PROJECT REPORT

1. INTRODUCTION

1.1 Project Overview

The Project “TrafficTelligence: Advanced Traffic Volume Estimation with Machine Learning” where TrafficTelligence is an advanced system that uses machine learning algorithms to estimate and predict traffic volume with precision. By analyzing historical traffic data, weather patterns, events, and other relevant factors, TrafficTelligence provides accurate forecasts and insights to enhance traffic management, urban planning, and commuter experiences.

1.2 Purpose

- **Provide Accurate Traffic Predictions:**
  Deliver real-time, data-driven traffic volume estimates for urban areas to enhance decision-making.
- **Overcome Traditional Limitations:**
  Address the shortcomings of manual, delayed, and often unreliable traffic monitoring systems with automated, machine learning-based predictions.
- **Reduce Traffic Congestion:**
  Enable smarter traffic management to minimize congestion and improve urban mobility for all users.
- **Benefit Multiple Stakeholders:**
  Serve commuters, city planners, and logistics companies with actionable insights for route optimization, infrastructure planning, and efficient deliveries.
- **Enable Scalable Urban Mobility Solutions:**
  Support seamless integration across multiple cities or regions and allow easy expansion as new data sources become available.
- **Enhance Travel Efficiency and Satisfaction:**
  Help individuals and organizations save time, reduce costs, and experience more predictable, stress-free journeys.
- **Support Data-Driven Urban Planning:**
  Equip city authorities with critical insights needed for evidence-based planning and policy-making.
- **Facilitate Continuous Improvement:**
  Create a feedback loop where real-world usage and data help refine and optimize the traffic estimation system over time.

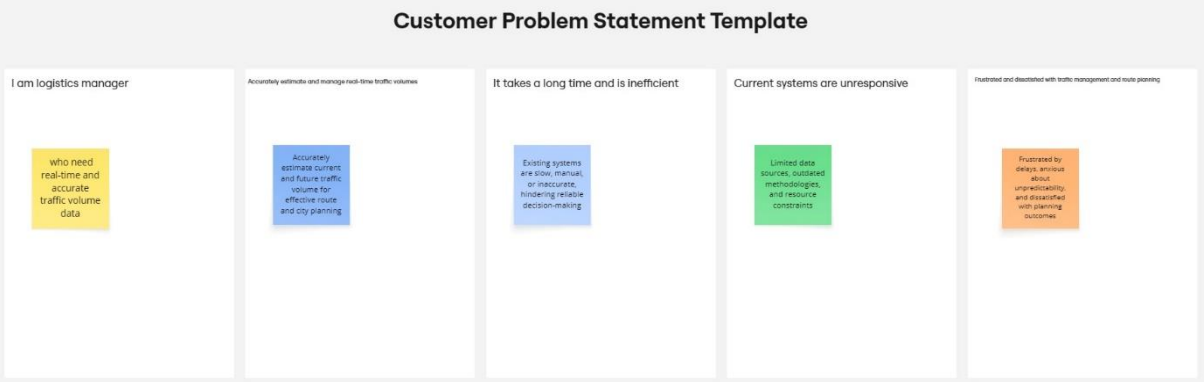
2. IDEATION PHASE

2.1 Problem Statement

Customer Problem Statement Template:

Create a problem statement to understand your customer's point of view. The Customer Problem Statement template helps you focus on what matters to create experiences people will love.

A well-articulated customer problem statement allows you and your team to find the ideal solution for the challenges your customers face. Throughout the process, you'll also be able to empathize with your customers, which helps you better understand how they perceive your product or service.



Reference: https://miro.com/templates/customer-problem-statement/

Problem Statement (PS)	I am (Customer)	I'm trying to	But	Because	Which makes me feel
PS-1	A city planner or commuter	Accurately predict and manage current and future traffic volumes	The data I receive is often outdated or incomplete	Current systems rely on slow, manual reporting methods	Frustrated, powerless, stressed
PS-2	A logistics manager or daily traveller	Plan optimal delivery routes or daily commutes	Traffic volumes are unpredictable and rarely automated	Traffic systems don't integrate real-time, diverse datasets	Anxious, dissatisfied, uncertain

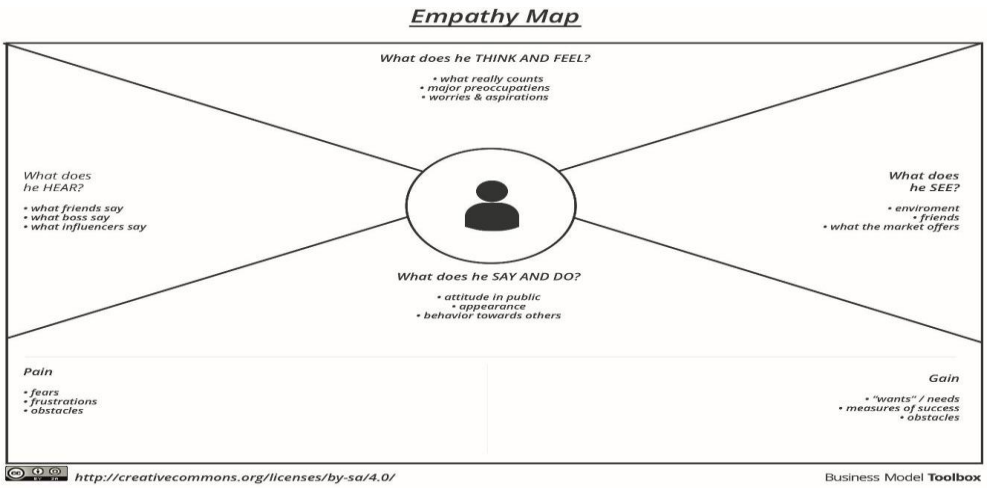
2.2 Empathy Map Canvas

Empathy Map Canvas:

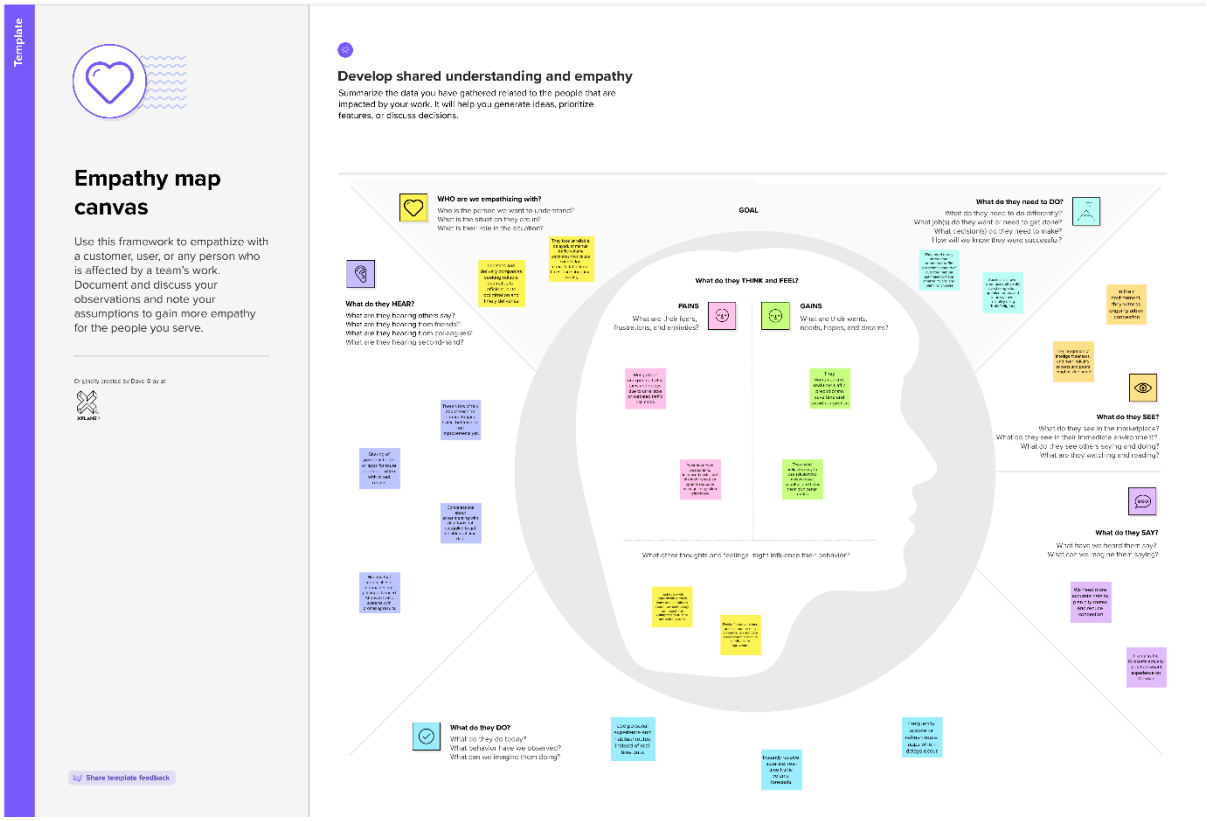
An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes.

It is a useful tool to helps teams better understand their users.
Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

Example:



Reference: https://www.mural.co/templates/empathy-map-canvas



2.3 Brainstorming

Brainstorm & Idea Prioritization Template:

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions.

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

Reference: https://www.mural.co/templates/brainstorm-and-idea-prioritization

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

Template

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare
1 hour to collaborate
2-8 people recommended

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

A **Team gathering**
Define who should participate in the session and send an invite. Share relevant information or pre work ahead.

B **Set the goal**
Think about the problem you'll be focusing on solving in the brainstorming session.

C **Learn how to use the facilitation tools**
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

1 Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

Accurately estimate real-time traffic volume using machine learning by integrating diverse data sources to address the limitations of traditional, slow, and inefficient traffic prediction methods, thus improving congestion management and commuter planning

Key rules of brainstorming

To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

Step-2: Brainstorm, Idea Listing and Grouping

2

Brainstorm

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

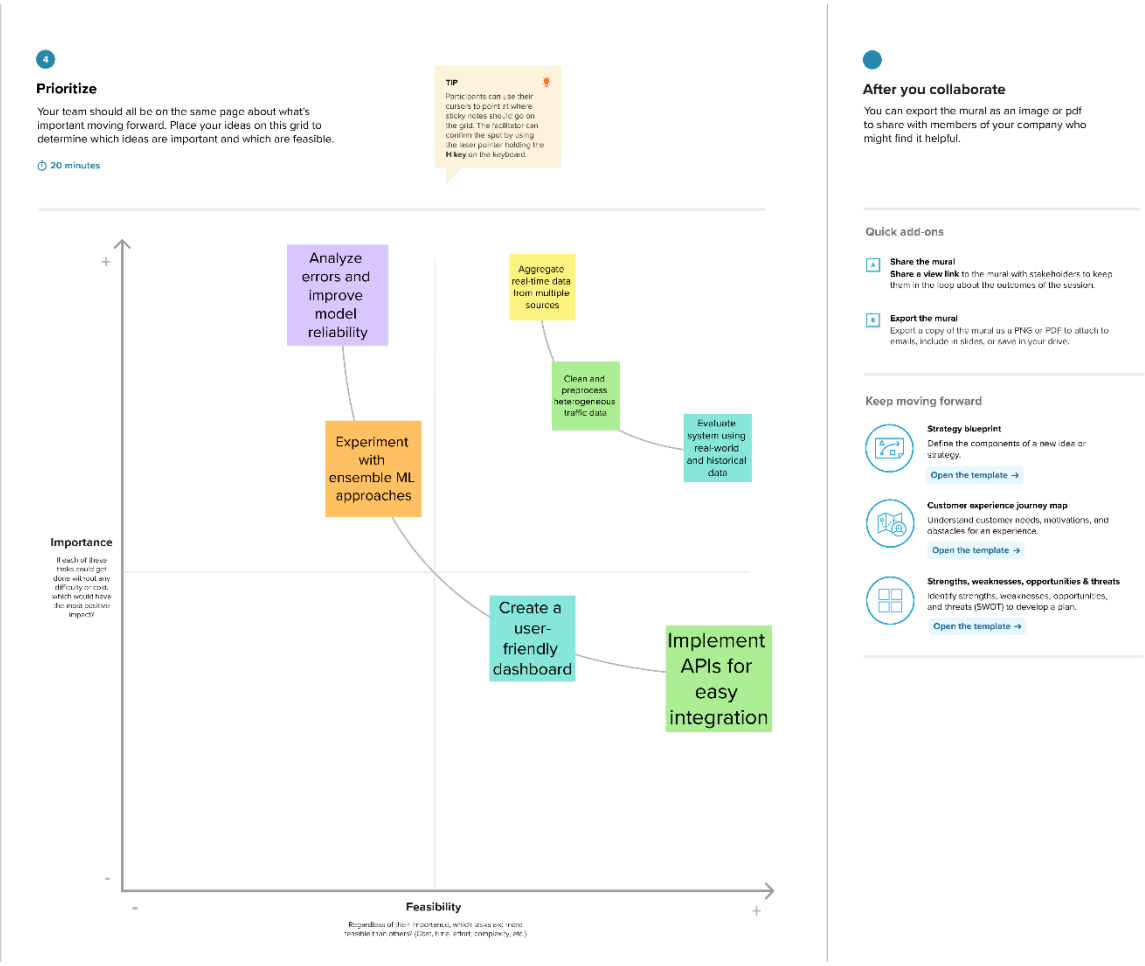
10 minutes

TIP

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

Shaik Ruksana	Syed Asha Sulthana	Teegala Navya Gopika	V.L.V.Sai Pavan
Data Collection & Integration	Machine Learning Model Development	System and Interface Implementation	Evaluation & Continuous Improvement
Aggregate real-time traffic data from sensors, cameras, and GPS sources.	Design and train ML models (e.g., regression, neural networks) for traffic volume estimation	Develop a user-friendly dashboard to visualize traffic predictions.	Test the system using real-world and historical data to validate performance.
Clean and preprocess heterogeneous data for consistency.	Experiment with ensemble approaches to improve predictive accuracy.	Implement APIs for data input and result dissemination to stakeholders.	Analyze errors and fine-tune models for higher reliability.

Step-3: Idea Prioritization



3. REQUIREMENT ANALYSIS

3.1 Solution Requirement

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Real-Time Data Collection	- Integrate with city sensors, traffic cameras, and GPS data sources. - Automate data ingestion and storage. - Support for multiple data formats (CSV, JSON, API streams).
FR-2	Machine Learning-Based Traffic Volume Estimation	- Develop and train predictive models for traffic volume. - Support continuous model retraining with new data. - Provide real-time prediction API endpoints for authorized users.
FR-3	Visualization and Reporting	- Design interactive dashboards for traffic volume visualization. - Implement historical and predictive reporting features. - Allow data export in standard formats (CSV, PDF
FR-4	User and System Integration	- Implement secure user authentication and role-based access. - Provide APIs for integration with external government and logistics

		platforms. - Enable notifications/alerts for significant traffic events.

Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The system must have an intuitive, easy-to-navigate interface for all user roles.
NFR-2	**Security**	Data must be protected via encryption in transit and at rest; adhere to local data privacy standards
NFR-3	**Reliability**	System should maintain >99% uptime (excluding planned maintenance) and offer error recovery.
NFR-4	**Performance**	Predictions and data retrieval must occur within ≤2 seconds for real-time user experience.
NFR-5	**Availability**	The service must be accessible 24/7, with support for redundant infrastructure to minimize downtime.
NFR-6	**Scalability**	Capable of handling increased data volumes and concurrent users as deployment expands to new regions or cities.

3.2 Data Flow Diagram

Data Flow Diagrams:

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

User Stories

Use the below template to list all the user stories for the product.

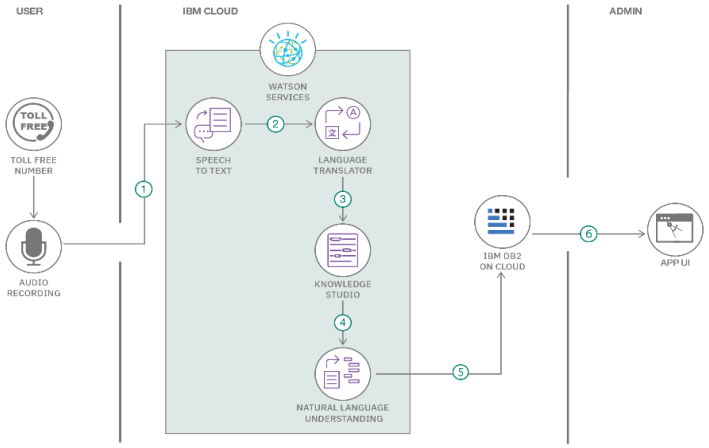
User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Commuter	Real-time traffic information display	USN-1	As a commuter, I want to view up-to-date traffic volumes on my route so I can choose the fastest path.	User sees present traffic data mapped and receives timely updates	High	Sprint-1

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
City Planner	Traffic analysis dashboard	USN-2	As a planner, I want to access a dashboard with historical and predicted traffic data for different zones.	Planners download/analyze reports showing accurate past/future trends.	High	Sprint-1
Logistics Manager	Route optimization through API	USN-3	As a logistics manager, I want to plug our software into an API to get real-time traffic estimates for routing.	API is accessible, responds in <1s, and returns accurate traffic predictions.	Low	Sprint-2
Data Scientist	Data quality monitoring	USN-4	As a data scientist, I want to monitor incoming data streams for quality and missing data alerts.	System flags gaps/anomalies, with alerts sent within 5 min of issues.	Medium	Sprint-1
Platform Admin	System health and uptime monitoring	USN-5	As an admin, I want automated system health checks and uptime alerts to ensure the service is reliable.	Uptime is monitored; downtime alerts sent within 1 min of failure.	High	Sprint-1

3.3 Technology Stack

Technical Architecture:

The Deliverable shall include the architectural diagram as below and the information as per the table1 & table 2



Example: Order processing during pandemics

Guidelines:

Include all the processes (As an application logic / Technology Block)
Provide infrastructural demarcation (Local / Cloud)
Indicate external interfaces (third party API's etc.)
Indicate Data Storage

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g. Web UI, Mobile App, Chatbot etc.	HTML, CSS, JavaScript / Angular Js / React Js etc.

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.	MySQL, NoSQL, etc.
6.	Cloud Database	Database Service on Cloud	IBM DB2, IBM Cloudant etc.
7.	File Storage	File storage requirements	IBM Block Storage or Other Storage Service or Local Filesystem
8.	External API-1	Purpose of External API used in the application	IBM Weather API, etc.
9.	External API-2	Purpose of External API used in the application	Aadhar API, etc.
10	Machine Learning Model	Purpose of Machine Learning Model	Object Recognition Model, etc.
11	Infrastructure (Server / Cloud)	Application Deployment on Local System / Cloud Local Server Configuration: Cloud Server Configuration :	Local, Cloud Foundry, Kubernetes, etc.

Table-2: Application Characteristics:

S.No	**Characteristics**	**Description**	**Technology**
1.	Open-Source Frameworks	List the open-source frameworks used	Technology of Opensource framework
2.	Security Implementations	List all the security / access controls implemented, use of firewalls etc.	e.g. SHA-256, Encryptions, IAM Controls, OWASP etc.
3.	Scalable Architecture	Justify the scalability of architecture (3 – tier, Micro-services)	Technology used
4.	Availability	Justify the availability of application (e.g. use of load balancers, distributed servers etc.)	Technology used
5.	Performance	Design consideration for the performance of the application (number of requests per sec, use of Cache, use of CDN's) etc.	Technology used

4. PROJECT DESIGN

4.1 Problem Solution Fit

Problem – Solution Fit Template:

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioral patterns and recognize what would work and why

Purpose:

- Solve complex problems in a way that fits the state of your customers.
- Succeed faster and increase your solution adoption by tapping into existing mediums and channels of behavior.
- Sharpen your communication and marketing strategy with the right triggers and messaging.
- Increase touch-points with your company by finding the right problem-behavior fit and building trust by solving frequent annoyances, or urgent or costly problems.
- **Understand the existing situation in order to improve it for your target group.**

Template:

4.2 Proposed Solution

Proposed Solution Template:

Project team shall fill the following information in the proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Accurate real-time estimation of traffic volumes is lacking, causing congestion and inefficiency.
2.	Idea / Solution description	Develop an ML-powered system that integrates live sensor, camera, and GPS data to predict and visualize real-time traffic volumes.
3.	Novelty / Uniqueness	Combines multi-source real-time data with innovative ML models for highly accurate, automated predictions.

4.	Social Impact / Customer Satisfaction	Reduces congestion, saves commuter time, improves urban planning, and enhances reliability for public and commercial users.
5.	Business Model (Revenue Model)	Subscription-based model for city authorities, premium dashboard services for logistics companies, API licensing for developers.
6.	Scalability of the Solution	Can be deployed in multiple cities or countries, easily integrates new data sources, and supports growing data volumes.

4.3 Solution Architecture

Solution Architecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.

Example - Solution Architecture Diagram:

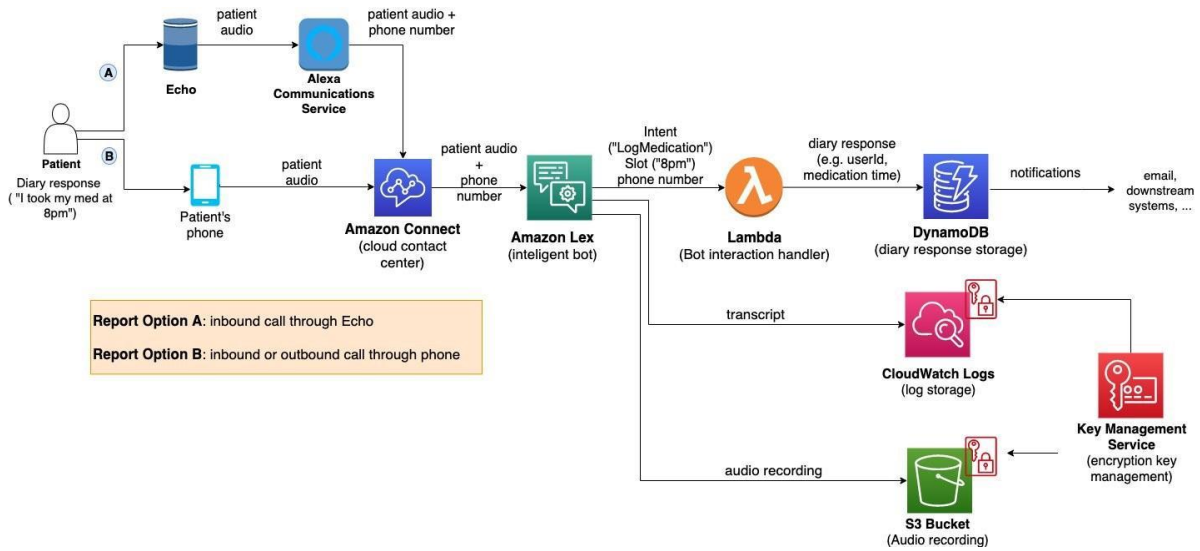


Figure 1: Architecture and data flow of the voice patient diary sample application

5.PROJECT PLANNING & SCHEDULING

5.1 Project Planning

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	**Pre requisites**	USN-1	As a user, I can install the **Anaconda navigator software**	5	Medium	1. Vusa Leela

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
						Venkata Sai Pavan 2. Shaik Ruksana 3. Syed Asha Sulthana 4. Teegala Navya Gopika
Sprint-1	Data Collection.	USN-2	As a user, I will Collect the dataset or Create the dataset	4	Low	1. Vusa Leela Venkata Sai Pavan 2. Shaik Ruksana 3. Syed Asha Sulthana 4. Teegala Navya Gopika
Sprint-2	Data Pre-processing.	USN-3	As a user, I can • Import the Libraries. • Importing the dataset. • Checking for Null Values. • Data Visualization. • Taking care of Missing Data. • Feature Scaling. • Splitting Data into Train and Test.	2	High	1. Vusa Leela Venkata Sai Pavan 2. Shaik Ruksana 3. Syed Asha Sulthana 4. Teegala Navya Gopika
Sprint-2	Model Building	USN-4	As a user, I can • Import the model building Libraries • Initializing the model • Training and testing the model • Evaluation of Model • Save the Model	4	Medium	1. Vusa Leela Venkata Sai Pavan 2. Shaik Ruksana 3. Syed Asha Sulthana 4. Teegala Navya Gopika
Sprint-3	Application Building	USN-5	As a user, I can • Create an HTML file • Build a Python Code • Run the App	3	High	1. Vusa Leela Venkata

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
						Sai Pavan 2. Shaik Ruksana 3. Syed Asha Sulthana 4. Teegala Navya Gopika
Sprint-3	Output Process	USN-6	As a user, • Copy the HTTP link and paste it in google link tab, it will display the form page • Enter the values as per the form and click on predict button • It will redirect to the page based on prediction output • The output will be displayed in the prediction text as Estimated Traffic volume is in units.	1	Medium	5. Vusa Leela Venkata Sai Pavan 6. Shaik Ruksana 7. Syed Asha Sulthana Teegala Navya Gopika

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	16 June 2025	21 June 2025	20	21 June 2025
Sprint-2	20	6 Days	18 June 2025	23 June 2025	20	23 June 2025
Sprint-3	20	6 Days	20 June 2025	25 June 2025	20	25 June 2025
Sprint-4	20	6 Days	22 June 2025	27 June 2025	20	27 June 2025

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

https://www.visual-paradigm.com/scrum/scrum-burndown-chart/

https://www.atlassian.com/agile/tutorials/burndown-charts

Reference:

https://www.atlassian.com/agile/project-management

https://www.atlassian.com/agile/tutorials/how-to-do-scrum-with-jira-software

https://www.atlassian.com/agile/tutorials/epics

https://www.atlassian.com/agile/tutorials/sprints

https://www.atlassian.com/agile/project-management/estimation

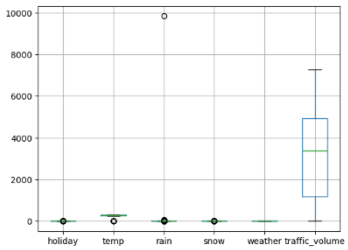
https://www.atlassian.com/agile/tutorials/burndown-charts

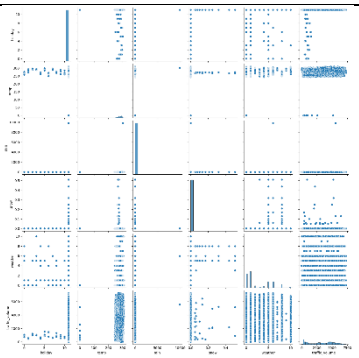
6.FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing

Model Performance Testing:

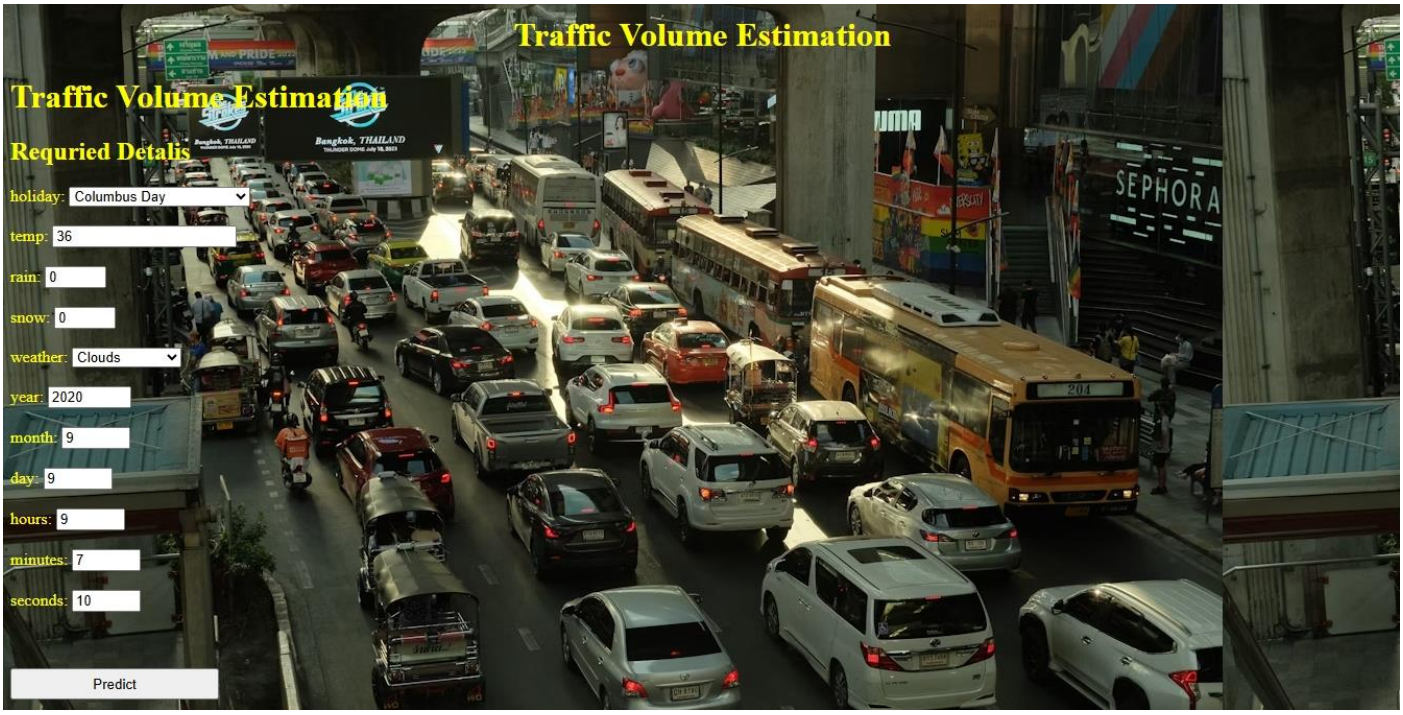
Project team shall fill the following information in model performance testing template.

S.No.	Parameter	Values	Screenshot
1.	Metrics	**Regression Model:** MAE - , MSE - , RMSE - , R2 score - **Classification Model:** Confusion Matrix - , Accuray Score- & Classification Report -	
2.	Tune the Model	Hyperparameter Tuning - Validation Method -	

7. RESULTS

7.1 Output Screenshots



8.ADVANTAGES & DISADVANTAGES

Advantages:

- **Accurate Real-Time Traffic Predictions**
  - Utilizes machine learning models and multiple data sources (sensors, cameras, GPS) to provide precise, current traffic volume estimates.
- **Automation and Scalability**
  - Reduces manual effort with automated data collection and analysis.
  - Can be deployed across various cities or regions, accommodating expanding datasets.
- **Improved Congestion Management**
  - Helps authorities and commuters proactively manage bottlenecks, reducing traffic jams and travel times.
- **Enhanced Decision-Making for Stakeholders**
  - Benefits commuters, logistics companies, and city planners with actionable insights for route optimization, schedule planning, and infrastructure development.
- **Supports Data-Driven Urban Planning**
  - Supplies city authorities with reliable, granular traffic data to inform infrastructure investments and policy-making.
- **Continuous Learning and Improvement**
  - Machine learning enables the system to improve over time as more data is collected and feedback is integrated.

Disadvantages:

- **Data Quality and Availability Issues**
  - Model accuracy depends heavily on the quality and comprehensiveness of input data. Missing or incorrect data can degrade performance.
- **Complexity of Integration**
  - Combining various real-time data sources (sensors, cameras, GPS) can be technically challenging and may require significant setup and maintenance.
- **Potential High Initial Costs**
  - Implementing advanced sensors, data storage, and machine learning infrastructure involves upfront investment.
- **Privacy and Security Concerns**

- Aggregating and analyzing real-time location and traffic data may raise privacy issues and requires strong data protection measures.

➢ **Model Limitations in Unusual Cases**

- Unexpected events (e.g., major accidents, unplanned road closures, extreme weather) can lead to inaccurate predictions if not adequately represented in historical data.

➢ **Ongoing Maintenance Needs**

- Regular updates, model retraining, and hardware maintenance are necessary to ensure sustained accuracy and reliability.

9.CONCLUSION

TrafficTelligence: Advanced Traffic Volume Estimation with Machine Learning demonstrates a transformative approach to urban traffic management by harnessing the power of machine learning and diverse real-time data sources. The system effectively addresses the shortcomings of traditional traffic monitoring methods—such as delayed, manual, or unreliable estimations—by delivering automated, precise, and scalable traffic volume predictions**.**

10.FUTURE SCOPE

1**. Integration of Emerging Data Sources**

- Utilize IoT sensors, connected vehicle data, and mobile device analytics for richer real-time insights.
- Incorporate data from smart city infrastructure and social media for enhanced situational awareness.

2. Expansion to Multimodal Transportation

- Extend volume estimation to bikes, public transit, and pedestrian flow for holistic urban mobility management.
- Support route optimization that considers all transportation modes and interconnectivity.

3. Predictive and Prescriptive Analytics

- Move beyond estimation to proactively forecast future traffic events, incidents, and demand surges.
- Offer prescriptive recommendations, such as alternate routes or signal timing adjustments to ease congestion.

4. AI-Driven Adaptive Systems

- Implement self-learning models that continuously adapt based on new patterns and user feedback.
- Leverage reinforcement learning for dynamic traffic signal control and route planning.

5. Enhanced User Personalization

- Develop personalized alerts and recommendations tailored to user preferences and habits.
- Support integration with personal navigation and fleet management platforms.

6. Geographic and Market Scalability

- Deploy solutions across multiple cities, regions, or countries with region-specific adaptation.
- Enable service scaling for both dense urban centers and less-connected rural areas.

7. Collaboration and Policy Support

- Enable data sharing with government agencies for emergency response, urban planning, and sustainability initiatives.
- Support analytics for regulatory planning, such as emission reduction and smart zoning.

8. Continuous Improvement through Feedback Loops

- Incorporate feedback mechanisms to learn from real-world deployment and user interactions.
- Regularly update models to address emerging urban challenges, such as infrastructure changes or evolving mobility trends.

9. Advanced Visualization and Decision Support

- Develop interactive dashboards for stakeholders with predictive heatmaps, anomaly detection, and what-if scenario analysis.
- Provide simulation tools for policy makers to test the impact of infrastructure or policy changes.

10. Research and Innovation

- Collaborate with academia and industry to advance research in traffic modeling, anomaly detection, and explainable AI.
- Pilot cutting-edge techniques such as federated learning for privacy-preserving model training across cities and organizations.

11.APPENDIX

Source Code:

traffic volume-1.ipynb

Dataset Link:

traffic volume.csv

GitHub & Project Demo Link:

Saipavan39u/TrafficTelligence-Advanced-Traffic-Volume-Estimation-with-Machine-Learning

Project Demo Link:

Traffic Volume Estimation Projecy vi