SIGNS WITH SMART CONNECTIVITY FOR BETTER ROAD SAFETY

IBM PROJECT REPORT

Team ID - PNT2022TMID27681

SUBMITTED BY

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Final Deliverables Report

Date	20.11.2022
Team ID	PNT2022TMID27681
Project Name	Signs with Smart Connectivity for Better Road Safety

Team members and their Contributions:

Name	Roll no	Contribution
PONNARASAN K	311419104064	CREATED SOURCE CODE FOR THE WOKWISIMULATOR AND MIT APP CODE.
MANIKANDAN M	311419104055	CREATED NODE RED AND IOT WATSON PLATFORM.
MATHAN KUMAR B	311419104056	PROJECT REPORT MAKING PROCESS AND GATHERINGIDEAS FOR CREATING PROJECT.
PON SURYA K	311419104065	WORKING IN NODE RED FLOW AND IBM CLOUD DEPLOYMENT.

Introduction:

1. Sprint 1 – Create and initialize accounts in various public APIs like OpenWeatherMap API, and write a Python program that outputs results given the inputs like weather and location.
2. Sprint 2 – Push data from local code to cloud
3. Sprint 3 – Hardware & Cloud integration
4. Sprint 4 – UI/UX Optimization & Debugging

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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

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
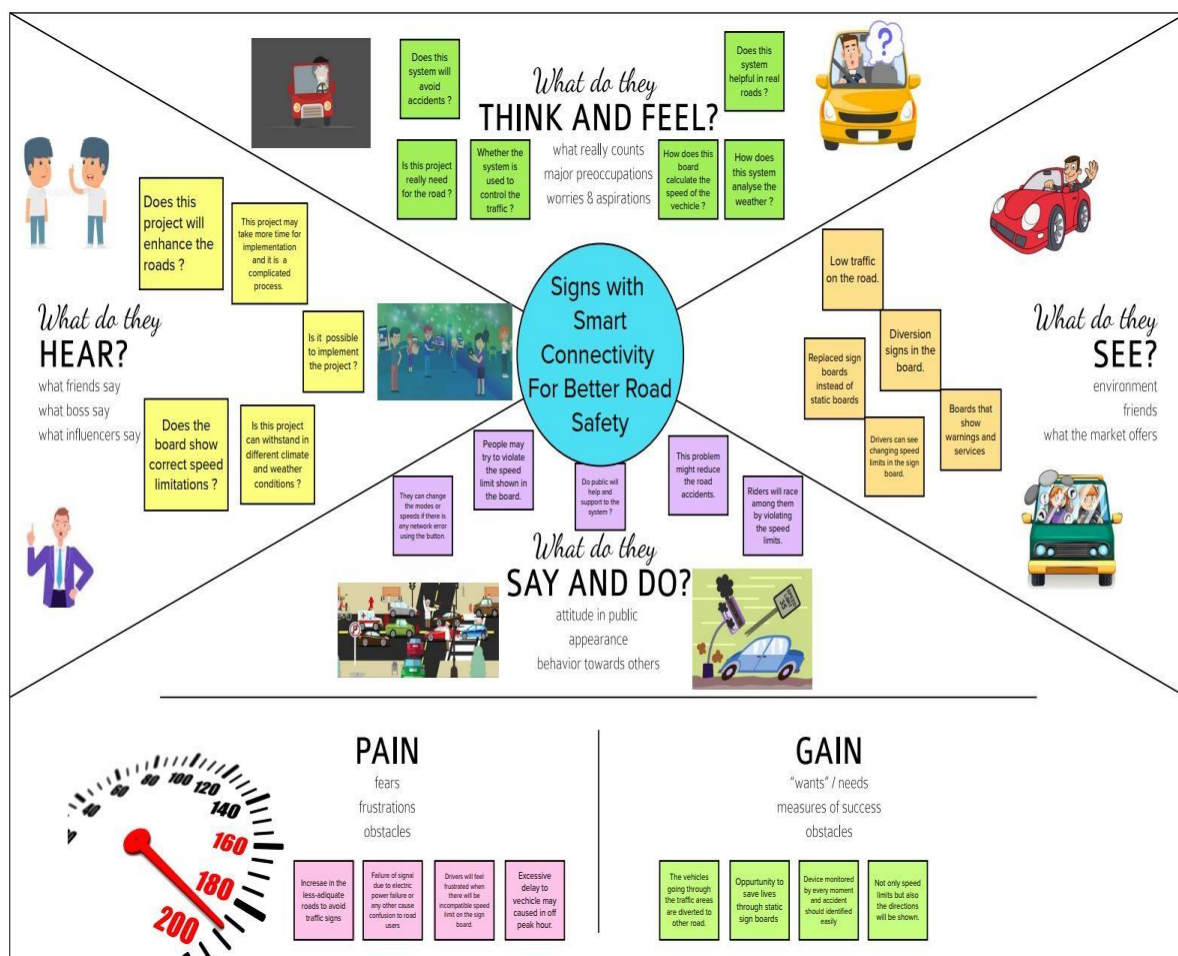
3.2 Ideation & Brainstorming Map

3.3 Proposed Solution

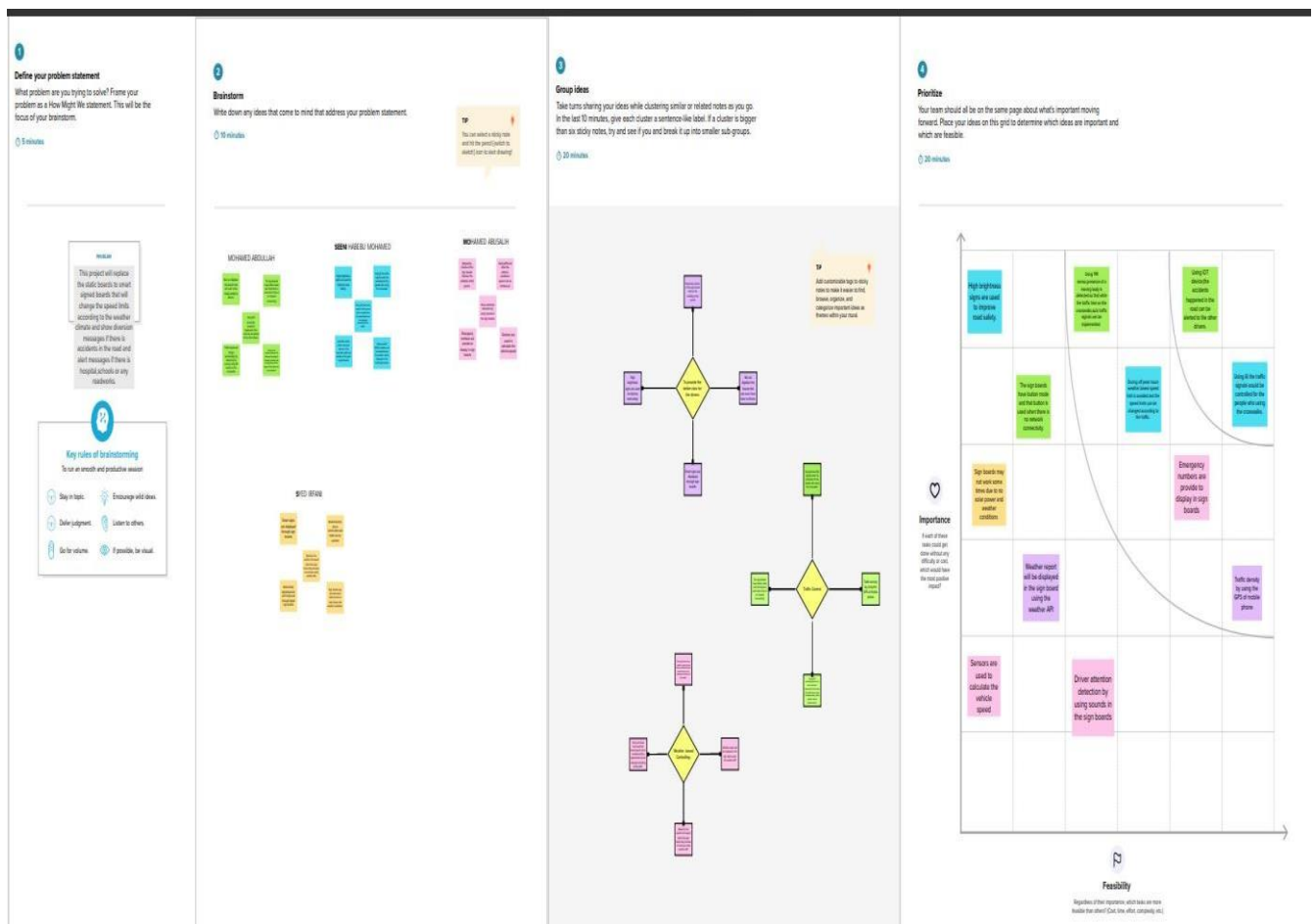| S.No.	Parameter	Description
1.	Problem Statement	To replace the static signboards, smart connected sign boards are used.
		These smart connected sign boards get the speed limitations from a web app using weather API and update automatically.
		Based on the weather changes the speed may increase or decrease
		Based on the traffic and fatal situations the diversion signs are displayed.
		Guide (Schools), Warning and Service (Hospitals, Restaurant) signs arealso displayed accordingly.
		Different modes of operations can be selected with the help of buttons.
2.	Idea 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 willbe 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

S.No.	Parameter	Description
		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 trafficwill be analyzed immediately. Accordingly, the sign of the traffic signal will be changed. This in turn reduces the frequent changing of the traffic signs even if the pedestrians are not present.
3.	Novelty	Generic Sign board for all applications that uses both buttons and web service for updation. Pedestrians are given the access to request the sign change of the signal to cross the road
4.	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	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

Project Title : Signs With Smart Connectivity For Better Road Safety

Problem Solution Fit

Team ID: PNT2022TMID27681

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) `CS`

Who is your customer?
i.e. working parents of 0-5 y.o. kids

1. Passengers
2. This is useful for drivers those who are travelling Different road structures.

6. CUSTOMER CONSTRAINTS `CC`

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.

Customers no need to spend any money, power, network Connection. These project will available anytime until it gets damaged.

5. AVAILABLE SOLUTIONS `AS`

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.

This project can with stand better than man made painted signs.
This project gives proper and clear understanding traffic signs and day to day current weather condition.

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS `J&P`

Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.

1. It educates people about traffic signs who are travelling in roads.
2. Showing different weather conditions and Indicating Temperature Values for passenger Convenience.

9. PROBLEM ROOT CAUSE `RC`

What is the real reason that this problem exists?
What is the back story behind the need to do this job?
i.e. customers have to do it because of the change in regulations.

Most people are not following traffic conditions & not trying to have knowledge about various traffic signs. Back story: Most of the people forget to wear seat belts And using mobile phones during travelling due to this This type of behaviour it leads to major road accidents.

7. BEHAVIOUR `BE`

What does your customer do to address the problem and get the job done?
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)

The Digital signs educating the customers and the smart Weather condition detection, this helps the customer to address the problems and get job done.

Focus on J&P, tap into BE, understand RC

3. TRIGGERS `TR`

What triggers customers to act? i.e. seeing their neighbour installing panels, reading about a more efficient solution in the news.

1. Not every people have knowledge about various traffic signs. so, it helps some people about the different traffic signs.
2. Conditions of the weather can't be predictable in some of the times. so it shows temperature values to the people who are travelling in roads.

10. YOUR SOLUTION

If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.
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.

Nowadays road signs and speed limits are static, road signs and speed limits can't be changed in some cases. If we replace static

8. CHANNELS of BEHAVIOUR

1.1 ONLINE
What kind of actions do customers take online? Extract online channels from #7 Customers can address their feedback through app or mail to get their job done.

1.2 OFFLINE
What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.
Customer can address their feedback through toll free number or text messaging.

4. EMOTIONS: BEFORE / AFTER

EM

How do customers feel when they face a problem or a job and afterwards?
i.e. lost, insecure > confident, in control- use it in your communication strategy & design.

- Some people don't have basic knowledge about various traffic signs & cannot
  Predict weather conditions while travelling.so, due to that most of the road accidents happening.
  After implementing this project it helps and educate the people about various traffic signs & indicating the current weather condition to the passengers. Due to this we can prevent major road accidents.

signs with dynamic signs, the signs can be changed at any time and anywhere, even we can change the signs during a sudden change in weather conditions or if any accidents happened we can change the signs & tell the people to have another route or direction. If we replace ordinary signs with smart signs a large number of happening accidents can be reduced and we can save a lot of time by reducing the traffic. Even this type of system is helpful for education and medical institutions.

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-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 signscorrectly 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 respectto time.
NFR-2	Security	Should be secure enough that only the intendedmessages are displayed in the display.
NFR-3	Reliability	Should convey the traffic information correctly.
NFR-4	Performance	Display should update dynamically whenever theweather 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 onservers horizontally.

5. PROJECT DESIGN

5.1 Data Flow Diagram
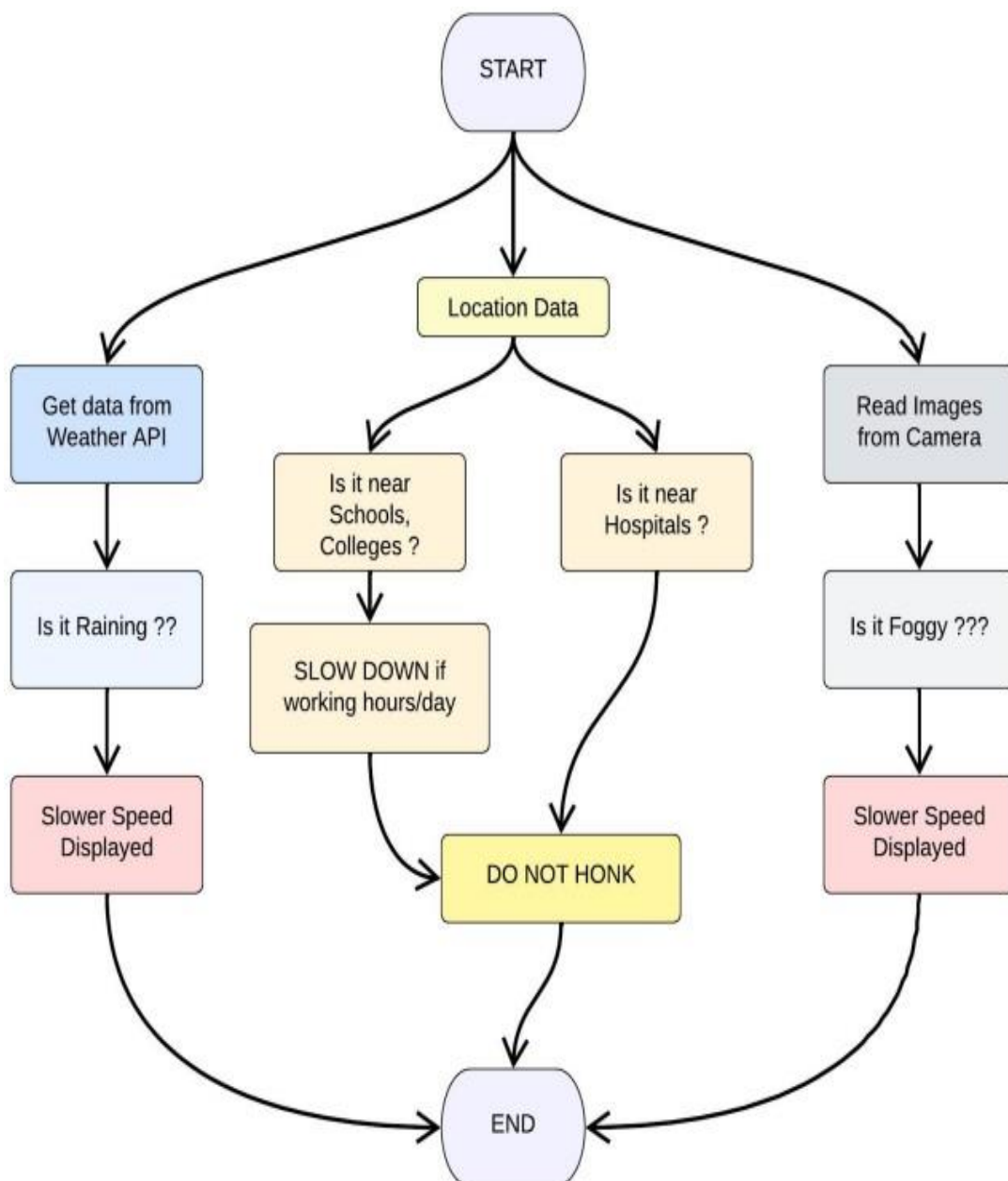
5.2 Solution & Technical Architecture

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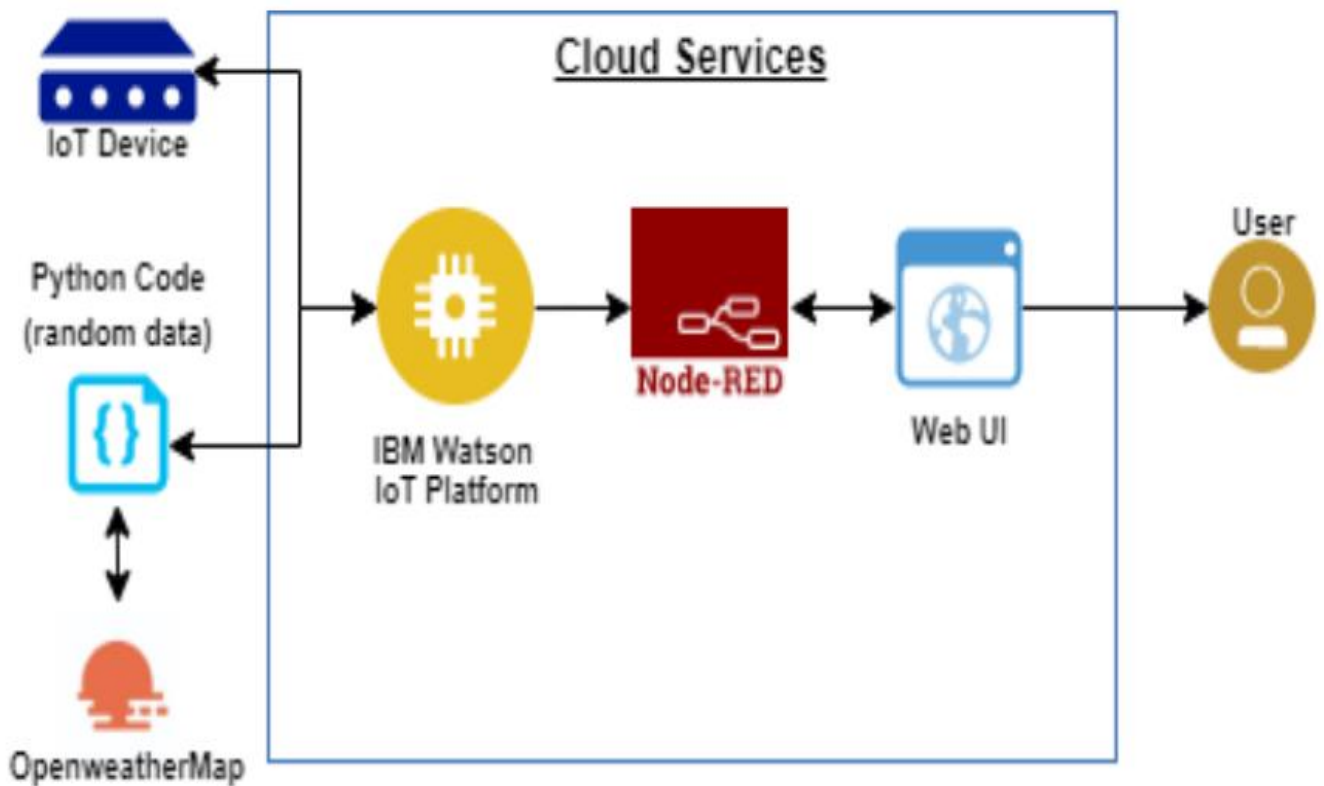
Following is the Solution Built

Table-1 : Components & Technologies:

S.No	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: Cloud Server Configuration:	Local, Cloud Foundry, Kubernetes

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Table-2: Application Characteristics:

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

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5.3 User Stories

SCENARIO: Browsing, booking, attending, and rating a local city tour	Entice — How does someone initially become aware of this process?	Enter — What do people experience as they begin the process?	Engage — In the core moments in the process, what happens?	Exit — What do people typically experience as the process finishes?	Extend — What happens after the experience is over?
Steps — What does the person (or group) typically experience?	Customer sees available traffic signs and data / Customer must have right attitude about driving	They were get ready to follow a note that guides a direction towards safety / Get pre-idea of road infrastructure	Road display condition of road will be updated with the help of rain drop sensor / Provide a collection of data about traffic area / Speed limits also be submitted	People have information with regard to publicised instruction / Less than power and automatic updates are displayed	Record traffic offenses & provide existing data
Interactions — What interactions do they have at each step along the way? People: Who do they see or talk to? Places: Where are they? Things: What digital touchpoints or physical objects would they use?	Interaction with digital sign board / Sign boards placed mostly on demand areas	Features include access about the traffic / People will get updated with the traffic situation	Provide pre-functional record of specific voice note / Collecting information displayed on LED display	Dynamic sign board system helps to allow people predicting day to day comparities / Updates are done with less max power & auto-updates through sensors	Maintaining road events & displayed even in dark & low light area / Provides flexible services along long distances
Goals & motivations — At each step, what is a person's primary goal or motivation? ("Help me..." or "Help me avoid...")	Helps to know road condition is safe or not / Helps to know the speed limit and other update if any	Make a communication fast as possible / It helps the customer to reach on time by knowing roadway condition	Customer will be able to travel their journey with more updates on trending	To provide a communication strategy in the smart city manner / Helps to reach the destination safely or that time	To provide a congestion free traffic management
Positive moments — What steps does a typical person find enjoyable, productive, fun, motivating, delightful, or exciting?	Get new experience of smart city technology / Visual effect makes highly interaction	Make a travel peaceful	Prediction of data gives them a fair understanding help them to travel with a limit of speed	Flow of updates is quick and easy	Getting new information / Make great attention into environment
Negative moments — What steps does a typical person find frustrating, confusing, angering, costly, or time-consuming?	It is so difficult to understand, who are unaware of signs	Accessing of information takes some time	Lack of notes converting the analisation into confusing mode	Maintenance risky / There is chance of error in the transfer of data	Is it trust worthy?
Areas of opportunity — How might we make each step better? What ideas do we have? What have others suggested?	Helps to traveler behavior towards the awareness of travel	Making the travel easy through the idea notification	Improve the road safety measures	Data is useful in understanding the road user behavior & flow of traffic	To alert the drivers to reduce delay & congestion while travelling time

6. PROJECT PLANNING AND SCHEDULING

6.1 Sprint Planning & Estimation

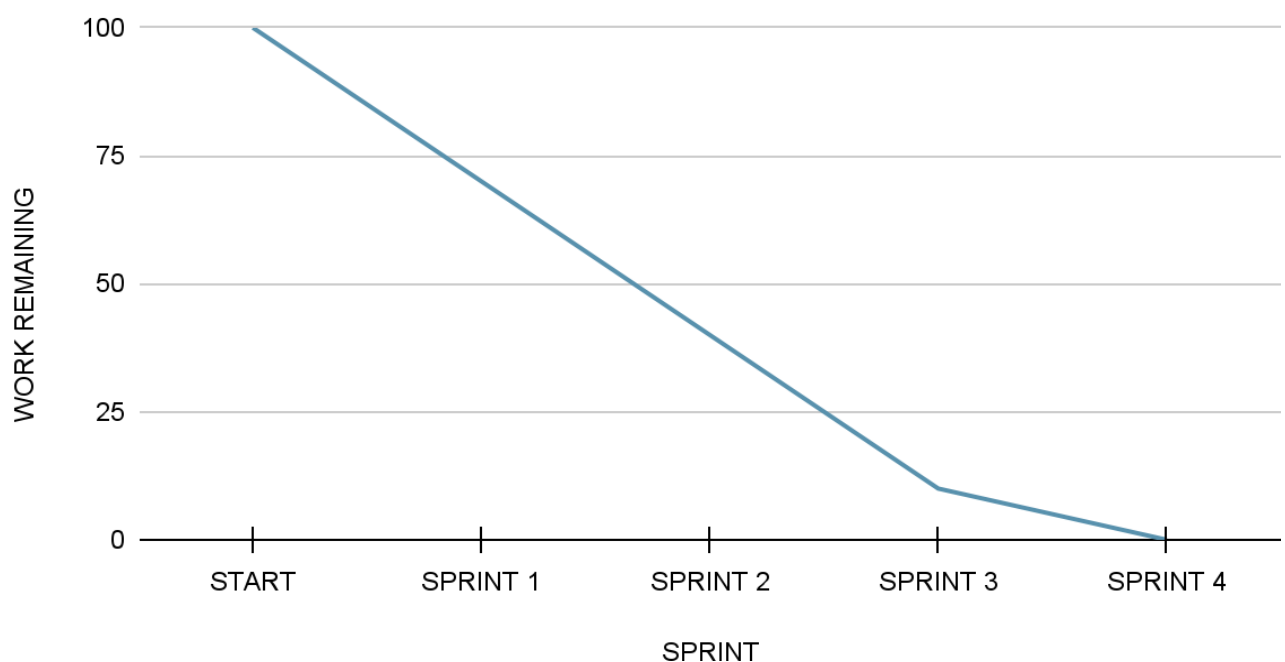| Sprint	Functional Requirement (Epic)	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Resources Initialization	Create and initialize accounts in various public APIs like OpenWeatherMap API.	1	LOW	PONNARASAN.K MATHAN KUMAR.B MANIKANDAN.M PON SURYA.K
Sprint-1	Local Server/Software Run	Write a Python program that outputs results given the inputs like weather and location.	1	MEDIUM	PONNARASAN.K MATHAN KUMAR.B MANIKANDAN.M PON SURYA.K
Sprint-2	Push the server/software to cloud	Push the code from Sprint 1 to cloud so it can be accessed from anywhere	2	MEDIUM	PONNARASAN.K MATHAN KUMAR.B MANIKANDAN.M PON SURYA.K
Sprint-3	Hardware initialization	Integrate the hardware to be able to access the cloud functions and provide inputs to the same.	2	HIGH	PONNARASAN.K MATHAN KUMAR.B MANIKANDAN.M PON SURYA.K
Sprint-4	UI/UX Optimization & Debugging	Optimize all the shortcomings and provide better user experience.	2	LOW	PONNARASAN.K MATHAN KUMAR.B MANIKANDAN.M PON SURYA.K

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6.2 Sprint Delivery Schedule

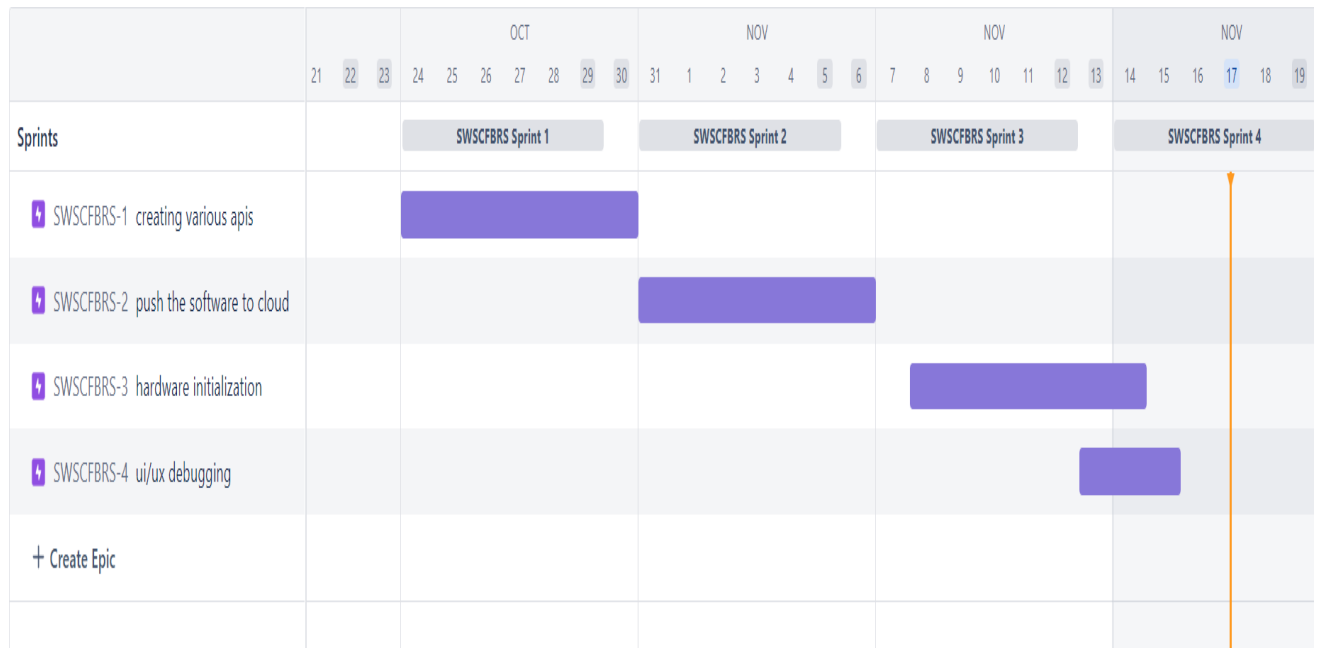Project Tracker, Velocity & Burndown Chart:

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	21 NOV 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	21 NOV 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	21 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	21 Nov 2022

Burndown Chart:

Balance Work

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6.3 Reports from JIRA Software

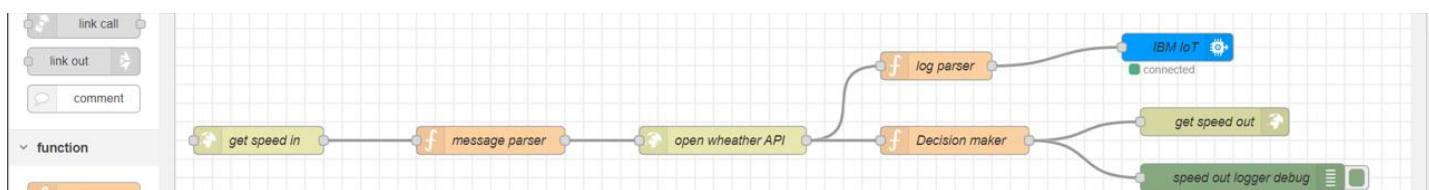|		OCT	NOV	NOV	NOV
		21 22 23 24 25 26 27 28 29 30	31 1 2 3 4 5 6	7 8 9 10 11 12 13	14 15 16 17 18 19
Sprints		SWSCFBRS Sprint 1	SWSCFBRS Sprint 2	SWSCFBRS Sprint 3	SWSCFBRS Sprint 4
SWSCFBRS-1 creating various apis					
SWSCFBRS-2 push the software to cloud					
SWSCFBRS-3 hardware initialization					
SWSCFBRS-4 ui/ux debugging					
+ Create Epic					

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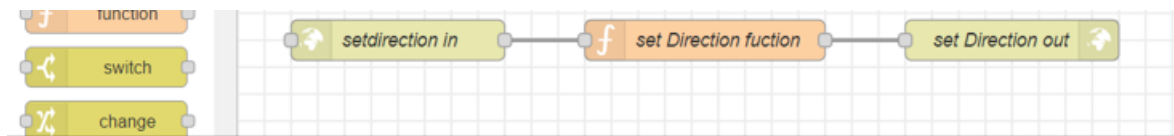
This part of Node RED flow accepts an **http GET** end point at **"/setDirection"** from which the uid and direction information are passed by the respective authorities**. Set Direction** Function block adds the direction information to the database and returns the same as an http response. This data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

- **DISADAVNTAGES**
  - 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.

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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

- **GITHUB AND PROJECT DEMO LINK**
  https://github.com/IBM-EPBL/IBM-Project-12604-1659454869

- **DEMO VIDEO DOWNLOAD LINK**

  https://youtu.be/f3PKb8N_2TA

- **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);
}
```

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