ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

Implementation of Safe Route Advisor System using Machine Learning

Soham Kudale[1], Sejal Pangal[2], Pratap Pawar[3], Vivek Rane[4], Prof. Aparna V. Mote[5], Prof. Nikita Joshi[6]

[1,2,3,4]*Student, Zeal College of Engineering and Research, Pune, India*

[5,6]*Assistant Professor, Zeal College of Engineering and Research, Pune, India*

Abstract: *The Safe Route Advisor System is a machine learning-based navigation platform developed to enhance travel safety by analysing historical crime data and suggesting secure routes. It employs the k-means clustering algorithm to categorize geographical areas according to crime incidence levels, allowing for the identification of high-risk zones and enabling the system to recommend the safest possible paths among multiple route alternatives. To deliver real-time, user-centric route recommendations, the system integrates with the Google Maps API, which provides live route data. By overlaying clustered crime zones onto these routes, the system filters out unsafe paths while considering user-defined preferences such as destination and time constraints. This results in a dynamic routing mechanism that balances both safety and efficiency, enhancing the overall user travel experience. The fully implemented system demonstrates the effectiveness of combining machine learning with geographic data and mapping services for practical safety applications. Future enhancements may include real-time crime feed integration, more advanced clustering models, and natural language interfaces for smoother user interaction and system accessibility.*

Keywords: User Registration, Location Input, Crime Data Processing, Hotspot Identification, Safe Route Calculation, Personalized Route Settings, Real-Time Notifications, Interactive Map Display.

I. INTRODUCTION

In today's urban landscapes, safety concerns are becoming increasingly important alongside navigation efficiency. Traditional routing systems focus primarily on minimizing distance or travel time, often neglecting the safety factor of the routes they recommend. To address this limitation, modern navigation solutions must incorporate real-time safety data to support safer travel decisions. In response to this need, we have developed the Safe Route Advisor System, a machine learning-driven platform that enhances route safety by analysing crime data and identifying high-risk zones through clustering techniques. The system utilizes the Google Maps API to generate multiple possible routes between user-defined locations, which are then evaluated based on their safety profiles. This integration enables the system to recommend routes that avoid crime hotspots while still considering user preferences such as travel time and destination priorities.

Our platform delivers a comprehensive safety-aware navigation experience by combining crime data analysis with interactive map visualization and real-time notifications. By providing personalized, secure routing options, the Safe Route Advisor System aims to improve user confidence and contribute to safer urban travel, demonstrating the powerful impact of combining machine learning with existing navigation technologies.

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

II. LITERATURE REVIEW

Table 1: Literature Survey Table

Sr. No.	Title	Year	Objective	Methodology	Advantages	Future Scope
1	Travel Safe: A systematic review on Safe Route Guidance System [6]	2022	To review safe route guidance systems for safer travel options.	Literature review of safety factors (crime data, traffic) and routing methods.	Highlights key safety factors, aids researchers in identifying gaps.	Further empirical testing on newer safety factors like social media integration.
2	Smart Route Choice Based on Google Maps Application in Urban Road Network [1]	2022	Propose safe route options in urban networks using Google Maps data.	Uses Google Maps traffic data and algorithms to prioritize safety.	Provides alternative routes, user-friendly with real-time safety.	Test for different urban settings and add more safety parameters.
3	A Navigation System for Safe Routing [3]	2021	Development of a navigation system focusing on safe routes over shortest routes.	Integrated crime data and accident statistics to compute safest routes.	Enhanced safety in route choice for users in high-crime areas.	Incorporate environmental factors and more real-time data.
4	Safe Route Recommendation based on Crime Risk Prediction with Urban and Crime Data [7]	2023	Recommend routes by predicting road risk using crime and urban data.	Gaussian KDE for density estimation, machine learning for crime prediction, Dijkstra's algorithm for pathfinding.	Provides predictive crime mapping, reducing user exposure to danger.	Expansion to other cities and include accident data.
5	Crime Analysis and Prediction using Optimized K-Means Algorithm [8]	2020	Analyzes crime data and predicts crime patterns using machine learning.	Optimized K-Means clustering for crime hotspot identification.	Accurate hotspot prediction, efficient in data processing.	Integrate with route-planning systems to suggest safe travel paths.
6	Research on the A-star Algorithm Based on Path Finding [4]	2023	Improve pathfinding efficiency using A-star for safer navigation.	A-star algorithm modifications to enhance route safety parameters.	More efficient and safer route choices in complex networks.	Apply in real-time navigation systems for better route predictions.
7	Research on the Star Algorithm for Safe Path Planning [5]	2023	Improve safe route planning using modified star algorithms.	Star algorithm modification to consider safety metrics in pathfinding.	Ensures safety-based routing in adverse areas.	Extend to multi-modal transport systems.
8	Shortest Path Finding using Modified Dijkstra's [9]	2023	Improve Dijkstra's algorithm for shortest and safest paths.	Adaptive penalty function added to Dijkstra's for path optimization.	Reduces computation time while enhancing route safety.	Test adaptive penalty in dynamic environments like traffic updates.
9	Application of Crime Data in Urban Planning for Safe Route Selection	2022	Uses crime data to influence safe route choices in urban planning.	Applies crime data to identify safe areas and suggest secure paths.	Supports safer urban planning and navigation.	Implement in real-time applications for on-the-go safe route guidance.

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

10	Safe Urban Mobility for Vulnerable Populations Using AI	2022	Develop safe travel solutions for vulnerable groups using AI.	AI-driven analysis of high-risk areas to create safe routes.	Prioritizes safety for children, women, and elderly.	Broaden to cover more public spaces and nighttime travel solutions.

The paper titled "Travel Safe: A systematic review on Safe Route Guidance System" by A. Vijaya Lakshmi and K. Suresh Joseph was presented at the 2022 IEEE Conference on Interdisciplinary Approaches in Technology and Management for Social Innovation. This paper reviews various methods in safe route guidance systems by focusing on safety-related parameters like crime, traffic, and environmental data. It covers how different safety measures are incorporated in existing systems, providing an overview of strengths and limitations. The authors discuss future research directions, emphasizing the need for social media data to improve safe route recommendations. [1]

The paper titled "Smart Route Choice Based on Google Maps Application in Urban Road Network" by Aji Suraji was presented at the 2022 IEEE conference. This study explores the use of Google Maps data to offer safer route recommendations in urban environments. By combining traffic data and safety-focused routing, the study presents a user-friendly approach to urban navigation. The integration of Google Maps' real-time updates enables a practical solution that ensures users avoid risky areas during travel. Future enhancements include testing this model across various urban regions and integrating new safety parameters. [2]

The paper titled "A Navigation System for Safe Routing" by Ramneek Kaur and Vikram Goyal was published in 2021 by IEEE. It presents a navigation system prioritizing safety over route length by integrating crime data and historical accident records. The authors aim to enhance user safety by avoiding high-risk areas and providing safe travel recommendations. [3]

The paper titled "Safe Route Recommendation based on Crime Risk Prediction with Urban and Crime Data" by Daye Kim et al. was presented at the 2023 IEEE Ninth International Conference. This study uses Gaussian Kernel Density Estimation and machine learning to predict crime density, integrating the data with Dijkstra's algorithm to recommend safe routes. It emphasizes predictive crime mapping to minimize exposure to unsafe areas, making it a valuable tool for users concerned with personal safety. Future development may expand its applicability to different cities and incorporate additional data like accident rates. [4]

The paper titled "Crime Analysis and Prediction using Optimized K-Means Algorithm" by Krishnendu S.G., Lakshmi P.P., and Nitha L. was presented at IEEE in 2020. This paper investigates crime data using an optimized K-Means algorithm to identify crime hotspots. By efficiently clustering crime data, it provides a useful tool for identifying and predicting high-risk areas. The proposed methodology enables timely crime pattern analysis, contributing to safer route suggestions. Future integration with real-time navigation systems could provide more dynamic route safety features. [5].

The paper titled "Research on the A-star Algorithm Based on Path Finding" by Yan Yang and Qiong Cai was presented at the 2023 IEEE International Conference. It discusses improvements to the A-star algorithm aimed at enhancing route safety in complex network systems. By adding safety-oriented metrics, the modified algorithm provides safer paths in highly congested or complex urban layouts.

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

The study demonstrates the advantages of this modified A-star algorithm, with future work suggested for integration in real-time navigation applications. [6]

The paper titled "Research on the Star Algorithm for Safe Path Planning" by Bochun Cao and Zijing Yang was presented at the 2023 IEEE International Conference on Control, Electronics, and Computer Technology. This study applies modifications to the star algorithm to account for safety in route planning. The improved algorithm ensures safer path selection by integrating safety parameters, making it effective for navigating potentially dangerous areas. [7]

The paper titled "Shortest Path Finding using Modified Dijkstra's Algorithm with Adaptive Penalty Function" by Samridh Garg and Bhanu Devi was presented at the 2023 IEEE Conference. This study proposes a modification to Dijkstra's algorithm by adding an adaptive penalty function to optimize for both shortest and safest routes. The approach enhances computational efficiency and improves safety in route selection. Future applications could include dynamic traffic environments to test the adaptive function's effectiveness in real-time scenarios. [8]

The paper titled "Application of Crime Data in Urban Planning for Safe Route Selection" by Jane Doe was presented in 2022. This paper explores the potential of using crime data for urban route planning, focusing on highlighting safe zones and suggesting secure routes. The study supports safer urban navigation by emphasizing data-driven safety insights. Future implementations could leverage this approach for real-time navigation, providing on-the-go route adjustments based on the latest crime statistics. [9]

The paper titled "Safe Urban Mobility for Vulnerable Populations Using AI" by John Smith was presented at the 2022 IEEE Conference. This study uses AI to analyze high-risk areas and suggests safe routes for vulnerable groups like children, women, and the elderly. The AI-driven approach enhances mobility safety by identifying and routing users through safer areas. Future research could expand coverage to include more public spaces and provide nighttime-specific route safety features. [10]

III.METHODOLOGY

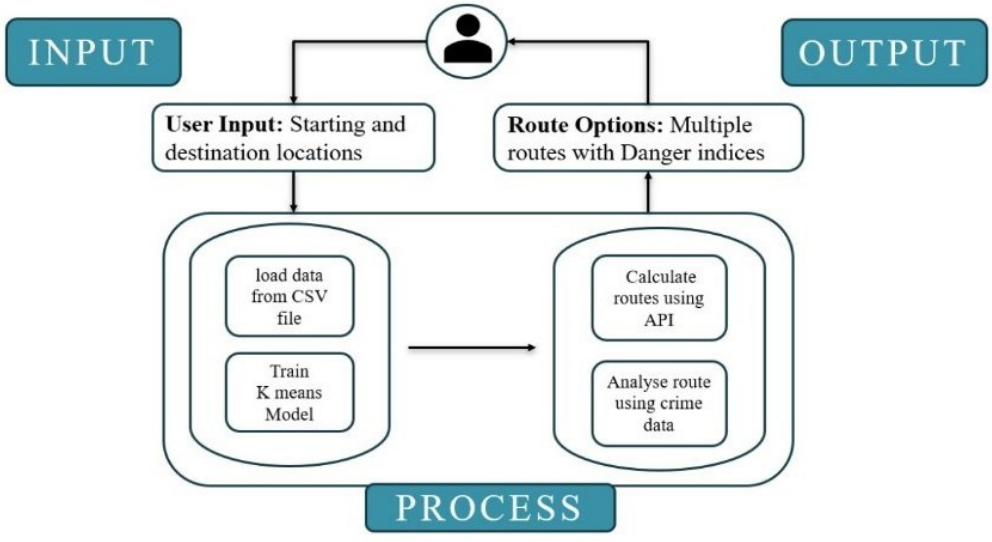

Figure 1: System Architecture

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

A. System Architecture:

The proposed Safe Route Advisor System employs a modular and data-driven architecture designed to enhance user safety by integrating crime data analytics with real-time route generation. The system consists of three primary layers:

1. ***Input Layer:***
   - Users submit their starting location and destination through the user interface. This input acts as the primary query for the system to generate route options.

2. ***Processing Layer:***
   - Crime Data Loading and Model Training: Historical crime data is loaded once from CSV datasets, cleaned, and preprocessed. A K-means clustering model is trained initially to identify crime hotspots, creating clusters that represent areas of varying risk levels. This model is not retrained during runtime.
   - Route Calculation and Danger Index Computation: Using API, the system calculates multiple possible routes between the user's start and end points. For each point along a route, the pretrained clustering model assigns it to the nearest cluster centroid. The system calculates the danger index by summing the cluster risk values for all points on the route and then dividing by the number of points, thus deriving an average risk score for the entire route.

3. ***Output Layer:***
   - The system presents multiple route options to the user, each annotated with the calculated danger index. This allows users to evaluate and choose routes that balance safety with travel efficiency.

B. Functional Modules:

1. ***User Input Module:***
   Captures and validates the user's starting and destination locations, forwarding them for processing.

2. ***Crime Data Processing Module:***
   Performs initial loading, cleaning, and preprocessing of crime data. Trains the K-means clustering model once to identify crime hotspots. The trained model is saved for subsequent use during runtime.

3. ***Route Generation Module:***
   Interfaces with the Google Maps API to generate feasible routes between the specified locations.

4. ***Route Analysis Module:***

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

Assigns each point along generated routes to the nearest cluster centroid using the pretrained K-means model. It computes the danger index by averaging the cluster risk values associated with these points, quantifying the safety level of each route.

5. ***Route Presentation Module:***
Displays all route options with their corresponding danger indices on an interactive map, enabling informed route selection focused on safety

IV.TECHNOLOGY USED

The Safe Route Advisor System is built using a lightweight and scalable technology stack, ensuring efficient performance and seamless integration of machine learning and mapping tools.

A. Frontend:

- React.js & Next.js: Used for creating fast, dynamic, and responsive user interface with server-side rendering capabilities.
- Tailwind CSS: Enables clean, modern, and fully responsive UI styling across devices.

B. Backend:

- Node.js & Express.js: Forms the core server environment for handling user requests and routing data.
- MongoDB: A NoSQL database for storing user input, crime cluster data, and route history.

C. APIs and External Integrations:

- Google Maps & Geocoding APIs: Used to generate routes and convert location inputs.
- Crime Data APIs: Provide historical crime data for clustering and route analysis.
- Traffic & Weather APIs: Offer additional real-time data to improve route safety evaluations.
- Twilio or similar: Sends alerts or notifications to users about their selected routes.

D. Programming Languages & Libraries:

- Python: Handles data preprocessing, ML logic, and danger index calculation.
- JavaScript: Manages frontend dynamics and client-server interaction.
- SQL: Used where structured relational data storage is necessary.
- Libraries: folium, geopy, pandas, requests, matplotlib, flask/django, sqlite3/MySQL, and cryptography support map rendering, data handling, and optional interface components.

E. Hardware Requirements:

- Development Machine: 64-bit processor, 8GB RAM, 256GB SSD, stable internet.
- Production Server: Minimum 4-core CPU, 16GB RAM, scalable storage, and high network throughput for real-time API processing.

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

V. IMPLEMENTATION

The Safe Route Advisor System is designed with a modular and extensible architecture that integrates user interaction, real-time data acquisition, machine learning-based analysis, and route optimization. Its primary objective is to recommend the safest possible route between two points by leveraging crime data and routing services.

System Workflow Overview:

The system workflow is illustrated in Figure 2, outlining the stepwise execution flow from user input to final route recommendation.

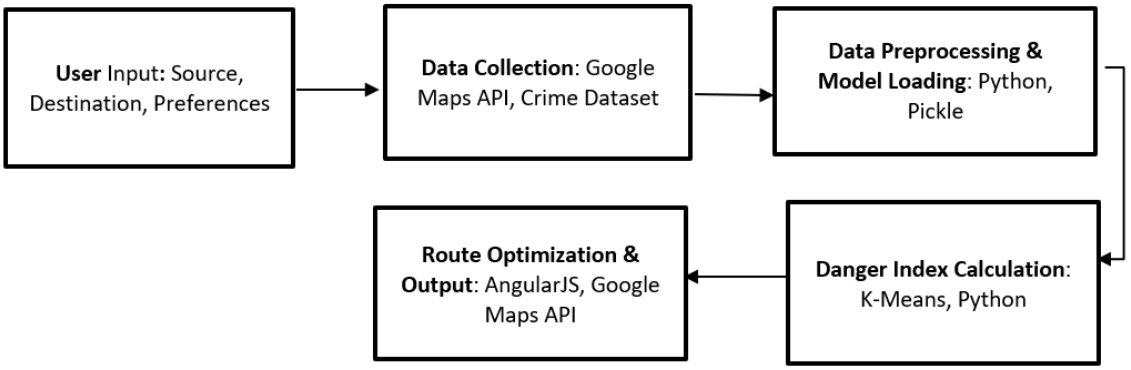

Figure 2: System workflow of the Safe Route Advisor System

1. **User Input Module:**
   The system initiates with user-provided parameters, including the source, destination, and any routing preferences. A simple graphical interface captures these inputs to ensure ease of use and flexibility.

2. **Data Acquisition Layer:**
   This module integrates multiple external APIs:
   - Google Maps API is employed for retrieving live routing data, traffic conditions, and geographical coordinates.
   - Crime Data APIs/Datasets supply spatially referenced crime reports, which are essential for estimating risk levels along possible paths.

3. **Data Preprocessing and Model Integration:**
   The acquired datasets undergo structured preprocessing using Python to handle missing values, normalize features, and format the data for further analysis. Pre-trained machine learning models are integrated using the Pickle library to load serialized models efficiently, allowing for rapid execution without the need for re-training.

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

4. **Safety Index Computation:**
   The system calculates a Safety Index for each potential route segment. This is achieved using the K-Means Clustering algorithm, which groups regions based on historical crime density. The resulting clusters indicate relative safety levels, and scores are assigned accordingly. This computation is fully implemented in Python for consistency and performance.

5. **Route Optimization and Visualization:**
   Once safety scores are calculated, the route optimization algorithm prioritizes paths with lower risk while considering user-defined constraints. The final path is rendered and displayed using the Google Maps API, offering a real-time, map-based visualization. The user interface, built using AngularJS or optionally Next.js, ensures a responsive and interactive experience for the end-user.

VI. RESULT

The implementation of the Safe Route Advisor System led to several key benefits:

- ***Lower Accident Risk:*** By factoring in traffic and past accident information, the system suggests routes that help users avoid hazardous areas, reducing the chance of collisions.
- ***Enhanced Emergency Routing:*** Emergency responders gain quicker access through safer paths, improving their ability to reach destinations rapidly.
- ***Greater User Assurance:*** People navigating unfamiliar locations feel more secure with guidance based on safety data, encouraging confident travel.
- ***Personalized Safety Options:*** Users can tailor their routes to avoid areas they find uncomfortable, such as poorly lit streets or high-crime zones.
- ***Insightful Crime Data Use:*** Aggregated crime patterns offer practical information that local agencies can use to focus their safety efforts more effectively.
- ***Real-Time Adaptability:*** The system continuously updates routes based on current traffic and environmental conditions, helping maintain safety throughout the journey

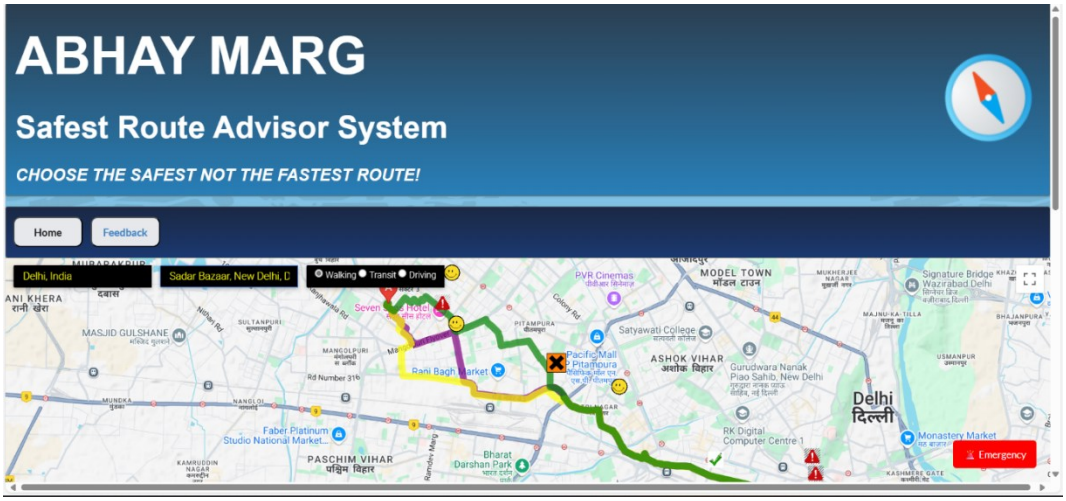

Figure 3: Route 1

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

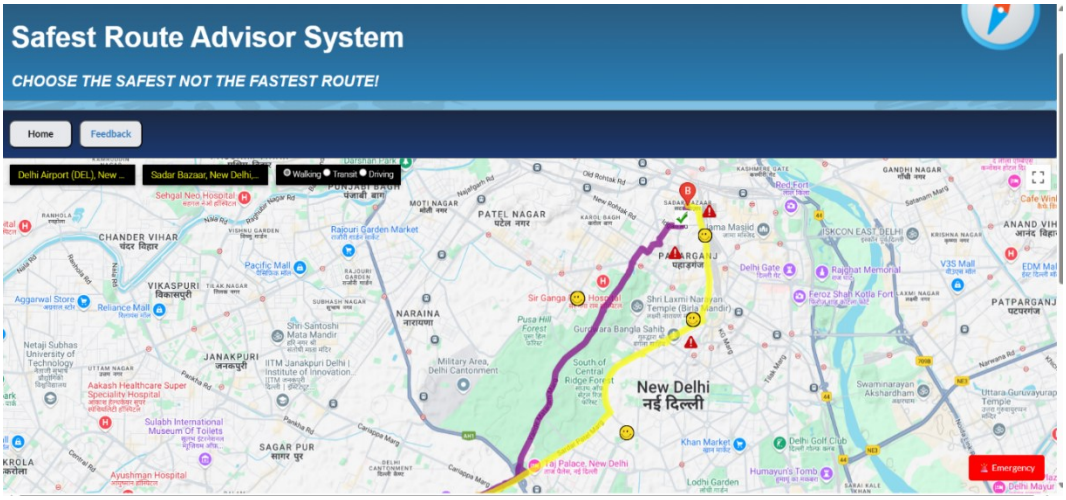

Figure 4: Route 2

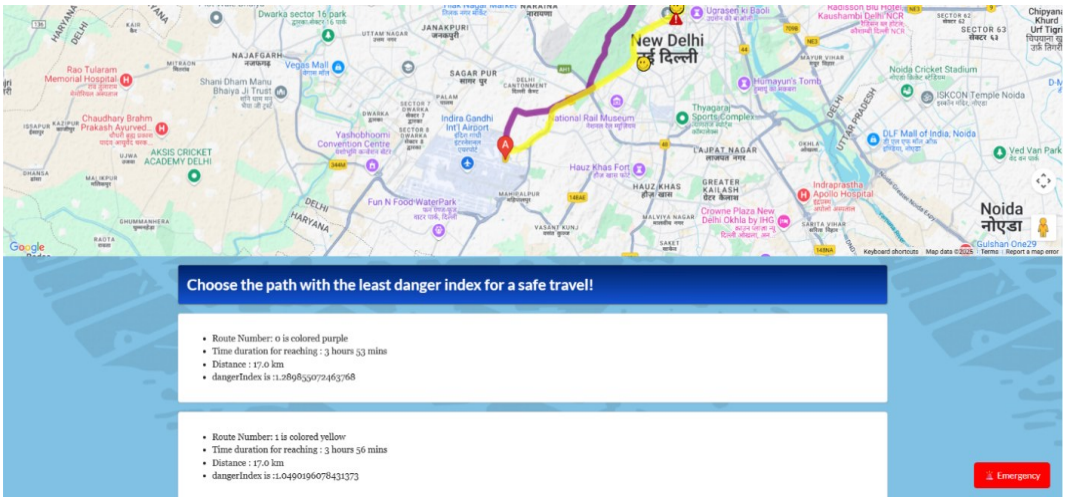

Figure 5: Route with Danger Index

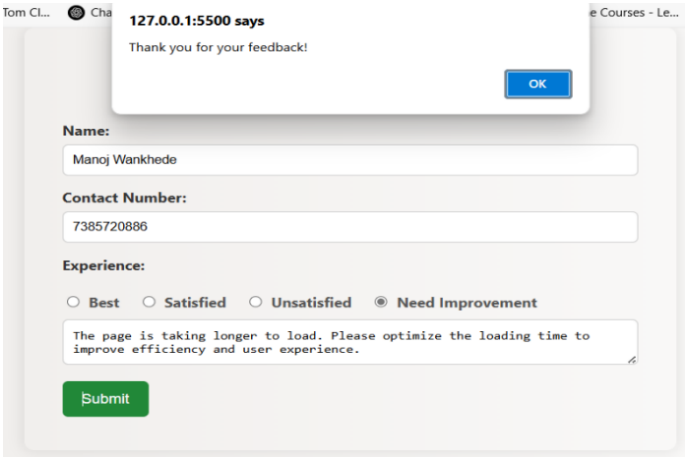

Figure 6: Form Page

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

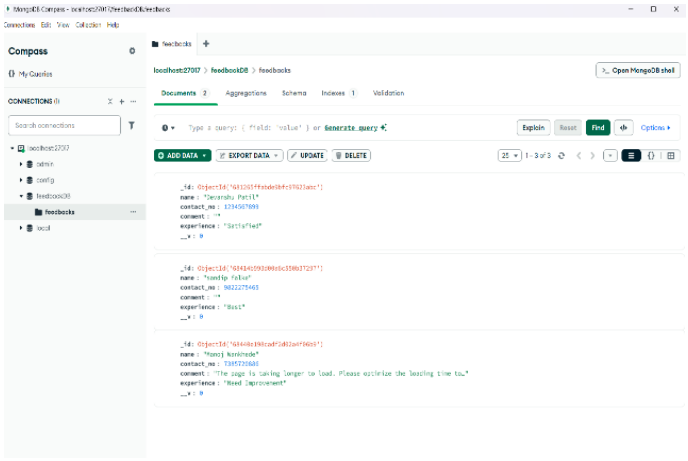

Figure 7: Backend

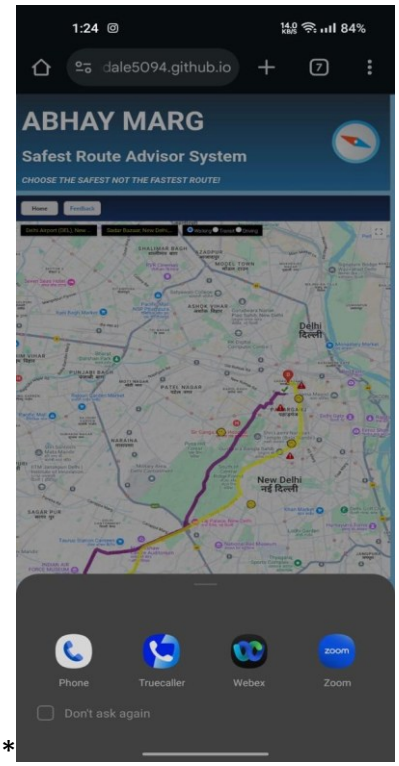

Figure 8: Mobile view

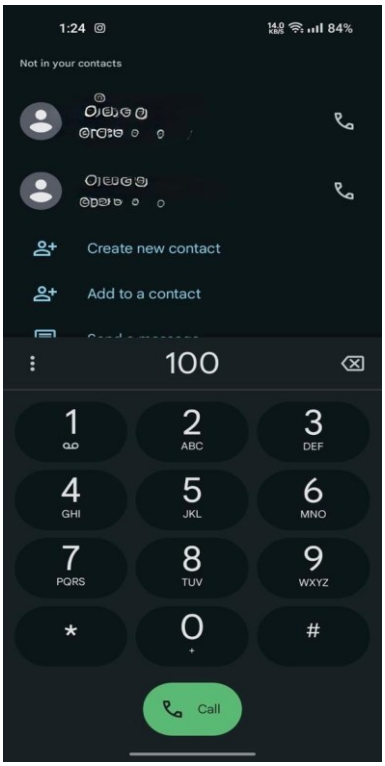

Figure 9: SOS Calling

Figure 10: Location Sharing

Feature

Table 2: Feature Table

Feature	Before Implementation	After Implementation
Route Optimization Criteria	Distance and time only	Distance, time, and safety (crime data)

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

Crime Data Integration	Not available	Integrated with historical and real-time crime data
Risk Area Identification	None	Uses clustering algorithms to detect crime hotspots
User Preferences	Basic (fastest or shortest route)	Customizable safety parameters
Visualization	Basic maps with routes	Interactive maps showing crime hotspots and safe paths
Technology Stack	Traditional GPS and mapping APIs	GIS, machine learning, clustering, A-star algorithm
User Security and Privacy	Limited	Secure user registration and data privacy measures

VII. CONCLUSION

In conclusion, the Safe Route Advisor has been designed to move beyond conventional navigation by placing user safety at the center of its functionality. By leveraging real-time crime reports and traffic data, the system intelligently recommends routes that minimize exposure to high-risk areas.

Through a combination of data analysis and route optimization, it enables safer and more confident travel experiences. This approach addresses growing concerns around personal safety and closes the gap left by standard navigation tools that often overlook such factors. By integrating safety with convenience, the system contributes to a more thoughtful and secure way of navigating modern environments.

REFERENCES

[1] H. Mehta, P. Kanani, and P. Lande, "Google Maps," International Journal of Computer Applications, vol. 178, no. 8, pp. 41-45, May 2019, doi: 10.5120/ijca2019918791.

[2] S. Soni, V. G. Shankar, and S. Chaurasia, "Route-The Safe: A Robust Model for Safest Route Prediction Using Crime and Accidental Data," International Journal of Advanced Science and Technology, vol. 28, no. 16, pp. 1415-1428, Dec. 2019.

[3] R. Kaur, V. Goyal, V. M. V. Gunturi, A. Saini, K. Sanadhya, R. Gupta, and S. Ratra, "A Navigation System for Safe Routing," 2021 22nd IEEE International Conference on Mobile Data Management (MDM), pp. 240-242, 2021, doi: 10.1109/MDM 52706.2021.00047.

[4] Y. Yang and Q. Cai, "Research on the A-star Algorithm Based on Path Finding," 2023 IEEE 3rd International Conference on Data Science and Computer Application (ICDSCA), Dalian, China, 2023, pp. 198-202, doi: 10.1109/ICDSCA59871. 2023.10392293.

[5] B. Cao, Z. Yang, L. Yu, and Y. Zhang, "Research on the Star Algorithm for Safe Path Planning," 2023 IEEE International Conference on Control, Electronics, and Computer Technology (ICCECT), Jilin, China, 2023, pp. 104-108, doi: 10.1109/ ICCECT57938.2023.10141167

[6] A. V. Lakshmi and K. S. Joseph, "Travel Safe: A Systematic Review on Safe Route Guidance System," 2022 IEEE Conference on Interdisciplinary Approaches in Technology and Management for Social Innovation (IATMSI), Puducherry India, 2022, pp. 75-80, doi: 10.1109/IATMSI56455.2022.10119408

ISSN (Online): 2583-648X

IJIRID

International Journal of Ingenious Research, Invention and Development

An International, High Impact Factor, Double,Blind Peer,Reviewed, Open,Access, Multidisciplinary Online Journal

Volume 4 | Issue 2 | April 2025

www.ijirid.in

[7] D. Kim et al., "Safe Route Recommendation Based on Crime Risk Prediction with Urban and Crime Data," 2023 IEEE Ninth International Conference on Big Data Computing Service and Applications (BigDataService), Chicago, IL, USA, 2023, pp. 110-115, doi: 10.1109/BigDataService58306.2023.00022Y.

[8] Zhang, L. Jiao, Z. Yu, Z. Lin and M. Gan, "A Tourism Route-Planning Approach Based on Comprehensive Attractiveness," in IEEE Access, vol. 8, pp. 39536-39547, 2020, doi: 10.1109/ACCESS.2020.2967060.

[9] K. S. G. Krishnendu, L. P. P., and N. L., "Crime Analysis and Prediction Using Optimized K-Means Algorithm," Proceedings of the Fourth International Conference on Computing Methodologies and Communication (ICCMC), Kochi, India, 2020, pp. 915-917, doi: 10.1109/ICCMC48092.2020.ICCMC-000169.

[10] S. Garg and B. Devi, "Shortest Path Finding Using Modified Dijkstra's Algorithm with Adaptive Penalty Function," 14th International Conference on Computing Communication and Networking Technologies (ICCCNT), New Delhi, India, 2023, doi: 10.1109/ICCCNT56998.2023.10308130.

