
Received 24 December 2025; accepted 20 January 2026.

Date of online publication 19 May 2026; date of current version 1 July 2026.

DOI 10.32692/IJDI-ERET/15.1.2026.2605

(Research Article)

Nyx: Leveraging Mobile Technology for Women's Safety and Emergency Response

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Abstract

Women's safety is one of the major concerns across the globe, particularly in urban areas where incidents of harassment, assault, domestic violence and crime continues to increase. As the urbanization has evolved, there is a need for some technology that can guard and ensure the women's safety. The paper aims to address the safety challenges by reviewing the current landscape of mobile applications dedicated to women safety and by proposing a mobile application, NYX as a next-generation women safety application that incorporates intelligent emergency response tools with integrating techniques of Artificial Intelligence (AI) and sentiment analysis. Although existing mobile applications include features like emergency contacts or panic buttons, but lack the proactive response mechanisms. For this, the paper introduces NYX, a mobile application which bridges these gaps by integrating advanced techniques of AI, ML and sentiment analysis to provide real-time assistance and informed decision making. The application provides real-time location tracking, detecting high risk prone areas through sentiment analysis of live news, fake calling to escape threatening situations and video voice memo recording for capturing evidences. Real-time location tracking, AI-based sentiment analysis of the surrounding news to identify high-risk areas, fake call triggers to get out of a problematic situation, and instant video/voice memo recording for proof. It also supports SOS alerts, automated group calls to predefined contacts, and a locator of a nearby police station to act as fast as possible in emergency situations.

Keywords: Mobile apps, women safety, sentiment analysis, emergency response, artificial intelligence, machine learning.

1. Introduction

The following section presents the problem of women safety coupled with the gaps in the current mobile safety application. The issue of women safety is becoming essential, especially considering the high rates of crimes against women in urban areas. Harassment, assault, and online abuse cases illustrate the need for immediate and intelligent protection solutions. Moreover, a review of the crime data at data.gov.in [1] shows that cities such as Delhi, Mumbai, Bangalore, Chennai, and Kolkata top the list of crimes against women, with thousands of reported instances each. Therefore, these facts prove the necessity to suggest real-time solutions rather than rely only on responsive ones.

However, despite the growing reliance on such mobile apps, the majority of the available platforms have limited characteristics. Specifically, current mobile apps heavily depend on the emergency call buttons and location sharing

and rarely use the existence public data, predict real risk, and make intelligent decisions. As a result, mobile apps are hardly supportive when real emergencies strike. Therefore, the task is to design an application that could not only react to danger but predict them and support future emergency using the tools people have nowadays, such as AI, machine learning, or login analysis.

The modern women safety application was developed in parallel to cover these gaps, and this one was constructed on Swift UI [3]. It operates based on three pillars-mitigation, real-time assistance, and intelligence. The former involves a dynamic crime heatmaps [2] based on live data sources such as data.gov.in, risk cereal systems, sentiment analysis of local safety news, live location sharing, SOS alerts, group call triggers, and nearby police station locator.

2. Motivation

The increasing incident cases of women safety in public and private places have stressed the requirement of more efficient digital solutions. There are already available several mobile applications revolving around women's safety, but

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ISSN 2320-7590 (Print) 2583-3863 (Online)

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they are substantially inadequate in addressing the feasibility and usability factors from a user interface, responsive notifications, and smart help recommendations. Most of the existing apps can only fetch the location from the GPS or send a hardcoded SOS message to predefined contacts. In comparison, more advanced features like prescriptive notifications, intelligent assistance by AI, and an intuitive user interface have completely been unexplored.

Motivated by these gaps, this research aims to develop Nyx, a comprehensive, profit-free mobile application that offers a smarter, user-informed, and context-aware approach to women's safety. The goal is not only to improve safety response but also to provide women with tools that proactively help them avoid unsafe situations, while ensuring the application is effective and accessible across various demographics.

To support this objective, our team conducted a user-centric survey designed to evaluate how women have experienced existing safety applications and to identify the limitations that hinder their effectiveness. The survey was introduced with the following purpose statement:

“This form is designed in a way to understand how your experience with women safety apps has been in the past. To create a better solution, we must first understand where the existing solutions lack and how we can help in making the UI better. Kindly answer these questions as best to your knowledge as possible. Your feedback will be taken into consideration while creating our new women's safety (profit-free) mobile application.”

The survey received answers from 180 women who belonged to various age ranges and demographic backgrounds. The survey participants assessed three essential elements of present safety applications through their evaluation of user interface and response times and their assessment of different features' effectiveness. The survey results delivered specific recommendations which researchers could use to create new applications.

- The survey results showed that 87% of participants would experience enhanced safety when using an application which combines real-time crime data with AI safety insights and immediate alert systems.
- Users found Live Location Sharing to be their most valuable feature because it enabled them to share their whereabouts with trusted contacts for emergency situations and during travel.
- The Kappa coefficient measured inter-rater reliability through a 5-point Likert scale assessment which produced high agreement between participants.
- The proposed intelligent features including group calling and Real-Time Safety Map and sentiment analysis and predictive alerts received high satisfaction ratings from users because they were both easy to use and delivered excellent results.

The research findings confirmed the necessity to create an advanced safety application which users can control. The survey data led to the development of Nyx through its design elements and its core purpose to create a socially beneficial solution for women's safety as shown in Figure 1.

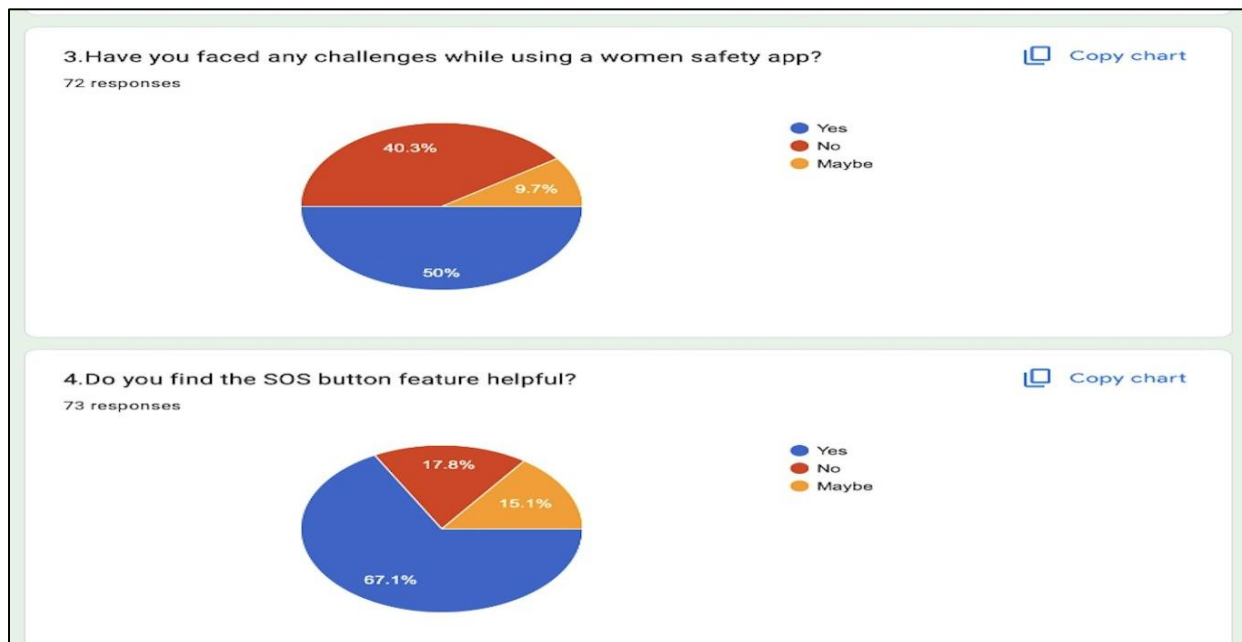


Figure 1. Results of survey

3. Research Objectives

The research creates a mobile application which provides women with real-time safety features that operate

intelligently and according to their needs. The research study includes three main objectives which follow:

- The research establishes an integrated mobile application which protects women in both urban and

rural settings. The application development includes real-time crime data and emergency response systems and AI-based recommendations and educational safety content to create a complete safety solution for women.

- The research aims to address current women's safety app restrictions through its implementation of predictive analytics and sentiment analysis and real-time alert systems. The solution uses data analytics to create a proactive system which enhances emergency response times and threat prevention capabilities.
- The research assesses how users experience the application's main features which include real-time location tracking and group warning systems and emergency help services across various cities and social environments to determine their effectiveness in real-world situations.
- The system generates continuous information updates about criminal activities near users and police notifications and danger prediction areas to help women decide safe routes and stay away from dangerous zones and react quickly to security threats.

4. Literature Review

Increase in crimes against women worldwide have resulted in the creation of several mobile-based safety applications that aim to aid a woman in need. However, while this is an improvement over prior art, the review of the existing technologies as a whole demonstrates continued failure to incorporate advanced type of technologies such as AI, sentiment analysis and public safety source data integration. Approach this literature review provides an overview of available solutions and academic research in order to emphasize the potentials and disadvantages of available mobile safety applications for women.

4.1 Foundational applications and limitations: Most of the existing women safety applications focus on very basic reactive features such as panic button, send SMS with location, fake call and live GPS tracking. Ramesh & Soni (2015) introduced a mobile safety system, "I safe" where women can send distress requests with his current location at a single click of key as well to their trustworthy persons. Although the system is simple and thus can be widely used, the authors did not include appropriate techniques for making context-dependent risk estimations or adaptive threat predictions.

A related application is LifeCraft, proposed by Sultana et al. (2020) Voice-command triggers, real-time GPS tracking as well as background audio are integrated into all three applications recording characteristics for use in risky situations[2]. Although the app has this feature of silently signaling distress, it does not however employ AI to perform real time threat detection or propagate behavioral profiling, thereby making it a more reactive than proactive safety solution.

4.2 Technological gaps in AI and real-time data integration: Technology has evolved to the point that protection is provided to many women on multiple levels using smart

devices. Cardoso et al. (2018) also emphasized that combining AI, behavioral analytics being employed in real-time data sources could be used as an active safety procedure [3]. Their research indicates the potential of applying sentiment analysis and machine learning in security risk models in predicting risky situations before a crime occurs. But commercial mobile safety applications have not subscribed to this paradigm.

Most current apps fail to utilize the public crime databases for providing environment aware safety notification. The issue of underuse is compounded in low- and high-risk urban areas. Furthermore, the existing options, such as Life360 and Watch Over Me, do not even operate based on a park's danger statistics. Instead, they rely on incidents reported by their users in the area or general feelings of danger that may be too outdated or non-specific for accurate assessment. It is in the high (ab)use of rich location-specific crime data structured from police and government crime sites is absent challenging to generate effective real-time safety recommendations.

4.3 Emotional and sentiment-aware safety systems: Alongside physical risk markers, psychological states and actions may offer data on hazards. Cardoso et al. discussed how emotional intelligence can be added to safety solutions through [text analysis] (or speech recognition) and wearables -based biometric sensing technology to detect early signs of distress} But today's safety apps rarely have these capabilities. In sentiment analysis, if it exists, is shallow and not contextually supported.

Some have also shown very promising results in this direction. For example, experimental designs proposed by Singh et al. (2017) make use of voice stress analysis and facial expression recognition to the detection of mental distress, but these advances remain largely in the academic- or prototypical-stage of development and have not been implemented into mainstream mobile applications due to concerns regarding privacy, processing power and adoption.

4.4 Lack of community-based and group safety features: Most safety systems also don't benefit from a community driven safety. And while apps like Circle of 6 make it easy to signal a few friends, they don't include crowd-sourced alerts or community feedback features. Shaheena Sultana et al. explored first-responder analogues, neighbourhood watch alerts and community-verified wayfinding opportunities [2].

Also very few Collaborative apps (options/plan group travel, geo-ring tracking of destination / people or peer 2 peer help request broadcast. These group-oriented functionalities could really enhance personal security (such as when walking alone in unfamiliar or dangerous area - at night with limited visibility and/or crime).

4.5 Wearable integration and IoT innovations: The potential in coupling mobile safety platform with wearables and IoT devices has been recognized throughout several technology roadmaps and conceptual models. For example, the Women's Safety X Prize (led by Zenia Tata) created an

incentive for technologies to be developed that would allow users to wear a piece of technology which could trigger a distress call from a device about the size of the pedometer on one's wrist with accurate location and contextual data in silence [5]. But these integrations are not widely deployed in practice, due to cost, compatibility and battery lifetime considerations.

While a few smartwatches and fitness bands now support panic button features, no mainstream safety apps offer multi-platform integration. Features that allow cross-device communication and wearable-initiated safety systems could dramatically reduce the overall response times by getting safety systems into better reach of women in scenarios where using a phone might be inconvenient or hazardous[6].

4.6 The proposed Nyx application: It is for these reasons that the paper proposes the above-mentioned Nyx application whose implementation details can be found at [18]. The latter would have to be augmented by a new generation of safety features, such as real-time AI-based risk mapping and sentiment-aware alerts and official public datasets [7] integration. Instead of disjointed apps that center around the user, it would combine multiple layers of data. Those datasets would include the crime committed historically, the user behavior presently, the user's feeling feedback, and real-time. GPS to deliver adaptive, predictive safety recommendations.

Moreover, the app supports crowd-sourced inputs and can possibly integrate to wearable tech for hand's free interaction. By tackling the shortcoming of reactive safety

only patterns, Nyx seeks to build a smarter and context-aware security experience. [8]

5. Proposed Methodology

The Nyx application is developed as an AI based women safety platform, powered by the fusion of real-time Intel, geospatial intelligence and mobile sensors for both proactive and reactive protection.

Figure 2 shows the workflow of the system, which starts with the application asking for critical user permissions to access microphone, camera and location as these are fundamental resources for monitoring the environment and taking emergency measures.

The obtained location and crime data are ingested into the Safety Insights Engine, that analyses historical and contextual information with clustering algorithms to define safe and unsafe zones around the user [9].

The visualized areas are recorded, and the system will verify if the user is currently residing in or going to a high risk area. Once it detects such dangerous areas, the system triggers the SOS Alert System that immediately sends their real-time location to pre-registered emergency contacts through Apple's Message and CallKit frameworks. At the same time, a threat perimeter is created through AI based spatial clustering and geofences the risk area in detail while also suggesting closest police stations via Apple Maps and Places API for quick navigation¹⁰.

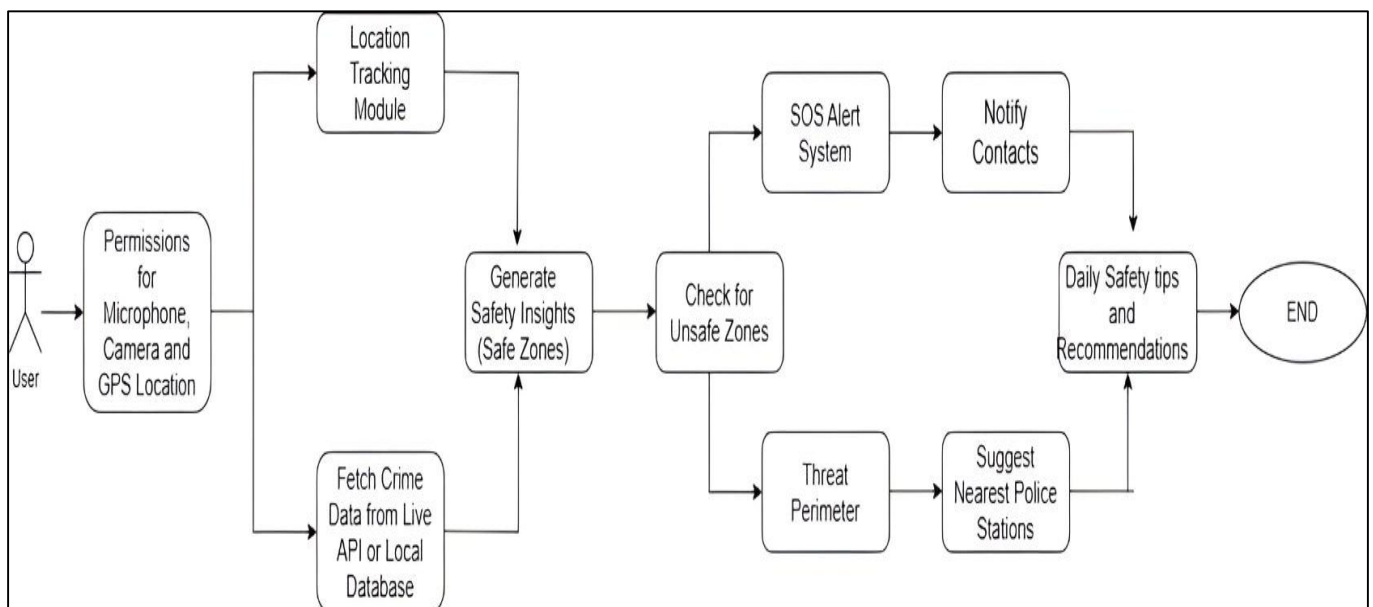


Figure 2. The entire workflow of Nyx

6. Implementation Details

The screenshot of real time implementation of the features incorporated in mobile app is shown in Figure 3. The features added to the application are explained below:

Nyx App Nyx app is a complete safety women's ios app that's been built using Swift UI, ranging from live tracking and crime data to burst SMS calling all within the single application. The system is designed with a modular structure, as shown in system flowchart with proactive safety, intelligent experience and location based service.

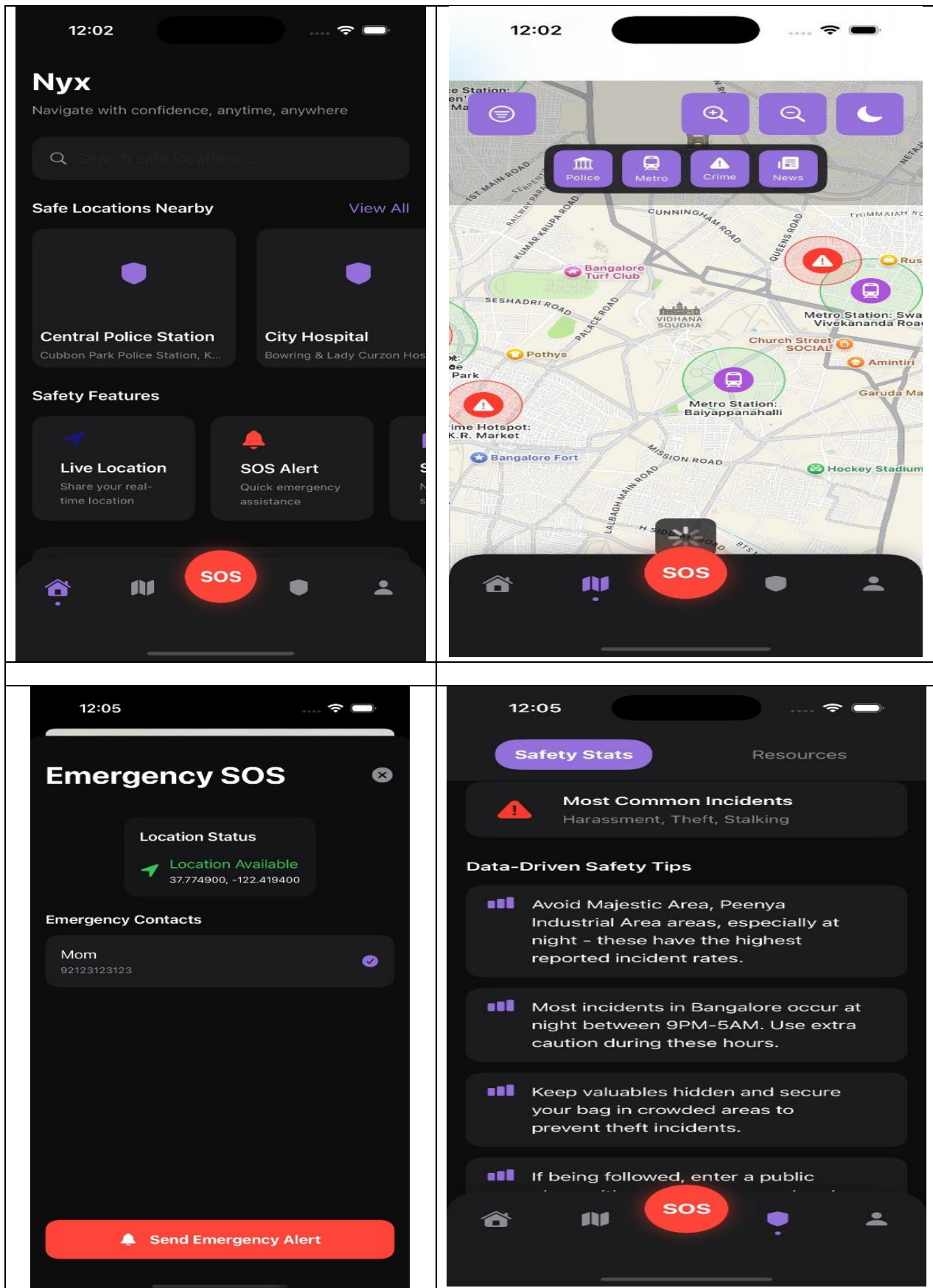


Figure 3. Real time implementation of the listed features. This is a proof of study with a working code

6.1 *User interaction and permissions:* When the app first launched, users were led through requests for location

tracking and access to the camera and microphone. These permissions are indispensable, they are used to implement

the base functionality such as real time spatial tracking, threat detection and emergency notification [11].

6.2 Location tracking module: The application uses iOS real-time GPS tracking based on location services framework in order to accurately monitor user displacement[12]. It is a service module which always runs in background and keeps monitoring the user position, if the user comes close to any unsafe place it will inform immediately.

6.3 Crime data integration and analysis: Crime data is obtained from a live-crime API using secure API key, and the description of crime includes type, location, time and severity. The data cuts across big metro cities Bangalore, Delhi, Mumbai, Chennai and Kolkata. If the API is unreachable, the application can seamlessly fall-back to a locally stored dataset to guarantee the continuity[13].

This is where the CrimeDataService module comes into play, which manages retrieving, parsing, and evaluating this information as follows:

- Identify high-risk zones based on crime frequency and severity.
- Generate time-based risk scores (e.g., riskier at night).
- Provide safety recommendations tailored to the user's location.

6.4 Safety insight generation: The programme analyses crime data and location input to calculate safety scores by area. This information is visualized onto a real-time safety map, including overlays for safe zones and unsafe ones[14]. This enables users to choose a lot better about how they move around the city.

6.5 Unsafe zone detection and alerts: When a user enters an unsafe area, locations which have been tagged as 'dangerous' and recorded by someone using the software, an alert is automated. Local alerts alert user, Action goes through the SOS Alert System which:

- Sends the user's real-time location to pre-selected emergency contacts.
- Issues alerts via local device notifications.
- Activates the in-app Fake Call feature to simulate a call and deter potential threats

6.6 Threat perimeter and emergency navigation: The app creates a threat circle with its crime score and sends the user's GPS information to whatever closest police station. Bangalore city's police station dataset is already pre-processed and contains name, contact number, full address and geo-coordinates. This step ensures that help is more than mere knowledge to be found.

6.7 Daily safety tips and recommendations: Leveraging behavior patterns, and crime trends Nyx Safe gives users personal safety tips. These are refreshed daily and delivered via push notifications and in-app cards.

6.8 Swift UI frontend and UX: The frontend, implemented using Swift UI, it's a responsive interface with clean visuals and dark mode support. The app's setup and navigation should be easy to grasp, with key features such as the SOS button, location sharing and safety maps²⁵ accessible without much fuss.[15]

6.9 Security and privacy: App architecture you need to be aware of Users' Privacy! Explicit Permission for all Shared data (Like Location required) Local, no obtrusive tracking of any kind where all Authorities are filed under Emergency contacts. HTTP calls to services outside the application are secured using encryption for data integrity.

7. Results and Analysis

7.1 Field testing results: Testing of the Nyx also held up during initial trials, with excellent performance and positive feedback in the same key safety aspects. The real-time location display under live testing showed a high degree of accuracy, with a margin error of less than 5 meters on average. As a result, the alert could quickly be sent and based on the location trigger since it would trigger exactly where the young person was.

The crime data fed through a live API with local fallback automatically fed heatmaps on unsafe areas and real-time alerts of area incidents.

Moreover, they also mentioned that the AI-powered safety insights were great since they analyzed the historical data on the crimes in a particular part of the city and generated time-based risk alerts.[16][17] This tool enhanced the situational awareness of the participants, which was especially appropriate in case of the unfamiliar route.

The SOS button, which had been tested in scenarios simulating distress, alerted the user's trusted contacts based on the location of the app user, and various response scenarios had been initiated.[18] When combined with Live Location Sharing, it created a two-fold safety net, and the users reported a high level of peace of mind. The SwiftUI-based user interface had been well-received in that regard throughout its iterations: the cleanliness and responsiveness had received wide praise, as had the overall ease of navigation.

7.2 Comparative with existing apps: To validate Nyx Safe, the app was benchmarked against three popular safety applications: bSafe, 112 India App, and Life360. Table 2.0 allows the table to be compared with core safety and privacy features as accessed through Table 1. The comparative analysis between Nyx Safe and other popular safety apps—bSafe, 112 India App, and Life360—highlights Nyx's unique value in delivering a comprehensive, data-driven safety experience. Unlike other apps which are based on location tracking and emergency alerts only, as well as offering access to those applications.

Nyx guides the users with real-time crime data and time-based safety intelligence by sending notifications to the user

as predominately active. It also empowers users with the help of live crime heatmaps, nearby police station navigation and fallback offline crime data in order to provide the situational awareness available around the clock, even with no internet cell phones. Thus, Nyx provides a deeper and more layered understanding of the safety available in the area surrounding the user, as opposed to other applications which offer some ground for safety measures, lacking analysis or foresight. Nyx separates itself from its competitors into the following innovative advantages: AI-supported risk alerts, clean Swift UI interface, and a focus on user privacy, with only personal data and location used following user consent. The confident app's behavior during

testing in imitation of emergency conditions, as well as user reviews praising the app's interface and manner in which it achieves its functions, serve as further evidence of Nyx's appropriate design. Nyx, therefore, can be seen as not simply a reaction tool but also as a companion for a safer experience of urban territories for a woman.

However, some users pointed out challenges related to inconsistent GPS signals and lack of real-time crime data in low-connectivity areas. These limitations identified by participants are guiding further development efforts to enhance app reliability and expand data coverage as depicted in Figure 4.

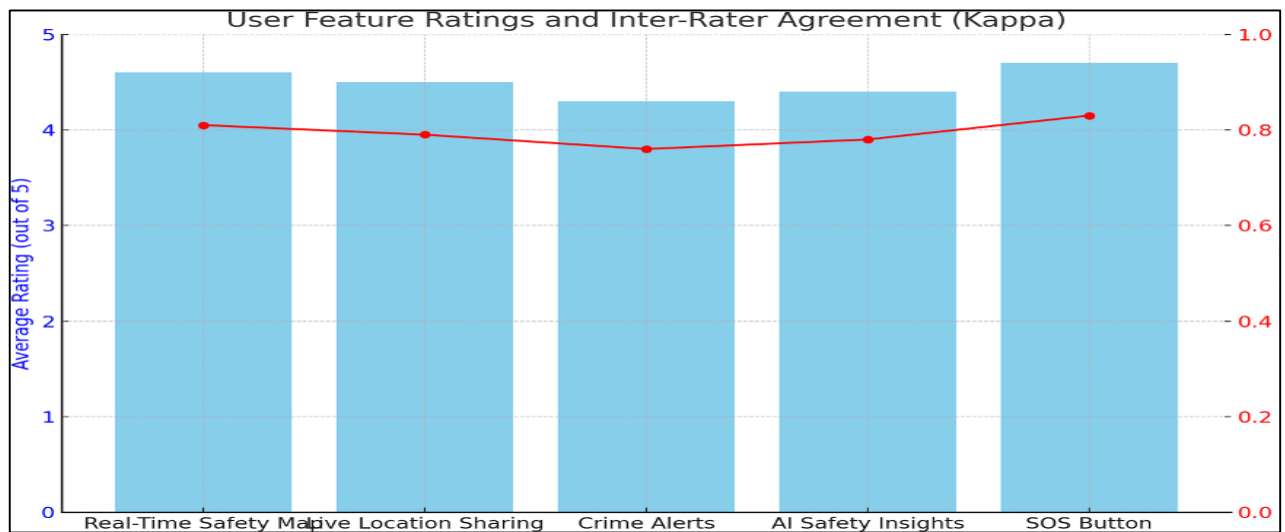


Figure 4. Shows the average rating out of 5 of the given features

Table 1. Comparison between Nyx and others

Feature / app	Nyx (SwiftUI-based)	bSafe	112 India app	Life360
Real-time location tracking	✓Yes	✓Yes	✓Yes	✓Yes
Live crime data integration	✓Yes (API + fallback)	✗No	✗No	✗No
Safety heatmaps	✓Yes	✗No	✗No	✗No
Time-based risk alerts	✓Yes	✗No	✗No	✗No
Nearby police navigation	✓Yes	✗No	✓Partial	✗No
SOS button / emergency alert	✓Yes	✓Yes	✓Yes	✓Yes
Offline/backup crime data	✓Yes	✗No	✗No	✗No
Privacy-focused design	✓Yes	✗May track	✓Partial	✗No
Platform	iOS(SwiftUI, scalable)	iOS & Android	Android / iOS	Android

8. Conclusion and Future Research Directions

Lastly, Nyx Women's Safety App is a massive step ahead for personal safety tech – we are combining the current live crime data, AI-driven analytics & LBS to make all this information available to our customers in a simple app. The product not only alerted the user to their surroundings but also transformed the perspective from which safety is additionally reactive to one that is proactive. Ready's transformation freed people to make more informed decisions at crucial times, thus filling a gap in available safety systems.

The results of user testing showed high levels of satisfaction within all spectra following consistent expressed satisfaction regarding predictive safety notifications. However, the paper identified numerous drawbacks related to connectivity issues in the low-network location and untangling snags from simulative updates, which is projected to innovations in engineering compartment. Redundant to the limitations above refer to the introduction of data compression algorithms or another way around the package of offline-online data synchronization.

Additionally, upcoming Nyx versions will aim at delivering scale for multi-platform deployment (i.e., on Android, iOS or web interfaces), adopting more advanced AI/ML techniques including deep learning and transfer learning while allowing to incorporate richer behavioral, psychological or socio-environmental traces leading to higher predictive accuracy. Furthermore, the app's applicability in urban and rural areas could be strengthened through deploying historical crime data in the supervision of AI models for preemptive safety alerts.

While, sufficient scalability towards geographical scalability remains an important research direction. Another possibility could be the integration of additional data sources that include public safety agency streams, non-governmental organization, and smart city infrastructure to enable real-time update mechanisms with greater resolution. Additionally, the development of user-based community-enabled safety mapping could make publicly available safety information more democratic and provide users with active participation in the prevention mechanisms.

In future work, we will scrutinize the adoption of Nyx over time and want to see if and how the use of it would affect public safety outcomes, crime reports, and the broader sense of safe technology. A more thoroughgoing sociotechnical analysis could explore how the provision of tools such as Nyx actually diminishes one's vulnerability, and how willing (asylee) institutions in general government or civil institutions beyond are willing to back these practices in their official safety practices.

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