



SIGNS WITH SMART CONNECTIVITY FOR BETTER ROAD SAFETY

IBM PROJECT REPORT

Team ID - PNT2022TMID18146

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Final Deliverables Report

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Team ID	PNT2022TMID18146
Project Name	Signs with Smart Connectivity for Better Road Safety

Team members and their Contributions:

Name	Roll no	Contribution
SONIYA B	201903156	CREATED SOURCE CODE FOR THE WOKWI SIMULATOR AND MIT APP CODE.
KIRTHIKA M	201903076	CREATED NODE RED AND IOT WATSON PLATFORM.
KARUNYA VARDANA S	201903073	PROJECT REPORT MAKING PROCESS AND GATHERING IDEAS FOR CREATING PROJECT.
SINDHUJA T	201903146	WORKINGS 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

SMART SIGN CONNECTIVITY FOR ROAD SAFETY

MENTOR: AMRUTHA E

TEAM NAME: SSKK

TEAM LEADER: SONIYA B

TEAM MEMBERS:

SINDHUJA T

KIRTHIKA M

KARUNYA VARDANA S

TITLE	AUTHOR	METHODOLOGY	MERITS	DEMERITS	YEAR
Digitalization of highways for vulnerable road safety development with intelligent IoT sensors and machine learning (IEEE)	<ul style="list-style-type: none"> Rajesh Singh Rohit Sharma Shaik Vaseem Akram Anita Gehlot Dharam Buddhi Praveen Kumar Malik Rajeev Arya 	<ul style="list-style-type: none"> IOT AI 	<ul style="list-style-type: none"> Embedding the deep learning techniques in the vision node at the traffic junction and the highway lighting controller is able to deliver an intelligent system that provides sustained experience and management of the highways. 	<ul style="list-style-type: none"> Smart reflectors, adoption of renewable energy, developing vehicle-to-vehicle communication in vehicles, and smart lamp posts are a few recommendations for the implementation of digitalizing highways 	2021

LITERATURE SURVEY

TITLE	AUTHOR	METHODOLOGY	MERITS	DEMERITS	YEAR
IOT BASED SMART TRAFFIC MANAGEMENT SYSTEM (IJERT)	Rachana K P, Aravind R, Ranjitha M, Spoorthi Jwanita , Soumya	<ul style="list-style-type: none"> ❖ IOT ❖ Digital Image Processing ❖ MATLAB 	<ul style="list-style-type: none"> ❖ IOT based traffic management easily penalize traffic violators and help officials to identify unauthorized drivers. ❖ Reroute the ambulance to low congestion roads to get help medical care at the earliest 	<ul style="list-style-type: none"> ❖ Additional security measures are required ❖ Require High Tech network infrastructure 	2021

TITLE	AUTHOR	METHODOLOGY	MERITS	DEMERITS	YEAR
RELIABLE SMART ROAD SIGNS (IEEE)	Muhammed O. Saying, Chung-Wei Lin, Eunsuk Kang, Shinichi Shiraishi, and Tamer Basar	<ul style="list-style-type: none"> ❖ Machine Learning to recognize the surroundings and can use its strategic decisions on the information learnt ❖ Dedicated short range communication (DSRC) radios. ❖ Game theoretical Approaches 	<ul style="list-style-type: none"> ❖ Road – sign classification in adversarial environments ❖ The detection mechanism involves multiple performance metrics 	<ul style="list-style-type: none"> ❖ Need state of the art vision based road sign recognition algorithms for better reliability ❖ Relaxation to attacker's algorithm under Stackelberg Equilibrium leads to trigger of false alarm 	2019

TITLE	AUTHOR	METHODOLOGY	MERITS	DEMERITS	YEAR
Incomplete Road Information Imputation Using Parallel Interpolation to Enhance the Safety of Autonomous Driving. (IEEE)	<ul style="list-style-type: none"> KAIFENG GAO BOWEN WANG LEI XIAO GANG MEI 	<ul style="list-style-type: none"> IOT AI 	The proposed method is capable of efficiently and effectively imputating the incomplete road point cloud data that are induced by obstacle vehicles, and outperforms other interpolation algorithms and machine learning algorithms.	By scanning road information, LiDAR sensors can obtain high-precision road point cloud information map. However, LiDAR scanning is sensitive to weather conditions. In rainy, foggy, or snowy weather, the performance of LiDAR is not ideal. In addition, LiDAR cannot detect small obstacles, such as traffic signs that are 60 meters away. Because they occupy a lower scanning angle than the resolution of the LiDAR, the LiDAR cannot detect such obstacles.	2021

2.1 Existing problem

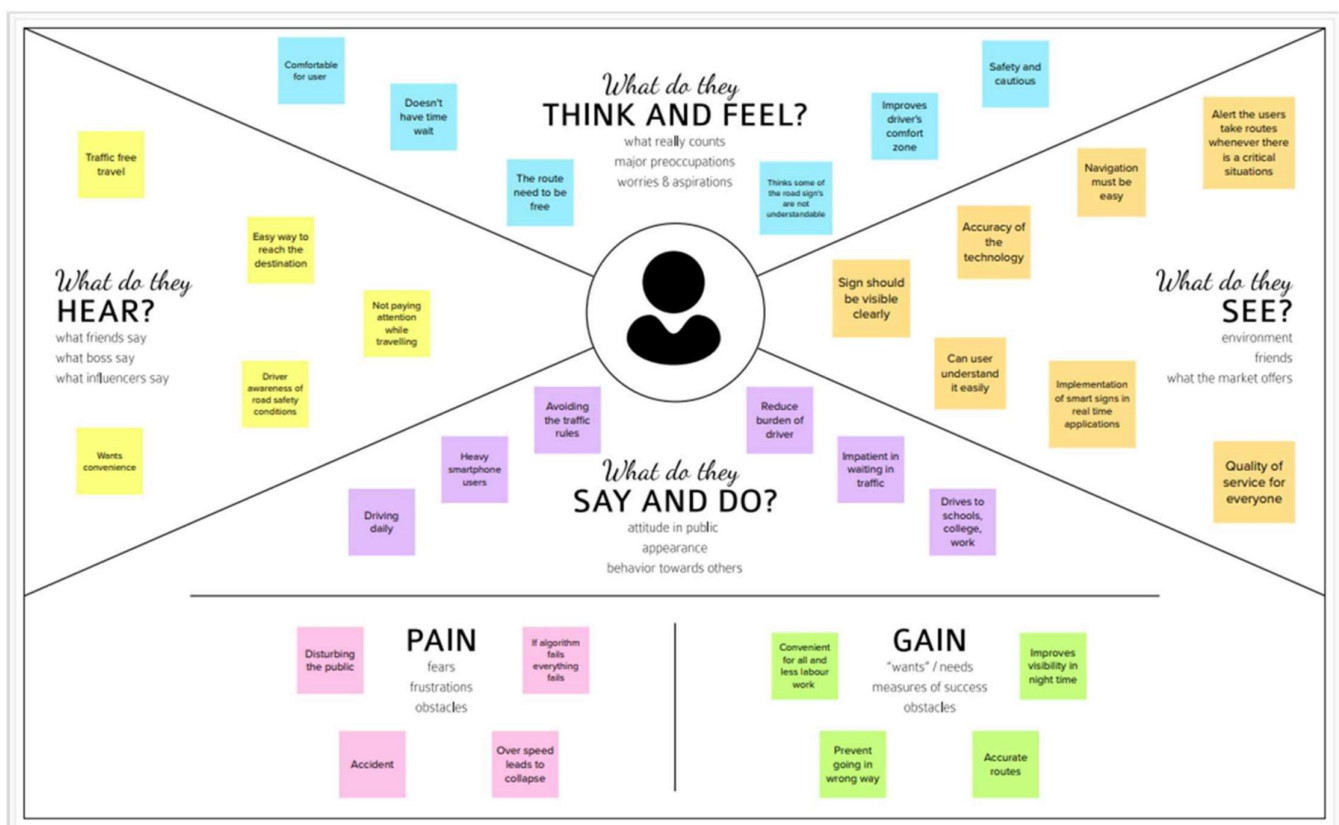
- Analysis of crash data has suggested a link between roadside advertising signs and safety.
- Research suggests that crash risk increases by approximately 25–29% in the presence of digital roadside advertising signs compared to control areas.
- On the other hand, static roadside advertising signs have 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 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

Soniya

Avoid drunk
and driving

Smart LED
lights are
visible from
far distances

denotes the
instant
information
on LED

can provide real-
time information
about the status
of the traffic light

checking the
condition of the
vehicle in
climated
regularly through
iot devices

automatic message
and warning sent to
emergency
services through
connected cars by
iot devices.

Kirthika

It alerts about
the upcoming
accident
prone zones

vehicle speed
exceeds more
than road speed
it generate
buzzer and alert
them

stable
technology for
monitoring
,maintenance
and repair of
roads

It works
perfectly in
climatic
conditions

ADAS is
considrabale to
drive about 36
billion euros.

Electronic are
always the
essential use for
no traffic path
and secure
roads

Karunya

Cost
efficient

Vehicle system
always collect
the details of the
vitals by inbuilt
sensors and
make access of it

It makes the user
aware nearby
hospitals,schools,etc.

aim to reduce
accidents around
the taffic light and
their violation
through real-time
monitoring

It alert the officilas
to nearest
emergency sevice
can reach there
within minimum
time

All this basically
helps to avoid
breakdowns
and prevent
accidents.

Sindhuja

Weather
monitoring

It helps in
reducing
the risksks
for accident

help to detect
temperature
both internal
as well as
external

knowing the
position of other
vehicle ,iot can
regonize the speed
and there is no
need for
emergency braking

It can reduce
more
accidents and
improve
circulation

suggest
speed limit
while
driving

3.3 Proposed Solution

S.No.	Parameter	Description
1.	Problem Statement	Replacing the static signs for roads by digital sign board for better navigation, avoid traffic and fatal situations like floods, natural calamities, etc.
2.	Idea description	By setting a digital sign with the help of IoT concepts and algorithms to improvise the system to digitalize the sign boards for reliable and effective for future.
3	Novelty / Uniqueness	<ul style="list-style-type: none"> • As it uses real time weather conditions the signs change according to current situations. • Even in extreme weather conditions these sign boards are clearly visible and help the drivers to navigate to their respective destination. • The speed limits are also got vary according to weather, or with respect to roads or any other locations like school zones, hospital areas, etc. • Signs will be displayed according to the locations like schools, hospitals, etc.
4	Social Impact / Customer Satisfaction	<ul style="list-style-type: none"> • This will useful for the traffic officers to regulate the traffic easily. • The customer satisfies by this as it shows the correct routes even though there is any problem in the way to their destination. • This will be useful for the beginners to learn the traffic regulations while traveling to different places.
5	Business Model (Revenue Model)	<ul style="list-style-type: none"> • With this model all the people get aware of the traffic rules and can drive safely. • It's a budget friendly and government support this creative ideation. • Every people get beneficial and can improve their lifestyle.
6	Scalability of the Solution	This model will greatly helpful in both day and night and even in extreme weather situations and reduce accidents.

3.4 Problem Solution fit

Problem -solution fit		Signs with Smart Connectivity for Better Road Safety	
Define CS, fit into CC	1. CUSTOMER SEGMENT(S) Who is your customer? All the people who travel on the road.	6. CUSTOMER CONSTRAINTS What constraints prevent your customers from taking action or limit their choices of solutions? Network connection, availability of required devices at all the roads. Amount to be spent and lack of skill to handle the technology are the constraints in establishing this smart board.	5. AVAILABLE SOLUTIONS 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 is an alternative to digital notetaking? At present, there is a board with static sign. There will be no frequent updating about the climate and speed. It results in many accidents and other issues as well. But using digital smart boards, these issues can be eliminated surely.
	2. JOBS-TO-BE-DONE / PROBLEMS Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides. The smart board will update the current climatic conditions and the speed limit to the passengers by using the sensors and also display in the web.	9. PROBLEM ROOT CAUSE What is the real reason that this problem exists? What is the back story behind the need to do this job? People can adopt this to ensure better road safety for themselves in this hectic busy life and to avoid accidents and fatal situations	7. BEHAVIOUR What does your customer do to address the problem and get the job done? time on volunteering work (i.e. Greenpeace) Customers should be alert while driving and travelling. They must be aware of the traffic rules and they should follow them strictly. They must value the human life, Avoid drink and drive.
Focus on J&P, fit into BE, understand RC	3. TRIGGERS What triggers customers to act? Nothing triggers. As everyone should use the road safely which is common to all, the travel should be safe enough. So, the smart board signs will alert them to travel safely.	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. As we employ API app and weather monitoring system, instant updation will be there about the prevailing climate, etc. IBM cloud is used to store the information and it will be much helpful to view the status. Warnings about the schools, hospitals and major landmarks will also be given by this board. Speed limits in the particular zone according to the existing climatic conditions will also be shown on the board. On the whole, it is one of the most advantageous system to adopt and follow.	8. CHANNELS of BEHAVIOUR 8.1 ONLINE What kind of actions do customers take online? The customers can message or mail about their queries to the respected authority and create some awareness videos and content about the road safety. 8.2 OFFLINE What kind of actions do customers take offline? Obeying the traffic rules is the primary job of our customer in offline mode because safety is prior to other things.
Identify strong TR & EM	4. EMOTIONS: BEFORE / AFTER How do customers feel when they face a problem or a job and afterwards? Fear, tensed, lack of instant thinking, etc.		Identify strong TR & E

4. 1. REQUIREMENT ANALYSIS

4.1 Functional Requirements

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Requirements	Traditional signs are replaced with digitalized sign boards which meets all the criteria.
FR-2	User Registration	The registration can be done via website or form or Gmail or LinkedIn
FR-3	User Conformation	The conformation can be done by phone calls, OTPs and Gmail.
FR-4	Payment Options	Payments can be done by bank transfers or net banking.
FR-5	Product delivery and installation	The installation will be depend on the road length and the condition of the road.
FR-6	Product feedback	Feedback can be given via forms, Gmail or websites.

4.2 Functional Requirements

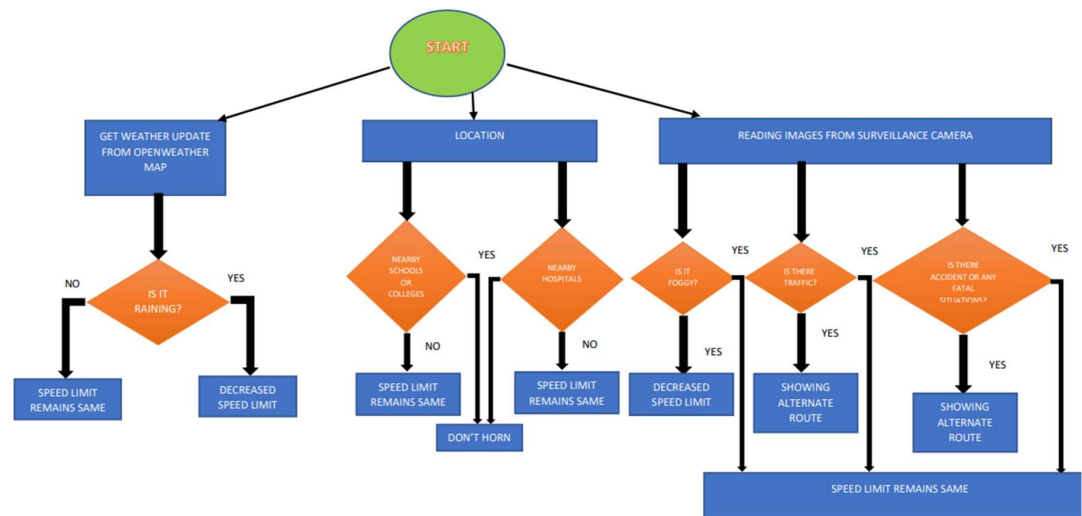
Non-functional Requirements:

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

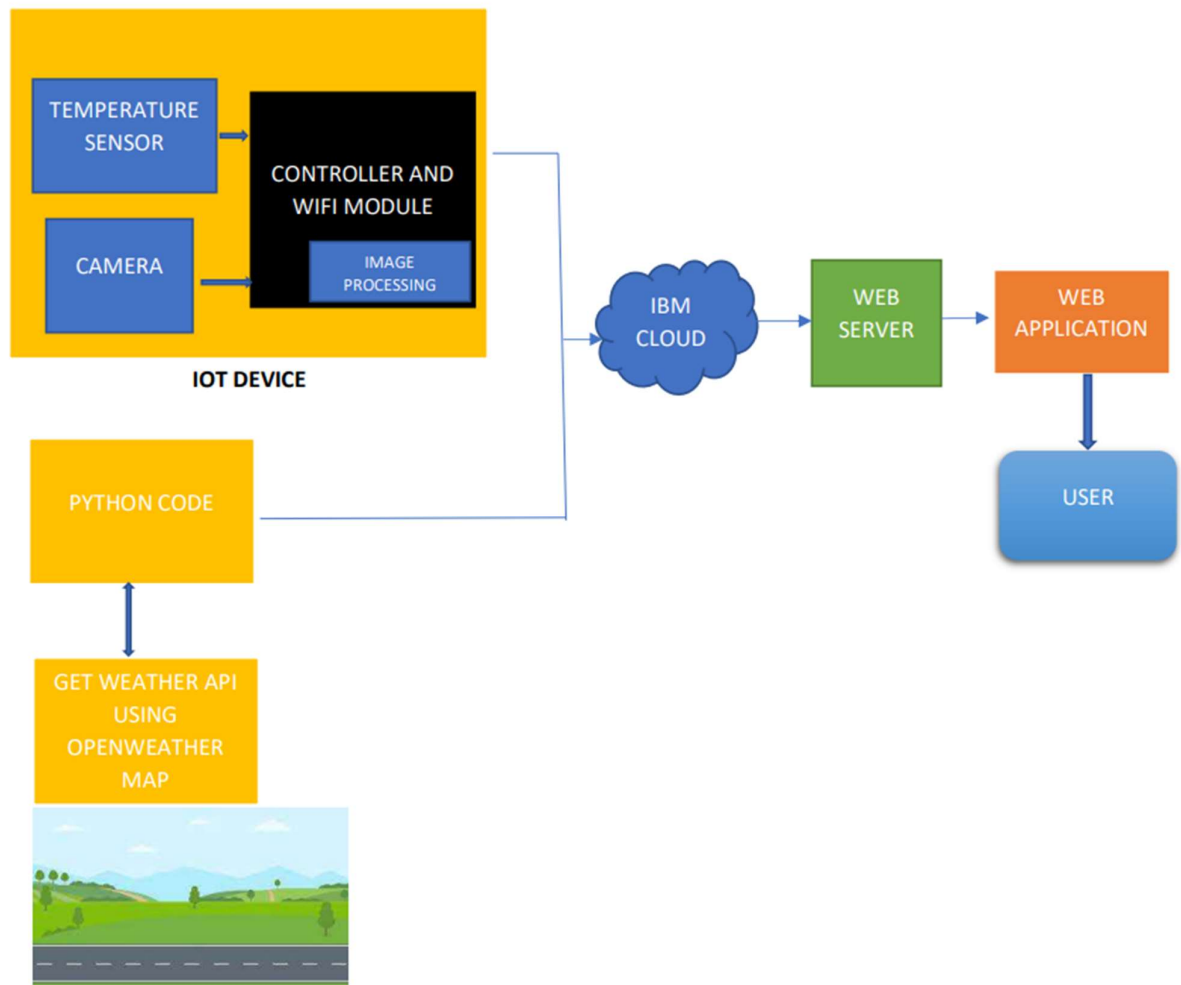
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Should be convenient, easy and dynamically change according to the users.
NFR-2	Security	The Safe System approach to road safety emphasizes safety-by-design through ensuring safe vehicles, road networks, and road users.
NFR-3	Reliability	High reliable and should convey the traffic information correctly.
NFR-4	Performance	<ul style="list-style-type: none"> • Should update dynamically whenever the weather or traffic values are updated. • Cost efficient • Better Traffic Management and Safety and prevent accidents.
NFR-5	Availability	This will be working 24/7 even in extreme weather conditions.
NFR-6	Scalability	It can be moved from a smaller to a larger operating system and the larger number of users that could be handled.

5. PROJECT DESIGN

5.1 Data Flow Diagram



5.2 Solution & Technical Architecture



Following is the Solution Built

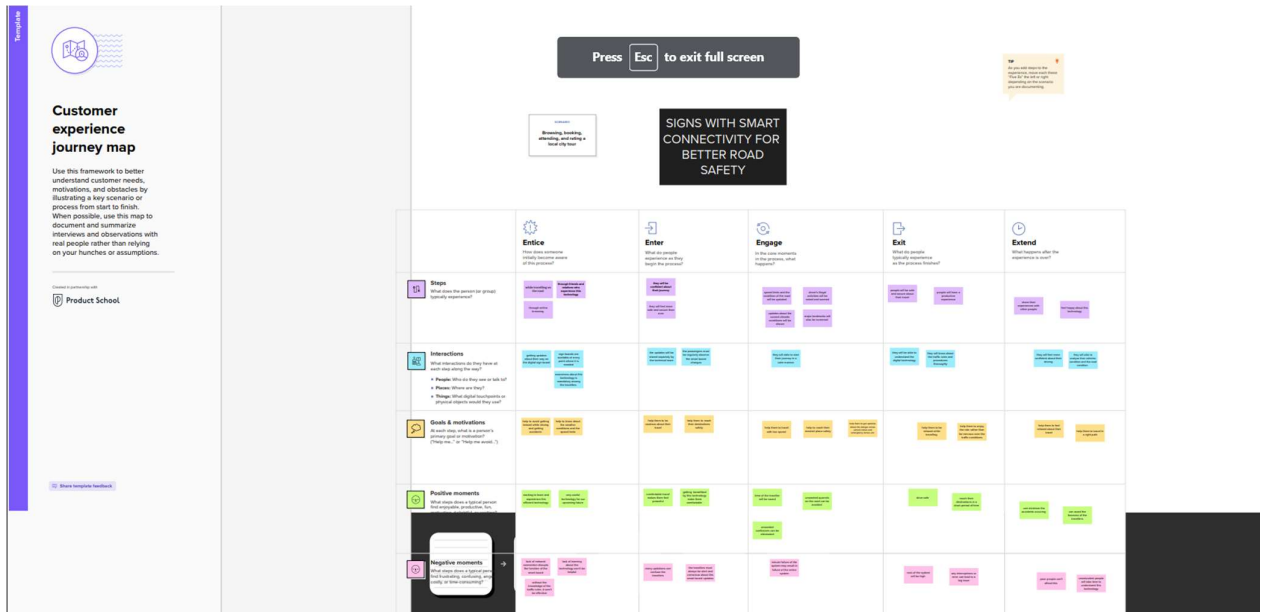
Table-1 : Components & Technologies:

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

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 THE AID 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

Product Backlog, Sprint Schedule and Estimation(4Marks)

Use the below template to create product backlog and sprint scheme 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	Soniya B Karunya Vardana S Kirthika M Sindhuja T
Sprint-1	Local Server/Software Run	Write a Python program that outputs results given the inputs like weather and location	1	MEDIUM	Soniya B Karunya Vardana S Kirthika M Sindhuja T
Sprint-2	Push the server/software to cloud	Push the code from Sprint1 to cloud so it can be accessed from anywhere	2	MEDIUM	Soniya B Karunya Vardana S Kirthika M Sindhuja T
Sprint-3	Hardware initialization	Integrate the hardware to be able to access the cloud functions and provide inputs to the same	2	HIGH	Soniya B Karunya Vardana S Kirthika M Sindhuja T

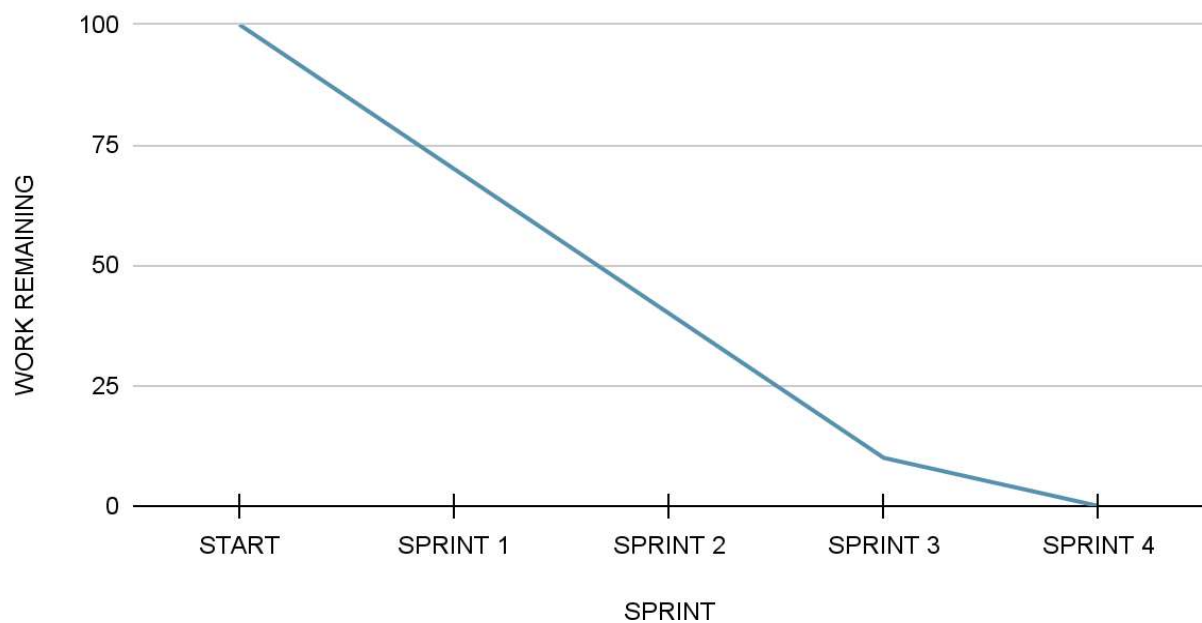
6.2 Sprint Delivery Schedule

Project Tracker, Velocity & Burndown Chart:

Project Tracker, Velocity & Burndown Chart:(4Marks) 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	6Days	24 Oct2022	29 Oct 2022	20	19 Nov 2022
Sprint-2	20	6Days	31 Oct 2022	05 Nov 2022	20	19 Nov 2022
Sprint-3	20	6Days	07 Nov 2022	12 Nov 2022	20	19 Nov 2022
Sprint-4	20	6Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

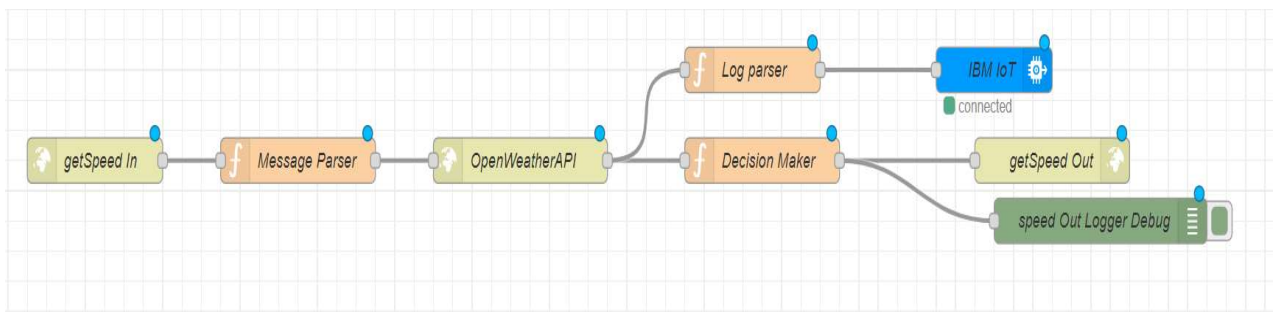
Burndown Chart:

Balance Work



7. CODING AND SOLUTIONING

7.1 Feature 1 - GET SPEED FOR GIVEN LOCATION & CLIMATE



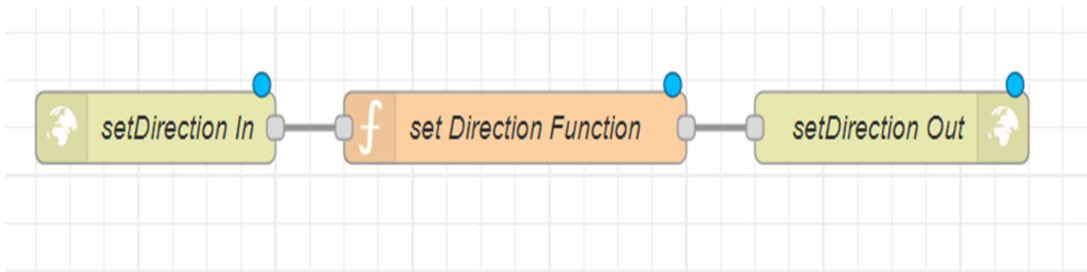
This part of Node RED flow accepts an http GET end point at **"/getSpeed"** from which the location, uid, hospital/school zone info are passed.

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.

A detailed documentation of all the workflows is available at the **following link**:

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 (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 LINK**

- <https://github.com/IBM-EPBL/IBM-Project-1623-1658403326>

- **PROJECT DEVELOPMENT PHASE LINK**

https://github.com/IBM-EPBL/IBM-Project-1623-1658403326/tree/main/PROJECT_DEVELOPEMENT_PHASE

- **SOURCE CODE – ESP 32**

```
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
TinyGPSPlus gps;
SoftwareSerial ss (3,4);
char n;
int a;
void setup() {
  Serial.begin(9600);
  ss.begin(9600);
  pinMode (2,INPUT);
  pinMode (6,OUTPUT);
  pinMode(11,OUTPUT);
  pinMode(10,OUTPUT);
  pinMode (9,OUTPUT);
  pinMode (12,OUTPUT); //ap
  digitalWrite(11,HIGH);
  digitalWrite(6,HIGH);
  attachInterrupt (digitalPinToInterrupt (2), piezo,CHANGE);
}
void loop() {
  n=Serial.read();
  Serial.println(" ");
  delay (200);
  if (n=='3') {
    digitalWrite(6,HIGH);
    digitalWrite(11,HIGH);
    digitalWrite(12,HIGH);
    delay(200);
    digitalWrite(12,LOW); }
  else if (n=='2'){
    digitalWrite(6,LOW);
    digitalWrite(11,LOW);
    digitalWrite(10,LOW);
    digitalWrite(9,LOW);
    digitalWrite(12,HIGH);
    delay(200);
    digitalWrite(12,LOW); }
  else if (n=='1'){
    analogWrite(11,100);
    analogWrite(6,100);
```

```
digitalWrite(12,HIGH);
delay(200);
digitalWrite(12,LOW);
}
}
displayInfo()
{
  if(gps.location.isValid()){
    Serial.print(gps.location.lat(), 6);
    Serial.print (F(", "));
    Serial.print(gps.location. lng(), 6); }
  else{
    Serial.print("10.305125");
    Serial.print(',');
    Serial.print("76.389582");
  }
  if (gps.date.isValid())
  {
    Serial.print(gps.date.month());
    Serial.print (F("/"));
    Serial.print(gps.date.day());
    Serial.print (F("/"));
    Serial.print(gps.date.year());
  }
  else
  {
    Serial.print(F("INVALID"));
  }
  Serial.print (F(" "));
  if (gps.time.isValid())
  {
    if (gps.time.hour() < 10)
    {
      Serial.print (F("0"));
      Serial.print(gps.time.hour());
      Serial.print(F(":"));
    }
    if (gps.time.minute() < 10)
    {
      Serial.print(F("0"));
      Serial.print (gps.time.minute());
```

```
Serial.print(F(":"));
}
if (gps.time.second() < 10)
{
  Serial.print(F("0"));
  Serial.print(gps.time.second());
  Serial.print(F("."));
```

```
}
if (gps.time.centisecond() < 10)
{
Serial.print(F("0"));
Serial.print(gps.time.centisecond());
}
}
else
{
// Serial.print (F("INVALID"));
}*/
Serial.println();
}
void piezo()
{
while (ss.available() > 0)
    if(gps.encode(ss.read()))
        displayInfo();
}
int a=0,b=0,c=0,d=0;
void setup() {
pinMode(D1, INPUT);
pinMode(D2, INPUT);
pinMode(D3, INPUT);
pinMode(D4, INPUT);
digitalWrite(D1,LOW);
digitalWrite(D2, LOW);
digitalWrite(D3, LOW);
digitalWrite(D4, LOW);
Serial.begin(9600);
}
void loop()
{
a=digitalRead(D1);
if (a==1) {
Serial.print("1"); }
b=digitalRead (D2);
if (b==1) {
Serial.print("2"); }
d=digitalRead(D4);
if (d==1)
{
Serial.print("3");
}
```