

# **SIGNS WITH SMART CONNECTIVITY FOR BETTER ROAD SAFETY**

**IBM PROJECT REPORT**

**Team ID -**

**PNT2022TMID14966**

**Project Report by**

Manoj kumar M-111519106085  
Harikrishnan T-111519106045  
Jegan S-111519106057  
Kirthik Saran P-111519106070

Bachelor of Engineering In

R.M.D Engineering College  
Kavaraipettai

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## **Final Deliverables Report**

|                     |  |
|---------------------|--|
| <b>Date</b>         | 18.11.2022   |
| <b>Team ID</b>      | PNT2022TMID14966                                     |
| <b>Project Name</b> | Signs with Smart Connectivity for Better Road Safety |

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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**

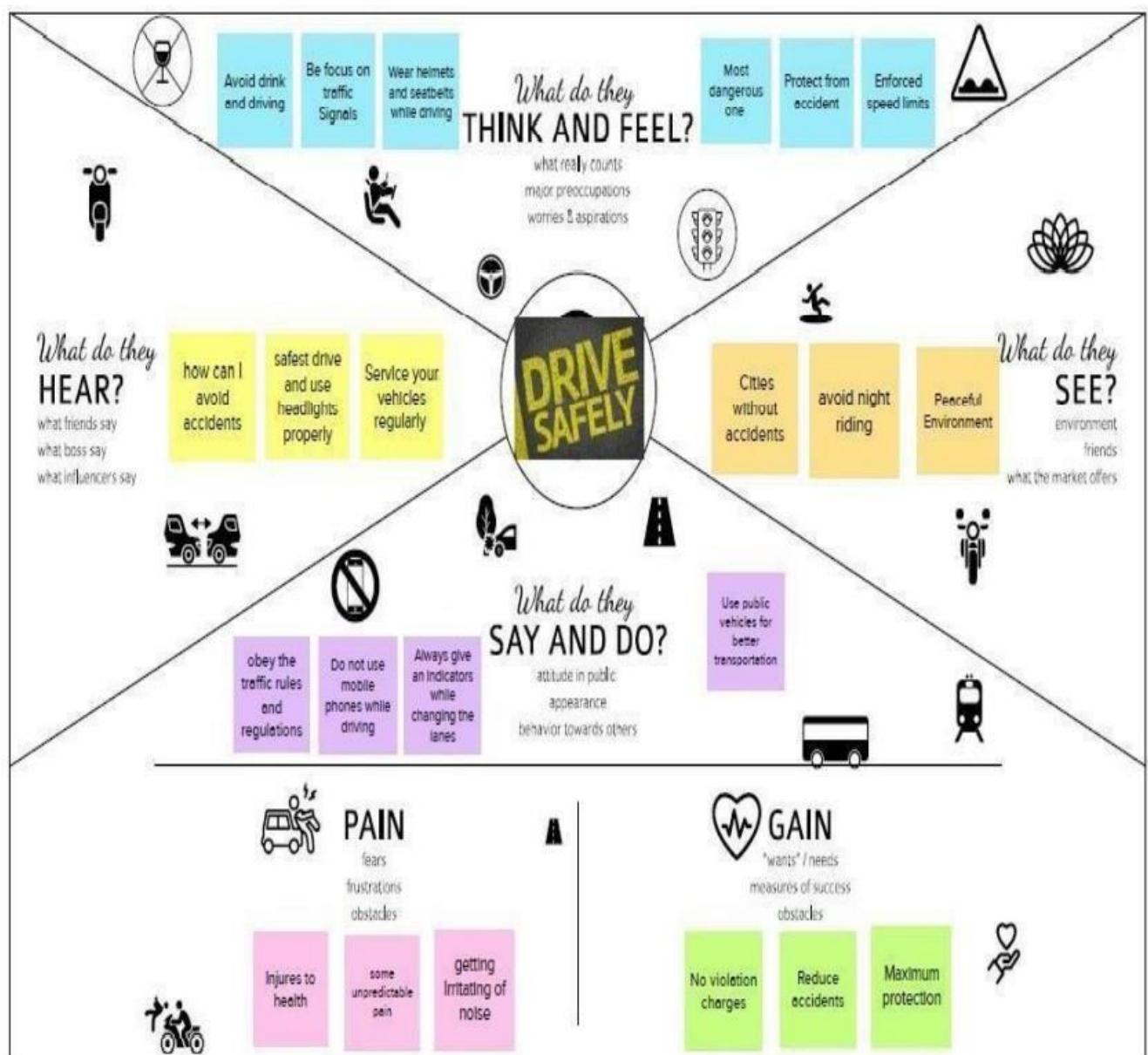
- [Islam, 2015; Sisiopiku et al., 2015](#)
- [Yannis et al., 2013, Staffeld \(1953\) and Ady \(1967\)](#)

## **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

2

### Brainstorm

Write down any ideas that come to mind that address your problem statement.

⌚ 10 minutes

**TIP**

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

JEGAN S

|                         |                                    |  |
|-------------------------|------------------------------------|--|
| Avoid Drunk and Driving | Ensures safety measures            | Drive the vehicle in correct speed limit |
| Manage stress           | Roads need to be in good condition |  |

HARIKRISHNAN T

|                                 |                             |   |
|---------------------------------|-----------------------------|---|
| Rash driving need to be avoided | Understanding the road sign | Optimizing the functions of the vehicle |
| Use of Helmets properly         | Indication of seat belt     |   |

KIRTHIK SARAN P

|                                  |                                       |                      |
|----------------------------------|---------------------------------------|----------------------|
| Use of public transports         | Speed need to be reduced near schools | Detection of turning |
| Avoid using mobile while driving | Service your car regularly            |                      |

MANOJ KUMAR M

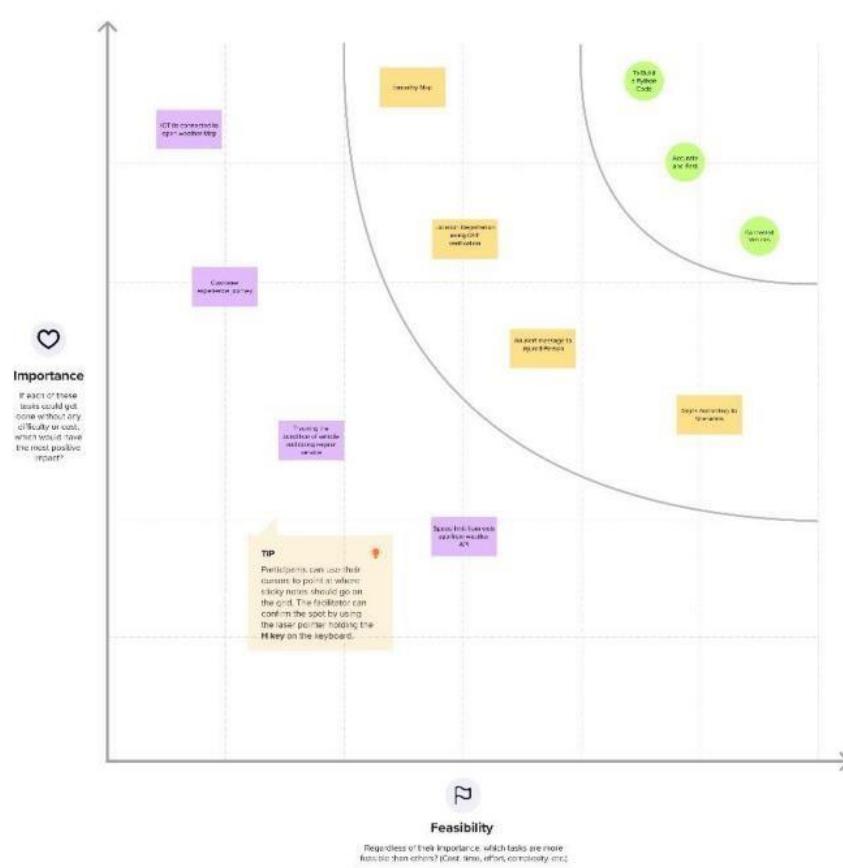
|                                      |                                    |                                |
|--------------------------------------|------------------------------------|--------------------------------|
| Automatic detection of traffic light | Minimizing the use of own vehicles | Do not cross the speed limits. |
| Maintain lane discipline.            | Maintain a safe distance.          |                                |

4

## Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

⌚ 20 minutes



## After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

### Quick add-ons

**A Share the mural**

Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

**B Export the mural**

Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

### Keep moving forward

**Strategy blueprint**

Define the components of a new idea or strategy.

[Open the template →](#)



**Customer experience journey map**

Understand customer needs, motivations, and obstacles for an experience.

[Open the template →](#)



**Strengths, weaknesses, opportunities & threats**

Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.

[Open the template →](#)

**Share template feedback**

### 3.3 Proposed Solution

| S.No. | Parameter                                | Description  |
|-------|--|--|
| 1.    | Problem Statement (Problem to be solved) | <ul style="list-style-type: none"><li>➤ To prevent road accidents by ensuring suitable measures using IOT.</li></ul>   |
| 2.    | Idea / Solution description              | <ul style="list-style-type: none"><li>➤ By Preparing smart signs using IOT instead of regular signs hung on the road.</li><li>➤ These smart signs provide a better clarity and are built with IOT and LED.</li></ul>   |
| 3.    | Novelty / Uniqueness                     | <ul style="list-style-type: none"><li>➤ Since LED is highly energy efficient – Less heat, more light, lower cost. Use less electricity for the same light output.</li><li>➤ The smart signs consist of temperature, humidity, wind speed.</li><li>➤ This information is received from weather monitoring app.</li><li>➤ It also gives information about nearby Places such as hospitals, schools, etc. so that the users can decide their speed according to that information.</li></ul> |
| 4.    | Social Impact / Customer Satisfaction    | <ul style="list-style-type: none"><li>➤ These create a noticeable impact on the road safety department.</li><li>➤ By deciding a speed limit for the user, there is significant chance in reducing the accidents.</li></ul>   |
| 5.    | Business Model (Revenue Model)           | <ul style="list-style-type: none"><li>➤ By executing these for commoners by the government, it is great initiative increasing an awareness among the people.</li><li>➤ A separate budget can be allotted for this by the government, which paves away for a safer environment.</li></ul>   |
| 6.    | Scalability of the Solution              | <ul style="list-style-type: none"><li>➤ It has greater chance in reducing the risk for the people as it is more visible than the normal signs, which saves a lot of lives at stake.</li></ul>  |

## 3.4 Problem Solution fit

Project Title: Signs with Smart Connectivity for Better Road Safety

Project Design Phase-I - Solution Fit Template

Team ID:PNT2022TMID14966

| Define CS, fit into CC  |     | Explore AS, differentiate   |    |   |    |
|---|-----|---|----|---|----|
| 1. CUSTOMER SEGMENT(S)<br>Who is your customer?<br>I.e. working parents of 0-5 y.o. kids<br><br>Highway Signals   | CS  | 6. CUSTOMER CONSTRAINTS<br>What constraints prevent your customers from taking action or limit their choices of solutions? I.e. spending power, budget, no cash, network connection, available devices.<br><br>When the connection or network breaks it causes the communication between the vehicle and the cloud breaks.  | CC | 5. AVAILABLE SOLUTIONS<br>Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? I.e. pen and paper is an alternative to digital notetaking<br><br>In the roadways , signs with correct directions gives clear solution.                    | AS |
| 2. JOBS-TO-BE-DONE / PROBLEMS<br>Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.<br><br>The boards which are used for signaling should keep track of temperature sensor and should inform the board about the speed of Customer's vehicle.  | J&P | 9. PROBLEM ROOT CAUSE<br>What is the real reason that this problem exists?<br>What is the back story behind the need to do this job?<br>I.e. customers have to do it because of the change in regulations.<br><br>If the connection between the sensor and the board breaks there will be weather alerts.Unnecessary pressing of indicator buttons by anyone would lead to problems.  | RC | 7. BEHAVIOUR<br>What does your customer do to address the problem and get the job<br>I.e. directly related: find the right solar panel installer; calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)<br><br>The IOT cloud updates the smart boards so that the customer can get the job done easily. | BE |
| 3. TRIGGERS<br>What triggers customers to act? I.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news.<br><br>The sensors in the board will alert the customers will by displaying about the weather. As weather causes most of the accidents.  | TR  | 10. YOUR SOLUTION<br>If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits really.<br>If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.<br><br>With the help of weather API and an application we can use smart boards in alternative to static sign boards which informs about the weather conditions ahead.<br>It provides instant support and safe journey. | SL | 8.CHANNELS OF BEHAVIOUR<br>8.1 ONLINE<br>What kind of actions do customers take online? Extract online channels from #7<br><br>The officers can receive the messages from the customers.  | CH |
| 4. EMOTIONS: BEFORE / AFTER<br>How do customers feel when they face a problem or a job and afterwards?<br>I.e. lost, insecure = confident, in control - use it in your communication strategy & design.<br><br>Based on the readings of the sensor the customers can change operation mode with the use of smart board and will follow the instructions from the smart board. | EM  | 8.2 OFFLINE<br>What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.<br><br>By using smartboards to check the state of the weather and roads instead of only direction boards.  |    | Identify strong TR & EM   |    |

# **4. REQUIREMENT ANALYSIS**

## **4.1 Functional Requirements**

Following are the functional requirements of the proposed solution.

| <b>FR No.</b> | <b>Functional Requirement(Epic)</b> | <b>Sub Requirement (Story / Sub-Task)</b>   |
|---------------|-------------------------------------|---|
| FR-I          | User Visibility                     | Sign Boards should be made of bright colored LEDs capable of attracting driver's attention Not too distracting to cause accidents |
| FR-2          | User Understanding                  | Should display information through means like images/illustrations with text so that the user can understand the signs correctly  |
| FR-3          | User Convenience                    | Display should be big enough to display all the signs correctly so that it is visible even to far away drivers                    |

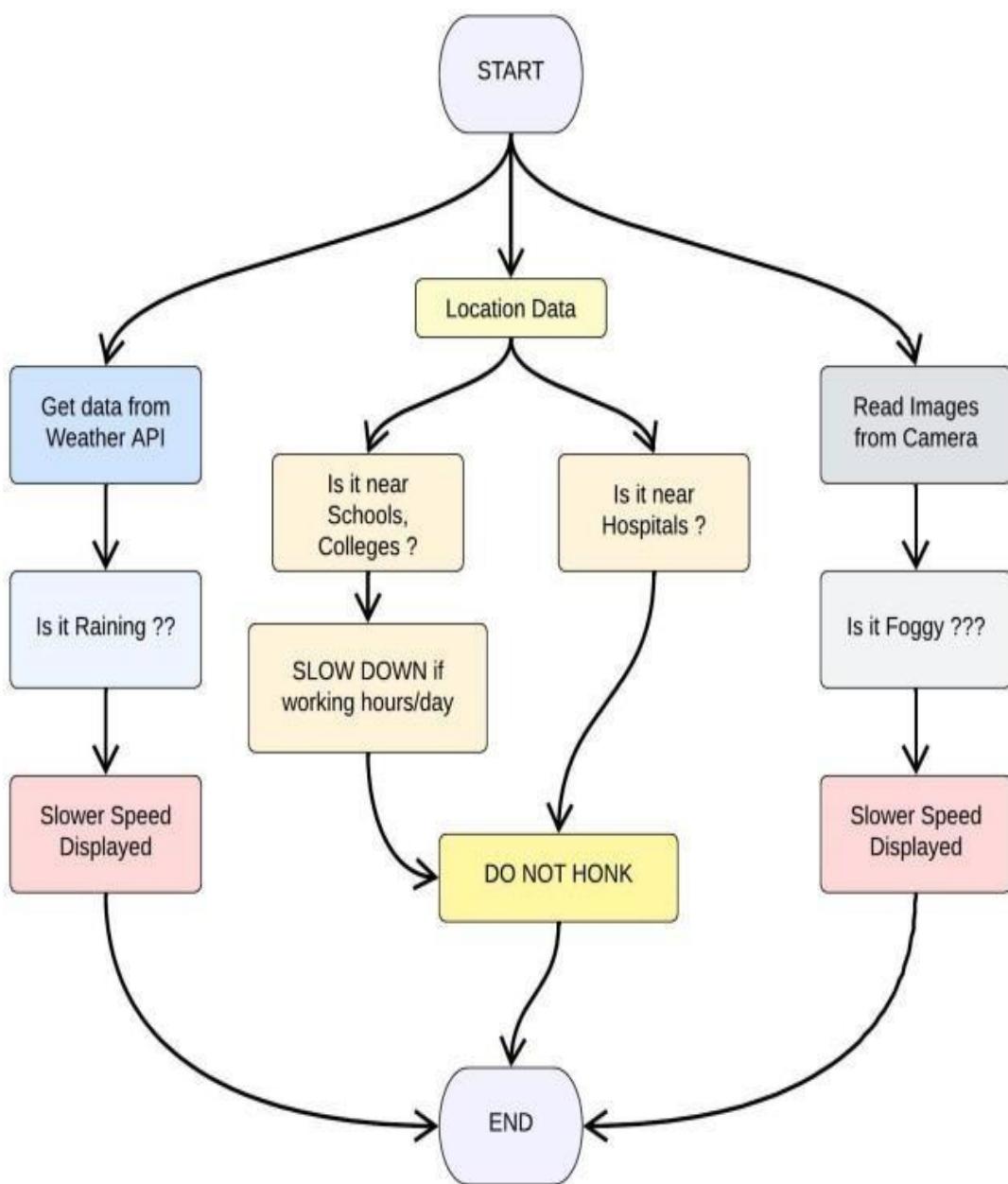
## 4.2 Non-Functional Requirements

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

| FR No. | Non-Functional Requirement | Description   |
|--------|----------------------------|---|
| NFR-I  | Usability                  | Should be able to dynamically update with respect to time.                            |
| NFR-2  | Security                   | Should be secure enough that only the intended messages are displayed in the display. |
| NFR-3  | Reliability                | Should convey the traffic information correctly.                                      |
| NFR-4  | Performance                | Display should update dynamically whenever the weather or traffic values are updated  |
| NFR-5  | Availability               | Should be on service 24/7   |
| NFR-6  | Scalability                | Should be modular and hence able to scale on servers horizontally.                    |

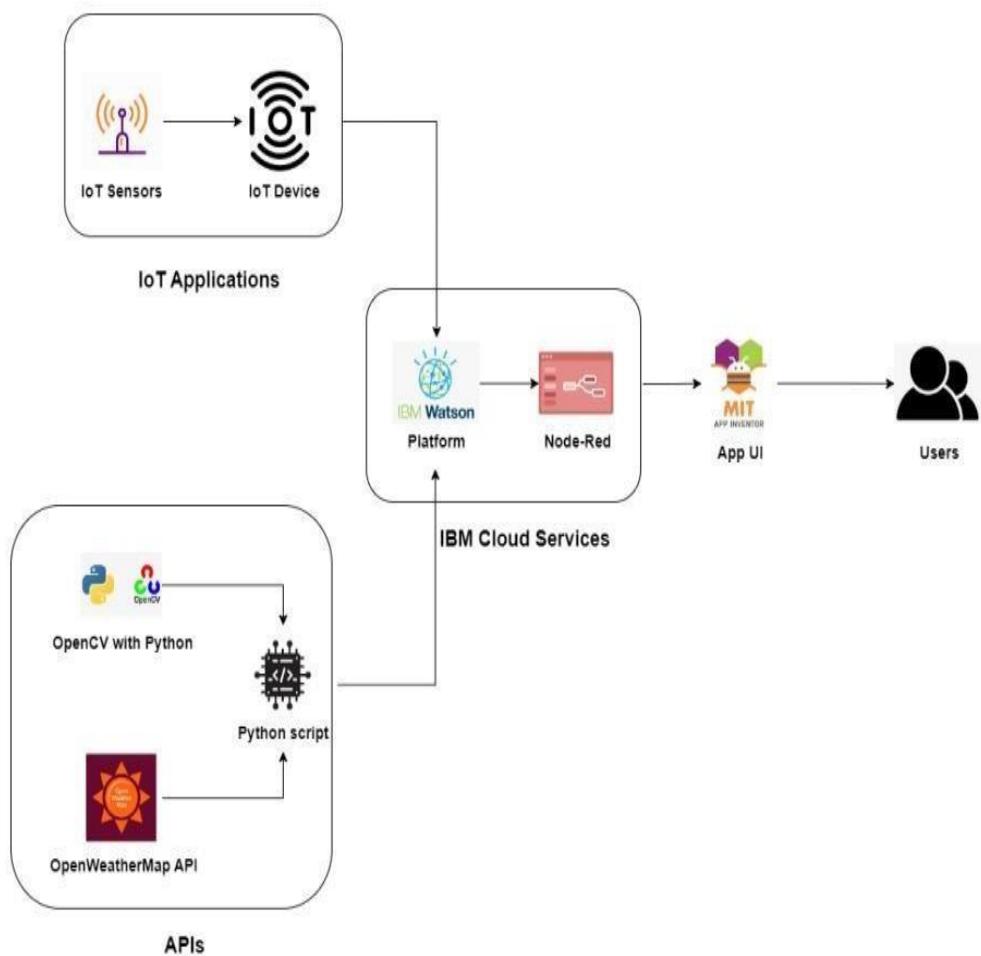
## 5. PROJECT DESIGN

### 5.1 Data Flow Diagram



## 5.2 Solution & Technical Architecture

Following is the Technical Architecture with slight change and is without the implementation of OpenCV API.



# Following is the Solution Built

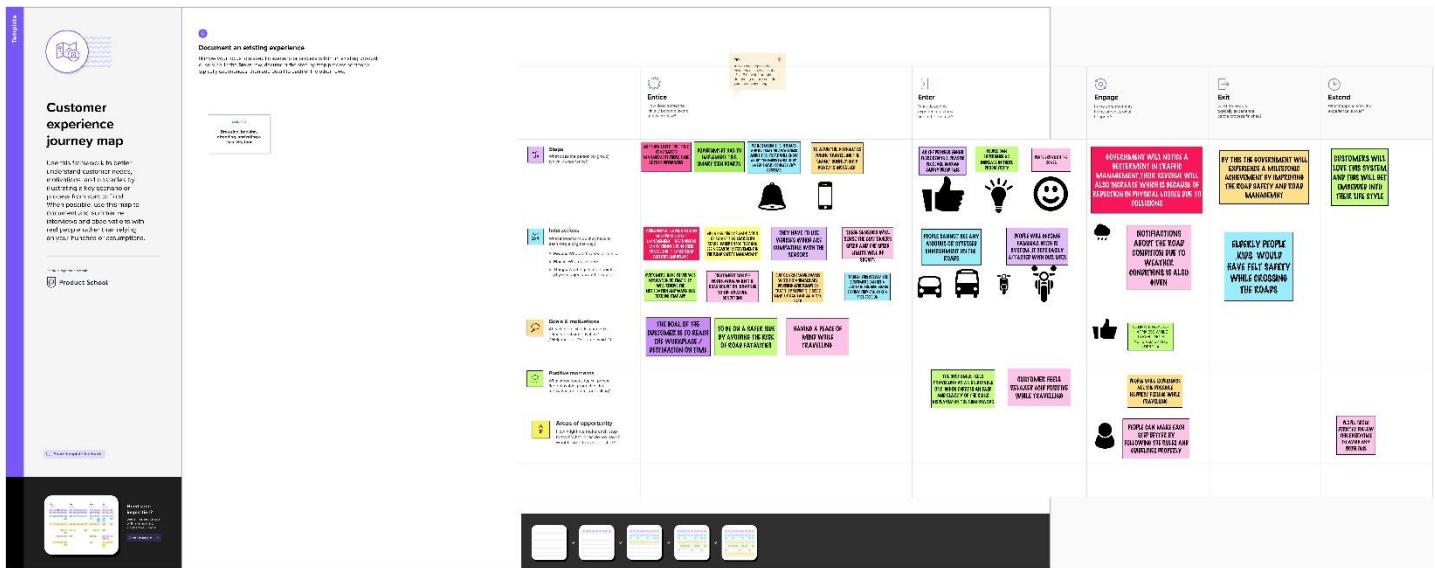
Table-1 : Components & Technologies:

| S.N<br>o | Component                       | Description  | Technology  |
|----------|---------------------------------|--|---|
| 1        | User Interface                  | User can interact with the app using MIT App   | HTML, CSS, JavaScript / Angular Js /React Js                  |
| 2        | Application Logic-1             | Logic for a process in the application   | Java / Python   |
| 3        | Application Logic-2             | Logic for a process in the application   | IBM Watson STT service  |
| 4        | Application Logic-3             | Logic for a process in the application   | IBM Watson Assistant  |
| 5        | Database                        | Data Type, Configurations etc.   | IBM Cloud   |
| 6        | Cloud Database                  | Database Service on Cloud  | IBM DB2, IBM Cloudant etc.                                    |
| 7        | File Storage                    | File storage requirements  | IBM Block Storage or Other StorageService or Local Filesystem |
| 8        | External API-1                  | Purpose of External API used in the application  | Open Weather Map API  |
| 9        | External API-2                  | Purpose of External API used in the application  | IBM Watson Platform, Node - Red                               |
| 10.      | Infrastructure (Server / Cloud) | Application Deployment on Local System / CloudLocal Server Configuration:<br>Cloud Server Configuration: | Local, Cloud Foundry, Kubernetes                              |

Table-2: Application Characteristics:

| S. No | Characteristics          | Description   | Technology                                     |
|-------|--------------------------|---|--|
| 1.    | Open-Source Frameworks   | <i>OpenWeatherMap, NODE-RED, IBM WATSON, MIT App Inventor</i>   | IoT, internet                                  |
| 2.    | Security Implementations | <i>Powerful security system for everyone's peace of mind No access data Hackers cannot access network</i> | Firewall, Firebase, cyber resiliency, strategy |
| 3.    | Scalable Architecture    | <i>EASY TO EXTEND THE NETWORK WITH THEAID OF THE BANDWIDTH OF THE NETWORK</i>                             | IBM Cloud                                      |
| 4.    | Availability             | <i>Available every time and everywhere 24/7 so long as the consumer is signed into the network.</i>       | IBM Cloud                                      |
| 5.    | Performance              | <i>AIDS MASSIVE RANGE OF USERS TO USE TECHNOLOGY</i>  | IBM Cloud                                      |

## 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 | Initialization of All required Services | USN-1             | Initialize services like OpenWeatherMap, NodeRED, etc. | 2            | High     | Manoj kumar<br>Harikrishnan<br>Jegan<br>Kirthik Saran |
| Sprint-2 | Implementation of Code                  | USN-2             | Coding to integrate all services as one                | 2            | High     |   |
| Sprint-3 | Hardware Integration                    | USN-3             | Hardware implementation on IoT Enabled Device          | 2            | Medium   |   |
| Sprint-4 | Optimization                            | USN-4             | Bug fixes and improvements                             | 2            | Low      |   |

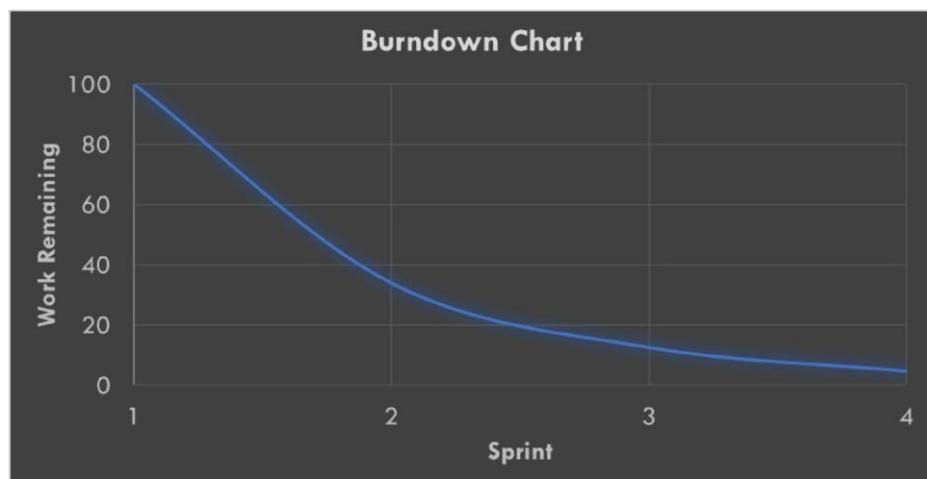
## 6.2 Sprint Delivery Schedule

Project Tracker, Velocity & Burndown Chart:

Project Tracker, Velocity & Burndown Chart: (4 Marks)

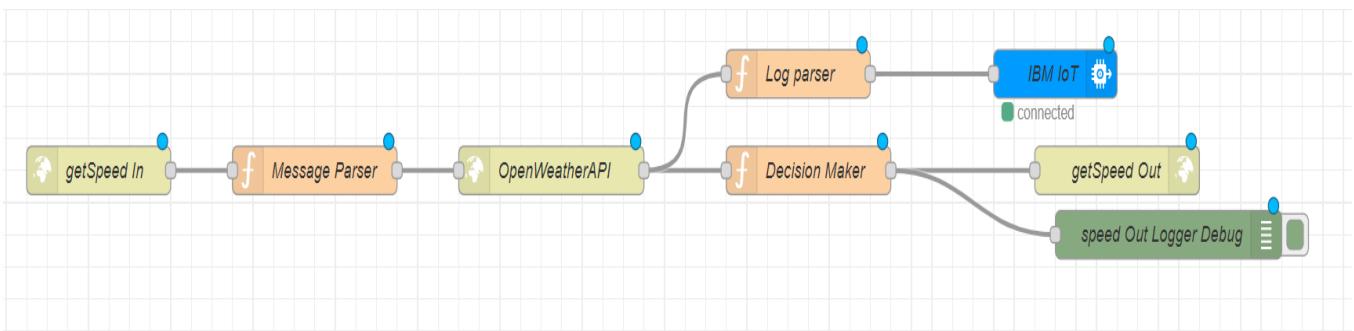
| Sprint   | Total Story Points | Duration | Sprint Start Date | Sprint End Date (Planned) | Story Points Completed (as on Planned End Date) | Sprint Release Date (Actual) |
|----------|--------------------|----------|-------------------|---------------------------|---|------------------------------|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

Burndown Chart:



## 7. CODING AND SOLUTIONING

### 7.1 Feature 1 - GET SPEED FOR GIVEN LOCATION & CLIMATE



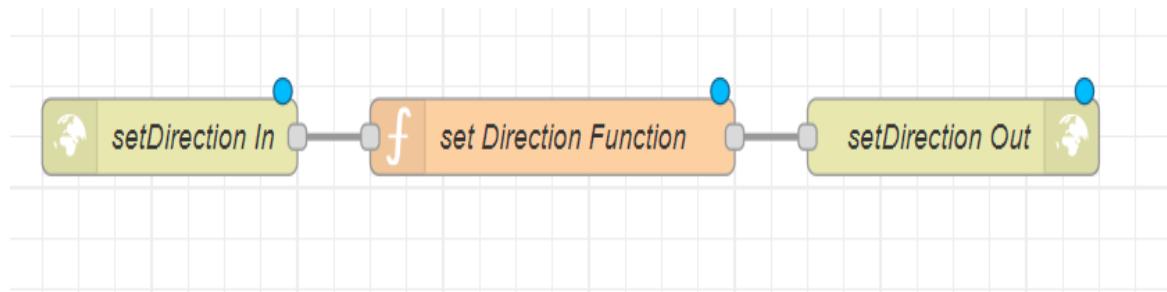
This part of Node RED flow accepts an http GET end point at "**/getSpeed**" from which the location, uid, hospital/school zone info are passed.

Message parser sets the required APIKEY for **OpenWeatherAPI** for the next block.

This data is then passed onto Decision Maker which makes all the decisions regarding the message to be output at the display and sends it as a http response.

This data is displayed at the microcontroller. Thus, a lot of battery is saved due to lesser processing time.

## 7.2 Feature 2 - SET DIRECTION REMOTELY FOR A GIVEN SIGN BOARD



This part of Node RED flow accepts an **http GET** end point at "**/setDirection**" from which the uid and direction information are passed by the respective authorities. **Set Direction** Function block adds the direction information to the database and returns the same as an http response. This data is sent to the microcontroller along with the "**/getSpeed**" path and the microcontroller displays it.

## **8. TESTING**

### **8.1 Test Cases**

#### **❖ TEST CASE 1**

Clear weather - Usual Speed Limit.

#### **❖ TEST CASE 2**

Foggy Weather - Reduced Speed Limit.

#### **❖ TEST CASE 3**

Rainy Weather - Further Reduced Speed Limit.

#### **❖ TEST CASE 4**

School/Hospital Zone - Do not Honk sign is displayed.

### **8.2 User Acceptance Testing**

Dynamic speed & diversion variations based on the weather and traffic helps user to avoid traffic and have a safe journey home. The users would welcome this idea to be implemented everywhere.

## **9. RESULTS**

### **9.1 Performance Metrics**

Based on the IBM pack we chose, 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**

- 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 systems.
- Dynamic Sign updating.
- School/Hospital Zone alerts

- DISADVANTAGES**

- The size of the display determines the requirement of the micro controller
- Dependent on OpenWeatherMap API and hence the speed reduction 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 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) could result in smoother traffic flows and, what is more important, in increasing a driver's awareness of the road situation.

## **13. APPENDIX**

- **GITHUB:**

**<https://github.com/IBM-EPBL/IBM-Project-34101-1660231714>**

- **SOURCE CODE**

```
#include <WiFi.h>
#include <HTTPClient.h>
#include <Adafruit_GFX.h>
#include <Adafruit_ILI9341.h>
#include <string.h>

const char* ssid = "Wokwi-GUEST";
const char* password = "";
```

```

#define TFT_DC 2
#define TFT_CS 15
Adafruit_ILI9341 tft = Adafruit_ILI9341(TFT_CS, TFT_DC);

String myLocation = "Chennai,IN";
String usualSpeedLimit = "70"; // kmph

int schoolZone = 32;
int hospitalZone = 26;

int uid = 2504;

String getString(char x)
{
    String s(1, x);
    return s;
}

String stringSplitter1(String fullString,char delimiter='$')
{
    String returnString = "";
    for(int i = 0; i<fullString.length();i++) {
        char c = fullString[i];
        if(delimiter==c)
            break;
        returnString+=String(c);
    }
    return(returnString);
}

String stringSplitter2(String fullString,char delimiter='$')
{
    String returnString = "";
    bool flag = false;
    for(int i = 0; i<fullString.length();i++) {
        char c = fullString[i];
        if(flag)
            returnString+=String(c);
        if(delimiter==c)
            flag = true;
    }
    return(returnString);
}

void rightArrow()

```

```

{
    int refX = 50;
    int refY = tft.getCursorY() + 40;

    tft.fillRect(refX,refY,100,20,ILI9341_RED);
    tft.fillTriangle(refX+100,refY-
30,refX+100,refY+50,refX+40+100,refY+10,ILI9341_RED);
}

void leftArrow()
{
    int refX = 50;
    int refY = tft.getCursorY() + 40;

    tft.fillRect(refX+40,refY,100,20,ILI9341_RED);
    tft.fillTriangle(refX+40,refY-
30,refX+40,refY+50,refX,refY+10,ILI9341_RED);
}

void upArrow()
{
    int refX = 125;
    int refY = tft.getCursorY() + 30;

    tft.fillTriangle(refX-
40,refY+40,refX+40,refY+40,refX,refY,ILI9341_RED);
    tft.fillRect(refX-15,refY+40,30,20,ILI9341_RED);
}

String APICall() {
    HTTPClient http;

    String url = "https://node-red-nwmrt-2022-11-04.eu-
gb.mybluemix.net/getSpeed?";
    url += "location="+myLocation+"&";
    url += "schoolZone="+String(digitalRead(schoolZone)+(String)"&";
    url +=
"hospitalZone="+String(digitalRead(hospitalZone)+(String)"&";
    url += "usualSpeedLimit="+String(usualSpeedLimit+(String)"&";
    url += "uid="+String(uid);
    http.begin(url.c_str());
    int httpResponseCode = http.GET();

    if (httpResponseCode>0) {
        String payload = http.getString();
        http.end();
    }
}

```

```
        return(payload);
    }
    else {
        Serial.print("Error code: ");
        Serial.println(httpResponseCode);
    }
    http.end();
}

void myPrint(String contents) {
    tft.fillScreen(ILI9341_BLACK);
    tft.setCursor(0, 20);
    tft.setTextSize(4);
    tft.setTextColor(ILI9341_RED);
    //tft.println(contents);

    tft.println(stringSplitter1(contents));
    String c2 = stringSplitter2(contents);
    if(c2=="s") // represents Straight
    {
        upArrow();
    }
    if(c2=="l") // represents left
    {
        leftArrow();
    }
    if(c2=="r") // represents right
    {
        rightArrow();
    }
}
}

void setup() {
    WiFi.begin(ssid, password, 6);

    tft.begin();
    tft.setRotation(1);

    tft.setTextColor(ILI9341_WHITE);
    tft.setTextSize(2);
    tft.print("Connecting to WiFi");

    while (WiFi.status() != WL_CONNECTED) {
        delay(100);
        tft.print(".");
    }
}
```

```
tft.print("\nOK! IP=");
tft.println(WiFi.localIP());
}

void loop() {
    myPrint(APICall());
    delay(100);
}
```