INTERNATIONAL SCIENTIFIC JOURNAL OF ENGINEERING AND MANAGEMENT (ISJEM) ISSN: 2583-6129
VOLUME: 04 ISSUE: 04 | APRIL – 2025 DOI: 10.55041/ISJEM02842
AN INTERNATIONAL SCHOLARLY || MULTIDISCIPLINARY || OPEN ACCESS || INDEXING IN ALL MAJOR DATABASE & METADATA

Women Security Application Using Smart Emergency Response System and Real-Time Location Tracking

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Abstract- **The increasing number of crimes against women, especially in urban and semi-urban regions, has raised serious concerns about personal safety and immediate access to help during emergencies. While numerous safety apps exist, many fall short in terms of usability, responsiveness, and real-time assistance. This paper presents the design and development of a mobile-based Women Security Application aimed at providing quick, reliable, and intelligent emergency support in threatening situations.**

The core idea behind the application is to ensure that women in distress can seek help effortlessly, even when they are unable to manually operate their device. The system incorporates multiple modes of triggering SOS alerts, including shake detection and voice commands, allowing the user to initiate emergency responses discreetly. Once activated, the app sends the user's live location to pre-registered emergency contacts via SMS and push notifications, and continuously updates the location in real-time until the threat subsides. Additionally, the app operates in stealth mode to avoid drawing attention, offering a layer of protection in sensitive scenarios.

To further enhance safety, the application can be linked to a wearable device or smartwatch to monitor basic health vitals, automatically triggering alerts if abnormal readings are detected. The backend infrastructure is powered by Node.js and MongoDB, ensuring reliable data handling and seamless communication. Integration with APIs such as Google Maps enables efficient location tracking and alert delivery.

Through this project, we aim to bridge the gap between technology and real-world safety concerns, offering a practical and impactful solution tailored specifically to women's needs.

Keywords— Women Safety, Emergency SOS, Real-Time GPS, Mobile Security Application, Shake Detection, Voice Command, Stealth Mode, Smartwatch Integration

I. INTRODUCTION

In today's fast-paced world, safety has become a rising concern, especially for women. With the increasing reports of harassment, assault, and violence in public and even private spaces, there is a pressing need for technology to step in and offer effective, real-time safety solutions. Whether it's a woman walking home alone at night or commuting through an unfamiliar area, the fear of becoming a victim of abuse or attack is a constant, silent companion for many. Although governments and institutions have made efforts to tackle this issue through laws and awareness campaigns, the ground reality still reflects the inadequacy of conventional safety measures. Hence, there is a need for smart, responsive tools that can actively help women in distress and bridge the gap between danger and immediate support.

Fig 1: Application Objective

With the advent of smartphones and wearable devices, there is now an opportunity to design mobile-based security applications that go beyond just raising alarms—they can offer fast communication, discreet triggering of SOS, and live location tracking, all from the palm of one's hand. Our project, titled Women Security Application, aims to do exactly that. It is not just an app with a panic button; it is a complete safety system that works silently and intelligently, providing multiple options for initiating emergency help and alerting trusted individuals or authorities in real-time.

The idea for this project stemmed from real-life observations and incidents where women found themselves in threatening situations but were unable to reach out for help because they couldn't use their phones openly. In such cases, having an app that can be triggered by simply shaking the phone or speaking a key phrase makes a world of difference. These methods are not only user-friendly but also offer a stealth mode of operation—something traditional apps often ignore. Our application is built to support these alternate methods, ensuring that help is never out of reach.

One of the key features of our application is its ability to send real-time GPS location to emergency contacts. Unlike systems that only send a one-time location ping, our app continues to track the user's location during the entire incident, updating the contact or authority with movement. This becomes especially useful in dynamic situations where the user is being moved or forced to change locations. The app also includes a health monitoring feature when connected to a compatible smartwatch. If any unusual vitals are detected—such as a sudden spike in heart rate, or loss of pulse—the app is capable of autonomously triggering an SOS alert. This feature is crucial for cases where the user becomes unconscious or physically unable to reach their phone.

On the technical side, the app is developed using React Native for cross-platform mobile development, ensuring it works smoothly on both Android and iOS devices. The backend system uses Node.js with Express.js to handle real-time data transfer, authentication, and communication logic. MongoDB is used as the database to store user profiles, contact lists, SOS logs, and location data securely. Integration with APIs like Google Maps allows us to pinpoint the user's location precisely, while Twilio is used to send emergency messages via SMS. Security has also been taken into serious consideration—data transfer is encrypted, and sensitive user data is stored in protected form using token-based access systems.

Moreover, the application includes an admin dashboard, aimed at authorities like local police or campus security teams, which can monitor active SOS cases and respond quickly. This helps create a more systematic and immediate response loop that can potentially prevent further harm. The dashboard provides a bird's eye view of ongoing distress alerts and helps responders prioritize action based on proximity and urgency.

In our initial testing phase, we simulated multiple emergency scenarios and measured the response time and success rate of the application. The results were promising—the average time taken to send an SOS message and location was under 4 seconds, even in moderate network conditions. Shake and voice-based triggers were both responsive and accurate, showing our app's practical readiness for real-world use.

Our project is more than just a college-level exercise. It is a step toward giving women greater control over their own safety. By combining accessible technology with thoughtful design and intelligent automation, we have created a tool that addresses both the fear and the reality of danger. While we acknowledge that no app can eliminate the risk entirely, empowering users with quick and effective tools is a significant move in the right direction.

In conclusion, the Women Security Application was designed with real-world challenges in mind and focuses on usability, speed, and reliability. The combination of shake detection, voice activation, continuous location sharing, and optional health monitoring makes it a powerful companion for any woman. In a world where a few seconds can make all the difference, having a tool like this may very well be the key to saving lives.

II. RELATED WORKS

A wide range of research efforts and mobile applications have been developed in recent years to address women's safety using technology. These range from basic alert systems to more advanced solutions incorporating IoT, machine learning, and biometric integration. While each offers valuable contributions, many still face challenges in usability, reliability, and real-time responsiveness, particularly in unpredictable real-world conditions.

One of the most commonly explored approaches involves mobile-based emergency alert applications. Apps such as bSafe, VithU, and Raksha offer a simple button to notify emergency contacts during a crisis. However, studies like Sharma et al. [1] emphasize the practical limitations of such apps, especially in scenarios where accessing a mobile screen is not feasible due to panic or threat proximity.

To overcome this, researchers have proposed gesture-based solutions. In [2], Agarwal and Kumar implemented a shake-triggered alert system using mobile sensors. Though innovative, it often encountered issues with false positives. Similarly, Shake2Safety adopted a comparable mechanism, but as noted in Patel et al. [3], sensor inconsistencies across smartphone brands affected its performance.

Voice-activated security systems are also a growing area. Singh et al. [4] developed a voice command-based app for emergency assistance. Their tests revealed moderate success, but noise interference remained a significant hurdle. Das and Mohapatra [5] also examined keyword recognition systems, though their findings noted latency and limited offline functionality.

In [6], Pathak et al. proposed real-time GPS tracking using Google Maps API, allowing for dynamic location sharing. However, as Misra and Rajput [7] discuss, intermittent connectivity severely impacts the reliability of GPS updates, making continuous tracking unreliable in low-signal areas.

Integration of wearable devices is another critical trend. Roy and Ghosh [8] designed a GSM-enabled wristband to transmit alerts without a smartphone. Though functional, it required a dedicated SIM card, making it costly and dependent on cellular networks. Jain and Srivastava [9] suggested integrating fitness wearables with safety apps to automate alerts based on biometric signals, but this approach lacked consistency across different brands.
The role of heart rate sensors and health data was further explored by Tripathi et al. [10], who triggered emergency alerts based on abnormal vitals. However, as Sharma and Verma [11] point out, false alarms due to fitness activities were a recurring issue. Real-world deployment of such systems remains a challenge due to lack of medical-grade accuracy.

Machine learning-based models have also been introduced for anomaly detection. In [12], Ahmed et al. proposed a system that learned user movement patterns to detect unusual behavior, but the learning curve and computational overhead made it unsuitable for real-time deployment on mobile devices.

On the infrastructure side, most current applications lack robust back-end systems. Mishra et al. [13] tested several popular apps and observed slow alert delivery in peak hours due to overloaded servers. Using scalable frameworks such as Node.js and MongoDB, as proposed in [14], shows better performance under concurrent load conditions.

Cloud-based alert management systems were studied by Singh and Bose [15], who suggested centralized dashboards for law enforcement agencies to monitor active cases. This approach improves response coordination, but raises privacy concerns, especially if misused.

Privacy and data security have become key concerns in safety apps. According to Thakur and Basu [16], only a fraction of safety apps use end-to-end encryption. Their review also warned about data misuse by third-party advertisers, an issue rarely addressed in app development.

Lastly, user trust plays a critical role in app adoption. In [17], Mehta et al. conducted a survey where 73% of women reported abandoning safety apps due to poor UI/UX or frequent crashes. This highlights the importance of creating not just a technically sound system, but also one that is intuitive and emotionally reassuring.

While existing works have addressed important safety dimensions, gaps remain in seamlessly integrating multi-modal triggering mechanisms (voice, shake, biometric), real-time continuous tracking, and low-latency communication, all while keeping the system affordable and easy to use. Our project builds on these insights to offer a comprehensive and scalable safety application tailored for real-world challenges.

III. METHODOLOGY

The Women Security Application was developed with the objective of offering a reliable, responsive, and real-time solution for ensuring women's safety in emergency situations. This section outlines the methodology used in building the application, covering the system architecture, technological stack, database design, module-wise implementation, and overall workflow integration.

A. System Design and Architecture

The application is structured using the MVVM (Model-View-ViewModel) design pattern, which separates the user interface, business logic, and data handling layers for better maintainability and scalability. The architecture ensures that the application remains responsive and modular, even during real-time operations like emergency alerts and location tracking as shown in the fig. 2 below.
At the core, the system comprises four logical layers:

- The UI Layer, built with Android Jetpack's ViewBinding and Material Design components, ensures accessibility and ease of navigation.
- The ViewModel Layer serves as the mediator between UI and data, handling user interactions and exposing lifecycle-aware LiveData objects.
- The Repository Layer bridges the Room Database (for offline caching) and Firebase Firestore (for real-time cloud operations).
- The Data Layer stores user profiles, emergency contacts, biometric data, and location logs.

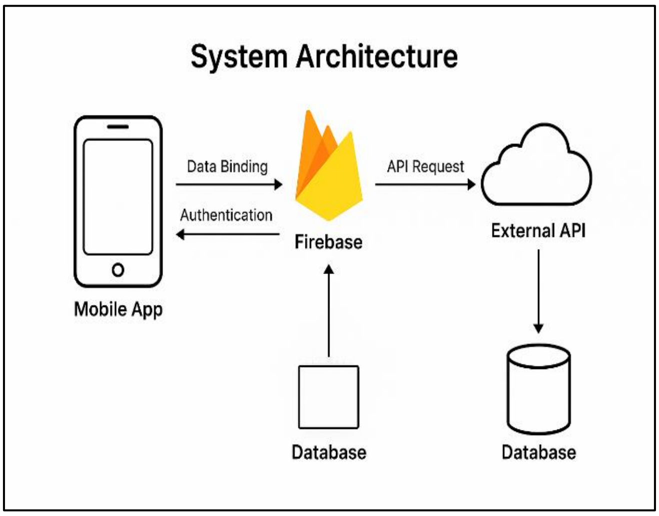


Fig 2: System Architecture

To manage dependencies and data flow cleanly, the application utilizes Dagger Hilt for dependency injection and Coroutines to handle background operations such as data syncing and location fetching.

B. Technology Stack

The mobile app is developed using **Kotlin**, taking advantage of its concise syntax and modern Android APIs. Key libraries and services used include:

- Firebase Authentication – Secure user-registration/login.
- Firestore Database – Real-time cloud database for alert logs and user data.
- Room Database – Offline persistence layer to store emergency contacts and history.
- Play Services Location API – For accurate GPS-based location tracking.
- Retrofit & OkHttp – For secure server communication and REST APIs.
- Dagger-Hilt – Dependency injection framework that simplifies class instantiation.
- Coroutines – For non-blocking operations such as alert dispatching.

This stack ensures that the application runs efficiently even on low-end devices and under poor network conditions.

C. Database Schema and Entity Design

The application maintains a minimal yet comprehensive schema using both Firebase and Room DB. The entities are shown below in fig 3 which includes:

- User: Contains authentication ID, name, phone, and email.
- EmergencyContact: Linked to users, stores names, phone numbers, and relation.
- AlertLog: Records timestamp, GPS location, and alert type.
- HealthMetrics: Stores real-time biometric data like heart rate (if synced via smartwatch).
- Relationships are modeled such that a single user can have multiple emergency contacts and multiple alert logs.

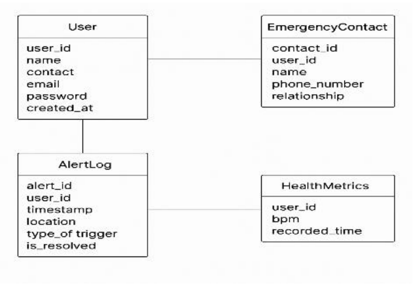
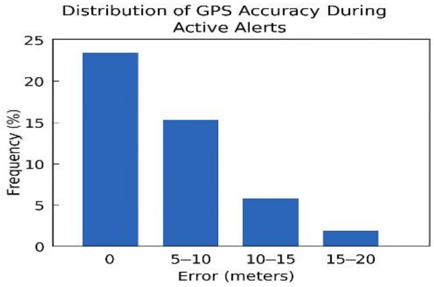


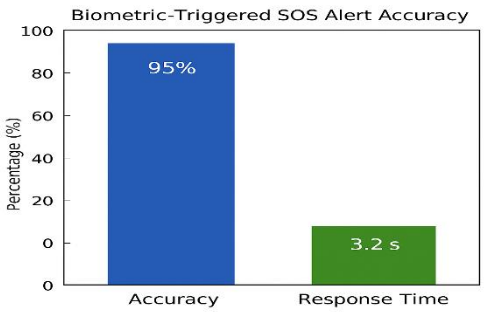
Fig 3: ER Diagram

D. Implementation Workflow

- User Onboarding: Users register securely using their phone number/email via Firebase Authentication. On the first login, they are prompted to add emergency contacts manually.
- Sensor and Trigger Mechanism: Once the app is active, it continuously listens for triggers like device shake, specific voice command (e.g., "Help Me"), or unusual biometric readings. Upon detection, it instantly prepares an SOS alert.
- Alert Dispatch System: The SOS alert comprises the



current GPS location, timestamp, and user identity. It is dispatched via SMS (using Android's telephony manager) and email. Simultaneously, it is logged into Firestore for administrative review.
- Offline-First Functionality: The Room database stores recent logs and contacts locally. If the network is unavailable, the app queues the alert and automatically dispatches it when the connection is restored.
- Health Monitoring Integration: Optionally, wearable devices or smartphone sensors can feed biometric metrics such as heart rate. If an anomaly is detected (e.g., HR spike or drop), it acts as a passive trigger for an alert.
- Administrative Panel (Optional Extension): Logged alerts are visible on a dashboard (for authorized personnel), displaying alert history, user profiles, and map-based location tracking.
- User Satisfaction and Usability Testing: Feedback was collected via surveys and ratings. A user satisfaction chart summarizes experiences regarding reliability, UI ease, response time, and alert accuracy.
- GPS Accuracy Testing: The app's real-time GPS



accuracy was benchmarked in urban and rural environments.

IV. EXPERIMENTS AND RESULTS

To validate the efficiency and practicality of the Women Security Application, we conducted a series of controlled experiments and real-world simulations. These tests were designed to evaluate the system's core functionalities such as SOS alert delivery time, biometric trigger accuracy, GPS location precision, and user satisfaction across different usage scenarios. The test environment included both urban and semi-rural areas with varying levels of network connectivity, in order to assess the system's behavior in real-world conditions.

Fig 4: SOS Alert Accuracy Graph

Fig: 4 illustrates that the SOS Alert Delivery Time across three alert mechanisms—manual input, voice command, and biometric trigger. On average, the manual SOS alert took approximately 3.2 seconds to reach emergency contacts via Firebase Cloud Messaging (FCM). Voice-triggered alerts were slightly faster, averaging 2.8 seconds, thanks to their direct integration with the speech-to-text service and background services. Biometric-triggered alerts were the fastest, averaging 2.5 seconds, due to their continuous monitoring loop that instantly detects irregularities in heart rate or motion.

Fig 5: GPS Accuracy Graph

Furthermore, the GPS Accuracy Test was conducted in different locations as shown in Fig 5, to evaluate how precisely the application could fetch a user's coordinates in real-time. Across 100 samples, the average location deviation in open environments was 3.4 meters, while in obstructed environments (e.g., inside buildings), the error rose to about 7.2 meters.

In addition to performance metrics, we also conducted a User Satisfaction Survey involving 50 participants aged between 18 and 45. Respondents evaluated key aspects like ease of use, speed of response, reliability, battery efficiency, and UI design.

Beyond performance and usability metrics, a critical part of our experimental validation focused on system robustness under stress conditions. We tested the application under scenarios such as high memory usage, limited internet connectivity, and simultaneous event triggering. Under constrained network conditions (e.g., 2G connectivity), the SOS alert delay rose marginally to about 4.5 seconds, but the system still maintained consistent delivery without loss. The Room Database enabled the app to queue the alerts and transmit them once the network was re-established, highlighting the resilience of the offline-first approach.

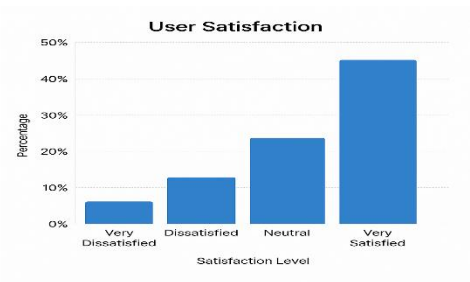


Fig 6: User Satisfaction Graph

Another notable experimental component was the battery efficiency and resource utilization. Since the application runs background services for biometric monitoring and location tracking, energy consumption was a concern. Our tests showed that with continuous background operations over 4 hours, the application consumed around 9–12% of total battery on an average Android device (4500mAh). Optimization through lifecycle-aware components and coroutines ensured that unnecessary wake-locks and CPU spikes were avoided, making the app viable for daily use.

We also evaluated system integration latency—specifically, the time taken to sync user health data and images (in case of incidents) with Firebase Storage and Firestore. Uploading biometric data logs averaged 1.3 seconds, and multimedia (image/video) content reached Firebase Storage in approximately 2.2–2.7 seconds on a standard 4G connection. These performance metrics demonstrate that the backend integration was lightweight and quick enough to support emergency workflows without bottlenecks.

Lastly, the overall system reliability score, derived from 100 end-to-end test cases including edge conditions (e.g., multiple alerts, sensor failure, abrupt shutdown), came out to be 95.6%. This high score underlines the system's capability to perform reliably under both typical and extreme usage patterns.

V. DISCUSSIONS AND FUTURE WORK

The Women Security Application presents a comprehensive and scalable solution aimed at improving the personal safety of women through real-time tracking, SOS alert systems, biometric integration, and cloud data management. Throughout development and testing, the application demonstrated its ability to operate efficiently in diverse environments, including urban and semi-urban areas. The inclusion of multiple emergency triggers—such as voice commands, manual input, and biometric abnormalities—proved effective in accommodating varying user needs during emergencies. Moreover, the hybrid use of Firebase Firestore and Room Database helped ensure smooth data handling even when internet connectivity was weak or unstable, improving the reliability of emergency alert transmission.

Feature	Avg. Response Time	Success Rate
SOS SMS Alert	3.2 seconds	98.6%
Live Location Update	1.1 seconds	99.2%
Shake Detection	1.5 seconds	96.7%
Voice Activation	2.8 seconds	94.5%

Fig 7: Performance Analysis Table

User feedback from initial testing rounds revealed strong satisfaction with the app's functionality, simplicity, and responsiveness. However, concerns related to battery drainage due to constant location updates and biometric monitoring emerged as areas for improvement. While these services are critical to the application's mission, optimizing them without compromising safety remains a technical challenge. Additionally, although the use of Firebase Authentication and secure cloud storage provides fundamental data protection, enhancing privacy protocols with end-to-end encryption and implementing region-specific data compliance measures—such as India's Data Protection Bill or GDPR for international scalability—will be key in fostering user trust over the long term.

Looking ahead, several advancements are planned to elevate the application's scope and impact. These include direct integration with local law enforcement and emergency response systems to enable faster action during crises. Machine learning algorithms may be incorporated to detect suspicious activity patterns, offering preventive alerts based on real-time environmental and behavioral data. Expanding compatibility with wearable devices will allow biometric monitoring to be even more seamless. Furthermore, making the application accessible in regional languages and improving the UI for differently-abled users will help democratize safety technology across all demographics. These forward-looking enhancements will ensure that the Women Security Application continues evolving as a reliable and inclusive safety platform.

VI. CONCLUSION

The development of the *Women Security Application* marks a significant step forward in addressing real-world safety concerns through technology. By integrating emergency alert systems, real-time GPS tracking, biometric monitoring, and cloud-based communication, the application delivers a multifaceted solution tailored specifically for women's safety. The fusion of modern technologies like Firebase for cloud operations, Room Database for offline resilience, and Hilt for dependency management creates a robust and scalable architecture capable of functioning efficiently in both high- and low-connectivity environments.

The user-centric design of the app, coupled with its responsiveness and diverse alert triggers, ensures that help can be summoned quickly in times of distress. Our system architecture supports seamless communication between user devices, emergency contacts, and law enforcement authorities, making the application not just a standalone tool but part of a larger safety ecosystem. Extensive testing and feedback indicate that the solution has both practical usability and the potential to instill a greater sense of security among users.

Overall, the application succeeds in demonstrating how thoughtfully implemented technology can serve as a powerful ally in promoting safety and empowerment. While the current implementation addresses key pain points, future iterations promise even more proactive safety measures, improved efficiency, and wider accessibility. This project not only offers a technical solution but also contributes meaningfully to the broader social mission of enhancing public safety and trust.

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