayed If there is no traffic, pedestrians can cross the street without waiting. Customer can reach the destination before the expected time.
5.	Business Model (Revenue Model)	Since APIs are used to actively monitor the customer's environment, this project employs a business strategy in which

		revenue will be generated on the basis of the length of time in which the customers actively interact with the product. This product is aimed to be free of cost to the public, but the revenue will be generated by selling this product to the government at a low cost, so there will be less accidents and the public will be aware of the discrepancies or accidents in the particular road. The public will also gain all the information about the road, even if they are checking for an alternate path because of some mishaps that happen on the roads and these functionalities will increase the value of the product in the global market.
6.	Scalability of the Solution	In the future, if any update is required either on the hardware or software side, it can be easily implemented. The hardware components can be directly interfaced with the microcontroller and small modifications can be made in the programming of the existing product. In case of the software, the website application has to be updated with the additional functionality by creating a new section for the updated hardware. So this will not affect the existing functionality of the product and new functionality can be easily integrated. In addition, a separate circuit will be kept along with the hardware to detect any problem which informs the web application. Also a notification will be sent to the product service department.

3.4 Problem Solution Fit



4. REQUIREMENT ANALYSIS

4.1 Functional Requirements

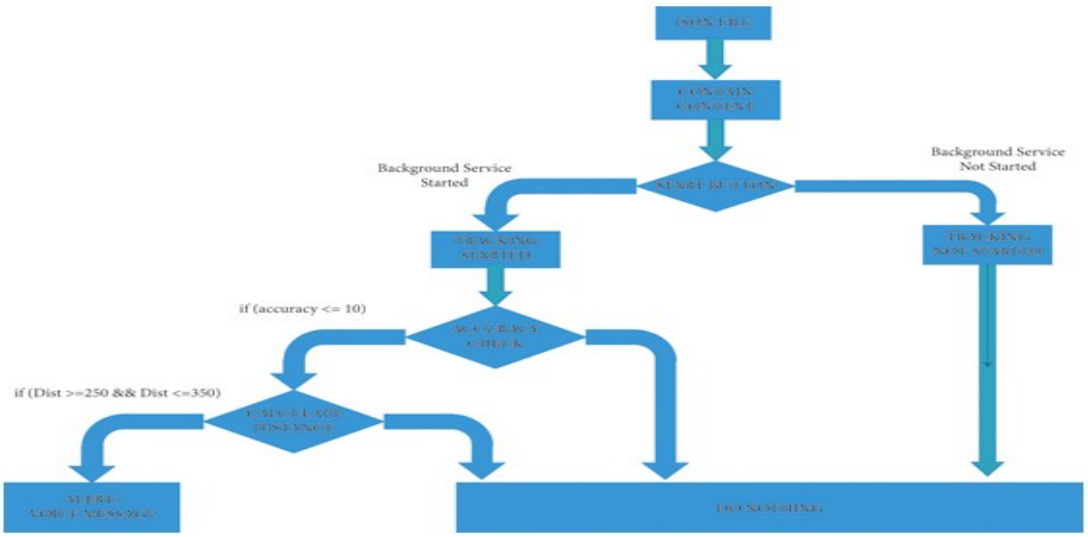
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Visibility	• Implementing crystal clear display boards • Showing warning signs on the display • Blinking light system to attract driver's attention • Traffic light signal countdown on display
FR-2	User Interaction	• Alert notification system • Manual crossing button • Manual information display system
FR-3	Traffic Detection	• Implementing traffic detection system • Crossing based on traffic detection
FR-4	Communication	• Weather alert based on location • Traffic diversion based on detection

4.2 Non-Functional Requirements

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	It should convey the right message to user and to save the customer's travel time.
NFR-2	**Security**	The manual information button should be secured with a key to prevent misinformation.
NFR-3	**Reliability**	It should convey the updated message on time and to build with service quality.
NFR-4	**Performance**	Display should be dynamically updated over cloud communication.
NFR-5	**Availability**	It should available 24/7 service with risk management measures.
NFR-6	**Scalability**	It should consume server space based on the usage and extend server space based on demand.

5. PROJECT DESIGN

5.1 Data Flow Diagram



5.2 Solution & Technical Architecture

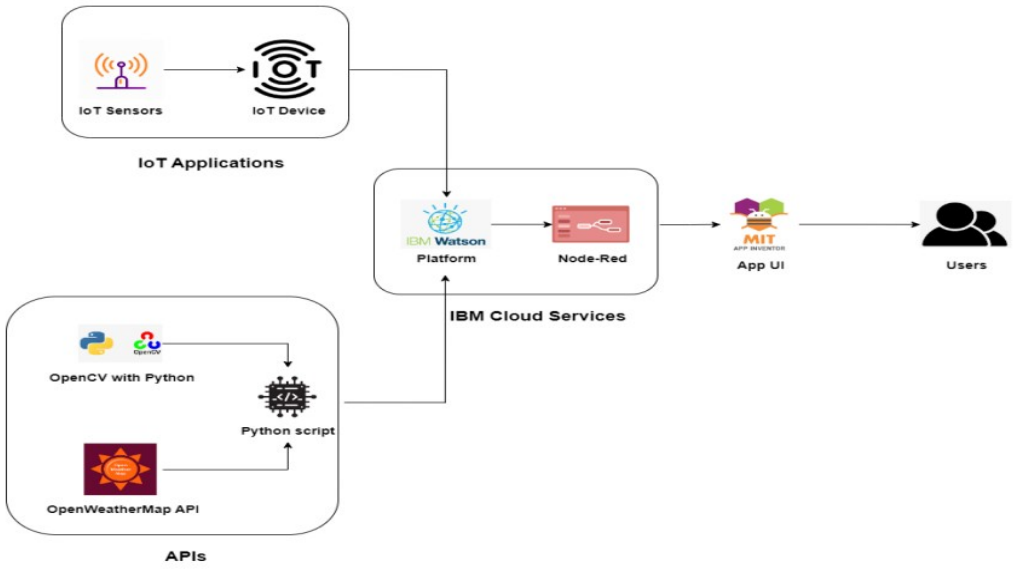


Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	User can interact with the app using MIT app	HTML, CSS, JavaScript / Angular Js / React Js etc.
2.	Application Logic-1	Detecting traffic and displaying information	Java / Python
3.	Application Logic-2	Sending notification to nearby users	IBM Watson STT service
4.	Application Logic-3	Communicating with physical device	IBM Watson Assistant
5.	Database	Storing on local phone storage	MySQL, NoSQL, etc.
6.	Cloud Database	Database Service on Cloud	IBM DB2, IBM Cloudant etc.
7.	File Storage	Storing on local phone storage	IBM Block Storage or Other Storage Service or Local Filesystem
8.	External API-1	To get current weather information of the location	IBM Weather API, etc.
9.	External API-2	To verify the driving license of the user	License API, etc.
10.	Machine Learning Model	To detect the traffic with cars present in the camera	Object Recognition Model, etc.
11.	Infrastructure (Server / Cloud)	Application Deployment on Local System / Cloud Local Server Configuration: User's phone storage Cloud Server Configuration : IBM cloudant DB	Local, Cloud Foundry, Kubernetes, etc.

Table-2: Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	OpenWeatherMap, Node-Red, IBM Watson and MIT App Inventor	IOT, Cloud communication
2.	Security Implementations	Private cloud, Limited database access, Security layer implementation, Private key to access physical device	e.g. SHA-256, Encryptions, IAM Controls, Private key etc.
3.	Scalable Architecture	Server provisioning, Server availability, Local phone storage	IBM Cloudant database
4.	Availability	24/7 service, Continuous update, Data maintenance, Private staff	IBM Cloud
5.	Performance	Distributed servers, Cloud communication, Notification system, Effective information sharing	IBM Cloud, Python

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Traveller)	User Visibility	USN-1	As a user, I can able to read the message on the display and became aware of it	I can able to read the message	High	Sprint-1
		USN-2	As a user, I can able to know the nearby warning signs and became aware of it	I can able to know the nearby warning signs	Medium	Sprint-2
		USN-3	As a user, I can became aware of crossing by blinking light system and it keeps me awake	I can aware of road crossing places	Medium	Sprint-1
		USN-4	As a user, I can able to know the traffic signal countdown and get ready to move	I can know traffic signal countdown	Low	Sprint-4
	User Interaction	USN-5	As a user, I can get to know about the road conditions through the notification	I can know road conditions in notification	Low	Sprint-4
Customer (Pedestrian)		USN-6	As a user, I can able to change the crossing button manually to cross the road	I can change the crossing button manually	High	Sprint-2
Administrator		USN-7	As an admin, I can able to change the display messages manually using a security key	I can change the display message manually	Medium	Sprint-2
	Traffic Detection	USN-8	As an admin, I can able to track the traffic and able to display the message accordingly	I can track the traffic density	High	Sprint-3
		USN-9	As an admin, I can able to change the traffic lights based on the traffic detection	I can change traffic lights in case of emergency	High	Sprint-3
Customer (Traveller)	Communication	USN-10	As a user, I can get the weather alert based on the location	I can get weather alerts	Medium	Sprint-4
Administrator		USN-11	As an admin, I can able to alert the diversion to the user based on the traffic	I can alert the diversion to the user	High	Sprint-4

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	User Visibility	USN-1	As a user, I can able to read the message on the display and became aware of it.	2	High	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan
Sprint-2		USN-2	As a user, I can able to know the nearby warning signs and became aware of it.	1	Medium	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan
Sprint-1		USN-3	As a user, I can became aware of crossing by blinking light system and it keeps me awake.	2	Medium	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan

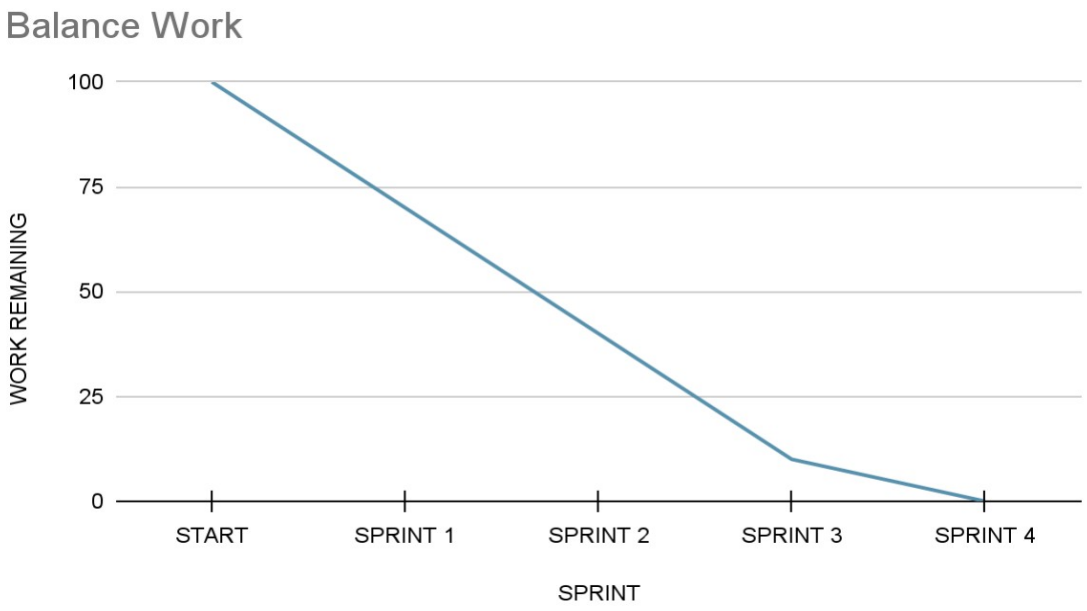
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-4		USN-4	As a user, I can able to know the traffic signal countdown and get ready to move.	1	Low	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan
Sprint-4	User Interaction	USN-5	As a user, I can get to know about the road conditions through the notification.	1	Low	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan
Sprint-2		USN-6	As a user, I can able to change the crossing button manually to cross the road.	2	High	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan
Sprint-2		USN-7	As an admin, I can able to change the display messages manually using a security key.	2	Medium	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan
Sprint-3	Traffic Detection	USN-8	As an admin, I can able to track the traffic and able to display the message accordingly.	2	High	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-3		USN-9	As an admin, I can able to change the traffic lights based on the traffic detection.	2	High	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan
Sprint-4	Communication	USN-10	As a user, I can get the weather alert based on the location.	1	Medium	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan
Sprint-4		USN-11	As an admin, I can able to alert the diversion to the user based on the traffic.	2	High	Mohamed Rasith, Ameer Khan, Mohamed Khan, Mohamed Raiyan

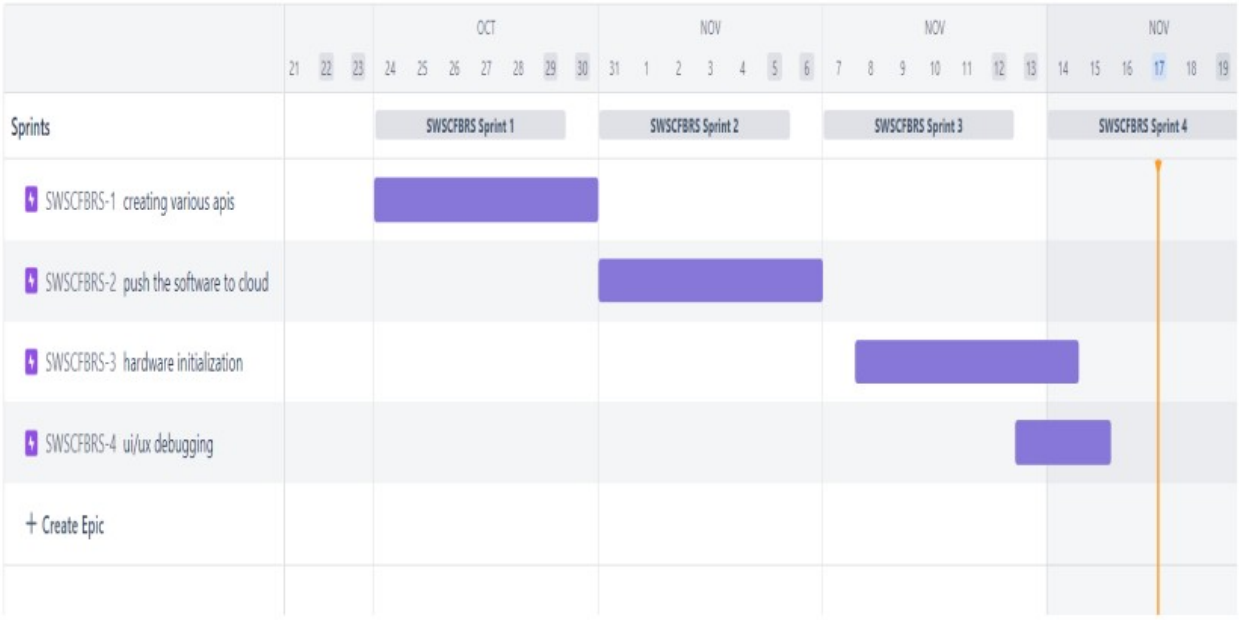
6.2 Sprint Delivery Schedule

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	10 Nov 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	13 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	16 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

Burndown Chart:

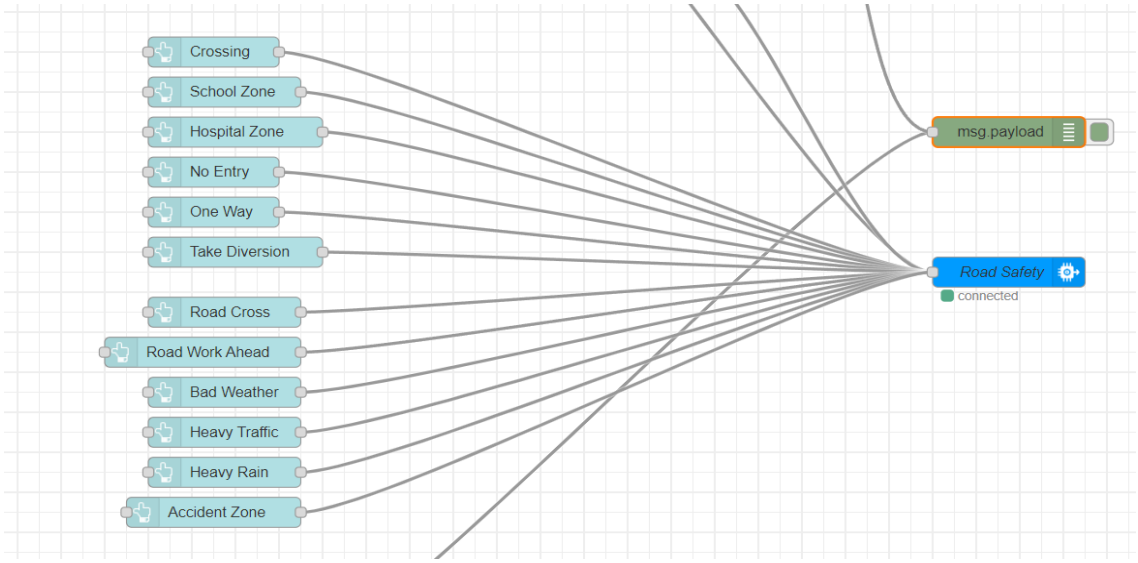


6.3 Reports from JIRA Software



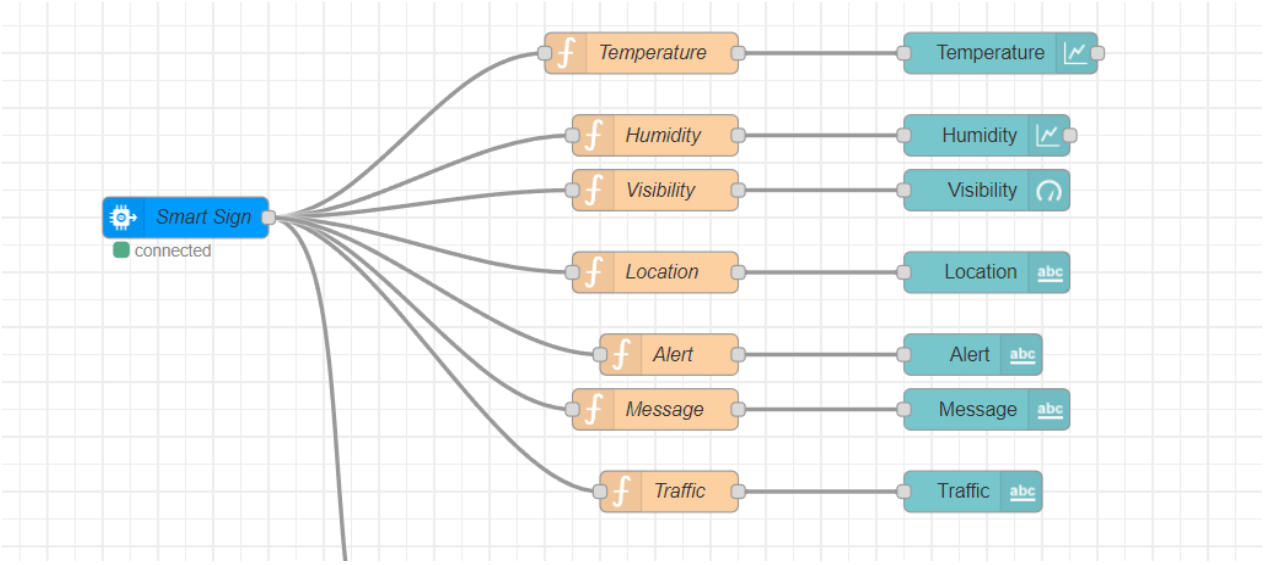
7. CODING AND SOLUTIONING

7.1 Feature 1 – Admin UI



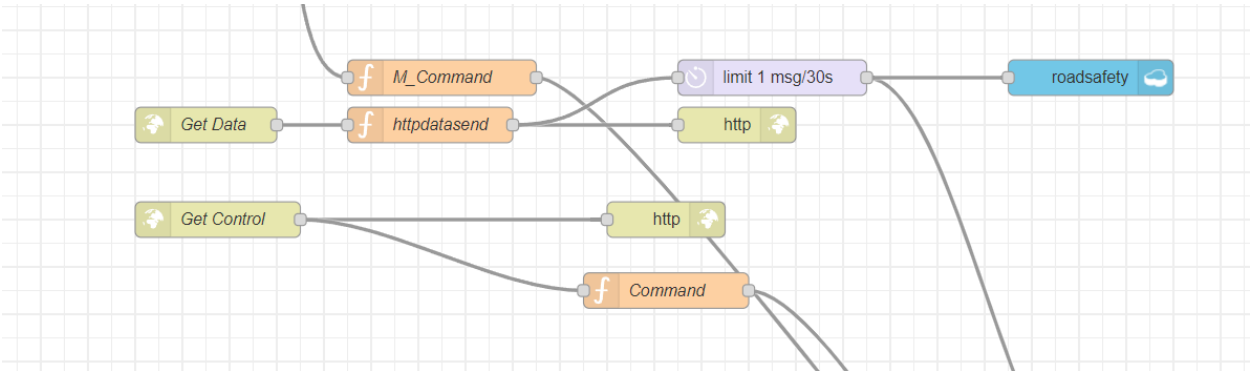
This part of Node RED flow creates a UI for Admin to control the display board to change the sign manually from a remote location. There is also an App for Admin to control the sign boards.

7.2 Feature 2 – User UI



This part of Node RED flow creates a UI for Users where user can able to see current weather update and road conditions. A python code sends the data to the user UI through IOT Watson.

7.3 Database Schema – Cloudant DB



This part of Node RED flow gets the information from HTTP request and store it in the cloudant DB named “roadsafety” for every 30 seconds from the MIT App.

8.TESTING

8.1 Test Cases

Test Case 1: Display welcome message on the digital sign board when no data received from the IOT Watson.

Test Case 2: Display message on the digital sign board based on the information from the IOT Watson.

Test Case 3: Display alert messages on the digital sign board based on the admin input from IOT Watson.

Test Case 4: Change the traffic light when manual crossing button is pressed by the user.

8.2 User Acceptance Testing

Dynamic changes in the sign boards based on the input from the python code to the IOT Watson helps user to avoid traffic and have a safe journey to home. The uses would welcome this idea to be implemented everywhere.

9. RESULTS

9.1 Performance Metrics

Based on the IBM pack we choose, the performance of the website varies. Built upon NodeJS, a light and high performance engine, Node RED is capable of handling up to 10,000 requests per second. Moreover, since the system is horizontally scalable, an even higher demand of customers can be served.

10. ADVANTAGES & DISADVANTAGES

10.1 Advantages

▪ Lower battery consumption since processing is done mostly by Node RED servers in the cloud.

▪ Cheaper and low requirement micro controllers can be used since processing requirements are reduced.

▪ Longer lasting display systems.

▪ Dynamic Sign updating.

▪ School/Hospital Zone alerts.

10.2 Disadvantages

▪ The size of the display determines the requirement of the micro controller.

▪ Dependent on OpenWeatherMap API and hence the Weather data is same for a large area in the scale of cities.

11. CONCLUSION

Our project is capable of serving as a replacement for static signs for a comparatively lower cost and can be implemented in the very near future. This will help reduce a lot of accidents and maintain a more peaceful traffic atmosphere in the country.

12. FUTURE SCOPE

Introduction of intelligent road sign groups in real life scenarios could have great impact on increasing the driving safety by providing the end-user (car driver) with the most accurate information regarding the current road and traffic conditions. Even displaying the information of a suggested driving speed and road surface condition (temperature, icy, wet or dry surface) could result in smoother traffic flows and, what is more important, in increasing a driver's awareness of the road situation.

13. APPENDIX

SOURCE CODE:

1. IOT Device(ESP 32)

Sketch.ino:

```
#include <WiFi.h>//library for wifi
#include <PubSubClient.h>//library for MQtt
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>//library for display

#define LED 2
#define RED 19 //Red light
#define YELLOW 18 //Yellow light
#define GREEN 5 //Green light
#define CROSS 13
#define CROSSIN 4
#define CROSSOUT 15
#define Crossing 34 //Yellow Button
#define SchoolZone 35 //Black Button
#define HospitalZone 32 //White Button
#define NoEntry 25 //Gray Button
#define OneWay 26 //Green Button
#define TakeDiversion 27 //Red Button

void callback(char* subscribetopic, byte* payload, unsigned int payloadLength);

//-------credentials of IBM Accounts------

#define ORG "17rb95"//IBM ORGANITION ID
#define DEVICE_TYPE "Info_Device"//Device type mentioned in ibm watson IOT Platform
#define DEVICE_ID "Road_Safety"//Device ID mentioned in ibm watson IOT Platform
#define TOKEN "connecttoiot"     //Token
String message;
int buttonState = 0,i=30;
#define SCREEN_ADDRESS 0x3C

//-------- Customise the above values --------
char server[] = ORG ".messaging.internetofthings.ibmcloud.com";// Server Name
char publishTopic[] = "iot-2/evt/Data/fmt/json";// topic name and type of event perform and format in which data to be send
char subscribetopic[] = "iot-2/cmd/command/fmt/String";// cmd  REPRESENT command type AND COMMAND IS TEST OF FORMAT STRING
```

```
char authMethod[] = "use-token-auth";// authentication method
char token[] = TOKEN;
char clientId[] = "d:" ORG ":" DEVICE_TYPE ":" DEVICE_ID;//client id

//-------------------------------------
Adafruit_SSD1306 oled (128, 64, &Wire, -1);
WiFiClient wifiClient; // creating the instance for wificlient
PubSubClient client (server, 1883, callback ,wifiClient); //calling the predefined client id by passing parameter like server id,portand wificredential
void setup()// configureing the ESP32
{
  Serial.begin(115200);
  oled.begin(SSD1306_SWITCHCAPVCC, SCREEN_ADDRESS);
  pinMode(LED,OUTPUT);
  pinMode(RED,OUTPUT);
  pinMode(YELLOW,OUTPUT);
  pinMode(GREEN,OUTPUT);
  pinMode(CROSSIN,OUTPUT);
  pinMode(CROSSOUT,OUTPUT);
  pinMode(CROSS, INPUT);
  pinMode(Crossing, INPUT);
  pinMode(SchoolZone, INPUT);
  pinMode(HospitalZone, INPUT);
  pinMode(NoEntry, INPUT);
  pinMode(OneWay, INPUT);
  pinMode(TakeDiversion, INPUT);

  oled.clearDisplay();
  oled.setTextSize(1);
  oled.setTextColor(WHITE);
  oled.setCursor(10, 10);
  oled.println("Welcome to Chennai");
  oled.setCursor(20, 20);
  oled.println("Speed Limit 40");
  oled.setCursor(40, 30);
  oled.println("Go Slow!");
  oled.display();

  digitalWrite(GREEN, HIGH);
  digitalWrite(CROSSOUT, HIGH);
```

```
  delay(10);
  Serial.println();
  wificonnect();
  mqttconnect();
}

void loop()// Recursive Function
{
  changeText();
  roadCross();
  PublishData();
  ledBlink();
  delay(1000);
  if (!client.loop()) {
    mqttconnect();
  }
}

/*.....retrieving to Cloud.....*/

void PublishData() {
  mqttconnect();//function call for connecting to ibm
  /*
     creating the String in in form JSon to update the data to ibm cloud
  */
  String payload = "{\"Message\":\"Enter Command to Display\"}";


  Serial.print("Sending payload: ");
  Serial.println(payload);


  if (client.publish(publishTopic, (char*) payload.c_str())) {
     Serial.println("Publish ok");// if it sucessfully upload data on the cloud then it
will print publish ok in Serial monitor or else it will print publish failed
  } else {
    Serial.println("Publish failed");
  }
```

```
}
void mqttconnect() {
  if (!client.connected()) {
    Serial.print("Reconnecting client to ");
    Serial.println(server);
    while (!!!client.connect(clientId, authMethod, token)) {
      Serial.print(".");
      delay(500);
    }
     initManagedDevice();
     Serial.println();
  }
}
void wificonnect() //function definition for wificonnect
{
  Serial.println();
  Serial.print("Connecting to ");

  WiFi.begin("Wokwi-GUEST", "", 6);//passing the wifi credentials to establish the
connection
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
}

void initManagedDevice() {
  if (client.subscribe(subscribetopic)) {
    Serial.println((subscribetopic));
    Serial.println("subscribe to cmd OK");
  } else {
    Serial.println("subscribe to cmd FAILED");
  }
}

void ledBlink(){//function for led blinking system
```

```
  digitalWrite(LED,LOW);
  delay(1000);
  digitalWrite(LED,HIGH);
}

void countDown(){//traffic light countdown system
  for(i;i>0;i--){
    oled.clearDisplay();
    oled.setTextSize(3);
    oled.setCursor(48, 20);
    oled.println(i);
    oled.display();
    delay(1000);
  }
  oled.setTextSize(1);
  i=30;
}

void roadCross(){//manual crossing function
  buttonState = digitalRead(CROSS);

  if(buttonState == LOW){
    trafficOff();
    digitalWrite(CROSSOUT,LOW);
    digitalWrite(CROSSIN, HIGH);
    countDown();
    crossing();
    trafficOn();
    digitalWrite(CROSSIN, LOW);
    digitalWrite(CROSSOUT, HIGH);
  }
}

void trafficOn(){//traffic light set to go
  digitalWrite(RED,HIGH);
  delay(1000);
  digitalWrite(RED,LOW);
  digitalWrite(YELLOW,HIGH);
  delay(1500);
  digitalWrite(YELLOW,LOW);
```

```
  digitalWrite(GREEN,HIGH);
}

void trafficOff(){//traffic light set to stop
  digitalWrite(GREEN,HIGH);
  delay(1000);
  digitalWrite(GREEN,LOW);
  digitalWrite(YELLOW,HIGH);
  delay(1500);
  digitalWrite(YELLOW,LOW);
  digitalWrite(RED,HIGH);
}

void crossing(){//crossing display
  oled.clearDisplay();
  oled.setCursor(20, 25);
  oled.println("Crossing Ahead");
  oled.setCursor(40, 35);
  oled.println("Go Slow!");
  oled.display();
}

void schoolZone(){//school zone display
  oled.clearDisplay();
  oled.setCursor(30, 25);
  oled.println("School Zone");
  oled.setCursor(28, 35);
  oled.println("Do Not Honk!");
  oled.display();
}

void hospitalZone(){//hospital zone display
  oled.clearDisplay();
  oled.setCursor(25, 25);
  oled.println("Hospital Zone");
  oled.setCursor(28, 35);
  oled.println("Do Not Honk!");
  oled.display();
}
```

```
void noEntry(){//no entry display
  oled.clearDisplay();
  oled.setCursor(40, 25);
  oled.println("No Entry");
  oled.setCursor(10, 35);
  oled.println("No Vehicles Allowed");
  oled.display();
}

void oneWay(){//one way display
  oled.clearDisplay();
  oled.setCursor(40, 25);
  oled.println("One Way");
  oled.setCursor(30, 35);
  oled.println("Single Lane");
  oled.display();
}

void takeDiversion(){//take diversion display
  oled.clearDisplay();
  oled.setCursor(20, 25);
  oled.println("Take Diversion");
  oled.setCursor(10, 35);
  oled.println("Bad Road Condition");
  oled.display();
}

void roadWorkAhead(){//alert road work ahead
  oled.clearDisplay();
  oled.setCursor(40, 15);
  oled.println("CAUTION!");
  oled.setCursor(17, 25);
  oled.println("Road Work Ahead");
  oled.setCursor(15, 35);
  oled.println("Work On Progress");
  oled.display();
}

void badWeather(){//alert bad weather
  oled.clearDisplay();
```

```
  oled.setCursor(40, 15);
  oled.println("CAUTION!");
  oled.setCursor(30, 25);
  oled.println("Bad Weather");
  oled.setCursor(20, 35);
  oled.println("Low Visibility");
  oled.display();
}

void heavyTraffic(){//alert heavy traffic
  oled.clearDisplay();
  oled.setCursor(40, 15);
  oled.println("CAUTION!");
  oled.setCursor(25, 25);
  oled.println("Heavy Traffic");
  oled.setCursor(22, 35);
  oled.println("Take Diversion");
  oled.display();
}

void heavyRain(){//alert heavy rain
  oled.clearDisplay();
  oled.setCursor(40, 15);
  oled.println("CAUTION!");
  oled.setCursor(33, 25);
  oled.println("Heavy Rain");
  oled.setCursor(40, 35);
  oled.println("Go Slow!");
  oled.display();
}

void accidentZone(){//alert accident zone
  oled.clearDisplay();
  oled.setCursor(40, 15);
  oled.println("CAUTION!");
  oled.setCursor(25, 25);
  oled.println("Accident Zone");
  oled.setCursor(20, 35);
  oled.println("Speed Limit 30");
  oled.display();
```

```
}

void changeText(){//change display text
  if(digitalRead(Crossing) == LOW){
    crossing();
  }else if(digitalRead(SchoolZone) == LOW){
    schoolZone();
  }else if(digitalRead(HospitalZone) == LOW){
    hospitalZone();
  }else if(digitalRead(NoEntry) == LOW){
    noEntry();
  }else if(digitalRead(OneWay) == LOW){
    oneWay();
  }else if(digitalRead(TakeDiversion) == LOW){
    takeDiversion();
  }
}

void editText(String msg){//edit didplay text
  if(msg == "Crossing"){
    crossing();
  }else if(msg == "SchoolZone"){
    schoolZone();
  }else if(msg == "HospitalZone"){
    hospitalZone();
  }else if(msg == "NoEntry"){
    noEntry();
  }else if(msg == "OneWay"){
    oneWay();
  }else if(msg == "TakeDiversion"){
    takeDiversion();
  }else if(msg == "RoadCross"){
    trafficOff();
    digitalWrite(CROSSOUT,LOW);
    digitalWrite(CROSSIN, HIGH);
    countDown();
    crossing();
    trafficOn();
    digitalWrite(CROSSIN, LOW);
    digitalWrite(CROSSOUT, HIGH);
```

```
  }else if(msg == "RoadWorkAhead"){
    roadWorkAhead();
  }else if(msg == "BadWeather"){
    badWeather();
  }else if(msg == "HeavyTraffic"){
    heavyTraffic();
  }else if(msg == "HeavyRain"){
    heavyRain();
  }else if(msg == "AccidentZone"){
    accidentZone();
  }
}

//CallBack function
void callback(char* subscribetopic, byte* payload, unsigned int payloadLength)
{
  Serial.print("callback invoked for topic: ");
  Serial.println(subscribetopic);
  for (int i = 0; i < payloadLength; i++) {
    message += (char)payload[i];
  }
  editText(message);
  Serial.println("data: "+ message);
  message="";
}
```

Diagram.json:

```
{
  "version": 1,
  "author": "MOHAMED RASHITH",
  "editor": "wokwi",
  "parts": [
      { "type": "wokwi-esp32-devkit-v1", "id": "esp", "top": 34.67, "left": -72.67,
"attrs": {} },
    {
      "type": "wokwi-led",
      "id": "led1",
      "top": -49.86,
      "left": 105.01,
```

```
  "attrs": { "color": "red" }
},
{
  "type": "wokwi-resistor",
  "id": "r1",
  "top": 154.32,
  "left": 49.04,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-pushbutton",
  "id": "btn1",
  "top": 316.56,
  "left": -213.09,
  "attrs": { "color": "blue" }
},
{
  "type": "wokwi-led",
  "id": "led2",
  "top": 252.69,
  "left": -106.52,
  "attrs": { "color": "red" }
},
{
  "type": "wokwi-led",
  "id": "led3",
  "top": 256.44,
  "left": 2.26,
  "attrs": { "color": "blue" }
},
{
  "type": "wokwi-resistor",
  "id": "r2",
  "top": 341.12,
  "left": -2.29,
  "rotate": 270,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-resistor",
```

```
  "id": "r3",
  "top": 343.61,
  "left": -111.38,
  "rotate": 270,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-resistor",
  "id": "r4",
  "top": 182.65,
  "left": -219.89,
  "rotate": 180,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-pushbutton",
  "id": "btn2",
  "top": 29.25,
  "left": -500.47,
  "attrs": { "color": "red" }
},
{
  "type": "wokwi-pushbutton",
  "id": "btn3",
  "top": 29.17,
  "left": -245.44,
  "attrs": { "color": "grey" }
},
{
  "type": "wokwi-pushbutton",
  "id": "btn4",
  "top": 28.3,
  "left": -376.48,
  "attrs": { "color": "green" }
},
{
  "type": "wokwi-pushbutton",
  "id": "btn5",
  "top": -75.4,
  "left": -503.26,
```

```
  "attrs": { "color": "yellow" }
},
{
  "type": "wokwi-pushbutton",
  "id": "btn6",
  "top": -76.23,
  "left": -380.35,
  "attrs": { "color": "black" }
},
{
  "type": "wokwi-pushbutton",
  "id": "btn7",
  "top": -73.57,
  "left": -250.79,
  "attrs": { "color": "white" }
},
{
  "type": "wokwi-resistor",
  "id": "r5",
  "top": -10.74,
  "left": -601.04,
  "rotate": 270,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-resistor",
  "id": "r6",
  "top": 101.41,
  "left": -573.79,
  "rotate": 270,
  "attrs": { "value": "1000" }
},
{
  "type": "wokwi-resistor",
  "id": "r7",
  "top": -18.51,
  "left": -446.32,
  "rotate": 270,
  "attrs": { "value": "1000" }
},
```

```
    {
      "type": "wokwi-resistor",
      "id": "r8",
      "top": 114.2,
      "left": -429.47,
      "rotate": 270,
      "attrs": { "value": "1000" }
    },
    {
      "type": "wokwi-resistor",
      "id": "r9",
      "top": 88.92,
      "left": -302.03,
      "rotate": 270,
      "attrs": { "value": "1000" }
    },
    {
      "type": "wokwi-resistor",
      "id": "r10",
      "top": -12.18,
      "left": -327.32,
      "rotate": 270,
      "attrs": { "value": "1000" }
    },
     { "type": "board-ssd1306", "id": "oled1", "top": -87.55, "left": -73.97, "attrs":
{} },
    {
      "type": "wokwi-led",
      "id": "led4",
      "top": 208.45,
      "left": -463.52,
      "attrs": { "color": "red" }
    },
    {
      "type": "wokwi-led",
      "id": "led5",
      "top": 265.68,
      "left": -459.62,
      "attrs": { "color": "orange" }
    },
```

```
    {
      "type": "wokwi-led",
      "id": "led6",
      "top": 332.02,
      "left": -458.32,
      "attrs": { "color": "limegreen" }
    },
    {
      "type": "wokwi-resistor",
      "id": "r11",
      "top": 238.34,
      "left": -401.48,
      "rotate": 180,
      "attrs": { "value": "1000" }
    },
    {
      "type": "wokwi-resistor",
      "id": "r12",
      "top": 295.6,
      "left": -399.78,
      "rotate": 180,
      "attrs": { "value": "1000" }
    },
    {
      "type": "wokwi-resistor",
      "id": "r13",
      "top": 363.25,
      "left": -398.04,
      "rotate": 180,
      "attrs": { "value": "1000" }
    }
  ],
  "connections": [
    [ "esp:TX0", "$serialMonitor:RX", "", [] ],
    [ "esp:RX0", "$serialMonitor:TX", "", [] ],
    [ "led1:A", "r1:2", "green", [ "v0" ] ],
    [ "r1:1", "esp:D2", "green", [ "v0" ] ],
    [ "led1:C", "esp:GND.1", "black", [ "v82.85", "h23.86", "v51.14" ] ],
    [ "led3:A", "r2:2", "green", [ "v0" ] ],
    [ "r2:1", "esp:D4", "green", [ "v16.72", "h159.26", "v-232.25" ] ],
```

["led2:A", "r3:2", "green", ["v0"]],
["r3:1", "esp:D15", "green", ["v17.6", "h272.75", "v-212.89"]],
["btn1:2.l", "esp:GND.2", "black", ["h-47.62", "v-114.99"]],
["btn1:1.l", "r4:2", "green", ["h-24.05", "v-124.08"]],
["r4:1", "esp:VIN", "green", ["v0"]],
["btn1:1.r", "esp:D13", "blue", ["v-0.4", "h15.85", "v-106.9"]],
["led3:C", "esp:GND.1", "black", ["v8.55", "h27.37", "v-124.03"]],
["led2:C", "esp:GND.1", "black", ["v17.85", "h142.63", "v-126.8"]],
["btn2:2.l", "esp:GND.2", "black", ["h-15.39", "v126.03"]],
["btn5:2.l", "esp:GND.2", "black", ["h-13.55", "v231.63"]],
["btn4:2.l", "esp:GND.2", "black", ["h-9.72", "v121.31"]],
["btn6:2.l", "esp:GND.2", "black", ["h-5.96", "v228.51"]],
["btn3:2.l", "esp:GND.2", "black", ["h-14.04", "v119.97"]],
["btn7:2.l", "esp:GND.2", "black", ["h-8.69", "v204.89"]],
["btn5:1.l", "r5:2", "green", ["h0"]],
["r5:1", "esp:VIN", "green", ["h1.21", "v149.78", "h433.95", "v12.58"]],
["btn2:1.l", "r6:2", "green", ["h0"]],
["r6:1", "esp:VIN", "green", ["h1.23", "v26.55", "h412.82", "v24.77"]],
["btn6:1.l", "r7:2", "green", ["h0"]],
["r7:1", "esp:VIN", "green", ["h2.44", "v140.21", "h291.73", "v26.33"]],
["btn4:1.l", "r8:2", "green", ["h0"]],
["r8:1", "esp:VIN", "green", ["h285.75", "v35.94"]],
["btn7:1.l", "r10:2", "green", ["h0"]],
["r10:1", "esp:VIN", "green", ["h2.45", "v120.19", "h189.57", "v45.29"]],
["btn3:1.l", "r9:2", "green", ["h0"]],
["r9:1", "esp:VIN", "green", ["h0.33", "v11.72", "h172.72", "v50.55"]],
["btn5:1.r", "esp:D34", "blue", ["v-65.49", "h342.88", "v216.52"]],
["btn6:1.r", "esp:D35", "blue", ["v-51.29", "h205.71", "v209.39"]],
["btn7:1.r", "esp:D32", "blue", ["v-37.91", "h66.35", "v204.93"]],
["btn3:1.r", "esp:D25", "blue", ["v0.12", "h52.98", "v74.85"]],
["btn4:1.r", "esp:D26", "blue", ["v-1.13", "h8.28", "v69.78"]],
["btn2:1.r", "esp:D27", "blue", ["v0.19", "h9.84", "v84.54"]],
["oled1:GND", "esp:GND.1", "black", ["v-53.71", "h292.12", "v325.01"]],
["oled1:VCC", "esp:3V3", "red", ["v-43.17", "h274.76", "v322.37"]],
["oled1:SCL", "esp:D22", "blue", ["v-33.5", "h255.65", "v199.39"]],
["oled1:SDA", "esp:D21", "green", ["v-25.6", "h235.28", "v196.76"]],
["led4:A", "r11:2", "red", ["v0"]],
["led5:A", "r12:2", "red", ["v0"]],
["led6:A", "r13:2", "red", ["v0"]],
["led4:C", "esp:GND.2", "black", ["v10.08", "h-33.68", "v-76.14"]],

```
    [ "led5:C", "esp:GND.2", "black", [ "v10.92", "h-37.58", "v-132.92" ] ],
    [ "led6:C", "esp:GND.2", "black", [ "v12.98", "h-38.88", "v-221.97" ] ],
      [ "r11:1", "esp:D19", "red", [ "v-0.66", "h53.97", "v159.29", "h488.12", "v-298.11" ] ],
      [ "r12:1", "esp:D18", "red", [ "v-1.03", "h44.31", "v109.23", "h505.19", "v-295.83" ] ],
    [ "r13:1", "esp:D5", "red", [ "v-1.55", "h35.74", "v51.2", "h521.11", "v-293.55" ] ]
  ]
}
```

2. Python Code

publishdata.py:

```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random as r
import weather
#Provide your IBM Watson Device Credentials
organization = "17rb95"
deviceType = "Info_Device"
deviceId = "Smart_Sign"
authMethod = "token"
authToken = "connectsign"
#Data List
Message_list = ["Crossing","School Zone","Hospital Zone","No Entry","One Way","Take Diversion"]
Traffic_list = ["High","Moderate","Low"]
Notify_list = ["Heavy Traffic","Heavy Rain","Bad Weather","Road Work Ahead","Accident Zone"]
myLocation = "Chennai,IN"
APIKEY = "33f70e8a0b8b318ad16d3951c6ee700d"
# Initialize GPIO
def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    print(cmd)
try:
```

```
        deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod, "auth-token": authToken}
        deviceCli = ibmiotf.device.Client(deviceOptions)
        #.....................................
except Exception as e:
        print("Caught exception connecting device: %s" % str(e))
        sys.exit()
# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting" 10 times
deviceCli.connect()
while True:
      #Random Data
      Message = r.choice(Message_list)
      Traffic = r.choice(Traffic_list)
      Alert = r.choice(Notify_list)
      #Get Weather from OpenWeatherMap
      weatherData = weather.get(myLocation, APIKEY)
      if Traffic == 'High':
         Message = "Go Slow!"
         Alert = "Heavy Traffic"
      elif weatherData["weather"] == "['rain']":
         Alert = "Heavy Rain"
      #JSON Data
      data = {"d":{ 'temp' : round(weatherData["temperature"], 2),
                  'humidity' : weatherData["humidity"],
                  'visibility' : weatherData["visibility"],
                  'location' : myLocation,
                  'message' : Message,
                  'traffic' : Traffic,
                  'alert' : Alert}
            }
      #print data
      def myOnPublishCallback():
                              print ("Published Temperature = %s C" % round(weatherData["temperature"], 2), "Humidity = %s %%" % weatherData["humidity"], "to IBM Watson")
            success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0, on_publish=myOnPublishCallback)
      if not success:
         print("Not connected to IoTF")
```

```
        time.sleep(5)
        #CallBack
        deviceCli.commandCallback = myCommandCallback
# Disconnect the device and application from the cloud
deviceCli.disconnect()
```

weather.py:

```
import requests as reqs
def get(myLocation,APIKEY):
        apiURL = f"https://api.openweathermap.org/data/2.5/weather?
q={myLocation}&appid={APIKEY}"
    responseJSON = (reqs.get(apiURL)).json()

    #JSON Object
    returnObject = {
        "temperature" : responseJSON['main']['temp'] - 273.15,
        "humidity" : responseJSON['main']['humidity'],
                "weather" : [responseJSON['weather'][_]['main'].lower() for _ in
range(len(responseJSON['weather']))],
        "visibility" : responseJSON['visibility']/100
    }
    return(returnObject)
```

GITHUB LINK:

https://github.com/IBM-EPBL/IBM-Project-17304-1659633753

DEMO VIDEO LINK:

https://drive.google.com/file/d/1WDnOKdb0NXjmtrbJ7Gt_X5J6fjR0QMrs/view