

State of the Art in Safety Technology

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1. Abstract

The purpose of this work was to research the current state of the art in safety technology. The goal was to evaluate the existing technologies and determine the benefits and downfalls of implemented technologies. To do this, all the technologies were researched and critically examined. The technologies were then categorized by audience, technology and available features. This research found an underwhelming state of the art and provided recommendations moving forward for improvements on the various technologies.

2. Introduction

81% of women and 35% of men report significant short or long term impacts such as Post Traumatic Stress Disorder affecting them following sexual assault or harassment [1]. In the United States alone, 37% of adults say they do not feel comfortable walking alone near their home at night [2]. According to the National Sexual Violence Resource Center, one in five women and one in 71 men will be raped at some point in their lives [1]. For children, only 12% of sexual abuse is ever reported to the authorities [1].

Assault and harassment are a growing concern. Some researchers and business owners have dedicated their time to researching and producing different products that aim to help people in unsafe situations. This study focuses on the state of the art in safety technology, which defines safety technology as a technology that would benefit a person who is in an unsafe situation. This includes victims in the midst of an assault, or previous victims of assault. These safety technologies are important because users often cannot have the comfortability of another person's presence to ensure they are safe. Implementing technology to replace the availability of others aims to help the user be safe while they are alone.

Researching different technologies to help ensure the safety of citizens is important to mitigate these issues that different demographics are facing daily around the world. This paper is focusing on the current state of the art in safety technology and how it is helping people around the world currently either deter or report different unsafe interactions. The goal of this research is to identify the current state of safety technology and to discuss the benefits and drawbacks of different approaches to helping people be safer. This paper will first identify the state of the art in safety technology by describing each technology that has been researched or exists in the

market today. The discussion will focus on these technologies and provide recommendations for future technologies.

Of the technologies found 9.6% were made for college students, 61.3% were made for women, 6.4% were made for children, 3.2% for people with disabilities, and finally, 19.5% were made for the community which includes anyone who was not specifically identified in the previous declarations. This paper found that there were only twelve available solutions to this problem in the market today. Of these available solutions, only one was not a software based solution. Most of the technologies provided some sort of GPS features, alerts or deterrence. The novel ideas lied in the detection techniques, however, most were under thought and would lead to many false positives. Currently, the state in the art is lacking quality technologies that ensure the safety of users.

3. Methodology

During our research we attempted to find all of the technologies for any audience that would keep the user safe in some way. We define these as safety technologies. We first categorized all of our findings by audience. The intended audience of an application or device can greatly affect the features that it has. The audiences we defined were: women, children, people with disabilities, and the community. The audiences of the technologies are the people that would be using the technology. For example, an application designed for women to avoid street harassment would have the audience of women. Another example would be a form to report child abuse, the audience would be children, since they are the victim and would be someone using the form to report that abuse.

Secondly, we categorized by the type of technology that was developed. These include: software, wearable technology, prop based, and other. Software includes any application or website that is purely software and no additional hardware purchase is necessary. This could be phone applications, smart watch applications, or websites. Wearable technology is a separate device that must be bought and worn. This could include, for example, a belt. Wearable technology can, but doesn't need to, have a software application that it communicates with as well. Prop based technologies are technologies that include a prop that isn't worn. One example of this would be pepper spray, which is a separate device that is carried on the user. These prop based technologies also can also have a software aspect. The other category is used when the first three categories are not applicable.

Finally, we defined a few categories that help demonstrate what features these technologies have. These features are: localization / navigation, alerts, deterrence, detection, evidence collection, education, reporting, accessibility, and other. Localization and navigation include the features that provide location data. This could be anything from GPS tracking to providing directions to a location. Alerts are features that either send or receive messages or calls. Deterrence is a

feature that attempts to deter an attacker from continuing to attack the user. This could be anything from loud noises to an electric shock. Detection is a feature that attempts to automatically detect that the user is being attacked or in distress. These features typically use sensors to detect these situations. Evidence collection aims to collect evidence that could be later used during prosecution of the attacker. Education provides assistance to the user to ensure that they are educated on different topics relating to assault. This includes information centers, FAQ's, and other sources of information that help the user understand any situation and actions they could potentially take. Reporting provides the user with a method of formally submitting a report to either the police or a campus administrator. Accessibility features encompass any considerations during the design phase that would aid a user who might need extra help. This could include illiterate users and other similar disabilities. The other category provides features like cost, lock screen access and other considerations that the designers made that were noteworthy features.

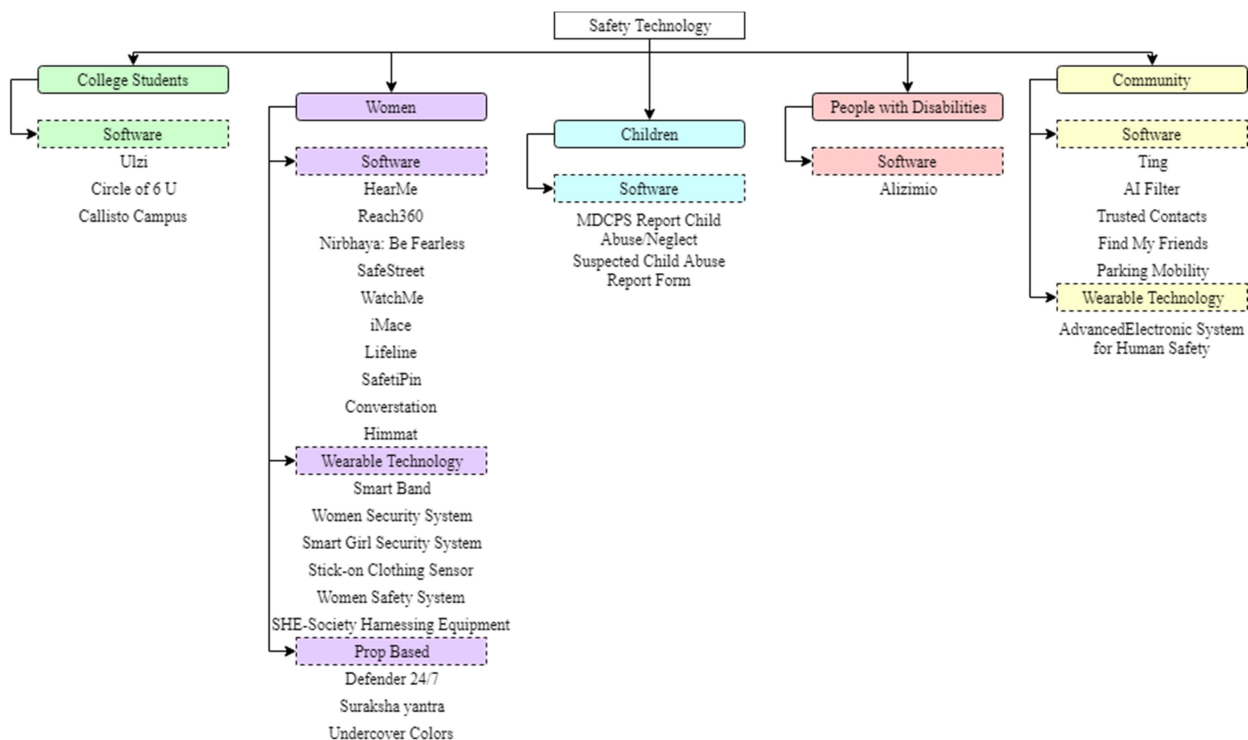


Figure 1. Taxonomy.

Defining our taxonomy in this way allows us to narrow down and categorize the benefits and downfalls of the existing technologies. The following table includes all of the technologies that we found and demonstrates which of the features they include within their technology.

<i>Audience</i>	<i>Technology</i>	<i>Name</i>	<i>Localization /Navigation</i>	<i>Alerts</i>	<i>Deterrence</i>	<i>Detection</i>	<i>Evidence Collection</i>	<i>Education</i>	<i>Reporting</i>	<i>Accessibility</i>	<i>Available</i>
College Students	Software	Ulzi [3]	✓	✓			✓				
		Circle of 6 U [4]		✓				✓		✓	✓
		Callisto Campus [5]					✓		✓		✓
Women	Software	HearMe [6]		✓	✓		✓	✓			
		Reach360 [7]	✓	✓					✓		
		Nirbhaya: Be Fearless [8]	✓	✓							✓
		SafeStreet [9]	✓				✓		✓		
		WatchMe [10]	✓	✓	✓	✓					
		iMace [11]	✓	✓			✓		✓		
		Lifeline [12]	✓	✓	✓						✓
		SafetiPin [13] [14]	✓								✓
		Converstation [15]							✓	✓	
		Himmat [16]									✓
	Wearable Technology	Smart Band ¹ [17]	✓	✓		✓					
		Women Security System ¹ [18]	✓		✓		✓				
		Smart Girls Security System ¹ [19]	✓	✓	✓						
		Stick-on Clothing Sensor ¹ [20]	✓	✓							
		Women Safety System [21]	✓	✓							
		SHE - Society Harnessing Equipment [22]	✓		✓						
	Prop Based	Defender 24/7 [23]	✓	✓	✓		✓				
		Suraksha yantra [24]	✓	✓							
		Undercover Colors [25]									✓
Children	Software	MDCPS Report Child Abuse/Neglect [26]						✓	✓		✓
		Suspected Child Abuse Report Form [27]							✓		✓
People with Disabilities	Software	Alizimio [28]	✓								
Community	Software	Ting [29]	✓	✓							
		AI Filter ¹ [30]						✓	✓		
		Trusted Contacts [31]	✓	✓		✓					✓
		Find My Friends [32]	✓	✓		✓					✓
		Parking Mobility ¹ [33]							✓		✓
	Wearable Technology	Advanced Electronic System for Human Safety ¹ [34]	✓			✓					

Table 1. Technologies and their features.

4. State of the Art in Safety Technology

4.1 College Students

Sexual assault on college campuses is a problem because of many reasons. One of the main reasons being the way that schools handle the reports of on-campus rape [35]. Only a few years ago, the Obama administration released guidelines regarding Title IX. However, in a study recently conducted by APCO Worldwide, they found that “fewer than a quarter of [general counsels and chief communications offices] plan on any changes at all to their current Title IX regimen” [36].

Recently, a “Me Too” movement has taken to social media. It aimed to address the number of people who have been affected by sexual assault in their lifetime, and expose the severity of this problem. However, APCO found that almost three fifths (3/5) of respondents said that this movement has not made them reconsider their policies at all. This mentality of “it isn’t a problem on my campus” affects students when they are deciding to report assault. “Campus police are often woefully unprepared to handle reports of rape and sexual assault” [35].

While all of these problems are focused on the aftermath of sexual assault, deterring sexual assault is also a problem on college campuses. “Approximately one-half of [sexual assault cases against women] involve alcohol consumption by the perpetrator, victim, or both” [37]. This is especially a problem on college campuses due to the fact that most young people aren’t aware of the risks of drinking alcohol in public areas yet.

Both reporting and deterrence of sexual assault has been addressed in the applications geared towards college students.

4.1.1 Software

One application, Ulzi [3] provides many localization and navigation features. This application started as a bystander intervention tool to prevent sexual assault and has morphed into a friends and family locator. The application provides GPS phone tracking, navigation, family locators and the option to alert others in case of an attack. One pro of the application is that it provides one option to only alert your friends or family and another option to alert law enforcement. The application also provides a feature to request that one of your friends virtually walk you home by watching your location while you walk home. It also provides video evidence collection in the case of an attack. This benefits the victims because if they choose to report, they have evidence proving their point, which will most likely aid them in feeling comfortable reporting.

Circle of 6 U [4] was the winner of the White House and HHS “apps against abuse” technology challenge. The application aims to prevent sexual violence among college students. It provides functionality to send messages to the user’s friends including ‘Come get me’ which also sends the users GPS location and ‘Call me and pretend you need me’ which can help the user get out of uncomfortable situations. One benefit to asking their friends to call them is that it allows the user to get out of uncomfortable, but not necessarily dangerous situations easily. One application of this includes a stranger approaching them on the street asking for directions persistently. This application also provides information about sexuality, relationships and safety and has the information for calling a hotline provided as well. There is also a generic version of the application available for users who are not college students.

Finally, Callisto Campus [5] allows the user to record information about attacks after they occur. They call it a journal that allows the user to write time stamped notes of an assault, which can later be used as evidence. The user also has the option to begin a report against a perpetrator and choose whether to submit it or not. If the user wants, there is a setting to automatically submit the report only if someone else has named the same perpetrator. The reports are sent to campus administrators. The application claims that “students who visited the site are 5x more likely to report and they will do it 3x faster than others” [5].

4.2 Women

Unwanted violence against women and girls affects at least a billion women across the globe [38]. Research suggests that about 35% of women worldwide have experienced physical or sexual violence [38]. Gender based violence is mostly prevalent against women. Some forms include: domestic violence, physical violence, sexual violence, psychological violence, and more [39].

The effects that violence against women has can be both physical and emotional. Physical effects include the pain of the violence or even pregnancy. Long-term emotional effects can include: drug and alcohol abuse, depression and more [41].

In the figure below, a researcher asked a group of men what they do every day to avoid assault. The researcher then asked women what they do every day to avoid assault. Recently, the results of this have been going viral. It is clear to see that helping women in feeling safe while they are alone in potentially unsafe situations is a problem that must be addressed.

"Nothing, I don't think about it."	"Hold my keys as a potential weapon"
	"Check the backseat before getting in the car"
	"Always carry a cell phone"
	"Don't go jogging at night"
	"Lock the windows when I sleep even on hot nights"
	"Be careful not to drink too much"
	"Never put my drink down & come back to it"
	"Make sure I see my drink being poured"
	"Own a big dog"
	"Carry mace/pepper spray"
	"Have an unlisted number"
	"Have a male voice on my answering machine"
	"Park in well-lit areas"
	"Never use parking garages"
	"Don't get on elevators with a lone man/group of men"
	"Vary my route home from work"
	"Watch what I wear"
	"Don't use highway rest areas"
	"Have & use a home alarm system"
	"Don't wear headphones when jogging"
	"Avoid wooded areas, even in the daytime"
	"Never rent first floor apartments"
	"Only go out in groups"
	"Own a firearm"
	"Always meet men for first dates in public places"
	"Make sure to have cab fare"
	"Never make eye contact with men on the street"
	"Make assertive eye contact with men on the street"
	"Make sure my family knows my itinerary"
	"Have extra locks on my doors & windows"
	"Make sure my garage door is closed all the way before I drive away"

Figure 2. Researcher Jackson Katz asks women and men what they do on a daily basis to avoid being sexually assaulted. [40]

Some of the solutions generated for women include software, wearable technology, and prop based technologies. These technologies are the most prevalent in the market right now, likely due to the fact that women are the main targets of gender based violence.

4.2.1 Software

The first of the technologies is a proposed application, HearMe [6], which was developed for women in the South Asian region due to the prevalence of social security problems. It provides accessibility features including a user interface that was designed for easy navigation and is icon based for the illiterate users. It also has lock screen access and makes use of the hardware volume buttons to trigger events. The alerts can be sent over SMS to contacts and an alarm is also triggered. There is a feature to request a fake call which can help users get out of uncomfortable situations. This application also collects photographic evidence which is hidden in a separate photo application so the attacker doesn't know the photographs exist, should they gain access to the phone. This application also has an information zone for educating the users. There is information regarding applicable laws, information on one stop crisis centers and also an FAQ section. The application attempts to minimize the data usage and size of the application. It also keeps all the information locally to protect the user's identity and information. This application has a lot of benefits because of the various features. It could be applicable to many of the situations that women face daily.

Reach360 [7] is an application that was developed by female students at the Jaypee Institute of Information Technology. It is an android application created for Indian women. It provides localization functionality to track friends' locations. It also allows the user to shake their phone to send SOS and crime alerts to police, friends and a women helpline number. One negative to the shake to send feature is the potential for false positives. However, a benefit is that the recipients of these alerts are configured in settings, and this would avoid sending false positives to the authorities. Another alert option is to send alerts to all users within 100m of the victim, but this option must be initiated by an administrator. The police would need to have this application and act as a separate user, as they would receive the alerts through the application. The application also forms a heat map of high crime areas which allows the user to see what areas should be avoided.

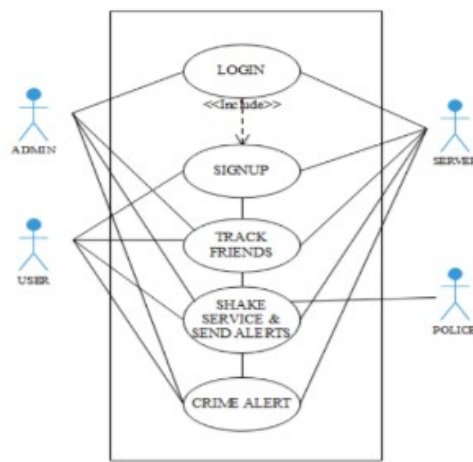


Figure 3. Reach360 design

Nirbhaya: Be Fearless [8] is another application that has localization and alert features. In case of an emergency the user can shake their phone to send emergency messages, even if the phone is locked. There is a touch to text and touch to call feature within the application. The user can also configure that one of their emergency contacts be the police. The user can mark their current location on a map using GPS which can be used to track the user. There is a geo fencing feature as well. Finally, there is a heat map of unsafe places recorded.

SafeStreet [9] is an application made for women to avoid street harassment. Street harassment as defined by the developers includes cat calling, groping and other similar occurrences during either day or nighttime. This application allows users to see highly reported areas so that they can be avoided during travel and also gives the option to provide navigation home avoiding these areas. The application also aims to collect evidence for later reports. It can capture experiences in real time using the camera and the user has the option to upload records at any time. There is

a journal feature along with the photo collection to write details of the attack down for later use. The user can also report these attacks anonymously to add data to the highly reported areas map.

WatchMe [10] uses the GPS and GSM modules in a smart watch and also transmits data to a phone. Since it is on the smart watch, it can make use of a number of sensors that exist within the smart watch such as the pulse rate sensor, temperature sensor, and motion sensor. The pulse rate sensor is used to monitor for a high pulse based on the concept that when someone is in a stressful situation their pulse will be higher. Once a target heart rate is reached and stays the same for a period of time, a high pitched alarm is activated and alerts are sent to a police station. One disadvantage, however, is the potential for false positives again. It is possible that users have incidents aside from reportable violence that could cause these sensors to automatically trigger alerts.

The proposed application iMace [11] uses localization, detection, alerts and evidence collection. It works by using the G sensor to detect shaking of the phone, similar to Nirbhaya. Once a threshold is reached, it sounds a loud alarm to scare the attacker and takes a photo for evidence collection. It will also notify friends and police of an attack occurring. One notable feature lies within the localization module. It mainly relies on GPS, however, when unavailable, it uses a wireless network positioning system.

Lifeline [12] is a smart phone application developed for women. The main goal of this application is to ensure that a trip home is safely endured. The user must keep their finger placed on their phone screen during the travel home. Should the user's finger come off the screen, a password is required to disarm the application. The disarm feature is integral to the mitigation of false positives for this application. The application will make a loud noise and begin to alert if the password is not correctly input. If the phone is broken then it will send the alert out automatically. If the attacker attempts to force the user to disarm, there is a secret code that will 'disarm' the application, but still send the emergency alert to get help. This feature is also a benefit to the user because they will still be able to send alerts without the attacker understanding that alerts are being sent. An alternate option to holding the user's finger on the phone screen is to use the timer mode. This will send a message after a set period of time to ensure that the user got safely home. There is an option to connect this to an Apple Watch, as well.

SafetiPin [13] [14] is an application that provides mainly localization and navigation services as well as some educational resources. There is a GIS mapping service that shows areas safety scores based on a survey of users. The safety score is based on users ranking areas based on the following factors: lighting in the area, openness of the area, visibility in the area, people density, security, walk path, transportation in the area, gender diversity in the area, and feeling of the area. The educational part of the application provides navigation to useful establishments nearby such as pharmacies, hospitals and more. This application also allows a virtual walk home

feature. This application is mostly useful for educating the user of high crime areas and useful establishments for more information on violence against women nearby.

Converstation [15] is a physical device meant to be placed in public areas for usage. The device was developed for Indian women and is meant to be used to report crimes. The user interface is graphic based for semi or illiterate audiences. For literate audiences there are multiple Indian languages that can be selected before entering the application. There is a central database where all the reports are sent to. One disadvantage to this system is that if a user were being attacked or was recently attacked, they would most likely not want to publically report this at a kiosk.

Himmat [16] scans the QR code of a taxi to make sure that the taxi is a legitimate taxi. This helps women avoid getting into perpetrators' cars that are disguising themselves as taxis. However, with the prevalence of ride share applications, this application is likely to be less applicable.

4.2.2 Wearable Technology

Smart Band¹ [17] is a wearable technology connects to a phone using Bluetooth Low Energy (BLE). This is a benefit because BLE is the battery saving version of Bluetooth. There are multiple sensors on the smart band such as the temperature, pulse and motion sensors. If the combination of these sensors is determined to be “unusual” then the device will send a message to the family with GPS coordinates, and will also send the coordinates to the police station. This will continue until the device is reset. A disadvantage of this technology is that the sensors may often present false positives and the device may not be easily resettable. If the police station is constantly getting notifications from these devices that are false positives of violence, then they will likely stop listening to the device notifications, and not respond to actual incidences.

Women Security System¹ [18] is an Arduino with a GSM module embedded into a watch-like device. There is one button which initializes pepper spray to be sprayed toward the perpetrator, triggers a loud noise and takes a photograph for evidence collection. There is also a localization feature that attaches the GPS coordinates to the photograph. This technology is very useful because while it is deterring the attacker and rendering them blind, it is also collecting evidence to later be presented to police. The user only needs to push one button to both deter and collect, and then can flee from the scene while reaching out for help.

Smart Girls Security System¹ [19] is a wearable technology that is a belt consisting of an Arduino. The belt has a pressure sensor, and when the pressure crosses the threshold the device is automatically triggered and location and emergency messages are sent to three contacts and the police every two minutes with an update location. The belt also can electrically shock the attacker. This technology's main flaw is pressure sensor, which will potentially be triggered

¹ Name derived for the purposes of this paper

very often. Simply the user going to the bathroom and undoing the belt may trigger the sensor, or the user sitting a certain way with something on their lap. In the proposed application's report, there are no results and there is seemingly no study conducted to measure the accuracy of the intended effect.

Stick-on Clothing Sensor¹ [20] is a clothing sensor that has an adhesive and is meant to be placed on the inside of the user's undergarment. There are two modes: active and passive response. For the active response the intended users are unconscious women, women under the influence or potentially users with disabilities. This response is triggered when the second layer of the stick-on clothing sensor is detected to be fondled, pinched or squeezed. If disrobing is detected by stretching or one of the previously mentioned actions, then a message is sent to the user to confirm disrobing. If there is no response within 30 seconds then the alerts are triggered. These alerts include: notify five contacts with a GPS location, emit tear gas, and call one contact and record the phone call for evidence. If forceful disrobing is detected the alerts are automatically triggered. In the passive response, the user must press a button to trigger the alerts. The benefit of this technology is the active or passive response mechanism, which allows the user to modify whether it is actively detecting assaults or passively working as a method for the user to trigger an alert. One downfall though, is the re-usability of a technology like this.

Women Safety System¹ [21] is a button that is a switch which can be operated without the use of a mobile phone. The RFID and GSM communication allows five contacts to be messaged when the switch is turned on.

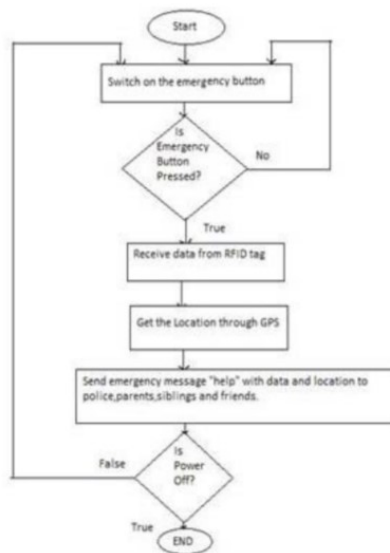


Figure 4. Women Safety System design.

SHE - Society Harnessing Equipment [22] is a wearable technology similar to the stick-on clothing sensor. It is supposed to be attached to an undergarment. The SHE provides GPS data and contains a GSM module to transmit. There is also a shock circuit board which would shock an attacker. [25] One downfall is the fear of the user also being shocked should the shock circuit board be triggered. It could solely harm the user, and not the attacker.

4.2.3 Prop based

Defender 24/7 [23] is a version of pepper spray that also has other attachments within it. This can connect to a smart phone and provides GPS monitoring. There is also a siren that is triggered when the button is pressed. Along with exerting pepper spray, it also captures a photo of the perpetrator to be used later on for evidence. There is also a medical alert button that can be used for health situations. This typically costs 180\$ - 500\$ per year to have an employee monitor the user's GPS coordinates to ensure they are safe. This prop being so expensive will cause users' to be less likely to use the technology.

Suraksha yantra [24] is a small remote like device. It uses GSM to send messages upon button press to parents with the GPS location attached in case of emergency.

Undercover Colors [25] is a drink tester which aims to determine whether or not the user's drink has been drugged. The test takes 30 seconds to determine it and can be used in both alcoholic and non-alcoholic drinks. Initially it costs 35\$ and ten single use refills cost 50\$. These are unlikely to be used as well due to the cost and frequency that women would need to monitor their drinks. If a woman were unsure about the safety of her drink, they would most likely ditch the drink rather than test it to see if it were drugged.

4.3 Children

Studies show that "one in four girls and one in eight boys are sexually abused before the age of 18" [42]. Abuse can be physical, emotional, verbal or sexual [42].

There are a lot of difficulties with detecting child abuse. The main responsibility lies on adults to detect the abuse of children. However, when the only adults surrounding the children are the ones abusing the child then it becomes even more difficult to detect and report these abuses. Often times, "children who are abused are afraid to complain because they are fearful that they will be blamed or no one will believe them" [42].

The technologies geared towards child abuse or neglect are designed for adults to use them, and both are simply forms for reporting the abuse or neglect.

4.3.1 Software

MDCPS Report Child Abuse/Neglect [26] is an online form that submits a formal report of suspected child abuse or neglect. The website also has an educational center which educates the user about indicators of abuse and gives guidance on what constitutes as abuse or neglect.

Suspected Child Abuse Report Form [27] is an online form that submits a formal report of suspected child abuse.

4.4 People with disabilities

“Approximately 1 in 8 of all U.S adults aged 35 to 64 has a disability” [43]. A disability can be any physical or mental condition that effects a person’s movements, senses or activities [44]. In a research brief conducted on adults with disabilities using a personal assistant, “68% of 305 adult women with disabilities reported experiencing one or more types of abuse” [43]. In this, the study defined abuse as physical violence, neglect, withholding of care, financial, emotional, verbal, and sexual abuse [43].

There was only one technology that could be found that was designed for people with disabilities.

4.4.1 Software

Alizimio [28] is designed for people with dementia. It has localization, alert and detection features that aim to keep the user safe. There is a geo-fencing feature that uses GPS to ensure that a user doesn’t cross over the boundary of the geo-fence too many times. If it seems the user is doing so, it is deemed as suspicious activity and is reported to the contacts. The application also has a “take me home” feature that navigates the user to their home from their current location. There is also a detection feature for predefined unsafe activities, such as biking or driving. If it is detected the user is doing so alerts are sent out. There is also a setting for a periodic check on me. It will periodically alert the user to ensure the user knows where they are and what they are doing. Failure to respond to the check on me alert will alert the contacts. This application has a concrete design and methodology.

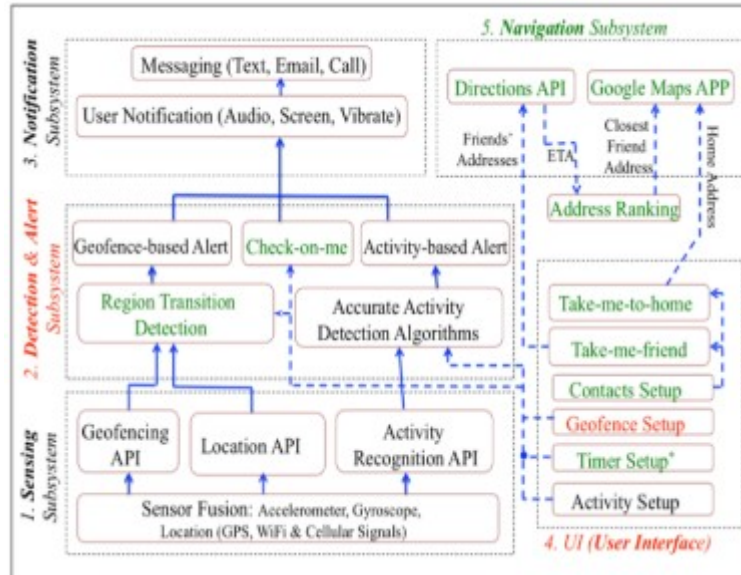


Figure 5. Alizimio design.

4.5 Community

The community, although potentially not victimized, also faces problems when it comes to violence against others. Bystanders must choose to intervene or disregard these situations. The following applications provide opportunities for companies, families, or individuals to intervene or look out for potential victims of these situations.

4.5.1 Software

Ting [29] allows for tracking of friends and family using GPS. It also allows the users in the group to view certain statistics about the other users' phones including: battery status, volume level and call logs. These statistics would be used in case a user isn't responding to their friends, they could see if it is unusual activity. There is also a geo-fencing feature that alerts the friends if the user goes out of the predefined fence. For example, if the user typically takes one way home and then strays from that path.

AI Filter¹ [30] is a proposed concept would use Artificial Intelligence to notify corporate employees when they are acting inappropriately through communication forms. If someone were to send an inappropriate slack message, the user would get an alert stating that it was inappropriate and the AI would contact the human resources representatives. This would be useful in the workplace because it would allow people to understand when they are being inappropriate, and inappropriate actions would be automatically detected and reporting to Human Resources. However, it does not account for any verbal interactions that could be inappropriate.

Two very similar applications, Trusted Contacts [31] and Find My Friends [32] are applications developed by, respectively, Google and Apple. The applications are location sharing applications which allow for the users to set alerts on each other when they leave or arrive at certain locations. Both are useful because they are easy to use, and well-known. Trusted Contacts also has the ability to share locations cross platform.

The Parking Mobility¹ [33] form allows the user to report when non-handicapped folks are parking in the handicapped spots in public parking lots.

4.5.2 Wearable Technology

Advanced Electronic System for Human Safety¹ [34] consists of three units: controller, wrist and base station. They communicate using RF and together, aim to detect and transmit health information about the user. It uses biomedical sensors to collect temperature and heart beat information about the user. This information along with the GPS coordinates of the user can be sent to a base station.

5. Discussion

It is clear to see that most of the safety technologies that exist or have been researched were geared towards women audiences. As a woman, I'm unsure that I would personally use these technologies. One major flaw with a few of them is the number of false reports that would be filed each time the application is in use. A few of the applications, like Lifeline [12], allow for the user to respond to an alert to stop the alerts from being sent if it was a false detection. However, the others automatically report incidents that are potentially normal situations. The automatic detection technologies, such as WatchMe [10], would have a high rate of false positives because of this. Simply relying on the pulse and body temperature to determine if a user is being attacked, and then sending information to the police immediately, does not seem like a reliable method to detect assault. The research paper on this application did not provide any reasoning for why they chose pulse and body temperature. One application, HearMe [6], would also have a large number of false positives. The application relies on the volume hardware buttons, which is a benefit because it gives the user the ability to access the application while the phone is locked. However, simply relying on a double press of the volume button to trigger an alarm and emergency SMS texts to be sent, would result in a large number of false positives since the application is, theoretically, always running in the background. The research backing up some of these technologies is lacking solid evidence.

Of the listed technologies, only 59% of them are technologies that can be downloaded or bought in the market today. Of the products that exist, such as the reporting forms or applications, many do not provide a victim with many features that could not easily be accessed elsewhere. For example, many of the technologies provide a feature to track the user's location using GPS.

However, iPhones already have a feature called Find My Friends which provides this functionality without the need for an extra application on the phone. Find My Friends, although not marketed as a safety application, also has features like receiving alerts when their friends reach a location or also sending alerts when the user reaches a location. Trusted Contacts has similar features to Find My Friends, but it works cross-platform which is a benefit. Many of the other safety applications, although they provide GPS services, don't allow for similar features. Another common feature of these applications is being able to send a one click message to friends or family members. On iPhones, all a user needs to do is swipe left to access their emergency contacts and call them; however, for most of these applications the user would need to unlock their phone, access the application, and then contact their emergency contacts. Spending this extra time would put the user in more danger in some situations.

Some of the technologies, like the wearable and prop based technologies, provide the user with features that they could not access without the technology. For example, Suraksha yantra [24] is a device that allows the user to contact emergency contacts with one button press. It is a better than using a phone to do so because the button press is more accessible and more intentional. The user is less likely to accidentally trigger a response if it is a separate device that they would carry only when they are entering unsafe situations, like walking home. This is a benefit of the prop based technologies versus the software only technologies.

Within this community, there is a lack in technologies that are targeting demographics aside from women. One target audience that is not as focused on is children. The Bureau of Justice Statistics claims that in 2017, 42.2% of rape victims first experienced rape before the age of 18 [45]. However, only a select few of these existing technologies are geared towards young people and helping them remain safe. The main two technologies, the MDCPS Report Child Abuse/Neglect [26] and the Suspected Child Abuse Reporting Form [27], were made for reporting abuse or neglect against children. However, the technologies do not make any clear effort to design their user interface so that a child would understand how to use it. Neither technology makes the child understand that they are submitting a formal report against the perpetrator either. There was a technology that was geared towards women, but was mostly applicable to children, the Smart Girls Security System [19]. However, this technology was only proposed and is not available for people to purchase.

On the opposite side of this, there were also no technologies created to aid elderly people. Elder abuse and neglect occurs within 4-10% of elderly persons [46]. If there were technologies developed to help elderly people report abuse, then there would likely be less abuse occurring within nursing homes and this would improve the quality of life for elderly people. Physicians are one of the groups of people that are required to report suspected abuse. However, less than 2% of Adult Protective Service reports are filed [46]. One barrier could be the lack of education or reasonable suspicion of these abuses. However, relying on someone else to report the abuse is

not a viable method, and technologies should exist for these elderly people to report their own abuse, if they choose to.

One place that is majorly lacking is helping people with disabilities feel safe or report abuse against themselves. Only a few of the technologies had accessibility considerations, one example being using a graphic based user interface for the illiterate. However, only one technology was actually developed for people with disabilities. It was specifically for people with dementia and ensuring they did not get lost. Almost all the technologies assume that the user is fully abled and can perform actions such as typing. The technologies that would be most useful for people with disabilities are the wearable technologies. Specifically, the Stick-on Clothing Sensor¹ [19], could be altered to also be useful for people with disabilities. However, more research needs to be done in this area to fully design a safety technology for people with disabilities.

Some of the technologies, although marketed for one audience, could be easily modified and marketed to a wider audience. For example, as mentioned previously, the Stick-on Clothing Sensor¹ [19] could easily be modified to be useful for any audience, especially people with disabilities. To modify it for people with disabilities the passive response would need to have a different verification method, other than texting to ensure it isn't a false positive. Similarly, this could be used for children or elderly persons as well.

Almost any of the technologies that were designed for women could be used for other demographics. In terms of marketing, the company would just need to market it for any demographic, instead of solely women. The only technology designed for women that would need modifications to be designed for men as well would be the stick on sensors, since men don't typically wear bras. All of the software solutions however, are truly applicable to any demographic whether it is college students, mature children, men, elderly persons, or people with disabilities who are able to type and use a smart phone.

6. Conclusion

The safety technologies that have been researched are lacking in many different ways. The main problems are the high likelihood of false positives and lack of educational features. As shown in the image below, it is clear that lack of knowledge and resources are barriers to reporting assault. If these applications were to make educational features more prevalent and accessible, this may reduce the barrier.

Barrier to reporting	Women	Men	<i>p</i>
Shame, guilt, embarrassment	4.0	4.8	<.001
Fear of being judged gay	NA	4.3	NA
Fear of retaliation	4.0	2.4	<.001
Confidentiality concerns	3.8	4.2	<.01
Fear of not being believed	3.7	4.2	<.01
Financial dependence on perpetrator/ perpetrator not allowing help	3.6	2.3	<.001
Does not want family member or friend to be prosecuted	3.4	3.1	<.05
Disbelief in successful prosecution	3.3	3.5	NS
Unaware of importance of treatment	3.3	3.2	NS
Lack of knowledge about how to get help	3.0	3.1	NS
Lack of resources to obtain help	2.9	2.3	<.001
Lack of available services	2.7	2.6	NS
Dislike or distrust of police and justice system	2.4	2.6	NS
Cultural or language barriers to obtaining help	2.3	2.0	<.05

Note. Mean scores for Likert scale: 5 = extremely important; 1 = not important (*n* = 215).
NS = not significant.

Figure 6. Barriers to reporting rape and sexual assault. [47]

Other problems include availability and cost. The figure states “Lack of available services” as a barrier to reporting. Although these technologies exist, there is still a barrier for helping people who have been assaulted or harassed feel comfortable reporting this. Some of the other main reasons that victims do not report their assaults can be seen in the figure which demonstrates the results of a study conducted by Sable et al. on college students.

Most of these technologies’ main goals are to help people deter and report these incidents. This field is lacking in products, however, and the research backing many of the technologies claims needs more evidence to prove the successfulness of these implemented methodologies. The Himmat application has already failed because only 0.1% of the 19 million citizens in the city downloaded the application that was made specifically for that city and marketed on the news [16]. Although these technologies exist, education about the existence and education about benefits of reporting are still hurdles that need to be addressed before the use of these technologies will be widespread.

Moving forward, modifying these technologies so they are applicable to larger audiences is integral to the use of the technologies. Alongside that, moving from research paper to product is also important. Only twelve technologies actually exist in the market today. The cumulative list of technologies was difficult to find and research which also concludes that the marketing for these technologies is lacking. Having them in the market is important, but if nobody is using them they are not making an impact on the safety of society.

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