



Empowering Safety: A Study of Smart Technologies in The Next Frontier of Women's Safety Devices

Dr. Ambili A.R¹, Malavika Pradeep², Dr. Sreevidya P.³, Beenu Riju⁴

Department of ECE, FISAT, Angamaly, India^{1,2}

Department of EI, FISAT, Angamaly, India^{3,4}

Abstract: Throughout civilizations worldwide, women's safety has consistently ranked as a primary concern, prompting the development and refinement of numerous safety technologies aimed at empowering individuals and facilitating swift responses to potential threats. This paper delves into the domain of women's safety devices, with a particular emphasis on the diverse triggering mechanisms employed in these devices. By discussing the advantages, disadvantages, and current research gaps, this review aims to illuminate the spectrum of technological advancements, including smart technology, in women's safety technology. These advancements encompass a wide range, from conventional manual triggers like push buttons to cutting-edge features such as voice activation, fingerprint identification, and artificial intelligence (AI) integration. Despite ongoing progress, crucial areas still warrant further investigation. By highlighting these research gaps, this review aspires to catalyze subsequent developments capable of fundamentally transforming the landscape of women's safety technology.

Keywords: Women Safety Devices, Triggering Mechanism, Image, Voice, Button Activated

I. INTRODUCTION

In recent times, the number of incidents involving harassment of women has been rising quickly. Women still experience physical and psychological abuse as well as harassment in various forms, even in this century of advanced technology and social consciousness. Sexual offenses, including sexual harassment and assault, are becoming more frequently recorded in both the workplace and daily life. Significant advancements have been made in the broad range of issues that Women Safety Devices (WSDs) are intended to address. Applications and devices for women's security are widely available. They are primarily concerned with reducing the hazards to women's safety, protecting against harm by malevolent actors, and addressing health problems resulting from general accidents and pollution. The government has set up cameras and monitoring stations to guarantee women's safety and security. Unfortunately, the expense of installing the necessary monitoring infrastructure limits the use of cameras in specific locations. Consequently, that causes criminal activity to move into areas not under observation, disproportionately affecting those with less money. Thus, a sizable workforce is required for efficient monitoring. Moreover, smartphone apps are made to function as "panic buttons" to improve women's security. However, their utility depends on having the gadget and being able to press the panic button, which may not always be possible under dangerous circumstances. One woman in India is raped every sixteen minutes, according to experts. Women's safety has become more widely known across the country because of the growth of the #METOO movement, the support of Women's Parliaments, and honorable women who share similar values.

There are plenty of research opportunities available in the realm of women's safety devices. These devices could be fully automated, semi-automated, or manual. One part of the manual triggering method is manual interruption. The devices are activated by a fingerprint or a push button switch. Speech and image processing technology have made it possible to create safety devices for women that can be activated by voice or image recognition. On the other hand, safety devices with autonomous triggering begin up on their own by assessing the emergency conditions. Such activation can be triggered by the victim's voice tone or by a video clip of the incident. A variety of sensors, including temperature sensors, heart rate monitors, fingerprint identification sensors, picture or audio input, and more, may be used by these devices. Among the other methods are shake sense-activated gadgets. When the devices shake or fall, the force sensor is triggered, an anticipated event that may occur in these circumstances. Some methods fall under the category of semiautomatics and combine elements of both manual and automatic modes.

This review is organized as follows. Section II describes the various studies related to different triggering methods and the novel techniques utilized in the proposed systems. Section III presents the conclusions and outlines the future scope of the work.



II. DIFFERENT STUDIES BASED ON DIFFERENT TRIGGERING METHODS

There are mainly three different ways of triggering mechanisms for these types of devices. These are manual, automatic and semi automatic. Manual triggering mechanisms for women safety devices are crucial for ensuring quick and easy access to assistance in emergency situations. Automatic triggering mechanisms for women safety devices can provide an added layer of security by activating in response to specific events or conditions without the need for manual intervention. Semi-automatic mechanisms for women's safety devices combine elements of both manual and automatic triggering. They typically involve a user-initiated action that is followed by automated processes to alert authorities or designated contacts. Here, the different methods used in these devices in emergencies include majorly manual push button triggered, voice-activated, and image-activated techniques. Classification Criteria: The major emergency triggering method (manual, voice-based, fingerprint/image-based, or AI-based) is used to classify the examined research. In order to maintain a clear and consistent classification, supplementary elements like IoT, GPS, cloud services, and AI analytics are described under the applicable category even if many systems integrate numerous technologies. Fig. 1. Comparative radar chart illustrating manual, voice-based, fingerprint-based, and AI-based triggering mechanisms for women's safety systems based on qualitative evaluation across ten performance criteria.

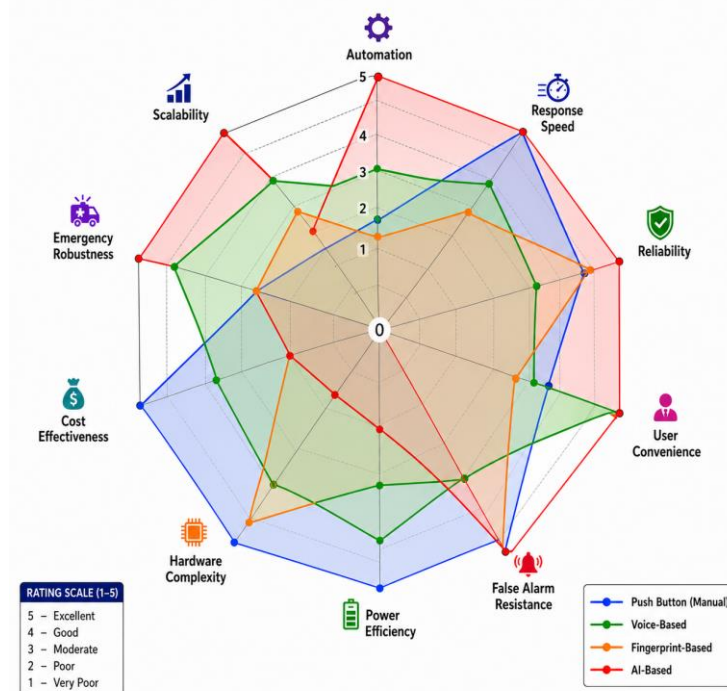


Fig 1 Shows Comparative radar chart of manual, voice-based, fingerprint-based, and AI-based triggering mechanisms for women's safety systems based on qualitative evaluation across ten performance criteria.

A. Manual Triggering

Several research studies have employed push-button manual triggering techniques. An Arduino-based system [1] that uses a GSM modem for messaging and GPS monitoring is intended to improve women's safety. In an emergency, the system can communicate with an alarm system and alert a neighbor. When the women's safety gear detects an emergency, it is equipped with loud sirens and flashing lighting to increase awareness and request aid. Another study describes a solution that offers wireless notifications and a communication channel using an embedded Raspberry Pi [2] device to address women's safety concerns. This image-based safety gadget for women uses a Raspberry Pi, sensors, GPS, GSM, GPRS, and an R-pi camera. The system's primary purpose is to use the Raspberry Pi camera module to take pictures. When a user presses a button, it notifies registered phone numbers with a link to the picture taken. The security device Touch Me Not [3] contains a button that can be worn on clothing and, when pressed, notifies contacts, including family members and law enforcement. The device has a built-in camera that records and takes images when the user triggers it. The contacts will also receive a copy of these images. The system uses a button spy camera, GPS/GSM module, Arduino, and other components. The work discussed "ABHAYA [4]," a Raspberry Pi 3B-based self-defense gadget for women. This security gadget is image-based and uses parts like a Raspberry Pi, GPS module, Picamera, and push button. The device has a camera to capture evidence, which may be activated when the framework is implemented. It will then automatically begin to record the incident and send a letter with the captured photo to the relevant person.



Cellular networks and smart phones are only sometimes available in remote places. A wireless Internet of Things-based solution for women's protection in rural areas is discussed in the research given in [5]. To prevent attacks, the study suggests a method that involves building a wireless network utilizing IoT technology and a portable device to notify the relevant authorities. A beacon device with a help button will be given to women. One can determine where she is based on how close the victim is to the nearest access point. This study [6] discusses an Internet of Things-based women's safety device. This women's security device uses sensors, location monitoring, notification, and image capture as its techniques. The suggested system uses various sensors, including a video camera, GPS, GSM, and buzzer. The location of the individual is tracked using a GPS module and GSM module, and a video camera is utilized to record and send images or videos to contacts for subsequent analysis. A wearable emergency response system for women is suggested in the study in the literature [7]. In addition to push buttons, a microphone array, a GPS module, sensors and actuators, the proposed gadget has a microcontroller. A SIM card with internet capabilities is needed in order to connect to the internet. A smart phone application based on geo-location maps and push notification services has also been developed to send push notifications to locals eager to help others. These manual triggering techniques are also being tested with mobile applications. A smart phone software called "WoSApp" [8] designed to keep women safe allows users to deliberately interact with the application's user interface by pressing the PANIC button on the screen or shaking their phone to activate the calling feature. The user instantly sends a message to the police, including their location and the phone number of an emergency contact list they have pre-selected. The technologies used are HTML/CSS, Java, PHP, MySQL, JSON, PhoneGap API, and Android SDK. HearMe" is a smart phone app designed for women's safety, featuring special abilities such as accessing it from the lock screen and quickly activating a loud siren on another person's phone [9]. Hardware buttons provide victims with rapid access to the HearMe application's modules. HearMe's ability to blast a loud siren at the receiver device even while the phone is in silent mode is another crucial feature that improves the likelihood of receiving assistance from the police station or family. Initiating an emergency alert requires intentional user intervention, despite the fact that manual triggering mechanisms are straightforward, dependable, and economical. As a result, these devices stop working when the victim is physically confined, incapacitated, or unable to reach the triggering device. Future studies should concentrate on autonomous triggering systems that can recognize emergency circumstances without the need for human activation.

B. Voice activated-Manual/Automatic/Semiautomatic

Activation methods in these systems can be either manual, with the user activating the device by speaking a specific keyword or phrase. After activation, the device prompts the user to confirm the distress signal within a set time (e.g., by pressing a button or repeating the keyword). Alternatively, it can be automatic, using sound recognition technology to detect distress sounds like screams or cries for help.

A voice-activated women's safety gadget is called KAVACH [10]. It may be operated by a single person's voice command and respond to input commands. The processor in this system is an Arduino. The system uses several gadgets, including a heartbeat sensor, GPS, GSM, RF camera, and voice recognition module. The camera module will activate and record video if the victim issues the command "Record." A related study that uses speech recognition on an Android phone was created [11] and addressed the applicability of voice recognition technology for women's safety. The primary objective is to promptly notify a reliable contact of your whereabouts and any risk you may be experiencing. In addition, the system has a web server, GPS, and a Bluetooth or microphone device. The research in [12] described a voice-activated tool that uses the victim's voice to activate and begin tracking their whereabouts using the device's GPS module.

Table 1 shows comparative analysis of previously reported women's safety devices based on sensors/components, triggering mechanism, key contribution, and limitation.

Sl. No.	Sensors and Components Used	Triggering	Key Contribution	Limitation	Ref.
1	Temperature sensor, Flex sensor, Pulse rate sensor, MEMS sensor	Automatic	Multisensor emergency detection	High hardware complexity and power consumption	[6]
2	Voice recognition module, Heart Beat Sensor, Arduino ATmega328	Automatic	Hands-free voice-based activation	Affected by background noise	[10]
3	Android phone, Web Server, Microphone	Automatic	Smartphone-based emergency monitoring	Requires Internet connectivity	[11]



5	Sensor Module, Switching Modules, NodeMCU	Automatic	Low-cost IoT implementation	Limited sensing capability	[14]
6	Temperature sensor, Heart Beat Sensor, Raspberry Pi, Arduino	Automatic	Physiological parameter monitoring	Higher energy consumption	[19]
7	Microphone, Voice Recognition module, Raspberry Pi	Automatic	Voice-triggered emergency alert	Reduced accuracy in noisy environments	[14]
8	Mobile Phone, Camera	Automatic	Vision-based threat monitoring	Privacy concerns and lighting dependency	[30]
9	Temperature Sensor, Raspberry Pi, Panic Button, Arduino ATmega328	Manual	Simple and reliable manual activation	Requires user intervention	[29]
10	Sound sensor, Camera module, Raspberry Pi	Automatic	Audio–visual threat detection	Computationally intensive	[15]
11	RF transceiver, Temperature Sensor, Voice Recognizer, LPC812	Button and Automatic	Hybrid triggering mechanism	Complex hardware integration	[17]
12	RF Transmitter, RF Receiver, HC-05 Bluetooth module, Comparator, Buzzer, Arduino ATmega328	Automatic	Wireless emergency communication	Limited communication range	[29]
13	Electronic Siren, LED Flash Lights, Arduino ATmega328	Automatic and Manual	Dual-mode emergency alert	Limited intelligent decision-making	[1]
14	LCD Display, Buzzer, Fingerprint module, Arduino ATmega328	Manual	Secure user authentication	Cannot operate if user is incapacitated	[25]
15	LM35 Temperature sensor, Pulse rate sensor, Arduino ATmega328	Automatic	Health parameter monitoring	Possible false alarms	[31]
16	HM2007 Voice Recognition IC, Force Sensor, Transmitter–Receiver, Lock System, ATMEL AT89S52	Automatic	Voice and force-based activation	Speech recognition affected by noise	[18]
17	Wi-Fi, Message Sending Module, Android SDK	Automatic	Real-time wireless notification	Dependent on network availability	[11]
18	Buzzer, Camera, Raspberry Pi	Automatic	Video-assisted emergency detection	High power consumption	[27]
19	16×2 LCD, Microphone, ATmega2560	Automatic and Manual	Supports multiple activation modes	Bulky implementation	[13]
20	BLE Module, Shock Circuit, Voice Recognition module, Arduino ATmega328	Automatic	Wearable emergency response	Limited battery life	[12]
21	Android Phone, Web Server, Microphone/Bluetooth device	Automatic	Cloud-enabled emergency monitoring	Requires continuous Internet access	[20]
22	Mobile Phone	Automatic	Portable and easy to use	Limited autonomous functionality	[23]



23	Beacon device	Manual	Simple wearable emergency device	Short communication range	[6]
24	Li battery, Data SIM card, GPRS module, Microphone Array, RePhone Kit	Manual	Long-range emergency communication	Large size and high power consumption	[7]
25	GPRS, Button, Spy Camera, Arduino ATmega328P	Manual	Location tracking with image capture	Manual activation required	[3]
26	Buzzer, Camera Module, ESP32 Microcontroller	Manual	Compact ESP32-based safety device	Limited battery backup	[16]

An alert message is delivered to the pre-registered contact number when the voice command and the device's location match. This circuit contains a voltage multiplier circuit, a high-voltage generator circuit, and a charging circuit. In the study referenced in [13], researchers explored an automated voice detection system aimed at enhancing women's safety. This system's ATmega2560 microcontroller gathers and transmits data from various sensors. Other parts used are a 16x2 LCD monitor, Bluetooth, GSM, GPS, microphone, and buzzer. The victim's location will be added to a pre-programmed contact list as soon as the victim's voice is recognized. The device also has a bell that will help warn those nearby.

Additionally, an IOT-based system for voice-activated techniques was looked into. RASHAK [14] is an Internet of Things (IoT) wearable safety device that uses voice recognition technology. It has a voice recognition module, camera, microphone, GPS, and GSM hidden inside. As soon as the voice command is activated, the camera will begin recording, and this data will be uploaded to cloud storage. An automated triggering mechanism based on the victim's screams was also tested in place of voice command detection [15]. It is an Internet of Things (IoT) lady safety device with GPS, GSM, sound sensor, camera module, and Raspberry Pi. The device triggers the camera module and records a 30-second video when it detects a scream. An IOT-based ESP-based smart device for women's safety was mentioned in the work [16]. The system has been put into place as a smart device that includes a buzzer, camera module, push button, ESP32, and other components to activate services for women's security. It has a built-in camera module to take pictures of the surroundings and GPS tracking to locate the victim. The emergency contact and police got the image that was taken. In recent research, there have been investigations into combining various triggering methods. For instance, a study cited in [17] integrates the outputs of temperature sensors and voice recognition technology to activate a proposed embedded system. This system consists of a GPS, GSM modem, RF transceiver system, and microcontroller (LPC812). The temperature sensor has a threshold value of 20°C, which triggers the SMS warning system. Here, the speech recognizer will deliver the two predefined codes, SAVEME and HELPME. Nevertheless, establishing individualized threshold values is likely to reduce the effectiveness of such a system. Another study highlights the usage of speech and force sensors for the device's automated activation [18]. The apparatus is known as "SURAKSHA." A woman safety device that combines automatic triggering, which happens when the item is thrown forcefully, via force sensor, or via voice command, with manual triggering, accomplished by a push button switch. The AT89s52 microcontroller is utilized in the components, which interpret data from sensors, switches, voice recognition systems, GSM modules, force sensors, transmitters and receivers, and lock systems. A multipurpose IOT-based safety device for women and children is proposed in this work [19]. The women employ the security equipment, which has four means to safeguard them (a button, a voice board, and two sensors) in case they are harassed. This architecture unifies GSM and GPS. The system can notify family members and the police station by connecting to the alarm system. It has a temperature sensor, a heart-rate monitor, GPRS, a Raspberry Pi 3 computer, and a GSM SIM 300 phone.

We also examined various studies concentrating on software applications that integrate voice recognition for this particular kind of voice-activated embedded device. A web-based Android application described a voice recognition system for women's safety that can be activated automatically or manually [20]. The application can be operated by click, shake, or voice recognition. This application will notify contacts who have registered when someone is being assaulted. A speech recognition device for women's safety is discussed in this study, alongside a software application [21]. The system comprises an Android phone, a web server, a GPS unit, and a microphone or bluetooth gadget. This software program allows for integration with local law enforcement agencies to assist the victim as soon as possible. For some works, multimodal conversion techniques, such as voice-to-text, were also tested. In particular works, a modality conversion is also examined. The study in [22] also evaluated a speech to text conversion technique. It talks about a voice recognition-based smart citizen security device, the prototype of which is a software component for automatically identifying insecure circumstances using natural language processing, pattern recognition, and speech recognition. The task of converting speech to text falls to the voice recognizer. It takes in sounds from the surrounding world as input and



outputs textual sentences that are recognized. A management application and voice-to-text converter design [23] built on the Google Cloud Speech API. In this instance, CCVoice, a recording service, is designed. It records daily life with mobile devices. It simultaneously uses GoogleCloud Speech API to convert the recorded file to text and saves the text file. CCVoice is an Android app. PHP and MySQL were used on a Java-based Linux Ubuntu 16.04 server. PHP, JavaScript, and HTML were used to implement web services. Although voice-based triggering increases hands-free accessibility, background noise, speech variability, linguistic variation, and emotional stress have a substantial impact on its effectiveness. Furthermore, a lot of systems need cloud-based processing, which raises privacy issues and response delay. Future research should focus on edge AI-based, multilingual, and noise-robust voice recognition methods that can function correctly in actual emergency situations.

C. Image Based-Finger Print-Manual/Semiautomatic

Research was done on designing an Internet of Things (IoT)-based women's safety gadget that uses a fingerprint-based connection mechanism to notify the police and other nearby individuals when a woman is in danger [24]. Finger impressions can identify dangerous situations for up to one minute. If the device detects signs, it will instantly notify the police and people in the vicinity. The system uses the ATMega328 microcontroller LCD, buzzer, shock wave generator, and GSM components. A power supply, microprocessor, LCD, buzzer, and fingerprint module are all included in the system suggested in [25] to provide multisensory data for women's protection. The system notifies the emergency contacts if the finger is removed from the sensor for an extended period. In addition, the user's call log's last-called number is regarded as the emergency contact in case the registered emergency contact is unavailable. A self-defense tool that combined GPS tracking with fingerprint verification and GSM alerts was tested [26]. The system consists of a fingerprint module to activate the device, an electric shock-producing circuit, a GSM/GPS module to track location and provide alerts, and all of these components interfaced with a microcontroller. A woman can activate the system by hitting the designated switch when she feels threatened or needs to defend herself. This will activate the complete system and send an SMS to the concerned party and their position via GPS and GSM. The fingerprint scanner in the proposed system enables the user to authenticate women's safety for ARDUINO to function well; GSM and GPS are also utilized.

In [27], a women's safety system with fingerprint activation, GPS sensor, and GSM modem for locating and transmitting the location of the woman in danger was shown. The system's primary components are a low-cost, lightweight microcontroller board unit interfaced with GPS, GSM, LCD, and fingerprint sensors. A lady only needs to place her finger on the scanner to activate this system, which sends SMS messages if she even suspects she might be in trouble. To ensure women's safety, an Arduino-based system with GPS monitoring [28] and notifications that can be linked to an alarm system and shared with a neighbour was introduced. This message system uses a GSM modem, an ARDUINO receiver, and GPS. This concept aims to develop an Internet of Things security device that detects and authenticates women's fingerprints. The suggested system, a women's safety thread, is described in this document [29]. Its main components are a comparator, an HC-05 Bluetooth module, an ATMEGA 328P, a GSM module, a GPS module, an RF transmitter and receiver, and a copper thread module. Each module—transmitter and receiver—is independent. The clothing is put together with the transmitter module and copper thread. In a distress situation, if the victim breaks the thread, the system activates the buzzer and sends an emergency call and alert message via GSM to the pre-programmed numbers. Although fingerprint and image-based systems improve authentication accuracy and decrease unlawful activation, they still need ideal environmental conditions or deliberate human interaction. Additionally, privacy issues and performance loss in low light or occlusion are introduced by camera-based methods. Future studies should look at multimodal biometric fusion for accurate emergency detection, contactless biometric authentication, and privacy-preserving computer vision.

D. AI-based women's safety device

In a time of rapid technological advancement, machine learning and artificial intelligence (AI) are potent allies in the fight against women's security issues. The research in [30] investigates a women's safety system driven by AI. With this AI-driven solution, users can access information about prior criminal incidences and safety in their present or prospective destinations. It also can predict and let users register to get alerts and cautions about any safety issues. The application's automatic speech recorder can capture background sounds. An IoT-based women's safety device was developed, where temperature and pulse sensor data are transmitted via Arduino to the cloud for machine learning-based danger detection, triggering alerts to emergency contacts upon threat identification [31]. Another study integrated GIS and machine learning to map crime hotspots using criminal records and real-time data from a wearable and mobile app, aiding in crime response and prevention [32]. Existing systems using fixed thresholds for body signals fail to detect emergencies accurately during physical activity. To address this, a wearable device with adaptive thresholds and logistic regression-based analysis was proposed, along with ZigBee mesh networks to ensure functionality without internet access [33].



A machine learning-based Social Threatening Filter (MLSTF) was proposed to detect threats against women on social media platforms like Facebook and Twitter [34]. A smart wearable device (SWD) was developed featuring a pen-hole camera, body position sensor, location tracker, accident detection sensor, emergency voice recognition mic, and IoT-based machine learning for improved accuracy. Another design integrates a soft button and Dc-RFO-IoT for emergency response, offering recommendations and emitting high-frequency sounds to deter attackers [35]. This deep learning-enabled IoT system demonstrated superior performance with 93.43% accuracy, 92.87% sensitivity, 98.34% recall, 97.34% safety ratio, and 97.89% F-measure. In order to protect women's safety, an Internet of Things (IoT) [36] based platform that uses Hidden Markov Models (HMM) offers opportunities for improved predictive analysis due to its dynamic probabilistic character. It also assisted us in creating a dense sensing strategy based on signs of suspicious activity. There is a situation-based analysis for relative modelling based on facial recognition and fuzzy labelling of vocal exchanges. With an accuracy of 94.7%, the experiment findings seemed quite promising. This research aims to provide a paradigm wherein no human involvement is necessary to trigger the system in light of the ongoing challenges in the lane and the pervasive influence of technology in every part of human life. To identify elevated pressure on the victim, pertinent machine learning algorithms are combined with enhanced notions of IOT [37]. The focus of this study [38] was on a safety system tailored for females, leveraging artificial intelligence (AI) and mobile applications known as SWMS to offer security to women facing risks. This system is designed to respond effectively in critical situations, offering both automatic and manual assistance. The proposed device includes a speech recognition device, a GSM modem, and several other detectors, including pulse detectors and an accelerometer, to accurately track the victim's condition. Avoidance or safety measures will be implemented based on the severity of the issue. The use of facial recognition software for missing persons, predictive police models, and the influence of artificial intelligence on wearables and mobile applications for women's safety are some topics covered in focused talks [39]. With a reported detection accuracy of over 90%, A. A. R. et al. [46] proposed an AI-based voice-activated emergency surveillance system that uses a Decision Tree classifier and a natural language processing (NLP) pipeline to analyze voice patterns for real-time threat detection, automatically activating GPS localization, camera surveillance, cloud storage, and emergency notifications. A. A. R. et al. [47] proposed an AI-based edge computing framework for women's safety that utilizes CNN-based speech emotion recognition with fused acoustic features to identify distress emotions and automatically trigger GPS-enabled emergency alerts, achieving an accuracy of 89.5%. Table I summarizes the reviewed women's safety systems, highlighting their key characteristics, technologies employed, and major contributions to facilitate a comparative understanding of existing approaches. By evaluating several sensor inputs, AI-based triggering systems exhibit exceptional accuracy and clever decision-making. However, its application is hampered by diminished interpretability, high computing complexity, energy consumption, and the scarcity of annotated datasets. For real-time wearable safety systems, future research should focus on federated learning, adaptive multimodal sensor fusion, TinyML, and lightweight explainable AI models.

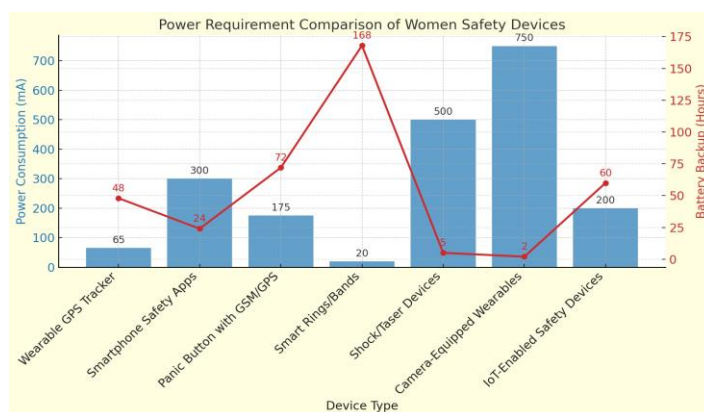


Figure 2 shows power requirement comparison of Safety Devices

The chart in Figure 1 compares the power requirements and battery backup of various women safety devices. An example comparison of the power consumption and battery backup of frequently reported women's safety gadgets is shown in Figure 2. The comparison is based on published research on smart wearable systems, smartphone safety apps, wearable GPS trackers, and GSM/GPS emergency devices [40]–[45]. Since battery backup varies with battery size, communication frequency, sensor workload, and operating conditions, the presented values are meant to show broad trends in energy consumption rather than precise experimental observations. Blue bars represent average power consumption in milliamperes (mA), while the red line indicates battery backup in hours. Devices like smart rings and GPS trackers consume less power and offer longer battery life. In contrast, camera-equipped wearables and smartphone apps consume significantly more power with shorter backup time. This comparison highlights the trade-off between functionality and power efficiency in wearable safety technology.



III. CONCLUSION AND FUTURE SCOPE

In conclusion, the landscape of women's safety devices is marked by significant advancements, from traditional manual triggers to cutting-edge technologies like voice activation, fingerprint recognition, and Artificial Intelligence (AI). However, this comprehensive review has shed light on several critical research gaps that merit attention and exploration for the continued evolution of these devices. User acceptance and adoption are only possible with a profound understanding of the cultural and sociocultural factors influencing preferences and concerns. The effectiveness of these devices across diverse environments still needs to be studied, preventing us from ensuring universal applicability and impact. The accuracy and reliability of manual triggering mechanisms, especially in real-world scenarios, demand further investigation. Addressing false positives/negatives is essential for enhancing user trust and confidence in these safety tools.

Moreover, ethical considerations, biases, and transparency in AI-powered devices pose challenges requiring thorough exploration to ensure responsible and fair usage. Privacy and data security concerns, customization options, and personalization features still need to be explored, limiting our understanding of how well these devices can adapt to individual needs while safeguarding user information. Additionally, the usability of safety devices for different age groups, integration with emergency response systems, and long-term durability and maintenance requirements require deeper scrutiny to ensure sustained effectiveness.

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