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Road Safety in India: Present Challenges and Future Emergency Response Solutions

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Abstract

India is struggling with crucial challenges in road emergency response system because of disintegrated services, deferred medical care, and the lack of a centralized system. Such problems results in increase the mortality in critical emergencies. This paper focuses on a centralized emergency response platform, Kavach, a mobile application that seeks to combine essential services under a unified platform. Kavach employs a unified and scalable system architecture, featuring a Go-based backend and a Kotlin Multiplatform mobile implementation, to ensure high performance, reliability, and cross-platform compatibility.The system supports real-time location tracking, rapid request processing, secure communication, and multi-agency coordination. Results of experimental analysis and interface design indicate that Kavach significantly improves response time, service availability, and ease of use over existing safety apps. The results indicate that a centralized and interoperable emergency response management platform can be extremely effective in improving road safety infrastructure and emergency response efficiency in India.

Keywords: Emergency Response System, System Architecture, Micro services, Cross-Platform Mobile Application

1. Introduction

India's network is one of the best in the world, stretching nearly 6.37 million kilometres across the country. Many of these roads cause much concern because every year, 1.73 lakh people die due to accidents, which means an average of 474 lives per day are lost, earning India the status of a dangerous place for driving [1]. Similarly, despite the government's efforts in 2018, 2019 and 2020, such as the National Road Safety Policy, the Motor Vehicle Amendment Act and the Safe City Project, the rate of road accidents did not decline due to emergency care being disorganized, long response times by medical support and no centralized control [2]. Partly, high death rates stem from slow ambulances, various emergency contact numbers and a lack of basic first-aid understanding when disasters strike [3]. Not getting medical attention fast after an accident can cause avoidable deaths. Using technology can improve disaster emergency response and save more lives. The study introduces Kavach, an application that combines police, fire, ambulance and blood bank for easier access. Developed using a GO-based system and Kotlin Multiplatform, Kavach increases the speed of handling important resources so that help for victims can be delivered sooner. Managers say that GPS tracking and rapid studies will make emergency services in India much more effective thanks to Kavach. For this research, we investigate road safety, possible hurdles in emergency aid and how Kavach is placed to help. Stricter rules, better technology and wider public knowledge can lead India to become safer on its roads and to match international standards.

1.1 Types of Roads

With growing populations, the number of vehicles increasing, border tensions and the overall economy, to sustain and support them, the need for roads, highways and expressways arose. As a result, the construction skyrocketed for the various types of Roads.

Table 1: Types of Roads

Types of Roads	Description	Maintenance & Funding	Significance	Contribution to Total Accidents
National Highways (NH) [5]	It's the backbone of India's Road transportation, connecting states and major urban centres.	It's maintained by NHAI and funded by the central government. 1.87 lakh crore allocated to NHAI (2025-26)	It carries 40% of the total traffic despite covering only 2% of the network.	It accounts for 30.3% of total road accidents and about 36% of deaths, despite constituting only 2% of the network.
Expressways [5]	It has High-speed, controlled access roads with 6-8 lanes, reducing travel time.	It was funded under NH projects with separate allocations for individual projects.	It facilitates Industrial growth and seamless logistics. Uses VIDS for safety. [9]	N/A
State Highways (SH) [5]	It connects major towns and roads within a state. Feeder to NH.	It is built and maintained by the State Government with Central support.	Enhances inter-district trade and local economic development.	Contributes to a significant portion of road accidents; combined with National Highways, they account for about 60.5% of the total road accident deaths, despite comprising only 4.9% of the total road length.
District Roads [5]	Provides connectivity with districts. It also includes Major District Roads (MDRS) and Minor District Roads (MIRS)	Funded by the respective State governments, supported Central Schemes.	It ensures connectivity with markets and essential services.	N/A
Rural Roads [6]	It covers 73% of India's total road length, primarily serving the rural population.	It is built under PMGSY using materials like Kankar, WBM and Murrum.	It facilitates agricultural activities, education and healthcare access in rural areas.	N/A
Border Roads [6]	It is very strategically important for the country's overall security and safety.	Maintained and constructed by BRO (Border Roads Organisation) with Central funding.	It enhances national security and supports border economies.	N/A

International Highways [6]	It extends India's trade, economic and diplomatic relations with other countries.	It is funded by bilateral and central agreements.	It strengthens international trade and regional integration.	N/A

2. Literature Review

India's road network extends over 6.37 million kilometres, making it the second-largest in the world, behind the United States. This extensive network ensures nationwide accessibility, fostering economic growth and social development [7]. The Figure 1 shows how roads are classified according to traffic density, indicating the minimum and maximum number of vehicles per day in light, medium, high, and very heavy traffic [8].

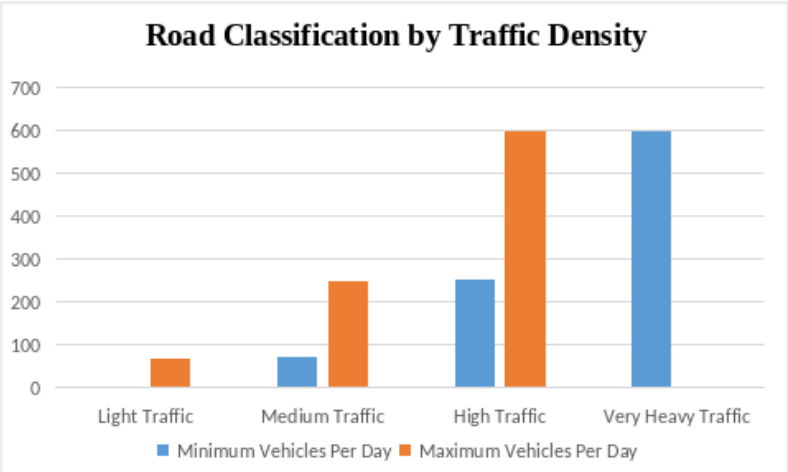

Figure 1: Road Classification by Traffic Density

Each year, road accidents result in 150,000 deaths, yet just 7% of head injury patients get to the hospital within the important first hour as shown in Figure 2 [9]. 24,012 lives are lost each day because of slow medical help [10]. Most trauma patients (80%) do not get treatment in the first sixty minutes after their accident. The system has equipment-deficient ambulances. About 90% lack the important equipment needed for basic life support. Ambulance responders are not fully trained. Ninety-five per cent of service members lack training in emergency care. Using these mainly for corpse transport comprises 98.5% of their activities. Among India's states, there is no single contact number for emergencies (108, 102, 112, etc.). The typical delay in exchanging information between various agencies in accidents involving many vehicles takes 40 minutes. Since 43% of emergencies are handled with official EMS, the other 50% rely on the untrained actions of lucky bystanders. There are 3,500+ blood banks linked by e-RaktKosh, but over 30% of these blood groups are not available during periods of greatest need [11]. A very small percentage of bystanders are educated about controlling behaviour at CPR or haemorrhage centres. Indian Red Cross provides first aid training to 600,000 people each year, yet it can reach just 0.04% of the population [12]. About two-thirds of community health centres cannot store blood. People in high-risk districts wait 23.4 minutes for an ambulance versus 12.7 minutes for people living in urban hubs. Each year, road accidents reduce GDP by nearly 3%. With every day that obstetric emergencies are delayed, India loses around ₹9,800 crores every year.

Gujarat EMS Authority saved 18% more lives due to its improved coordination of response plans for trauma [13]. e-RaktKosh made it possible to distribute 12.7 tons of blood via computerized planning every month during COVID-19. Also, toll-free numbers like 9200250000 have helped people with blood support. Automatic ambulance surveillance on the cloud has slashed the need for manual documentation in Maharashtra by 85% [14]. These numbers clearly show we need a national emergency response system with dispatch, training and real-time

resource tracking, on top of current successful state-level models, but also need to resolve gaps in infrastructure and how things are organized.

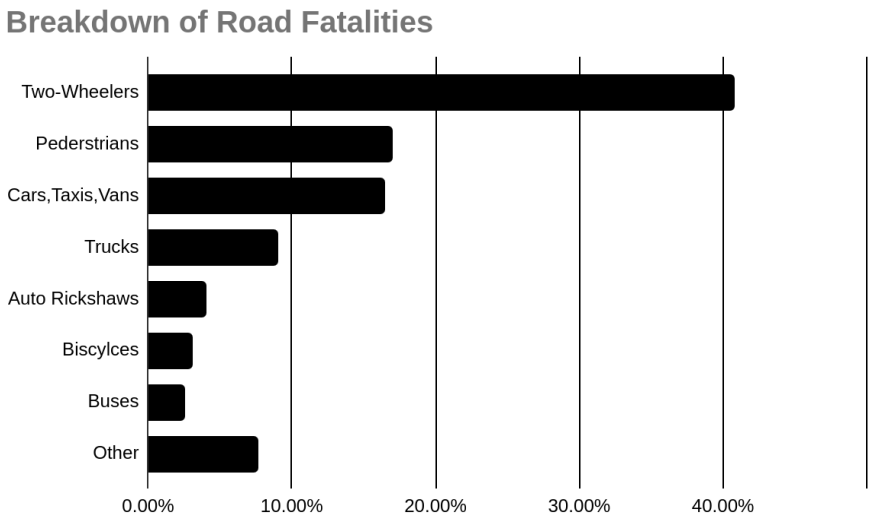

Figure 2: Breakdown of Road Fatalities

As shown in Figure 3, speeding is the most frequent traffic offense, constituting 69.6% of the offenses, followed by other offenses, which constitute 20.5% [15]. The other offenses include jumping red lights, using a mobile phone while driving, driving while drunk, and wrong-side driving, among others.

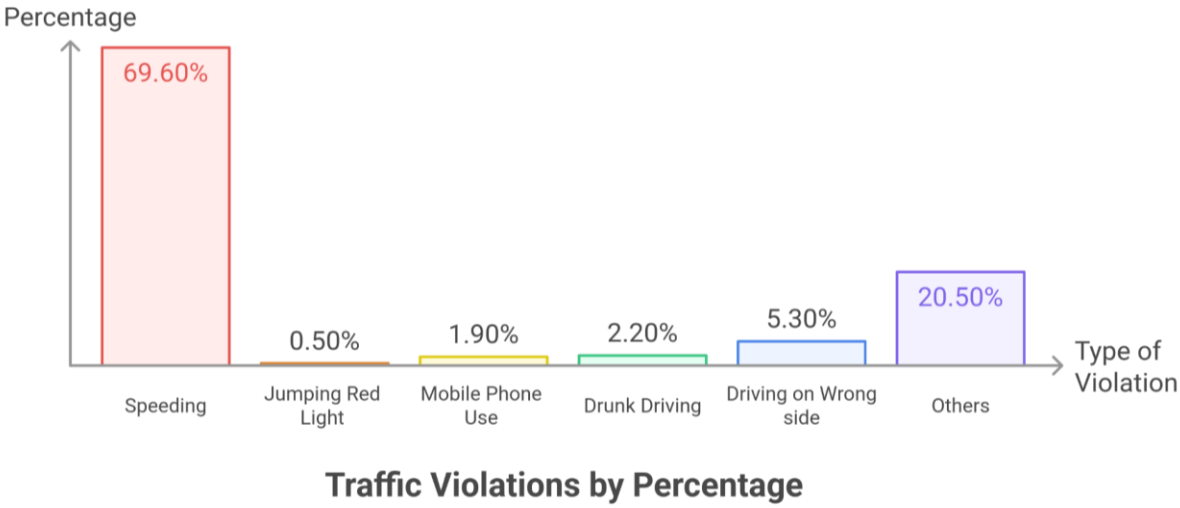

Figure 3: Traffic Rule Violations

Indian motorists often run into rough paths, people crossing the street, crowded highways and animals, without any protective gear. People most often break traffic laws by skipping signals, adding too many passengers to motorcycles, or driving drunk [16]. Often, to get a driver's license, people must pay bribes, sometimes letting untrained and inexperienced youth drive. Vehicles in India are checked against fewer safety measures than in the United States or European Union countries [17]. Lots of popular cars and trucks score poorly in safety tests. Stray animals on the Indian roads, such as cows and dogs, make being on the roads more dangerous.

Addressing these issues will require a multi-faceted approach, including better road design, stricter enforcement of traffic laws, improved vehicle safety standards, and effective management of stray animals.

3. Research Methodology

The system is developed using a combination of technologies that ensure high performance, scalability, and compatibility. The backend component of the system is developed in Go (Golang), which provides efficient concurrency and is ideal for developing scalable, distributed systems. For the application component, Kotlin Multiplatform is used to provide code-sharing capabilities for both Android and iOS platforms without compromising native performance and experience. Data communication between the client and server is enabled via secure RESTful APIs that encrypt data for confidentiality and integrity. A cloud-based deployment platform is used to ensure reliable hosting, load balancing, and high availability [18], as shown in the architecture diagram in Figure 4. Additionally, structured database systems are used for the storage of user profiles, emergency requests, and system logs. The technology stack ensures that the unified emergency response system works efficiently and effectively in real-world scenarios.

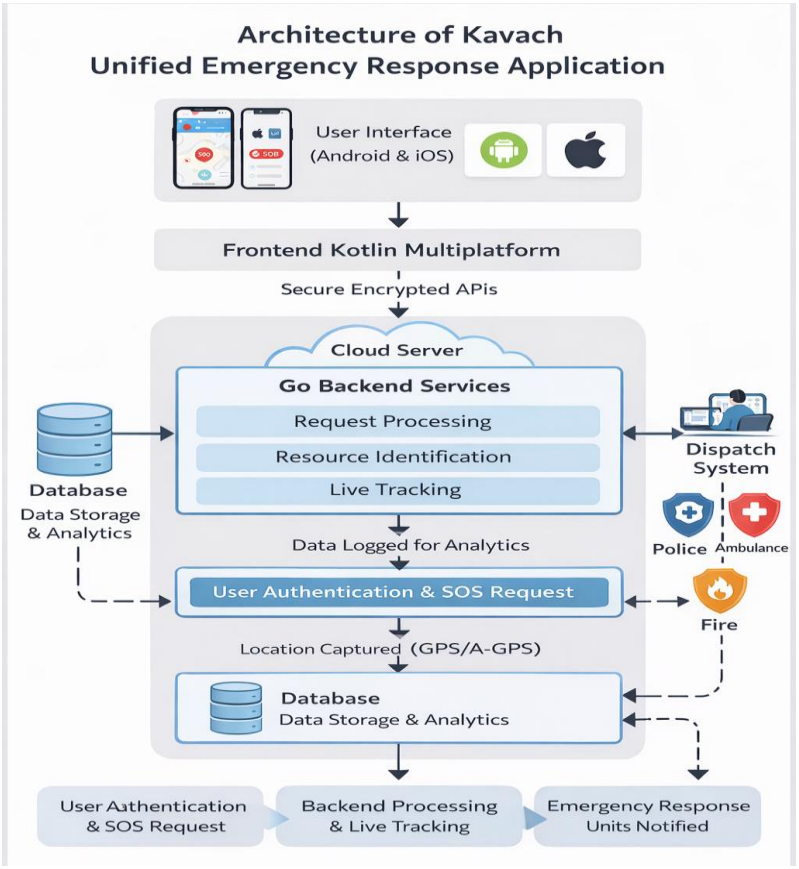

Figure 4: Kavach App Flow

Kavach is developed using proven and stable technologies that make the system faster, more stable, and easier to maintain. The system is designed with a focus on real-time communication, location tracking, and rapid assistance between the user and the emergency services. Although the app is developed for Android and iOS devices using Kotlin, the system is capable of handling thousands of emergency requests using the Go programming language (Golang). There is also no delay, and the system is compatible with GPS and maps, allowing users to easily share their location. This is a means of providing assistance to those who require it as soon as possible. SMS and phones assist in this process. It operates irrespective of mobile data connectivity and has a cloud infrastructure that supports the entire operation, ensuring that it functions well even in the midst of a large-scale emergency. Furthermore, a detailed description of the technologies used to implement this model is demonstrated in Table 2.

Table 2: Details of technologies used

Layer	Technology	Purpose	Advantages
Mobile Application	Kotlin (Multiplatform)	Develops the Kavach app for Android and iOS	One codebase for multiple platforms, fast and reliable
User Interface	Jetpack Compose / SwiftUI	Builds clean and responsive app screens	Modern UI, easy navigation during emergencies
Backend Server	Go (Golang)	Handles SOS requests and service coordination	Very fast, handles many users at the same time
API Communication	REST APIs (JSON)	Connects the mobile app with the backend server	Simple, lightweight, and widely supported
User Authentication	OTP via SMS	Verifies user identity	Quick login, works even with low internet
Location Tracking	GPS / A-GPS	Detects real-time user and responder location	Accurate location during emergencies
Maps & Navigation	Google Maps / OpenStreetMap	Shows routes and estimated arrival time	Trusted navigation with traffic support

Collectively, these features ensure that Kavach is highly effective for integration with state-level emergency response and extends smoothly to support nationwide initiatives.

4. Implementation and Analysis of Proposed System: Kavach

This section describes the working flow of the Kavach system and the efficient processing of emergency requests. It provides the algorithm, results of interface implementation, and a comparative study with existing emergency and safety applications.

4.1 Algorithm description of the Proposed System

The following algorithm describes the procedure of operations, starting from the user's SOS request to the dispatch of the nearest responder, tracking, and resolving the incident.

Algorithm: Integrated Handling of Emergency Requests in Kavach

Input: User SOS request, current location

Output: Closest responder sent with live location tracking and alerts

1. The user launches the Kavach app and logs in using OTP or existing credentials.

2. The user chooses SOS or the desired emergency service, and the system concurrently obtains the current location (GPS/A-GPS).

3. The app encrypts and transmits the SOS request with user and location information to the GO backend server.

4. The backend server checks the request, saves critical information in the database, and locates the closest available emergency responder.

5. Responder dispatch instructions are transmitted to the concerned authority (police/ambulance/fire department).

6. Live location tracking with ETA and route details is activated for the user, and emergency contacts are notified.

7. If required, first-aid instructions are shown to the user.

8. The system updates the request status until the matter is closed and stores data for analytics.

9. End

4.2 Results and User Interface Implementation of Kavach

This section highlights the results of the Kavach system implemented and the functionality of the system through various user interface screens. It also shows how users can effectively request services, track responders in real time, and get confirmations of arrival.

The Kavach application features a simple and intuitive interface that enables users to quickly access essential emergency services. The welcome screen allows language selection, while the home dashboard provides direct options for ambulance, police, fire brigade, blood request, and support services, along with safety guides. A dedicated emergency button ensures instant request generation during critical situations. The account screen securely stores user details and emergency contacts to facilitate faster and more accurate assistance, as displayed in Figure 5.

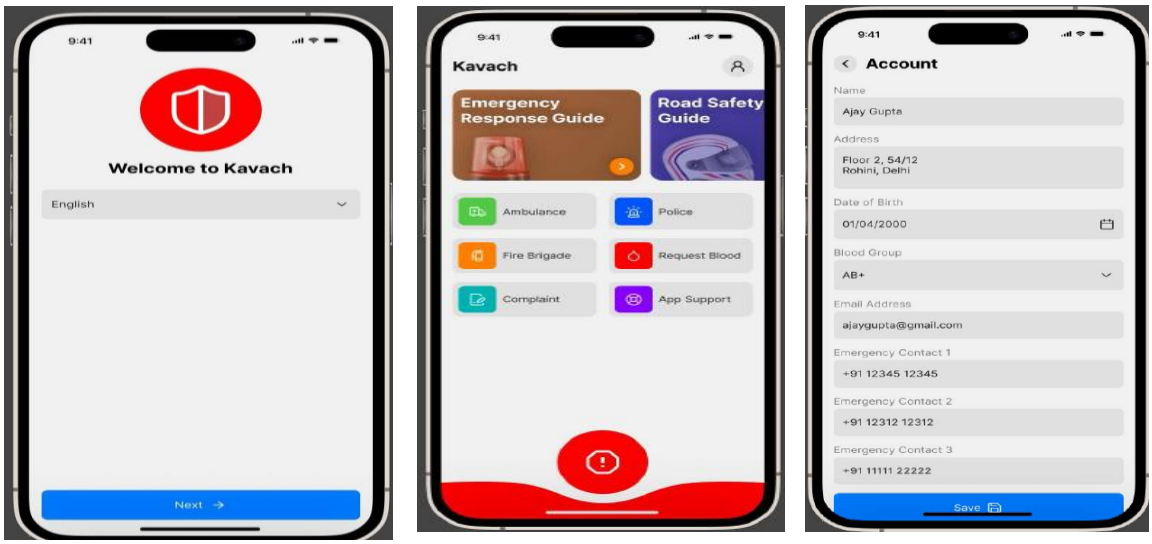

Figure 5: Kavach User Interface

The Requesting Services feature allows users to instantly connect with nearby emergency services, such as ambulance and police, with a single tap, as shown in Figure 6. The application automatically contacts the closest available responders, reducing response time. It ensures quick, reliable, and hassle-free assistance during critical situations.

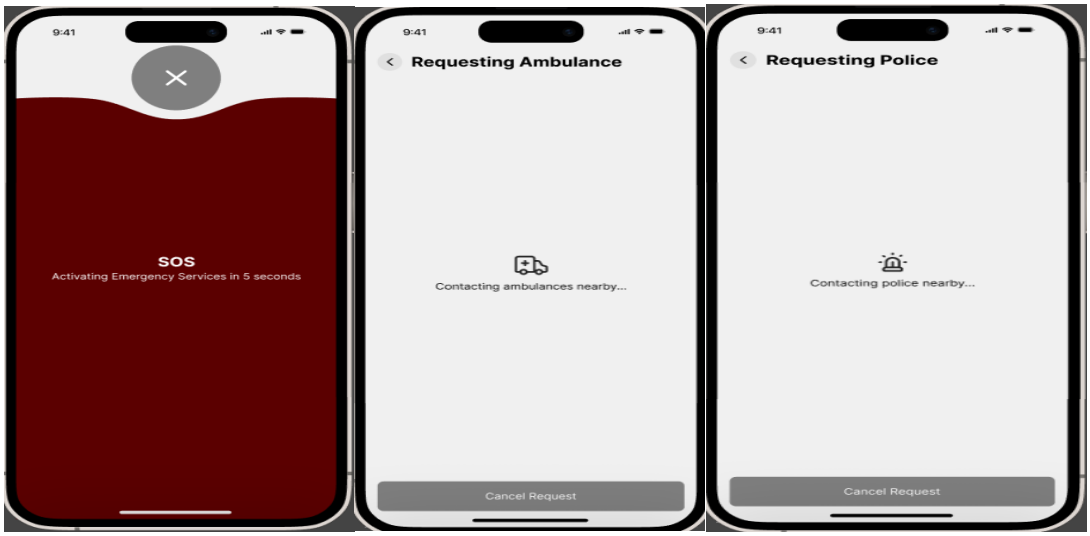

Figure 6: Kavach Requesting Services

The tracking interface displays the real-time location of the dispatched emergency service on an interactive map. Users can view the estimated arrival time, service details, and current status of the responder. This stage helps users monitor progress, stay informed, and remain prepared until the service reaches the destination.

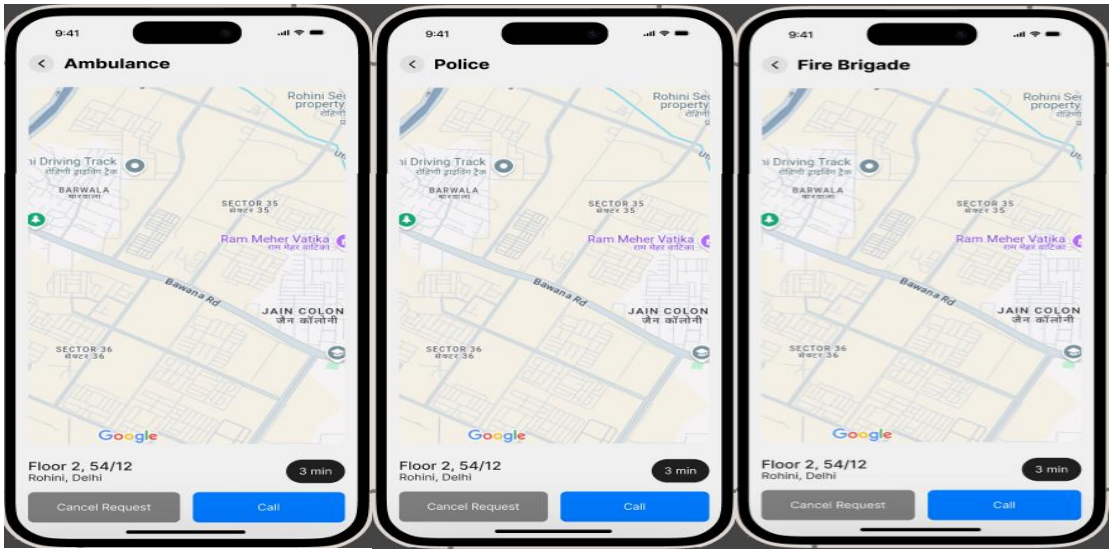

Figure 7: Real-Time Tracking Interface for Dispatched Emergency Services

The Services Arrived screen, as shown in Figure 8, instantly notifies users when the requested emergency service reaches their location and provides real-time status updates. This approach enhances user confidence by ensuring transparency and timely confirmation of assistance.

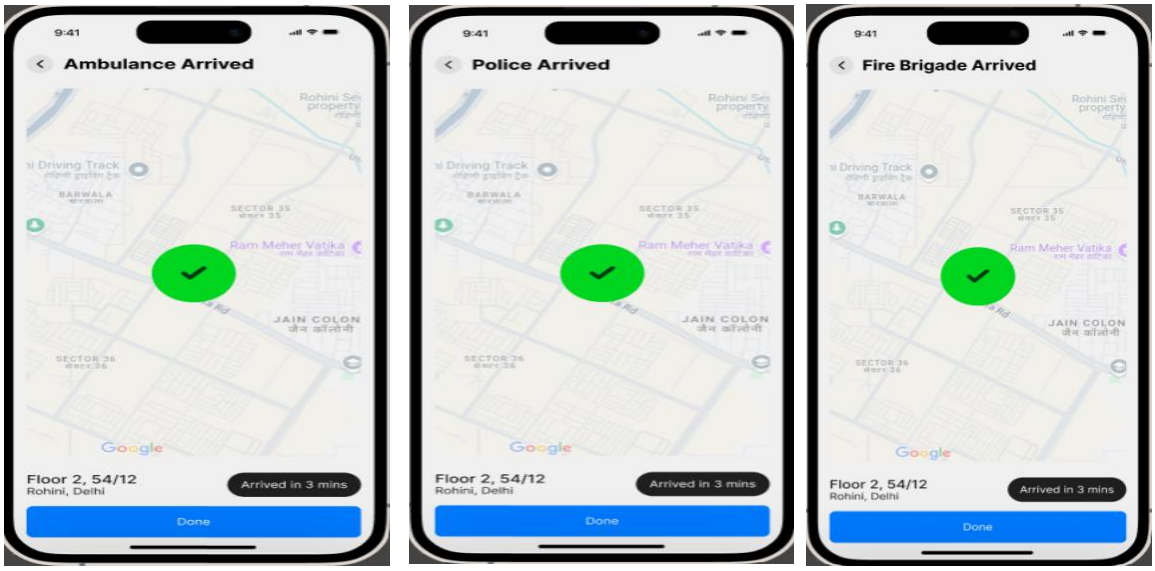

Figure 8: Services Arrived Interface Showing Real-Time Arrival Confirmation

4.3 Comparative Study on the Emergency/Contingency with Kavach

A comparative study is conducted to analyze existing emergency, contingency, and women's safety mobile applications in relation to the proposed Kavach system. This study focuses on evaluating key features such as emergency response time, service integration, real-time tracking, ease of use, and reliability. By comparing Kavach with widely used safety applications as shown in Table 3, the study aims to highlight the strengths, limitations, and unique capabilities of the proposed system, thereby justifying its effectiveness and relevance in real-world emergency scenarios.

Table 3: Comparative Study on Emergency Applications

Feature	**Kavach (Proposed Solution)**	**112 India App** [24]	**Shake2Safety** [25]	**Himmat** [26]	**My SafetiPin** [25]	**SOS Alert**
All-in-One Emergency Services	Police, Fire, Ambulance, Blood Banks, First Aid	Only SOS Alerts	Only SOS Alerts	Police and Family Alerts	Focus on safety info	To Contacts
One-Tap Emergency SOS	Present	Present	Present	Present	Absent	Present
Cross-Platform Compatibility	Android, IOS	Android, IOS	Android	Android,	Android	Android
Works without Internet	Partially (SMS & Calls)	Not possible	Fully Functional	Not possible	Not possible	Not possible
Live Location	Real-Time GPS	Available	Available	Available	Available	Available

	tracking					
Direct Emergency Services Contact	Integrated with all helplines	Available	Not Available	Police only	Not Available	Not Available
First-Aid Guidance	Built-in life-saving Instructions	Not Available	Not Available	Not Available	Not Available	Not Available
Blood Bank Connection	Real-time Access to the nearest blood banks	Not Available	Not Available	Not Available	Not Available	Not Available
Emergency Route Navigation	It directs to the nearest hospital, police, or fire station	Not Available	Not Available	Not Available	Available	Not Available
Multi-User Safety Alerts	It sends an SOS to family, friends & authorities	Available	Available	Available	Available	Available
Government Backing	Currently Private initiative	Government-developed	N/A	By Delhi Police	N/A	N/A

The comparative analysis proves that the proposed Kavach application is more comprehensive and integrated in terms of providing an emergency response solution compared to other existing emergency, contingency, and women's safety applications. Although most of the existing applications are limited to SOS alerts and location sharing, Kavach goes a step ahead by providing direct access to various emergency services such as police, ambulance, fire department, blood banks, and first-aid assistance.

Unlike most of the applications that require constant internet connectivity, Kavach partially works on SMS and call functions, which allows for basic emergency communication even when internet connectivity is low. Moreover, Kavach is the only application that provides first-aid assistance and emergency route navigation to the nearest hospital and service station, which is not provided by most of the other applications.

The comparison analysis clearly shows that Kavach fills the most critical gaps in the existing applications by providing emergency service integration, offline functionality, medical assistance, and navigation services all under one roof, making it a more reliable and feasible option for real-time emergencies.

5. Conclusion & Future Scope

The Kavach application offers a comprehensive safety solution by integrating various emergency, contingency, and medical support services under a single interface. Unlike other applications that currently focus on the specific needs of safety, Kavach provides a comprehensive solution through faster response mechanisms, real-time tracking, multi-agency coordination, and access to necessary first-aid advice. The cross-platform capability, partial offline support, and ease of use of the Kavach application further increase its effectiveness in critical situations. The results of this study suggest that Kavach is an effective solution to

the current shortcomings of safety applications and has immense potential to enhance the efficiency of emergency response and overall public safety.

The future improvements should aim to bolster both the technological and infrastructure aspects of safety management in India. This can be achieved through mandatory road safety audits before construction, rectification of accident-prone zones, strict enforcement of traffic rules through technology-based systems, and the implementation of international vehicle safety norms. Moreover, raising awareness of the laws can encourage bystanders to help victims of accidents. Taken together, these, along with the continued development of the Kavach system, can help reduce road accidents and create a more robust and efficient emergency response environment.

References

1. The Times of India. (2024). *474 Lives Lost Daily in Road Crashes in 2023: Govt Data*. Retrieved from https://timesofindia.indiatimes.com/india/474-lives-were-lost-daily-in-road-crashes-in-2023-says-govt-data/articleshow/114359854.cms
2. Ministry of Road Transport and Highways. (2022). *Road Accidents in India 2022*. Retrieved from https://morth.nic.in/sites/default/files/RA_2022_30_Oct.pdf
3. Kumar, S., & Singh, P. (2023). Emotional Appeal in the Tweets: A Study on Indian National Political Parties. *Journal of Communication and Management*, *2*(02), 95–97. https://doi.org/10.58966/JCM2023223
4. Wikipedia. (2023). *Roads in India*. Retrieved from https://en.wikipedia.org/wiki/Roads_in_India
5. Rohini College of Engineering & Technology. (n.d.). *Statistical Analysis of Road Networks in India*. Retrieved from https://www.rcet.org.in/uploads/academics/rohini_64158577983.pdf
6. Construction World. (2024). *Fastest Road Construction Records in India*. Retrieved from https://www.constructionworld.in/transport-infrastructure/highways-and-roads-infrastructure/nitin-gadkari--india-made-world-record-for-fastest-road-construction/26785
7. Testbook. Classification of Roads. Retrieved from
8. https://testbook.com/civil-engineering/classification-of-roads
9. Kumar, S. . (2023). Qualitative Analysis of Religious Drama in Hindi Cinema: A Study of Movie “Dharam Sankat Mein”. *MediaSpace: DME Media Journal of Communication*, *4*(01), 11–16. https://doi.org/10.53361/dmejc.v4i01.02
10. The Constructor. *Classification of Roads and their Details [PDF]*
11. Kumar, S. ., & Hooda, S. (2023). An Analytical Review of Political Communication in India with Special Reference to the Social Media. *MediaSpace: DME Media Journal of Communication*, *3*(01), 8–15. https://doi.org/10.53361/dmejc.v3i01.02
12. Ministry of Road Transport and Highways. (2022). *Summary of Accidents and Deaths in India*. Retrieved from https://app.powerbi.com/view?r=eyJrIjoiMjIzMTY5MmQtNjZmZC00OTAyLTkzOGMtYWEyOWYwZDE1YjU2IiwidCI6IjViN2ExMDIzLTI1ODgtNGU3Yi05MjZlLTgwYzllY2EwNWQ4OCIsImMiOjEwfQ%3D%3D
13. https://www.maharashtra.gov.in/Site/Upload/PDF/SDMP.pdf
14. e-RaktKosh. (2023). *Centralized Blood Bank Management System.* Retrieved from https://eraktkosh.mohfw.gov.in/eraktkosh.mohfw.gov.in
15. Indian Red Cross Society. (2023). *First Aid.* Retrieved from https://www.indianredcross.org/ircs/program/FirstAidIndian Red Cross Society+1Indian Red Cross Society+1
16. Gujarat Road Safety Authority. *Road Safety in India*. Retrieved from
17. https://gujrosa.gujarat.gov.in/road-safety-in-india
18. ResearchGate. Analyzing the Maharashtra Ambulance Service '108': The Prospect and Challenges. (2024). Retrieved from https://www.researchgate.net/publication/385141344_Analyzing_the_Maharashtra_Ambulance_Service_108_The_Prospect_and_ChallengesTaylor & Francis Online+2ResearchGate+2

19. MoRTH. *Working Group on Emergency Care in India*. Retrieved from
20. https://morth.nic.in/sites/default/files/Working_Group_on_Emergency_Care_in_India_0.pdf
21. [1] Scroll. in. (2024). *Death by delay: Revamping India's ambulance services could save lives lost to road crashes.* Retrieved from
22. Kumar, S., & Singh, P. (2023). Emotional Appeal in the Tweets: A Study on Indian National Political Parties. *Journal of Communication and Management*, *2*(02), 95–97. https://doi.org/10.58966/JCM2023223
23. https://scroll.in/article/1068217/death-by-delay-revamping-indias-ambulance-services-could-save-lives-lost-to-road-crashes
24. Envoys. (2024) *Video Incident Detection System (VIDS)* https://envoys.in/video-incident-detection-system-vids/
25. The Better India. (2025). *Golden Hour: How Bystanders Can Save Lives in Road Accidents.* Retrieved from https://thebetterindia.com/396132/good-samaritan-law-golden-hour-road-safety-month-bystanders-emergency/
26. Indian Journal for Preventive & Social Medicine Article. Retrieved from
27. https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://ijpsm.co.in/index.php/ijpsm/article/download/70/61/126&ved=2ahUKEwjimKLArrGNAxUdUGcHHRvqM1sQ-NANegQIJxAC&usg=AOvVaw0uYuKWMdHZr4T4i6S_v-IQ
28. Medical Buyer. (2024). *India's ambulances lack essential medical equipment.* Retrieved from
29. https://medicalbuyer.co.in/indias-ambulances-lack-essential-medical-equipment/Medical Buyer
30. Ministry of Health and Family Welfare. *Provider Course Manual for Paramedics NATIONAL EMERGENCY LIFE SUPPORT.* Retrieved from
31. https://mohfw.gov.in/sites/default/files/Provider%20Course%20Manual%20for%20Paramedics.pdf
32. Economic Times. (2025). Nitin Gadkari says, this one reason is costing India 3% of its GDP annually. Retrieved from https://economictimes.indiatimes.com/news/india/nitin-gadkari-says-this-one-reason-is-costing-india-3-of-its-gdp-annually/articleshow/119477424.cms@EconomicTimes
33. Bloomberg. (2023) *What Makes India's Roads the Deadliest in the World.* Retrieved from
34. https://www.bloomberg.com/news/features/2023-05-24/four-problems-and-solutions-for-india-s-dangerous-roads
35. The Times of India. (2024). *Popular Women's Safety Apps in India*. Retrieved from https://timesofindia.indiatimes.com/gadgets-news/popular-womens-safety-apps-in-india/photostory/99388808.cms
36. Ministry of Home Affairs*. Emergency Response Support System.* Retrieved from
37. https://112.gov.in/
38. RTIWala. (2024). *Women's Safety Apps: Best Tools & Helplines for Emergencies*. Retrieved from https://rtiwala.com/content/women-safety-apps-best-tools-helplines-for-emergencies/
39. Himmat Plus - Delhi Police Initiative For Women's Safety. Retrieved from
40. http://himmat.delhipolice.nic.in/
41. Press Bureau of India, Delhi. (2022). *Initiatives Taken by the Government to Prevent Road Accidents*. Retrieved from https://pib.gov.in/Pressreleaseshare.aspx?PRID=1776782
42. MoRTH. *Working Group on Emergency Care in India*. Retrieved from
43. https://morth.nic.in/sites/default/files/Working_Group_on_Emergency_Care_in_India_0.pdf