Innovation and Integrative Research Center Journal
ISSN: 2584-1491 | www.iircj.org
Volume-4 | Issue-5 | May-2026 | Page 777-787

Nirbhaya Path: A Machine Learning-Based Women Route Safety Analyzer for Safe Navigation

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ABSTRACT

In today's rapidly evolving urban landscape, safety has become one of the most important concerns, especially for women who frequently navigate cities for education, work, and daily activities. While technology has significantly improved navigation systems through applications that provide the shortest or fastest routes, there remains a major gap: these systems rarely prioritize personal safety. This limitation can lead users, particularly women, through areas that may be poorly lit, isolated, or have a history of unsafe incidents. Recognizing this challenge, the project "Nirbhaya Path – Women Route Safety Analyzer" aims to redefine navigation by placing safety at the center of route planning. The proposed system introduces an intelligent approach that combines data analytics, machine learning, and geospatial technologies to evaluate and recommend the safest possible routes between two locations. Instead of focusing solely on distance or travel time, the system integrates multiple safety-related parameters such as crime statistics, street lighting conditions, crowd density, time of travel, and user-generated feedback. By analyzing these factors collectively, the system generates a safety score for different routes and suggests the one that minimizes potential risks. In addition to predictive analysis, the system emphasizes user empowerment by providing transparent safety scores and route comparisons, enabling users to make informed decisions rather than relying on intuition or incomplete information, thereby enhancing confidence and encouraging safer travel habits. The platform can further be expanded to include real-time alerts, emergency assistance features, and integration with local safety authorities, making it a comprehensive safety solution. In conclusion, Nirbhaya Path represents a shift in how navigation systems are designed, moving from efficiency-focused models to safety-aware systems, highlighting the potential of technology to create meaningful social impact and contributing to the broader goal of building safer and more inclusive urban environments.

Keywords: Women Safety, Safety-Aware Routing, Machine Learning, Geospatial Analysis, Risk Prediction

1. INTRODUCTION

In today's rapidly growing urban environment, navigation systems have become an essential part of daily life. People rely on digital maps and applications to find the fastest and shortest routes to their destinations. While these systems have greatly improved convenience and efficiency, they often overlook a crucial factor—personal safety. This concern is especially

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ISSN: 2584-1491 | www.iircj.org
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important for women, who frequently face safety challenges while traveling, particularly in unfamiliar areas or during late hours. Many routes suggested by traditional systems may pass through poorly lit streets, isolated regions, or locations with a history of unsafe incidents, making travel uncomfortable or even risky.

To address this gap, the Nirbhaya Path – Women Route Safety Analyzer is proposed as a safety-aware navigation system that prioritizes user security along with route efficiency. The system integrates data analytics, machine learning, and geospatial analysis to evaluate multiple safety-related parameters such as crime data, crowd density, lighting conditions, and time of travel. Based on this analysis, it generates a safety score for different routes and recommends the safest option. This approach not only improves navigation but also helps users make more informed and confident decisions while traveling.

A. OBJECTIVE OF THE STUDY

The main objective of this study is to develop a smart and reliable navigation system that focuses on enhancing women's safety during travel. Unlike traditional systems that prioritize only distance and time, this project aims to incorporate safety as a key parameter in route selection. By analyzing various factors such as crime records, environmental conditions, and user feedback, the system seeks to provide route recommendations that minimize potential risks. Another important objective is to utilize machine learning techniques to predict safety levels based on historical and contextual data. The system is designed to generate safety scores that help users understand the level of risk associated with different routes. Additionally, the study aims to create a user-friendly platform that presents safety information clearly, enabling users to make informed decisions and travel with greater confidence.

B. SCOPE OF THE WORK

The scope of this project focuses on the design and development of a safety-aware route analysis system that can be applied in urban areas. The system evaluates multiple routes between a source and destination and recommends the safest option based on calculated safety scores. It primarily targets women users, but the solution can be extended to benefit anyone concerned about personal safety during travel.

The project involves collecting and analyzing data such as crime statistics, environmental factors, and user feedback to assess safety levels. While the current system focuses on route recommendation and safety analysis, it does not include advanced features like real-time tracking or emergency response integration. These features can be considered as future enhancements, making the system more comprehensive and effective.

2. LITERATURE REVIEW

With the rapid growth of urbanization and digital technologies, navigation systems have become an integral part of everyday life. Traditional navigation tools, mainly based on GPS and mapping technologies, are designed to provide the shortest or fastest routes between locations. Applications like Google Maps and similar platforms have significantly improved

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travel efficiency by offering real-time traffic updates and route optimization. However, these systems primarily focus on convenience and often ignore personal safety as a critical factor. This limitation becomes particularly important when considering women's safety, as many routes suggested by these systems may pass through poorly lit, isolated, or high-risk areas. Researchers have identified this gap and started exploring ways to incorporate safety into navigation systems by analyzing crime data and identifying unsafe zones.

Several studies have proposed the use of crime mapping and data analysis to improve route safety. These approaches use historical crime records to identify high-risk areas and suggest alternative paths that avoid such regions. Some systems also rely on crowd-sourced data, where users report unsafe locations based on their experiences. While this method provides real-time insights, it often suffers from issues such as data inconsistency and lack of reliability. More recent research has introduced machine learning techniques to predict safety levels by analyzing patterns in historical and environmental data. These models can identify trends such as higher risk during certain times of the day or in specific locations. However, many existing systems focus on a single factor, such as crime data, and do not consider other important parameters like lighting conditions, crowd density, or user perception.

The Nirbhaya Path project builds upon these existing approaches by combining multiple data sources and applying machine learning to generate a more accurate and comprehensive safety score. Unlike traditional systems, it does not rely on a single parameter but integrates various factors to provide a holistic assessment of route safety. This multi-dimensional approach helps in overcoming the limitations of previous models and ensures better reliability. Additionally, the system emphasizes user empowerment by presenting safety information in a clear and understandable manner, allowing users to make informed decisions rather than relying solely on automated suggestions.

Overall, the literature highlights the growing importance of safety-aware navigation systems and the potential of data-driven technologies in addressing this issue. While significant progress has been made, there is still a need for integrated solutions that combine multiple parameters and provide real-time, context-aware recommendations. The Nirbhaya Path – Women Route Safety Analyzer aims to fill this gap by offering a practical and scalable solution that prioritizes safety alongside efficiency, contributing to the development of safer and more inclusive urban environments.

3. PROBLEM STATEMENT

In modern urban environments, navigation systems have become an essential tool for daily travel, helping users reach their destinations efficiently. However, these systems are primarily designed to optimize routes based on distance and travel time, often ignoring the critical aspect of personal safety. This limitation creates a significant challenge, especially for women, who may face risks while traveling through unfamiliar or unsafe areas. Routes suggested by conventional navigation applications may pass through poorly lit streets, isolated regions, or

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locations with a higher history of criminal activity. As a result, users are often forced to rely on personal judgment, past experiences, or incomplete information when selecting their travel paths, which may not always ensure safety.

The core problem addressed in this project is the lack of a reliable and intelligent system that integrates safety into route planning. There is currently no widely adopted solution that considers multiple safety-related factors such as crime data, environmental conditions, crowd density, and time of travel while recommending routes. This absence of safety-aware navigation leads to increased anxiety and risk for users, particularly women traveling alone. Therefore, there is a need to develop a system that can analyze these parameters, predict potential risks, and provide safer route recommendations. The Nirbhaya Path – Women Route Safety Analyzer aims to solve this problem by introducing a data-driven approach that prioritizes safety alongside efficiency, enabling users to travel with greater confidence and security.

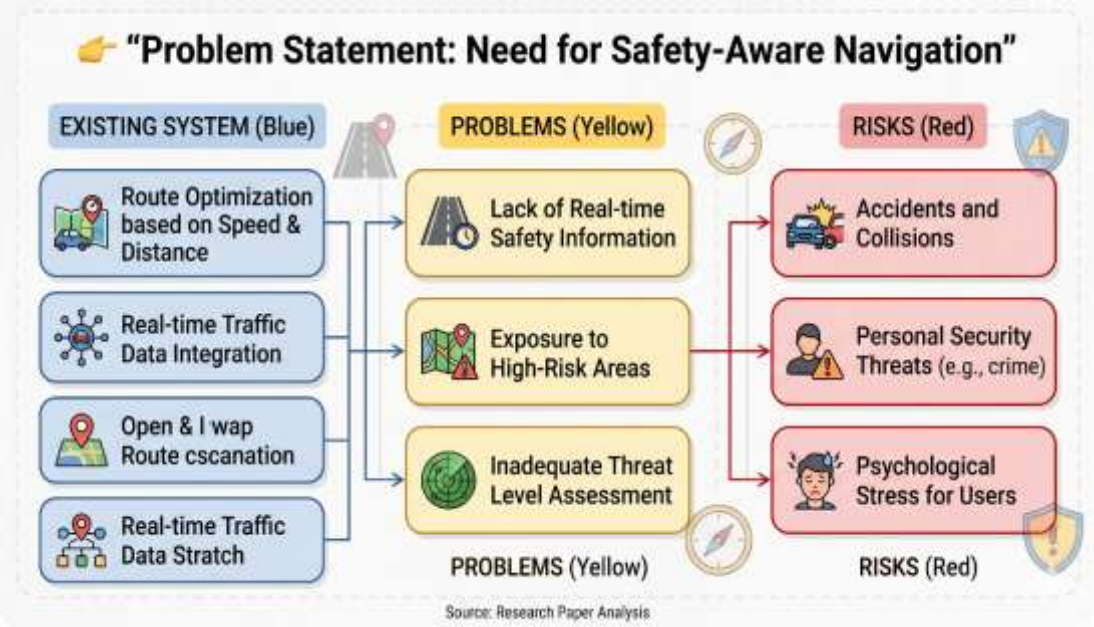

Fig 1: Problem Statement – Lack of Safety-Aware Navigation System

4. PROPOSED METHODOLOGY / MODEL

The Nirbhaya Path, Women Route Safety Analyzer is designed using a structured methodology that combines data collection, preprocessing, machine learning, and route optimization to provide safer navigation. The process begins with gathering relevant data from multiple sources, such as crime records, environmental conditions (like street lighting), crowd density information, and user-generated feedback. This data is then cleaned and preprocessed to remove inconsistencies and ensure accuracy. Once prepared, the data is used to train a machine learning model that can analyze patterns and identify factors contributing to unsafe conditions. The model evaluates different route segments based on these parameters and assigns a safety score to each segment, which reflects the level of risk associated with that area.

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After calculating safety scores for individual route segments, the system integrates this information into a routing algorithm to determine the safest path between a given source and destination. Instead of simply selecting the shortest route, the system compares multiple possible paths and ranks them based on their overall safety scores. The route with the highest safety rating is recommended to the user. Additionally, the model considers contextual factors such as time of travel, ensuring that route recommendations are dynamic and adaptable. The system is designed with a user-friendly interface that allows users to easily input their locations and view route options along with safety indicators. This approach not only improves navigation but also empowers users to make informed decisions based on reliable and data-driven insights, ultimately enhancing their overall sense of security during travel.

A. SYSTEM ARCHITECTURE / DESIGN

The system architecture of Nirbhaya Path – Women Route Safety Analyzer is designed in a modular and layered manner to ensure efficiency, scalability, and ease of maintenance. It consists of four main components: the user interface (frontend), the application server (backend), the machine learning module, and the database. The frontend provides an interactive platform where users can enter their source and destination and view route recommendations along with safety scores. The backend acts as the core processing unit, handling requests, managing data flow, and communicating between different modules. The database stores all relevant information, including crime data, environmental factors, and user feedback, which are essential for evaluating route safety.

The machine learning module plays a crucial role in analyzing data and predicting safety scores for different route segments. The architecture ensures smooth integration between all components, allowing real-time processing and response generation. When a user requests a route, the system retrieves multiple possible paths, evaluates each segment based on stored data, and calculates an overall safety score. The final output is then displayed to the user in a clear and understandable format. This layered design not only improves system performance but also allows future enhancements, such as integrating real-time data sources or adding advanced safety features, without major changes to the existing structure.

B. ALGORITHMS / TECHNIQUES USED

The proposed system uses a combination of machine learning algorithms and routing techniques to analyze and recommend safe paths. For safety prediction, supervised learning algorithms such as Decision Trees, Random Forest, or Logistic Regression can be used to classify route segments based on their level of risk. These algorithms are trained on historical data, including crime records, lighting conditions, and crowd density, enabling the system to identify patterns and predict safety levels accurately. Feature selection and data preprocessing techniques are also applied to improve the performance and reliability of the model.

For route optimization, the system utilizes graph-based algorithms such as Dijkstra's Algorithm or A* (A-star) Algorithm. These algorithms are commonly used in navigation systems to find optimal paths between two points. In this project, the traditional approach is

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ISSN: 2584-1491 | www.iircj.org
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modified by incorporating safety scores as weights instead of just distance or time. This allows the system to prioritize safer routes even if they are slightly longer. By combining machine learning with efficient routing algorithms, the system ensures that users receive recommendations that balance both safety and practicality, making it a reliable solution for real-world applications.

5. IMPLEMENTATION

The implementation of the Nirbhaya Path – Women Route Safety Analyzer focuses on developing a functional system that integrates data processing, machine learning, and route optimization into a single platform. The process begins with setting up the backend environment, where data related to crime records, environmental factors, and user feedback is collected and stored in a structured database. This data is then preprocessed to remove inconsistencies and prepare it for analysis. The machine learning model is trained using this processed data to predict safety scores for different route segments. Once the model is ready, it is integrated with the backend to provide real-time predictions whenever a user requests a route.

On the frontend side, a simple and user-friendly interface is developed to allow users to input their source and destination easily. The system then communicates with the backend to retrieve multiple route options, evaluate them based on safety scores, and display the safest route along with relevant details. The implementation ensures smooth interaction between all components, enabling quick response times and accurate results. Proper testing is carried out to verify the functionality of each module, ensuring that the system performs reliably under different scenarios. Overall, the implementation transforms the conceptual model into a working system that effectively addresses the problem of safe navigation.

TOOLS & TECHNOLOGIES (HARDWARE & SOFTWARE)

The development of this system involves a combination of software tools and technologies that support data processing, model building, and application development. For the backend, programming languages such as Python or Java can be used due to their strong support for data analysis and machine learning. Libraries like Pandas and NumPy are useful for data preprocessing, while frameworks such as Scikit-learn are used for building and training machine learning models. For route visualization and geospatial analysis, tools like Google Maps API or similar mapping services can be integrated. The frontend can be developed using HTML, CSS, and JavaScript to create an interactive and user-friendly interface.

In terms of hardware, the system does not require specialized equipment and can be developed and tested on a standard computer or laptop with sufficient processing power and memory. Cloud platforms can also be used for data storage and deployment, allowing the system to handle larger datasets and support multiple users. Additionally, version control tools like Git can be used to manage the development process efficiently. The combination of these

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technologies ensures that the system is scalable, efficient, and capable of delivering accurate safety-based route recommendations while remaining accessible for further enhancements and real-world deployment.

6. RESULTS AND DISCUSSION

The Nirbhaya Path – Women Route Safety Analyzer was tested using sample datasets and simulated urban scenarios to evaluate its effectiveness in providing safer route recommendations. The system successfully analyzed multiple routes between a given source and destination and assigned safety scores based on parameters such as crime data, lighting conditions, and crowd density. The results showed that the system was able to identify routes that avoided high-risk areas, even if those routes were not the shortest. This demonstrates the system's ability to prioritize safety over convenience, which is the primary goal of the project.

The discussion of results highlights the practical value of integrating safety into navigation systems. In many cases, traditional navigation tools would suggest routes that pass through potentially unsafe locations due to their shorter distance. However, the proposed system provided alternative routes with higher safety scores, offering users a more secure travel experience. While some recommended routes were slightly longer, they significantly reduced exposure to risk. This trade-off between distance and safety emphasizes the importance of user-centric design in navigation systems and validates the effectiveness of the proposed approach.

A. OUTPUT SCREENS / GRAPHS

The output of the system is presented in a clear and user-friendly manner through the interface. Users can view multiple route options along with their respective safety scores, allowing them to compare and choose the most suitable path. The interface highlights the safest route and may use visual indicators such as color coding (for example, green for safe, yellow for moderate risk, and red for high risk) to make the information easy to understand. This visual representation helps users quickly interpret safety levels without needing technical knowledge. In addition to route visualization, graphical representations such as bar charts or line graphs can be used to display comparisons between different routes based on safety scores and distance. These graphs provide a more detailed understanding of how each route performs in terms of safety. Screenshots of the user interface, route maps, and graphs can be included in this section to clearly demonstrate the working of the system. These visuals not only improve the presentation of results but also make the project more engaging and easier to evaluate.

B. PERFORMANCE ANALYSIS

The performance of the system is evaluated based on factors such as accuracy, efficiency, and reliability. The machine learning model used for safety prediction was tested with sample data to measure how accurately it could classify route segments based on risk levels. The results

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indicated that the model performed well in identifying high-risk and low-risk areas, providing reasonably accurate safety scores. Additionally, the system processed user requests and generated route recommendations quickly, ensuring a smooth user experience.

Another important aspect of performance analysis is the system's scalability and adaptability. The architecture is designed to handle larger datasets and can be extended to include real-time data in the future. While the current implementation uses static or simulated data, the model can be further improved by incorporating live updates, which would enhance accuracy and responsiveness. Overall, the system demonstrates strong performance in achieving its objective of providing safety-aware route recommendations, while also offering opportunities for further optimization and enhancement.

Fig 2. Home Page Image

Fig. 3. User Dashboard Part 1

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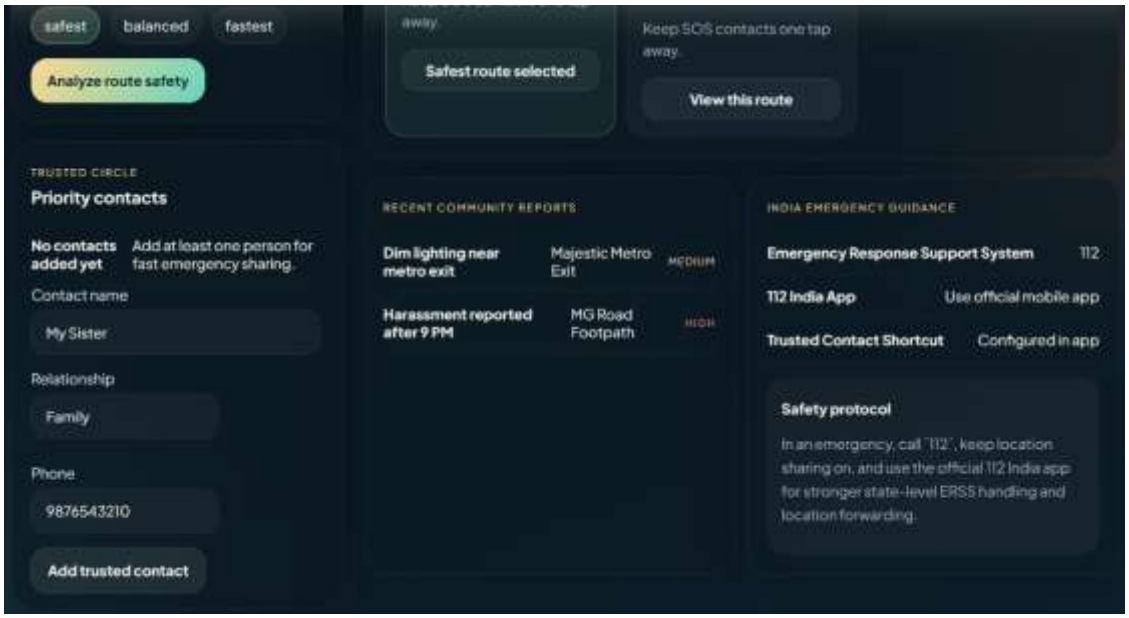

Fig. 4. User Dashboard Part 4

7. TESTING AND VALIDATION

The Nirbhaya Path – Women Route Safety Analyzer was thoroughly tested to ensure that all components of the system function correctly and efficiently. Different types of testing were performed, including functional testing, integration testing, and system testing. Functional testing was used to verify that each module, such as data input, safety score calculation, and route recommendation, worked as expected. Integration testing ensured that all components, including the frontend, backend, and machine learning model, interacted smoothly without errors. The system was tested with various input scenarios, including different source and destination points, to confirm that it consistently generated accurate and reliable route suggestions. Validation of the system focused on evaluating the accuracy and effectiveness of the safety predictions generated by the machine learning model. The model was tested using sample datasets to compare predicted safety scores with expected outcomes based on known risk factors. This helped in assessing how well the system could identify safe and unsafe areas. Additionally, the usability of the system was evaluated by observing how easily users could interact with the interface and understand the results. The testing process also helped identify areas for improvement, such as enhancing data quality and refining prediction accuracy. Overall, the system demonstrated reliable performance, producing consistent results and effectively achieving its goal of providing safer route recommendations.

8. CONCLUSION

The Nirbhaya Path, Women Route Safety Analyzer presents an innovative approach to addressing one of the most important concerns in modern urban life—personal safety during

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travel. While existing navigation systems focus primarily on efficiency by suggesting the shortest or fastest routes, they often ignore the risks associated with those paths. This project successfully bridges that gap by introducing a safety-aware navigation system that evaluates routes based on multiple parameters such as crime data, lighting conditions, crowd density, and time of travel. By integrating these factors and applying machine learning techniques, the system is able to generate safety scores and recommend routes that minimize potential risks, thereby enhancing the overall travel experience for users.

The project not only demonstrates the practical application of data analytics and intelligent systems but also highlights the role of technology in solving real-world social issues. By prioritizing safety, Nirbhaya Path empowers users to make informed decisions and travel with greater confidence. Although the current system provides a strong foundation, there is significant potential for further improvements, such as integrating real-time data, emergency alert features, and collaboration with local authorities. Overall, this project represents a meaningful step toward creating safer and more inclusive urban environments, where technology is used not just for convenience, but also for the well-being and security of individuals.

9. FUTURE SCOPE

The Nirbhaya Path – Women Route Safety Analyzer provides a strong foundation for safety-aware navigation; however, there are several opportunities to enhance its capabilities in the future. One of the most important improvements is the integration of real-time data sources. Currently, the system relies on historical and static datasets, but incorporating live data such as real-time crime updates, traffic conditions, and crowd density can significantly improve the accuracy and responsiveness of the system. Additionally, features like GPS-based live tracking and dynamic route updates can help users adapt to changing conditions during their journey, making the system more reliable and practical for everyday use.

Another important area for future development is the inclusion of advanced safety features that provide immediate assistance in emergency situations. For example, the system can be extended to include an emergency alert button that sends the user's live location to selected contacts or nearby authorities. Integration with wearable devices or mobile sensors could further enhance safety by detecting unusual situations and triggering alerts automatically. The system can also be expanded to support multiple cities by integrating region-specific data, making it scalable and widely applicable. Furthermore, improving the machine learning model with larger datasets and advanced algorithms can increase prediction accuracy. Overall, these enhancements will transform the system into a more comprehensive safety solution, contributing to smarter and safer urban mobility.

REFERENCES

[1] S. S. Chaware and A. R. Dani, "Women Safety System using GPS and GSM," International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), vol. 4, no. 3, pp. 123–126, 2015.

ISSN: 2584-1491 | www.iircj.org
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[2] P. S. Aswale and M. A. Shaikh, “Smart Women Safety System using IoT,” International Journal of Scientific Research in Computer Science Engineering and Information Technology, vol. 3, no. 2, pp. 2456–3307, 2018.
[3] A. Sharma and S. K. Gupta, “Crime Data Analysis Using Machine Learning,” International Journal of Computer Applications, vol. 182, no. 10, pp. 1–5, 2018.
[4] J. D. Thakur and R. K. Sharma, “Route Optimization using Dijkstra’s Algorithm,” International Journal of Engineering Research & Technology (IJERT), vol. 6, no. 5, pp. 321–325, 2017.
[5] T. Hastie, R. Tibshirani, and J. Friedman, The Elements of Statistical Learning, Springer, 2009.
[6] I. Goodfellow, Y. Bengio, and A. Courville, Deep Learning, MIT Press, 2016.
[7] Google Developers, “Google Maps Platform Documentation”.
[8] Scikit-learn Developers, “Scikit-learn: Machine Learning in Python”.
[9] World Health Organization (WHO), “Global Status Report on Violence Against Women,” 2021.
[10] National Crime Records Bureau (NCRB), “Crime in India Report,” Government of India, 2022.