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THE ROLE OF TECHNOLOGY ON WOMEN'S SAFETY

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ABSTRACT

This report investigates three different solutions for improving women's safety in different scenarios, such as in a public setting or a domestic situation. The solutions include a mobile application, wearable device, and IoT smart clothing device. Using background information, such as questionnaires and interviews, to develop user requirements for these solutions to fulfil the needs of the users. The aim is to create a prototype of these solutions to demonstrate the concepts which will be shown to users so they can evaluate the solutions and provide feedback and suggest improvements. These can then be developed on in the future work for the project.

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INTRODUCTION

The topic of women's safety is still a prevalent issue today and is being increasingly discussed after some of the recent incidents that have taken place. The murder cases of Sarah Everard and Sabina Nessa have started the wider conversation of the safety of women in the UK. The Office for National Statistics released data in August 2021 that revealed; "One in two women felt unsafe walking alone after dark in a busy public place, compared to one in five men." and "Two out of three women aged 16 to 34 years experienced one form of harassment in the previous 12 months; with 44% of women aged 16 to 34 years having experienced catcalls, whistles, unwanted sexual comments or jokes, and 29% having felt like they were being followed." [1]

As well as safety in public, another main concern is the number of women who are in dangerous domestic situations and feel unsafe being in their homes. According to the Crime Survey for England and Wales the year ending March 2019 an estimated 1.6 million women experienced domestic abuse within the last year [2]. For victims in these situations an effective solution could make a lot of difference.

In this report I will consider some of the existing solutions that are used and explore other technical solutions including IoT, mobile applications and wearable devices and how these emerging technologies can be efficient solutions for improving women's safety. The prototypes will demonstrate the functionalities of the solutions and include features that meet the needs and requirements of the users.

To evaluate the designed prototypes, I will be conducting a focus group activity with experts that work around women's safety such as in charities or NGO's. They will provide feedback of the prototypes and how they think these would be used in practice. As well as that I will do a user questionnaire to get feedback from the potential users.

This report will conclude with three solutions, which will include two wireframes and a concept prototype, as well as design and functionality suggestions by users and experts for future developments and iterations of these prototypes.

BACKGROUND

STATISTICS ON WOMEN'S SAFETY

A recent inspection report on the 'police response to violence against woman and girls' says that figures on VAWG are alarming and that "we consider they represent an epidemic of violent and abusive offending against women and girls in England and Wales." [3] Violence against women and girls has been recognised as a human rights issue and the UN Declaration on the Elimination of Violence against Women defines violence against women as: "any act of gender-based violence that results in, or is likely to result in, physical, sexual or psychological harm or suffering to women, including threats of such acts, coercion or arbitrary deprivation of liberty, whether occurring in public or in private life." [4]
The office for national statistics conducted an opinions and lifestyle survey which covered perceptions of personal safety and experiences of harassment, it gives some insight into the feelings regarding personal safety. There are some clear findings that show both men and women feel less safe after dark, but the extent to which women feel unsafe is significantly greater. [5]

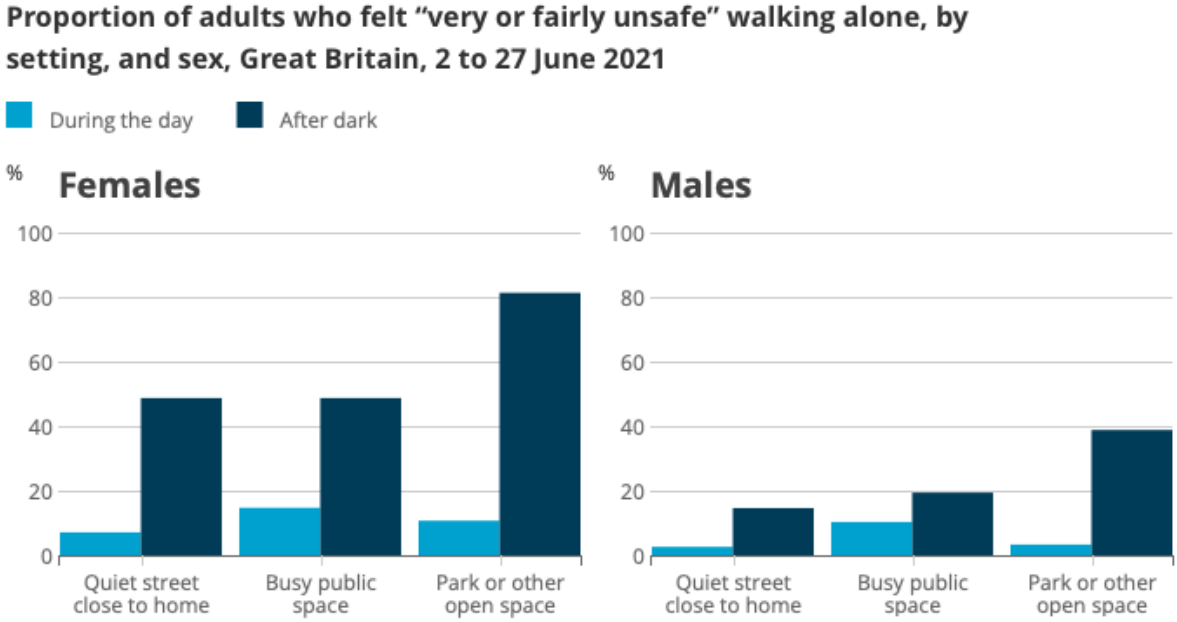


FIGURE 1 – PROPORTION OF ADULTS WHO FELT UNSAFE WALKING ALONE BY SETTING, AND SEX, UK

From Figure 1 we can see that in all settings women feel less safe walking alone than men, and the setting which most woman feel very or fairly unsafe walking alone through is a park or other open space. This was also the highest for men however the difference was 81% and 39% which is a large disparity.

As well as feelings about personal safety the survey also asked about experiences of harassment and found that of adults aged 16 to 34 years old, 65% of women had experienced harassment compared to 29% of men.

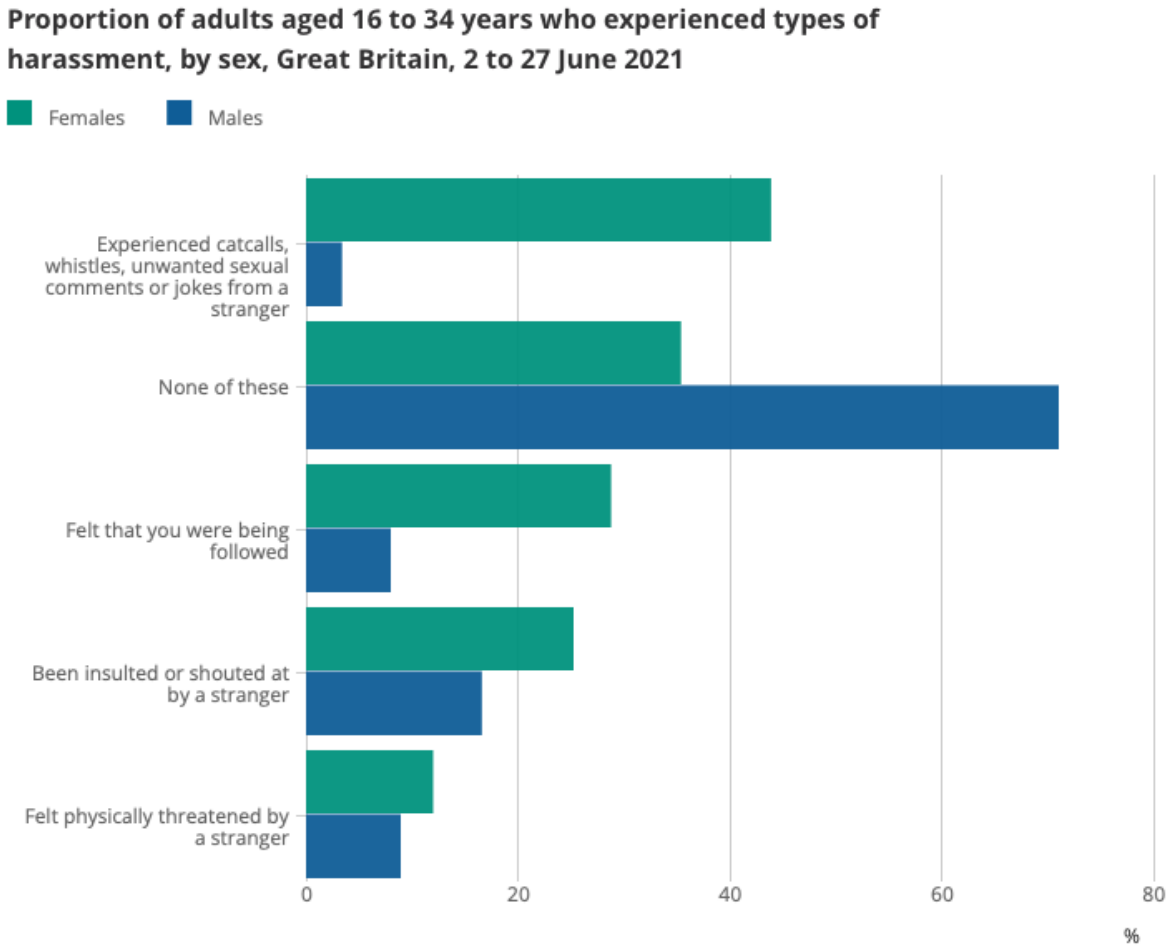


FIGURE 2 – PROPORTION OF ADULTS WHO EXPERIENCED TYPES OF HARRASSMENT, UK

Figure 2 shows that the most common type of harassment was catcalls, whistles, unwanted sexual comments, or jokes from a stranger. Around 45% of women experienced this compared to about 5% of men. This type of harassment would be common when walking alone which could explain why many more females feel unsafe walking alone. Figure 3 supports this as adults who had been harassed in the last 12 months were more likely to feel unsafe while walking alone. It also shows that in this case the proportion of females feeling unsafe was higher than males in both variables (experienced harassment and didn't experience harassment).

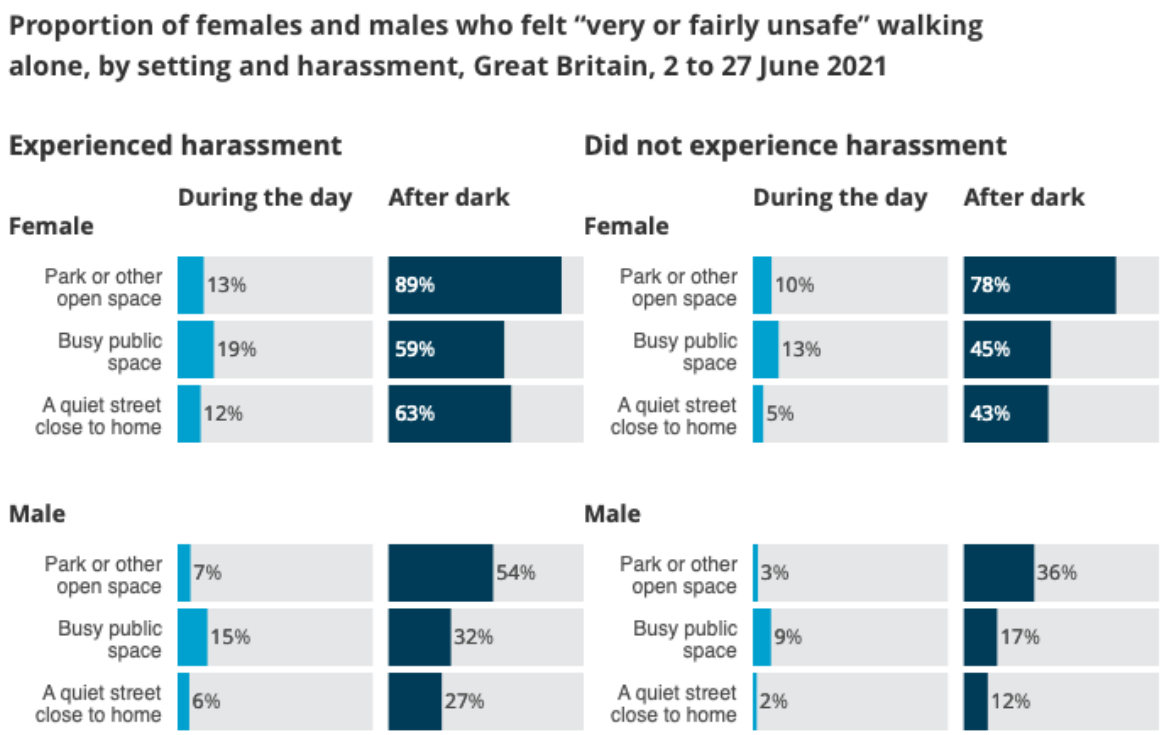


FIGURE 3 – PROPORTION OF FEMALES AND MALES WHO FELT UNSAFE WALKING ALONE, BY SETTING AND HARRASMENT, UK

These statistics show that in most types of harassment, women are more likely to experience it than men. Although, preventing this from happening would take changes in the attitudes and behaviour towards women and a cultural shift. There are still measures we can put in place to support women in feeling safer in day-to-day life and solutions that will aid this.

WHAT THE GOVERMMENT ARE DOING TO HELP

The Safer Streets fund allows police forces and local authorities to receive a share of 23.5million to help woman and girls feel safer on the streets. This was created initially with the objective of tackling crimes like car theft and burglary, the latest round of the Safer Street fund has a particular emphasis on the safety of women and girls [6]. Some of the crime prevention measures being put in place include close working with night-time economy establishments; improved street lighting; increasing CCTV coverage so people think twice before committing a crime and can be identified and brought to justice more quickly and education and awareness raising activity in communities and institutions to change behaviours and attitudes [7]. Implementing these measures are useful for prevention of these crimes, however I believe a technical solution such as an application or device would be useful alongside this to use in an unsafe situation which could be on the streets or not in public.

PRIMARY RESEARCH – INTERVIEWS

As I had started research into this topic in 'design thinking and prototyping for user experience' module I collected data from a few participants through interviews. This allowed me to gain further understanding of the problem and the needs of the users.
The interviews were conducted with five participants in my group all between the age of 20-21. The participants consisted of two females and three males, this provided two perspectives into the problem. These interviews took place face to face and used open ended questions to gain as much information from the participants and more qualitative data. Due to ethics restrictions, I was only able to interview my group which reduced my population sample; however, I was able to gain useful information as a starting point to developing the users' needs and requirements.
Before conducting the interviews, each participant was sent a participant information sheet, which explains the purpose of the research and a consent form to sign. As this research was based around women's safety in public the questions reflect this. The first questions were used to gain basic information about the participants such as age and gender, then general information about how they commute and whether they tend to travel alone. Lastly, I asked the participants what they find useful when travelling alone and what suggestions they have for potential solutions and new developments. The interview questions and answers from participants are included in the appendix (Appendix A).

RESULTS AND ANALYSIS

Trends across the participants were that all female participants said that they feel unsafe travelling alone in the dark, whereas male participants said that the dark would not stop them from travelling alone however they would be wearier. Overall, I can say that females are more cautious travelling alone than males and it is common practice for females to communicate on the phone to someone if they are alone or send their location. The sample of participants is small, which makes it difficult to generalise the results. However, the findings are consistent with the office for national statistics, so it improves the validity.
The interviews helped me to get some ideas and suggestions for specific features and functions to include in the potential solutions, some of the suggestions from participants were:

- A tracking device app, with friends to access their locations when you know you will be alone. (Participant 1)
- An alert system, e.g., someone being creepy on a particular road could warn other people
  Groups that walk people back to where they live
  Make sure people aren't walking home alone – write them a message to check up on them. (Participant 3)
- An application that updates location every 5- 10 minutes
  In case of emergency there is a button to call emergency contact or police
  My live location is being sent to that person (emergency contact) (Participant 4)
- App – S.O.S button – alert
  IoT device – wearable technology – emergency button to police and have GPS data (Participant 5)

After conducting the interviews, I used this data about the feelings and opinions of the participants to build an empathy map. An empathy map is a collaborative visualisation used to articulate what we know about a particular type of user. It externalises knowledge about a user in order to create a shared understanding of their needs and aid in decision making. [8] The empathy map is created based on what the participants have said in their interviews and can be used to determine the user attributes and needs. Below is the empathy map that I created:

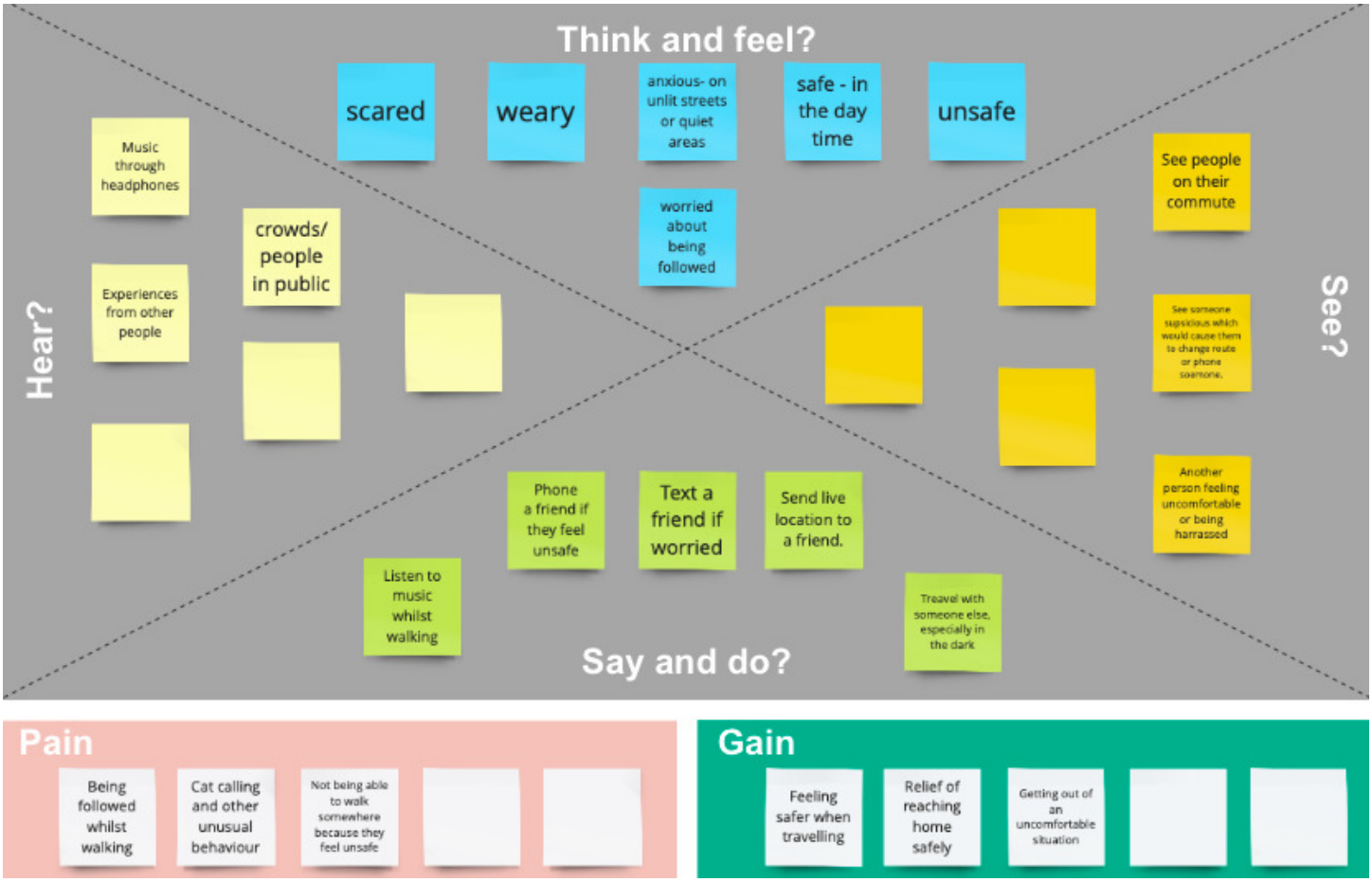


FIGURE 4 – EMPATHY MAP

In figure 4, the think and feel quadrant focuses on the beliefs, inspirations and worry points from the data and anything that occupies the users thoughts, or they might feel. The hear quadrant focuses on who they might hear from or influencing their decisions could also include the media. The see quadrant is to do with what they see in their environment and how these can influence decisions. The say and do quadrant focuses on describing a routine or user behaviour. Lastly, the pain and gain area look at frustrations and challenges the user faces and what they want to achieve.

SUMMARY

The aim of the questionnaire was to gain more understanding of the problem from the users perspective and identify the needs and requirements for potential solutions. The results proved useful for this as I was able to find out more about what causes people to feel unsafe when travelling alone and what they would find helpful to feel safer and more confident in doing so. Most of the participants said that when they feel unsafe, they like to communicate with someone else either on the phone or through text. This validates the need for a technical solution which could include a mobile application as many users already use their phones for this purpose. I believe that a solution like a mobile application or wearable device would be beneficial because it would include most of the important features that the user requires in one place. Such as live location, emergency button and messages to close friends and family.

RELATED WORK

DESIGN OF A SMART SAFETY DEVICE FOR WOMEN USING IOT – VELLORE INSTITUTE OF TECHNOLOGY, CHENNAI INDIA

A paper by Wasim Akram, Mohit Jain, C. Sweetlin Hemalatha [9], The article describes that one of the main disadvantages of existing handheld safety devices for women require human intervention for activating the device and such as pressing a button or shaking it. The aim of this paper is to propose a solution that will try to overcome these disadvantages and provide fool proof security to women. The proposed solution is an IoT based device that relies on a fingerprint-based method of connectivity to the device and alerting nearby people and the police if a woman is not safe. The proposed design comprises of features to notify family members and nearby police station for immediate assistance when women are not safe. Moreover, a shock wave generator is a part of the proposed design which women can use to attack the perpetrator. Some of the other features in the proposed work that provide additional support to women are as follows:

1. Sending group messages from the device as well as from the victims' phone.
2. Recording audio of the victim which may be later used as proof against the perpetrator.
3. Locating safe place from victim's current location on the map

Below is the device that is proposed, it shows the hardware design of the safety device. The device consists of a fingerprint scanner to activate the device, GSM (Global System for Mobile Communications) module for sending alert messages, buzzer for alerting the environment and shock wave generator for self-defence.

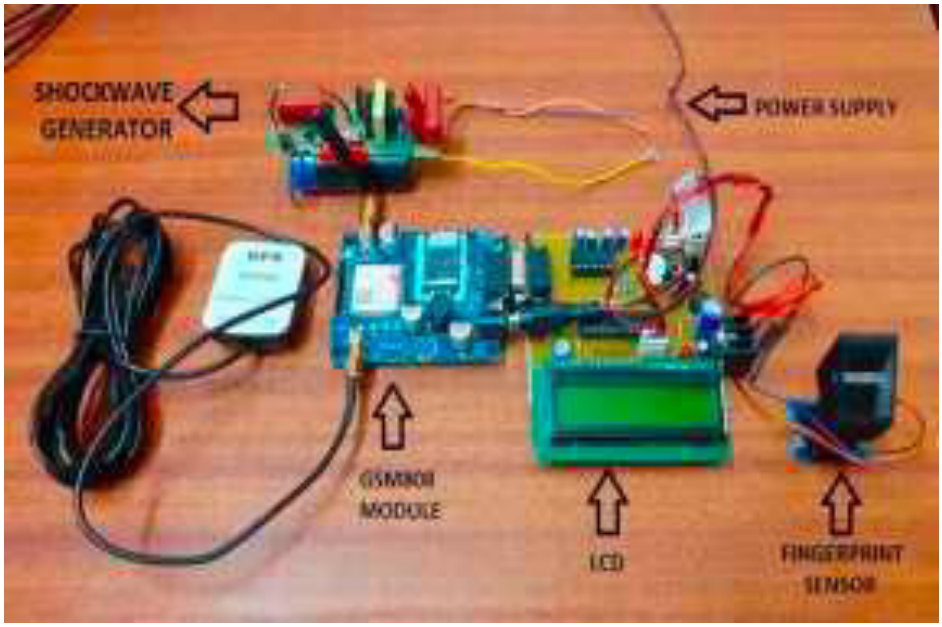


FIGURE 5 - HARDWARE OF PROPOSED DEVICE

Along with the device, they also propose an android application that allows the user to send group messages, an audio recording will be done so that the victim can use it as proof against the perpetrator, and Safe locations from victim's current location will be shown on the map using mobile app so that women can reach a safe place from their current location. A strength of the device proposed in this paper is that it requires little interaction so it would be efficient to use in a dangerous situation when there is no time to activate a device. On the other hand, there are a few limitations of the device. Firstly, as it is a physical device there could be situations such as the user forgetting to take the device with them or a technical malfunction with the device. As well as that, it requires the user to keep their finger pressed to the device every minute or an alert of a danger will be sent out this could become irritating for the user because they will need to constantly check the device to avoid an alert being sent out mistakenly. Secondly, the application used with the device is specific to androids which already limits a lot of potential users who use iOS. Therefore, to be accessible to as many women it would be beneficial to have a solution that is suitable for both android users and iOS users.

MOVEFREE: A UBIQUITOUS SYSTEM TO PROVIDE WOMEN SAFETY – SOHINI ROY, ABIJIT SHARMA, UMA BHATTACHARYA

This paper aims at designing a pervasive system compromising of a wearable computer that will act as a guardian angel for women in danger [10]. Pervasive technology is emerging with a revolutionary approach towards technological growth. With its omnipresent nature it can make the 'computers come and live in the real world of human beings'. Pervasive computing systems have also proved to be very useful in areas of where continuous monitoring is needed, in this example females travelling alone.
The device in this paper is a wearable sensor band which is capable of detecting heart rate, blood flow rate, glucose content, breathing rate and sweat of the person wearing it. these readings are collected by the wearable sensor band and sent to the smartphone of the woman through Bluetooth. If there is an abnormality in the readings the system detects

whether the woman is in danger, with the help of a decision tree. Based on the decision made, a SMS would be forwarded to the groups of friends or relatives of the woman, these phone numbers are previously registered in the mobile database of the smartphone. An alert is also sent to the nearest police station. Below is an image of the components of MoveFree:

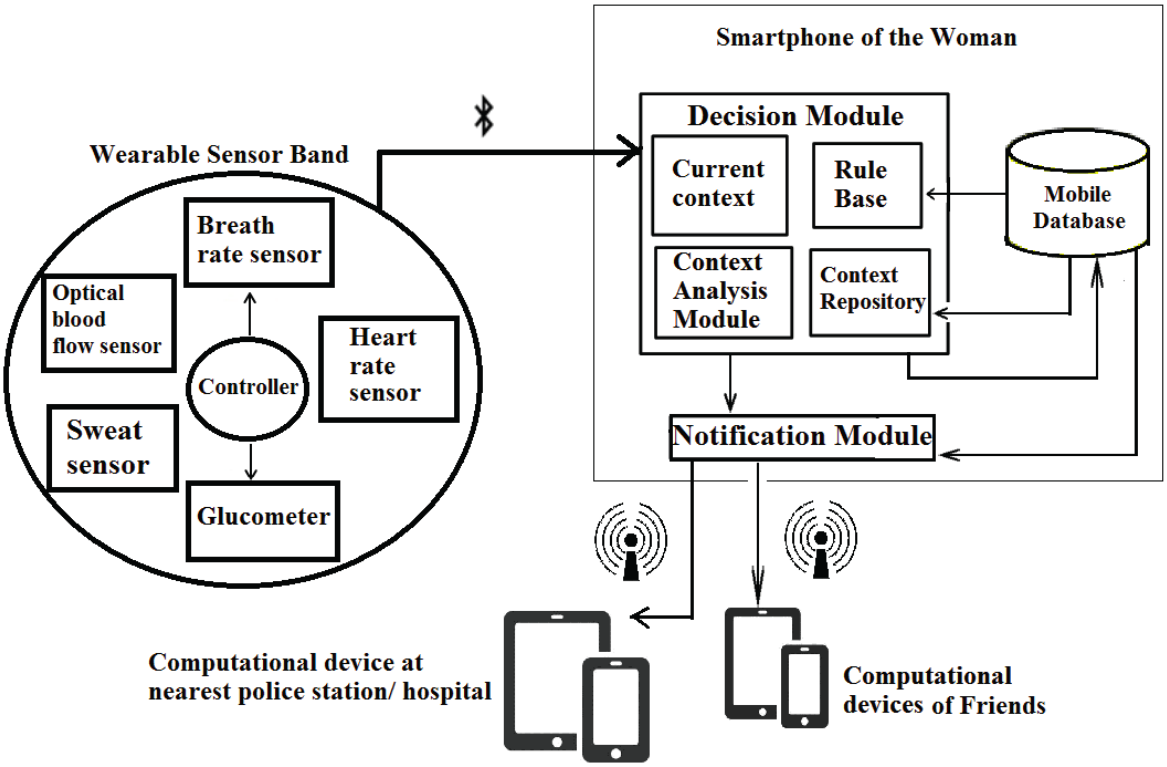


FIGURE 6 - MOVEFREE

There are many useful features of MoveFree and overall, it is a good solution for allowing women to feel safer to travel. I think that the combination with the mobile application and wearable device is a good approach, as it allows for features such as sending SMS alerts and contacting the police through the app and j. Some of the features included in this paper could be used as inspiration for the solution that I am designing as it will include an IoT wearable device.

EXISTING SOLUTIONS

The most common existing solutions are mobile applications, this could be due to the ease of accessibility as they are readily available and most of them are free to download. Since the murders of Sarah Everard and Sabina Nessa, the WalkSafe app has had a surge in popularity and is now the fastest growing app in the UK [11]. The main feature of this application is planning the safest route home by looking at recent crime data. As well as that it sends alerts when you are walking close to danger zones. WalkSafe will be introducing a new feature which will include a live map where your friends and family will be able to track your journey and chat with you in real time.

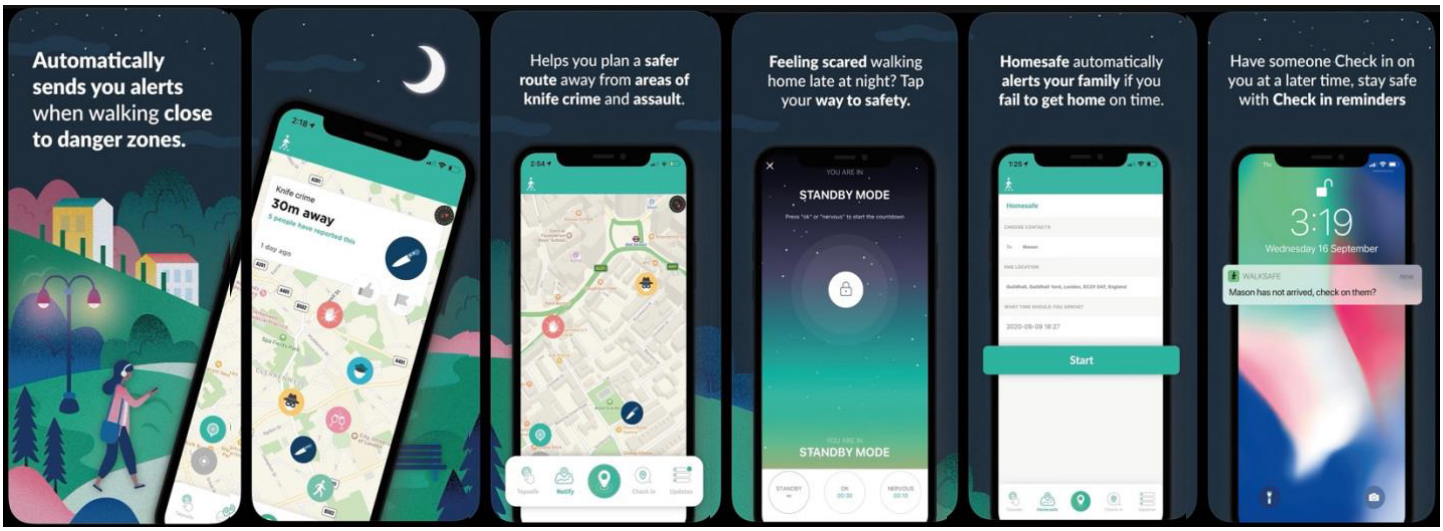


FIGURE 7 – SCREENSHOTS FROM APP STORE

However, there are a few limitations that need to be considered with this application. Firstly, based off the reviews of this application, one user has mentioned that the alerts go back from weeks before which is “essentially pointless”. The application alerting the user about incidents from weeks before has no relevance to their journey on that day and could cause them to feel more paranoid rather than safe. This user feedback is something to consider when deciding the features and requirements for the mobile application prototype that I will be designing as I can use this to design a solution that will better help to solve the problem.

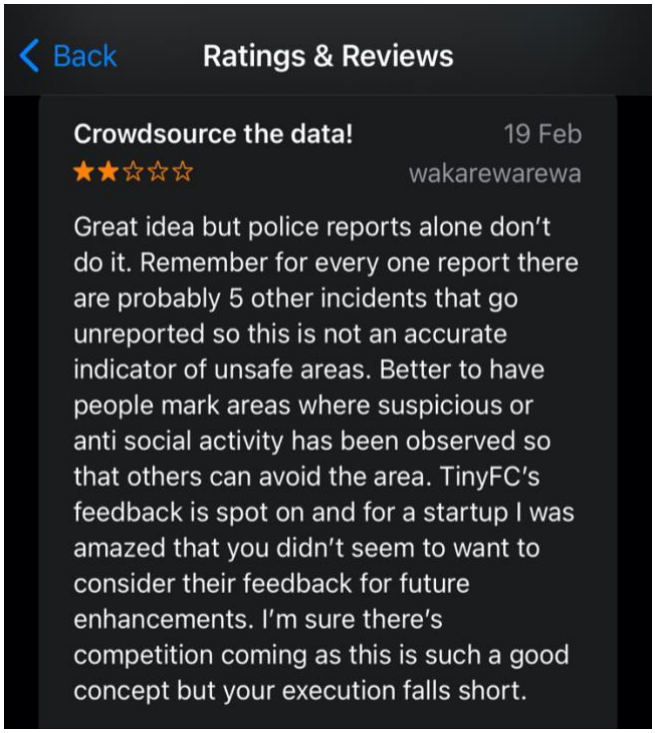


FIGURE 9 – SCREENSHOT OF A REVIEW FROM APP STORE

or input into a task or project by enlisting the services of a large number of people, either paid or unpaid, typically via the internet [13]. This feature would be a form of crowdsourcing as many users of the application create alerts to warn other users of areas where incidents have happened.

In addition to that another potential limitation of this application is that the only information used to produce the alerts is police reports, which alone won't be an accurate indicator of unsafe areas. Studies have shown that up to 60% of crimes go unreported, these can include serious or violent incidents as people may find it stressful or time-consuming going to the police [12]. The user who wrote the review suggests a way they think this can be improved is to have "people mark areas where suspicious activity has been observed so that others can avoid it". Crowdsourcing is the practice of obtaining information

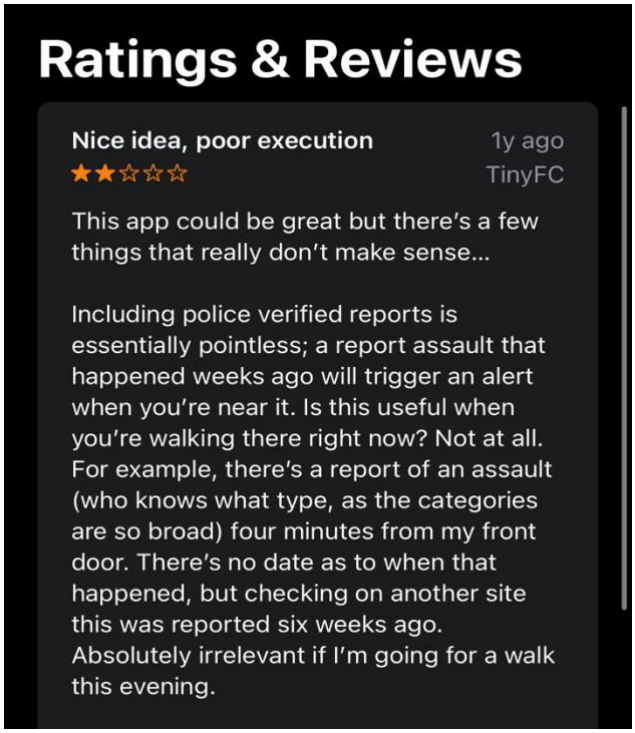


FIGURE 8 - SCREENSHOT OF A REVIEW FROM APP STORE

SUMMARY OF BACKGROUND RESEARCH

Through the research that I had conducted and analysed I was able to gain more understanding into how technology can be used to improve women's safety and what is currently available. As well as that I could evaluate the strengths and weaknesses of the current approaches which will be useful in helping me identify requirements for my solutions. The main take-aways from my research are:

- 1 in 2 women feel unsafe travelling alone, especially in the dark. This is due to the environment and the harassment that many women experience when travelling.

- There solutions available are still upcoming and emerging, the most common solution currently is mobile applications however the usefulness is dependent on the development of the features and the widespread use of the applications.

- There are different technologies that could be used to improve the safety of women, such as IoT in the form of a handheld device, an application or a wearable as discussed in the related work section. These each have their own benefits and concerns which will determine the effectiveness of them.

- The government have put funding into trying to make the streets safer for women and girls through adding more streetlights and CCTV, this means that they could potentially put funding into the development of technical solutions.

APPROACH

MOBILE APPLICATION - PROTOTYPE 1

INTRODUCTION

One solution that I believe to be a suitable solution for improving women's safety is a mobile application. Following the research that I had done through interviews with users, this was the most popular suggestion as a usable solution to help women feel safer when travelling. Due to the ease of accessibility with a mobile application, it makes it a feasible solution for many types of users as there are no extra devices or expenses required. The only thing needed is a smartphone and an internet connection.

The justification for this solution is that it would satisfy the needs of the users and include features that they would find useful. These would be based on the information provided by the users and from the reviews of current applications. The aim of the application is for it to be used amongst people who know each other meaning close friends and family.

Although there are existing mobile applications, I think this solution would be appropriate as it will aim to be an improved version of the current applications and develop on what is missing from them currently. As well as that I think another factor that will influence the usefulness of the application is how many people are using it and how widespread it is. Therefore, I think it would be important to promote the application to many women and girls through colleges and universities also work environments. By having more women and girls using the application there would be a larger source of information received by the app to improve safe routes. In addition to that, there would be a larger community of women who can interact and find people that they know.

For this application, I will be creating a mock-up wireframe of the prototype which will demonstrate the screens and the navigation buttons to show the features of the application. This will help to visualise the application and consider the amendments that can be made for future changes based on user feedback. The application will include a range of features such as live location, nearby alerts, and an emergency SOS button.

The design of the application will start with the user logging in or registering an account, this is so that each person who has an account is a verified user, to reduce the risk of people making fake accounts or misusing the application. On the main homepage the user will be able to see their location and alerts that have been reported nearby by other users of the application. The icon menu will allow the user to navigate between the main features of the app and will include an emergency SOS button, which can be used in a dangerous situation to call the police. The user can also create alerts and see where their friends are on the map which means if they are close, they can travel together. To use the application the user will need a smartphone device and to download the application from the app store. The existing architecture that will be required by the users will be a stable internet connection and location services to be enabled for GPS features.

REQUIREMENTS

To meet the needs of the users the design of the application will need to include certain functional and non-functional requirements. The users of the application will be the women and girls who feel unsafe travelling alone or have been encouraged by friends or family to download the app. The requirements and design of this prototype have been created following the information gathered through the interviews with users and reviews from the current applications. To prioritise and manage the requirements I will be using the MoSCoW method, this is an acronym that represents the four categories: Must-have, Should-have, Could-have, and Will-not have [14]. The must-have category consists of requirements that are non-negotiable needs for the solution, the should-have category is just a step below must-have and include the requirements that are essential but not vital to the solution. Could have requirements are described as "nice-to-haves" so they are not essential to the core solution and have less impact if they are left out. Lastly, is will-not have category, this is a very low priority and can manage the expectations of what will not be included in the solution.

FUNCTIONAL REQUIREMENTS:

TABLE 1 – FUNCTIONAL REQUIRMENTS OF PROTOTYPE 1

Requirement Reference	**Description of requirement**	**MoSCoW Category**
FR1	The user will be able to register an account in the application	MUST
FR2	The user will be able to log onto their account	MUST
FR3	The user can view and click an alert on the homepage, and be taken to the alerts page	MUST
FR4	The user can see their friends locations on the map	SHOULD
FR5	The user can create and submit an alert	MUST
FR6	The user can call emergency services using the SOS button	MUST
FR7	The user can search and add friends	SHOULD
FR8	The users can message friends and family from the application	COULD
FR9	The users can view and update their profile	COULD

FR10	The user can look at requests and accept friends	SHOULD
FR11	The alerts posted are cleared when they have been resolved or are no longer there	COULD
FR12	The users can call friends or family from the application	WILL NOT

Table 1 shows the functional requirements for the mobile application solution, the Must requirements are the core functions of the prototype and needed to be included for the success of the application. Given the limited time to design and build the wireframe prototype of this solution, all the features may not be fully developed. However, these are features that can be developed on in the future iterations and after user testing.
FR1 and **FR2** are the first key requirements for the solution as they are what allows the user to make an account and log in to the application, these are a must have as to improve the safety of the users it is important that all members are registered. The next core requirements are **FR5** and **FR6**, these are to let the user create an alert and call the emergency services which are main functionality requirements of the solution to improve safety. FR8 and FR9 are examples of requirements that can improve the application for the user but are not core to the functionality of the application.

NON- FUNCTIONAL REQUIREMENTS:

Non-functional requirements define system attributes such as security, reliability, performance, maintainability, scalability, and usability [15]. I will be using these to define some non-functional requirements for this mobile application. As NFR's are difficult to measure, I will be using acceptance criteria to check if the application satisfies the requirement or not.

TABLE 2 – NON-FUNCTIONAL REQUIREMENTS OF PROTOTYPE 1

Requirement Reference	**Description of requirement**	**Acceptance Criteria**
NFR1	The application will require a password protected account and to verify the user	The user must create an account or log in before they can use the application.
NFR2	Users will find the functions of the application useful in real life situations	The users have a positive view of the features of the application and think that they would use them.
NFR3	The application will be visually appealing for the users	The users have a positive view of the appearance of the application.

NFR4	The application will be easy to navigate and understand	The users can quickly learn how to use the application.
NFR5	The application can quickly make calls to emergency services, without a delay.	The call is placed within 2 seconds.
NFR6	The application will be able to handle many users at one time.	The application doesn't lag or slow down if there are many users at one time.
NFR7	The application is maintainable for the users	All features of the application are available to the users and doesn't require them to purchase anything.

Most of these non-functional requirements can be tested by the users of the solution through a survey which will determine if the acceptance criteria pass or fails. It can be interpreted from the survey based on their views of the prototype.
NFR1 is a requirement for security and is important that it is satisfied. Due to the sensitive information that is stored on the application, such as the GPS location of friends and family, it is important that only the authorised user has access. There could be an adverse effect and potentially dangerous consequences if an unauthorised user gains access to this information. This will be discussed in more detail later in this report.
Based on the discussion with an expert and opinion from users, I will be able to determine if **NFR2** is accepted. The experts can provide their feedback on how effective they think the features would be for the users and potential limitations or points to consider of these features.
NFR3 and **NFR4** are based on the users experience with the application, this will be judged from the survey that the users will be given which will show the prototype of the application. Ideally, it would be useful to get the users to test the prototype or final solution however given the time it would be too difficult to arrange this with a group of users.
NFR5 and **NFR6** are requirements that test the performance of the application to ensure it is efficient. To test these requirements, it would require an operational solution therefore they will not be tested. However, they have still been included in the requirements as they need to be considered and they can be tested properly in the future when the application has been created and the back- end has been developed.
NFR7 is a requirement aimed to ensure the application is maintainable for the users. A maintainable non-functional requirement must be capable of being maintained cost-effectively over its expected lifetime [16]. In this case this requirement aims to ensure the application is maintainable for the users by being cost-effective for them by not charging a cost for the application or extra features that may be developed over time.

WEARABLE SMARTWATCH- PROTOTYPE 2

INTRODUCTION

Another solution that I believe will be useful for improving women's safety is a wearable smartwatch, with features such as an SOS call to emergency services or designated primary contact, audio recordings and messages. This solution was also developed upon from the suggestion of a potential user from the initial interviews conducted.
The justification for this solution is that it is a feasible solution for many users and in some situations can be more efficient than a mobile application. As an example, in a domestic violence situation having a wearable device would be easier to access and potentially safer to use. The device can make audio recordings which could be useful as evidence for either the police or in court.
Although the features of the smartwatch and the mobile application may seem similar the main difference is the technology that is used and the accessibility of the device. The mobile application requires the user to download the application whereas the smartwatch device is designed for this purpose and comes with these features, which means that in terms of cost-effectiveness the smartwatch will have increased expenses for the users. However, if it is useful for the purpose of improving women's safety then there is the potential of government funding and grants for high priority users. This will be discussed in detail further in the report.
For this prototype I will be creating a mock-up wireframe of the solution which will include the design of the screens and how the user would be interacting between the screens. The prototype will be a touch screen smartwatch and use buttons and slide features to activate features. The aim of this prototype is for there to be minimal input from the user to activate attributes of the device, meaning that there aren't a lot of steps involved in completing one action e.g., calling the emergency contact. One main consideration with this prototype is that a smartwatch has a small screen therefore the features included need to be minimalistic but efficient.

REQUIREMENTS

The main users of this solution will be women and girls who are likely to be in unsafe situation, this can include victims of domestic abuse. As well as that, women and girl who typically travel alone and don't always feel safe. this could potentially be someone who finishes work in the evening when it is dark and feels anxious on their commute home. These requirements are created with these users in mind to ensure their needs for the solution are fulfilled and the device is useful to them.

FUNCTIONAL REQUIREMENTS:

TABLE 3 - FUNCTIONAL REQUIREMENTS OF PROTOTYPE 2

Requirement Reference	**Description of requirement**	**MoSCoW Category**
FR1	The user will be able to view their home page	MUST
FR2	The user can select the menu icon at the top left corner	MUST
FR3	The user can click the SOS button and the SOS page appears	MUST
FR4	The user can view their contacts and add a new contact	MUST
FR5	The user can access the settings page and choose their primary contact	MUST
FR6	The user can edit their profile	SHOULD
FR7	The user can turn their location services off	SHOULD
FR8	The users location is shared with their primary contact	SHOULD
FR9	The user can see if they have notifications	SHOULD
FR10	The user can send messages to their contacts	COULD
FR11	The user can view contacts locations	WILL NOT

Table 3 above shows the functional requirements for the wearable smartwatch, **FR1** to **FR5** are 'Must' requirements because they are part of the core functionality of the device, so they are needed for the successful completion of the device. Requirements **FR6** to **FR9** are the considered the 'Should' category because they would be extra features that could improve the application but are not considered essential. For example, **FR9** about the user being able to see if they have notifications is a feature that needs to be working but it doesn't affect the core workings of the device. A 'Could' requirement (**FR10**) for this prototype is the user being able to send messages to their contacts, if it doesn't make the solution feel overcomplicated or overcrowded then it can be included. A 'Will not' requirement for this prototype is the user being able to view their contacts locations, this is

a feature that doesn't seem feasible for a smartwatch device because it will have a small screen size meaning it won't be clear to see the locations, so it is better to remove this feature.

NON-FUNCTIONAL REQUIREMENTS:

TABLE 4 - NON-FUNCTIONAL REQUIREMENTS OF PROTOTYPE 2

Requirement Reference	**Description of requirement**	**Acceptance Criteria**
NFR1	Users will find the functions of the application useful in real life situations	The users have a positive view of the features of the device and think that they would make use of them.
NFR2	The interface will have a simplistic and minimalist design	The users think that the design has a clear layout.
NFR3	The interface will be easy to navigate and understand	The users can quickly learn how to use the application.
NFR4	The device can quickly make calls to emergency services and primary contact, without a delay	The call is placed within 2 seconds.
NFR5	The device can accurately record after a call has been placed	The device records and saves the recording externally
NFR6	Updates with the device are done efficiently	Updates are done and complete within a day
NFR7	If the device crashes or is damaged for some reason it can be easily repaired	A repair of the device is cost-effective and is done as quickly as possible.
NFR8	The device will still record without an internet connection	When the user places a call the audio recording will start even without an internet connection.

These non-functional requirements are testing for similar acceptance criteria to the NFR's of prototype 1 as they are mainly based on the performance and usability of the solution. The aim of this solution is to have a simplistic and minimalistic design of the interface so that it can be easy for the user, and it does not stand out too much so it may be used discretely in

a dangerous situation. **NFR2** will test if this is satisfied based what the users from the survey view of the solution design, as with **NFR3** the users will describe the prototype as easy to learn rather than difficult if they believe it is. The non-functional requirements from **NFR4** to **NFR7** will be difficult to test without an operational solution because there is no way to measure how efficient the updates would be with a digital prototype.

SMART-JACKET - PROTOTYPE 3

INTRODUCTION

The third technological solution that I am proposing as a way to improve women's safety is IoT smart clothing. This will be a conceptual prototype to demonstrate the way the smart jacket can be used in real life situations to improve safety. The inspiration of this solution comes from the Levi's X Jacquard by Google trucker jacket [17]. The jacket uses a small tag in the cuff of the sleeve which is connected to a smartphone device and enables the user to answer calls, play music and take photos right from the sleeve. The idea with this is to adapt the features of the jacket to make them suitable for improving women's safety, for example, allowing the user to make emergency call by tapping the sleeve and answer calls. This IoT device would be connected to a mobile application so there is an interactive interface for the user, as well as that the application would show the users the had commands for different functions. It would also allow for other features such as viewing and sharing location via GPS from the jacket. This would also be useful for finding the location of the jacket if the user leaves it somewhere.

REQUIREMENTS

As this is a conceptual prototype the functional requirements for this solution are what I believe would need to be considered when developing the final solution. It includes the core requirements that are needed for the solution to work.

FUNCTIONAL REQUIREMENTS:

TABLE 5 - FUNCTIONAL REQUIREMNTS OF PROTOTYPE 3

Requirement Reference	**Description of requirement**	**MoSCoW Category**
FR1	The user can call the emergency services by tapping three times on the cuff of the jacket	MUST
FR2	The user can swipe to answer calls	MUST
FR3	The GPS can accurately determine the location of the jacket	MUST
FR6	The application is simple and easy to understand	MUST

FR7	The smart- jacket can connect to the application	MUST
FR8	The hand commands will be easy to learn	SHOULD
FR9	The user can use the application to view and share location.	COULD

NON-FUNCTIONAL REQUIREMENTS:

TABLE 6 - NON-FUNCTIONAL REQUIREMENTS FOR PROTOTYPE 3

Requirement Reference	**Description of requirement**	**Acceptance Criteria**
NFR1	Users will find the functions of the application useful in real life situations	The users think that they would use the features of this prototype
NFR2	The smart- jacket will be a comfortable material	During the user testing, the users will find the material comfortable.
NFR3	The smart- jacket will be durable	The material used is hard-wearing and able to withstand wear.
NFR4	The smart- jacket will efficiently connect to the application	The users can easily connect to the application and there are no issues with the connection.
NFR5	The jacket will be maintainable for users	The technical issues and any wear and tear damage can be repaired.

The non-functional requirements are measuring the performance, usability, and maintainability of the solution however due to the prototype being conceptual these requirements wouldn't be able to be tested. **NFR1** could be tested through the user survey by showing the user the idea and concept of the prototype and having them analyse and evaluate if they would use the solution. **NFR2** and **NFR3** will need to be tested once a real-life operational prototype of the solution has been completed as it would require physical testing of the product. **NFR4** is a requirement that is meant to test the performance of how the IoT device connects and if it is working correctly. Lastly, **NFR5** is measuring the maintainability of the product for users, to efficiently measure this it would require physical testing with the product.

IMPLEMENTATION

To create prototype 1 and 2, I used an online software called Balsamiq, this is a wireframing platform that allows you to create realistic digital prototypes. It allows you to use buttons and links to transition between screens.

DELIVERABLE OF APPROACH PROTOTYPE 1 – MOBILE APPLICATION

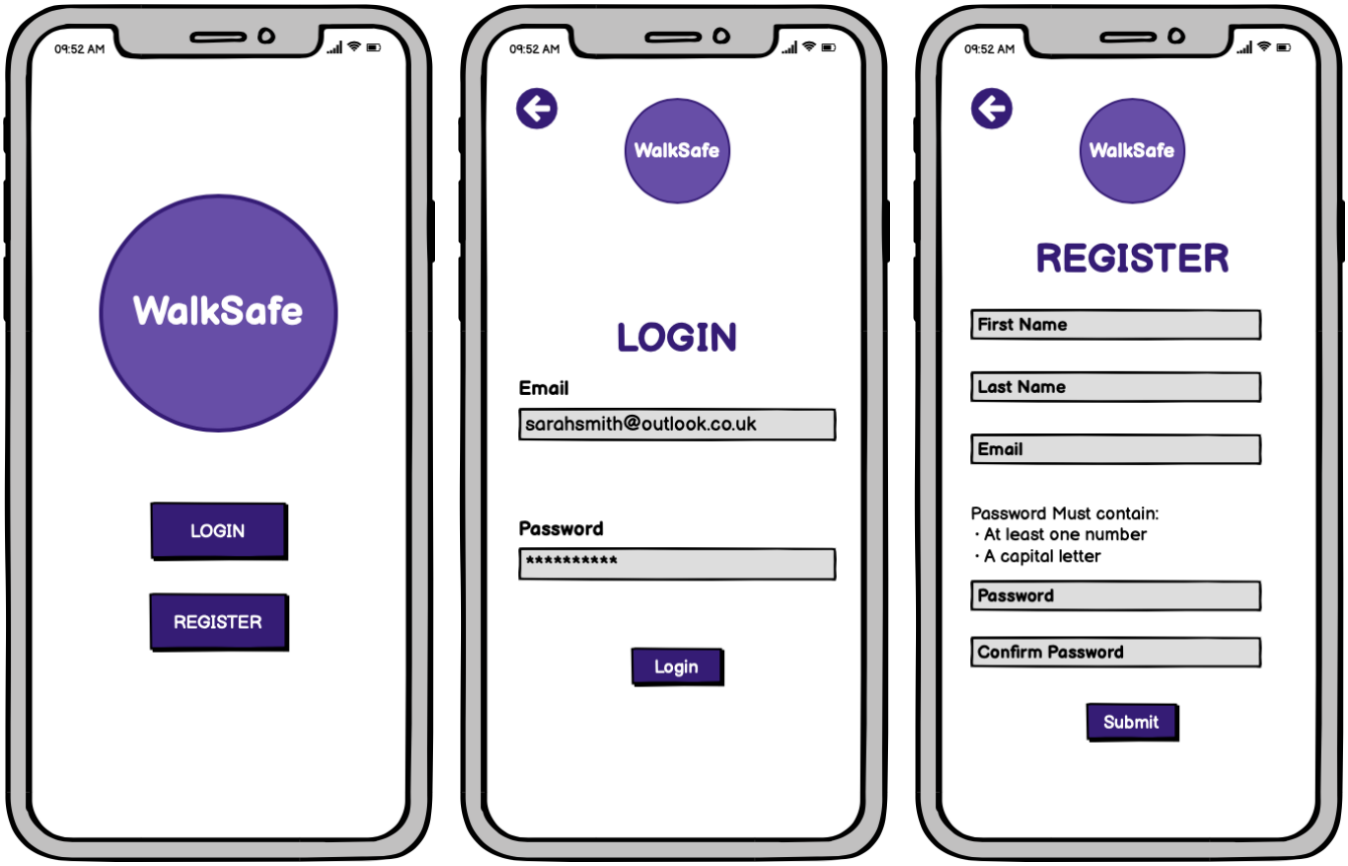


FIGURE 10 – LOGIN AND REGISTER SCREENS

The screens shown in figure 10 are the initial screens when starting the application for the first time after downloading. In the first image it has the application logo and the options to login or register an account. This prompts the user to select an option dependant on whether they are a new user or have an existing account. As it will not be required to login or register an account every time the user goes on the application, these screens will only be shown the first time. It would be frustrating for the user to have to login every time they click on the application as it would increase the time is takes to do they task they want to do. The user creating an account achieves the non- functional requirement (**NFR1**) because it would mean that they have a password protected account and are a verified user. This is a necessary feature because sensitive information is shared on the application, such as the users precise location so to improve safety it is important that as much as possible the users of the application are verified and not claiming to be someone else.

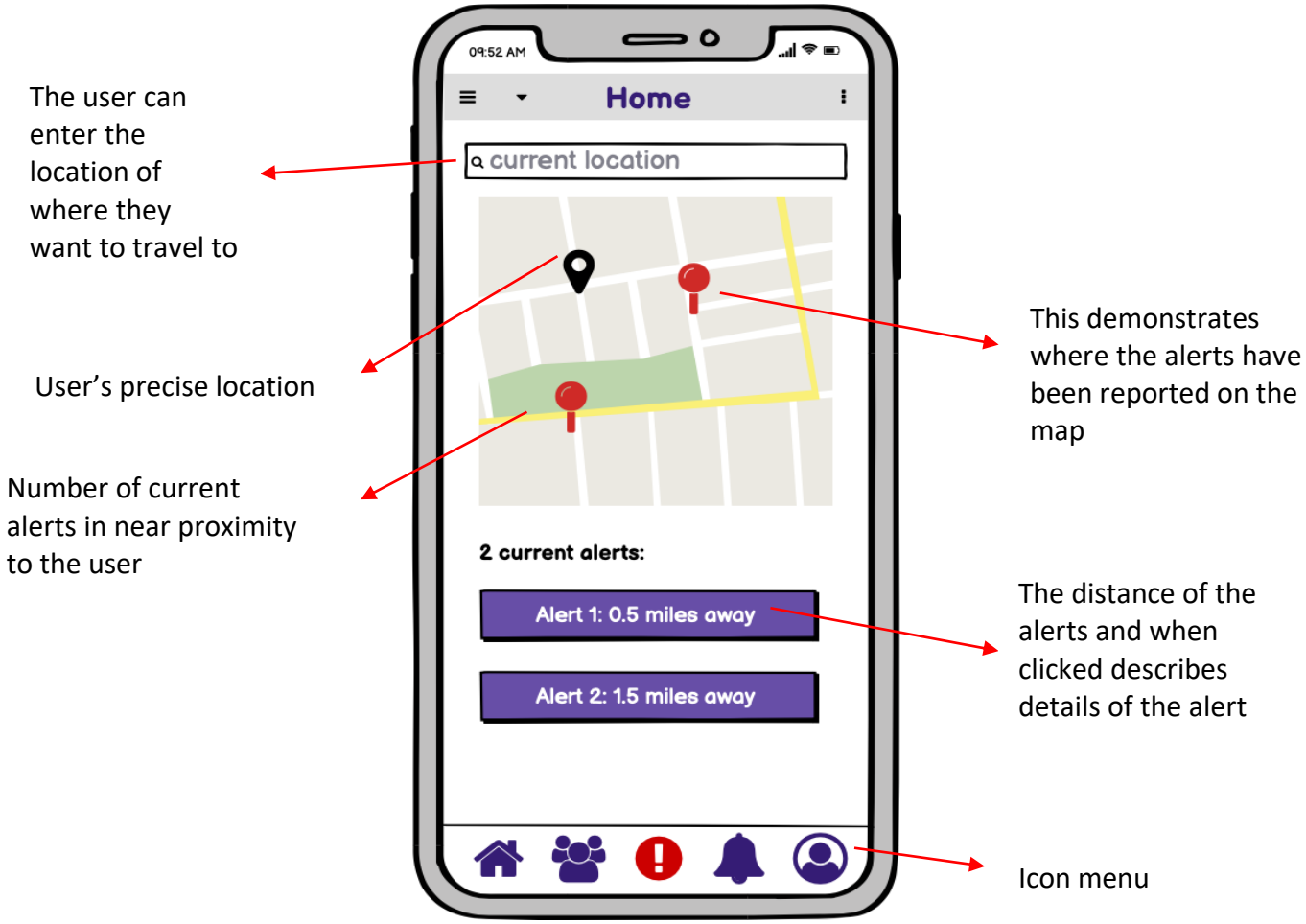


FIGURE 11 - HOMEPAGE

Figure 11 shows the home screen of the application, which is what the user will see when they first go on the application. The main feature on the homepage is the map which shows the users location and the alerts that have been reported near them. The alerts are shown by the red pins on the map and the user can click on them to view the alert in detail. This allows the user to plan the route they want to take and know where to avoid. The buttons under the map show the distance of how far the alert and when the user clicks on these buttons they are taken to the 'current alerts' page (figure 12). The icon menu is located at the bottom of the screen, it is how the users can navigate the application and make use of the features of the app. It allows the user to: get to the homepage, friends page, make an emergency call, create an alert, and view their profile. Maintaining consistency throughout the application is one key principle of designing a good user interface [17]. The icon menu being in the same position on each page is one way to achieve this. Additionally, using the same colour scheme and fonts on all pages throughout also achieves this homogenous design.

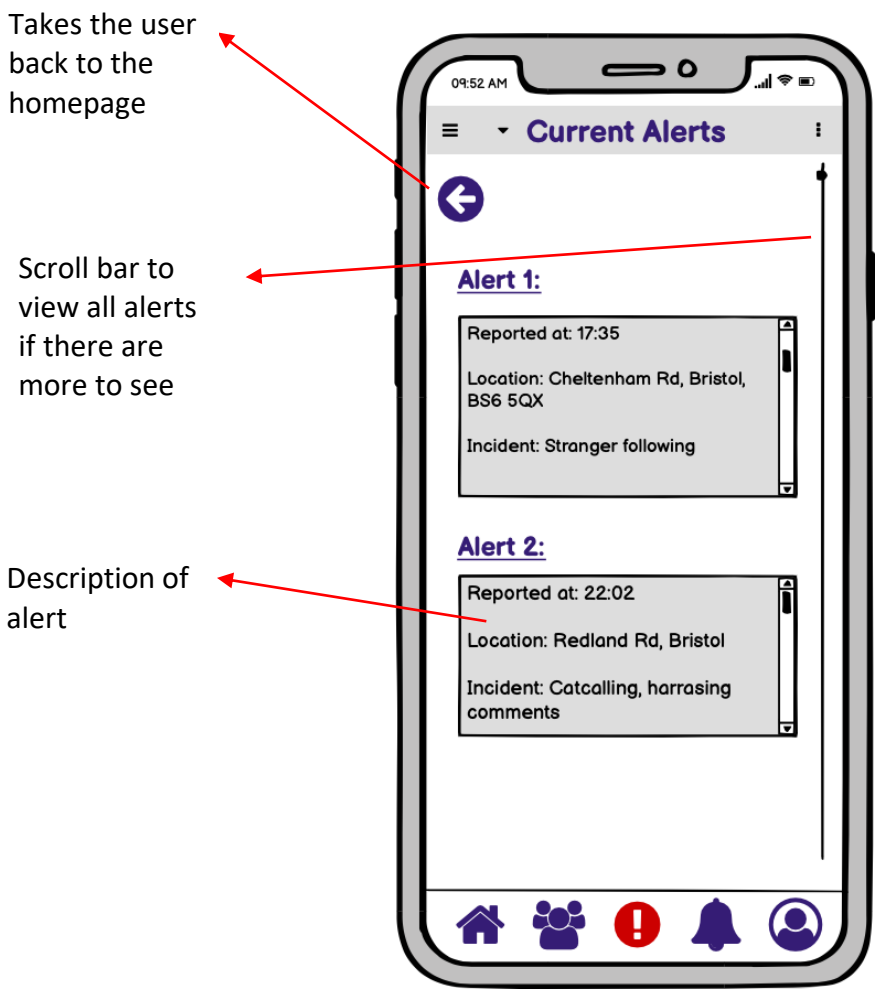


FIGURE 12 – CURRENT ALERTS

Figure 12 above shows the current alerts page of the application. This is the page shown to the user when they click on an alert from the homepage to view the alert in detail. The back button allows the user to quickly go back to the homepage, they can also use the home icon, but the back button is included for easy access. The interface on this page has been kept simple so it is clear and understandable, and the focus is the descriptions of the alerts.

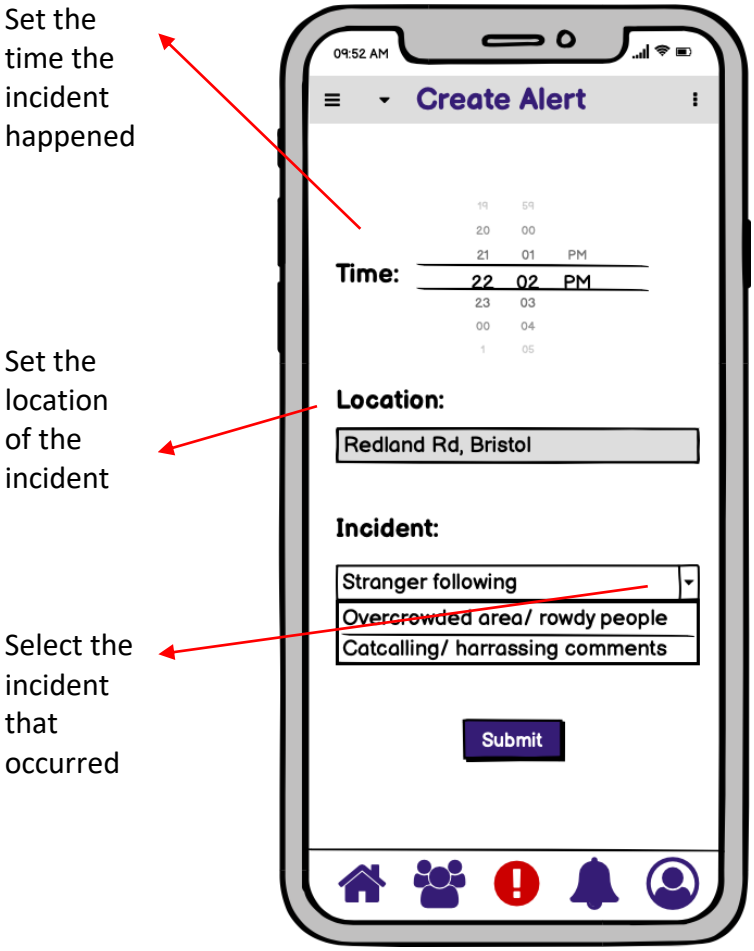


FIGURE 13 – CREATE ALERT

FIGURE 14 – ALERT CREATED

On clicking the bell icon in the menu, the user is directed to the 'create alert' screen which is shown in figure 13. This is one of the main features of the application as it is how the alerts are spread with the community of users. With many users creating alerts, it means that safety information can be crowdsourced and improve use of the application. The time of the alert is required so the users can see how recent the alert was posted and so that it can be removed within 24hours if it is not a prolonged incident. The location of the incident will be required so that the application add this to the map, to get a precise location the application will use the location services of the mobile device. As for the incident reported, the user can select from a selection of drop-down options which will include different categories. When the user clicks the submit button, they will get a pop up of a confirmation that the alert has been posted (figure 14). In UI design feedback is the principle of making clear to the user what action has been taken and what has been accomplished, according to Ben Norman's principles of interaction design, this is one key design principle when designing a technical solution using a human-centred design approach [18]. In figure 14 the confirmation message is a method of providing visual feedback to the user. Another message included on this screen is an informative message which has been written in red to stand out, it informs the user that they can use the SOS button if they have an emergency. The icon for the SOS has been included as a visual cue on the icon to press and make it clear to the user.

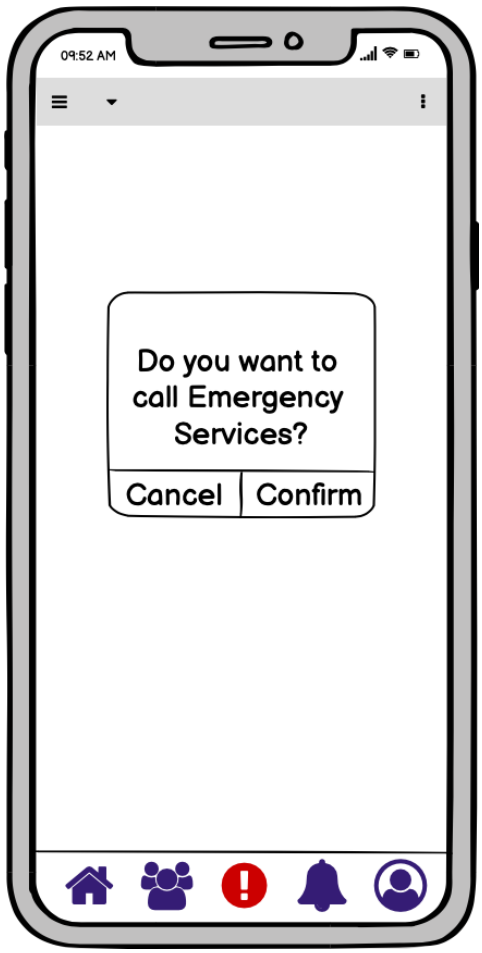


FIGURE 16 – CONFIRM SOS SCREEN

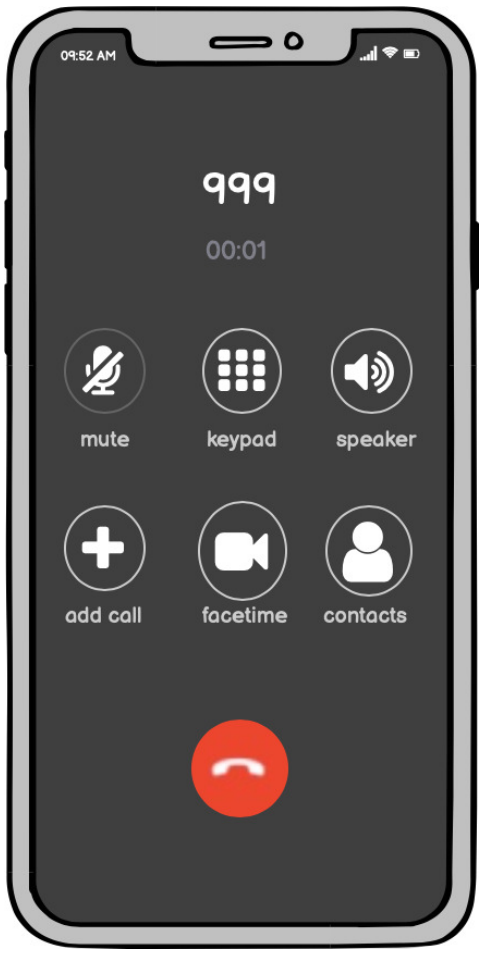


FIGURE 16 – EMERGENCY CALL SCREEN

Figure 15 is the screen shown when the user clicks the SOS button, the purpose of this screen is to avoid the user accidently pressing the button and not realising that they have called the emergency services. Although this may take an extra second in the process of calling the emergency services it is a useful error prevention method. If the user confirms they want to place the call, the call will go through (figure 16) and if they press cancel the user is redirected to the homepage. The 'confirm SOS screen' is meant to be a pop-up box, as this is a wireframe design it is not the fully developed final solution which will display it over whichever screen the user was on when they clicked the SOS button. The aim of this feature is for it to be easily accessible and efficient for the user, therefore, the chosen position for it was the centre of the icon menu and in a bright red colour. If the user is already on the app following the route, they want to walk home then they will be able to access the SOS button quickly in a potentially dangerous situation where it would be required.

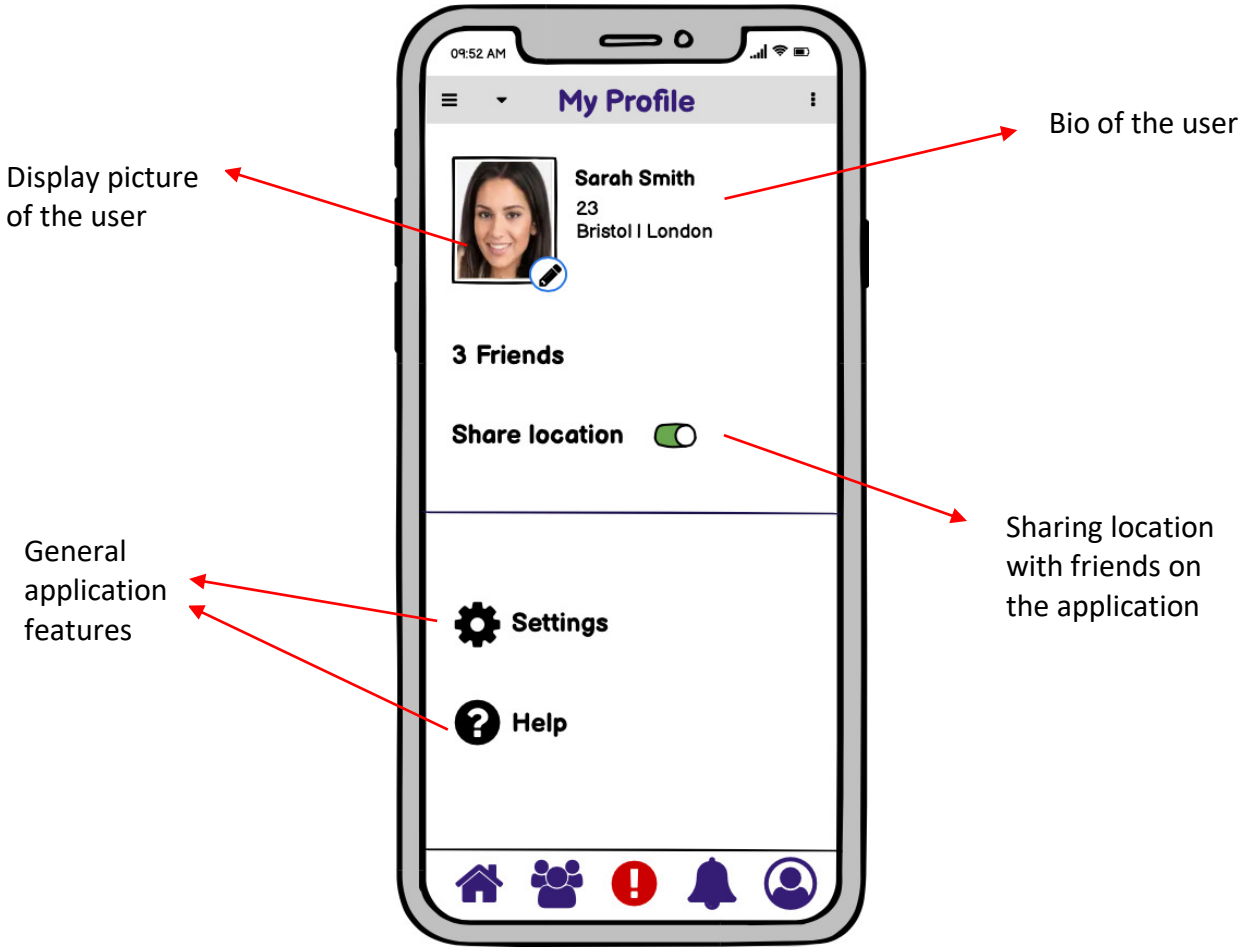


FIGURE 17 - PERSONAL PROFILE SCREEN

The profile screen of the application is designed for the user to include some basic details about themselves which is how they will be identified by people that they know. The user can include a display picture and a bio, where they can choose to write information such as their location and age. Also included on the homepage is the feature that allows the user to turn off 'sharing location' this means that their location will not be shown on the map to the users friends. This feature gives the user more flexibility to choose when they want to share their location for example, when the user is travelling alone somewhere or in a situation where they feel unsafe. If the app was to constantly track the users location and share that with their friends and family, this might deter some people from using the application so the usefulness of the application for improving safety will be reduced for a large group of potential users. On the bottom half of the page are the general features and settings for the application, that will allow to user to change privacy settings and notifications etc. The help button allows the user to gain assistance with using the application and how to set up particular features.

FIGURE 19 – FRIENDS SCREEN

FIGURE 19 – ADD A FRIEND SCREEN

Figure 18 shows the friends screen, which the user gets to by clicking on the friends icon in the menu. On this page the users can see where their friends locations are on a map, so they can see in relation to where they are. The aim of this feature is to allow the user to use this information and they can contact and friend or family member to walk with if they are close by. Below the map there is a list of the friends that are on the map with a description of what their exact location is, how long ago it was updated, and the distance they are from the user. At the top right corner of the map, there is the add a friend icon which takes the user to this page (figure 19). The icons used on the page and in the menu have been chosen as they are straightforward for the action or function that they represent. In this instance it would be easily recognisable for the user which icon would let them 'add a friend'. Figure 19 is the screen to add a friend after the user has pressed the button from the friends page. The search button allows the user to search for a person's name and they can see a list of users to select from. The two tabs on this page are the search area and the requests, this is where users will be able to accept or decline requests from other users of the application.

DELIVERABLE OF APPROACH PROTOTYPE 2 – SMARTWATCH

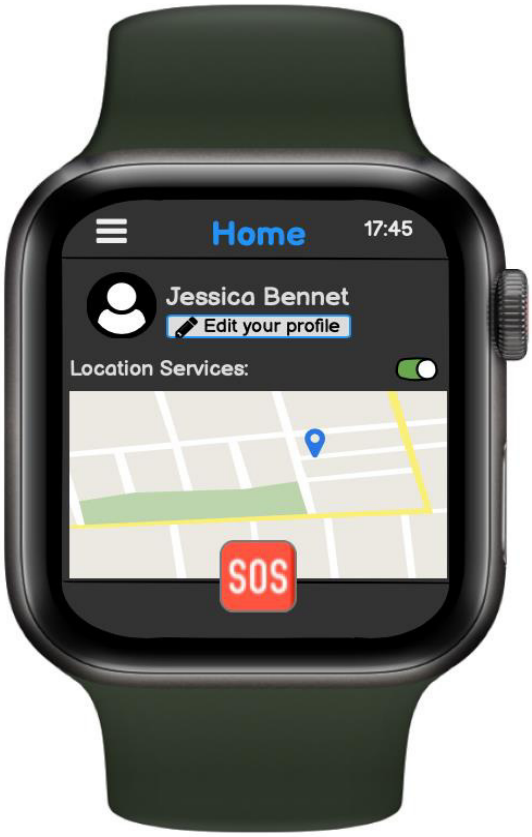


FIGURE 20 - HOME SCREEN PROTOTYPE 2

The home screen in the first screen shown to the user, due to this device being small, the amount that is on the screen must be considered. The homepage shows the user a map which can be clicked on to enlarge the view, it also allows the user to edit their profile meaning they can change key information such as address and primary contact. One of the main functions of this device is the SOS button which is meant to be used in emergencies and dangerous situations. This is the reason that it is on the homepage and is quick to access, it has also been made to stand out on the page. The potential users of this device could be victims of domestic violence or just any female who finds themselves in a dangerous situation. The purpose is that by wearing a watch the device is attached to you so if a potential attacker is near, contacting for help would be much easier. When the SOS button is pressed a screen appears which the user can select who to call (figure 21).

One the right, is the SOS screen that the user is directed to when they click the SOS button. From this screen they can call their primary contact (which is set up previously) or the emergency services such as police or ambulance. The device uses a swipe to call feature as it requires slightly more than just a button to call but it still an easy and efficient method of placing a call. When a call has been placed the device will begin audio recording the call, so that anything happening during the call can recorded for evidence which can be provided for evidence to the police or court.

FIGURE 21 - SOS SCREEN

FIGURE 23 - MENU SCREEN

To access the menu page the user clicks on the three lines icon in the corner, this is in the same position on every screen so the user can access the menu. As well as that, using icons and words for the buttons makes the menu very clear and easy to understand for the user. When there is a notification for the user to view the menu icon has a blue dot on it as shown in figure 23. The notifications are coming from the messages, so the number of unopened messages is displayed next to the button. When the user opens their messages, the notifications will be cleared. The menu page has been kept fairly simple with four different options; this is because the device is designed for a purpose of safety. Meaning that there is no need for there to be additional features that won't help the user further for the purpose of safety.

The second button on the menu is contacts, figure 22 shows what the contacts screen looks like. The colours and design used on this screen is very simplistic and clear, which fulfils **NFR2** that the interface will have a "simplistic and minimalistic design". The scroll bar allows the user to go through all their contacts and the '+ new contact' button averts the users to the add contact screen (figure 24).

FIGURE 22 - CONTACTS SCREEN

FIGURE 24 - ADD A CONTACT SCREEN

Once the user has pressed the add new contact button, this screen appears and requires the user to add the details of the person they wish to add as a contact. Once the user presses save, they will be redirected back to the contacts page and the contact will have been added to the list.

On the right side, figure 25, shows the messages screen which the user can get to from the menu. This screen shows a blue dot where the unopened message is and highlights this in bold to make it clear to the user which message is unread. This is useful on a small device such as a watch because it will be easier and quicker to find the chat that has a new message. As the device is touch screen the user can type the message and the device will assist them. It will do this by correcting the words that have been misspelt or suggesting words that go next to reduce the amount that the user must do.

FIGURE 25 - MESSAGES SCREEN

FIGURE 26 - SETTINGS SCREEN

Figure 26 shows the settings screen on the device, this is the last option on the menu page and brings the user to this page when they click on it. From this page the user can choose a primary contact, the drop-down box with a list of all contacts is there and the user selects who they want to be their primary contact. This can be changed regularly if the user wishes, one day it might be a parent and one day they are going to see a friend, so the user decides to set them as their primary contact as they are not far away. The other feature of this page would be the ability for the user to choose between dark mode and light mode for the display on the device. This is to do with the preference of user as they can keep it as it is or if they are used to light mode on their phones, they might wish to change it to that instead. It would be difficult to fit in too many settings as the size of the device is relatively small and would make it look overcrowded.

DELIVERABLE OF APPROACH PROTOTYPE 3 – SMART JACKET

Prototype 3 is a conceptual design that modifies the use of existing technology for the purpose of improving women's safety. It does this by adapting the design to enable features that allow the user to feel safer in a dangerous situation.

FIGURE 27 - SMART JACKET

This prototype uses a small IoT device in the sleeve of the jacket that connects to a smartphone to enable the user to be connected. The interactive cuff allows the user to use different hand commands to interact with the jacket. The smartphone application that is connected to the device shows the user these hand commands so they can become familiar with them.

MAIN FEATURES:

- User taps three times to call emergency services – this can be discrete so in a dangerous situation the user can call the police without alarming a potential attacker.
- Swipe to answer calls – the jacket is connected to a smartphone and can notify when a call is incoming.
- GPS location tracking which can be seen from a smartphone and is shared with selected people.

With the current main features of the smart jacket, the functional requirements for this prototype will be fulfilled. However, to measure whether the non-functional requirements are fulfilled it would require the prototype to be developed.

RESULTS AND EVALUATION

To evaluate the successfulness of the prototypes I will be using different evaluation methods such as measuring the completion of the functional requirements; the questionnaire and focus group activity, and Nielsen's Heuristics.

COMPLETION OF FUNCTIONAL REQUIREMENTS

PROTOTYPE 1

TABLE 7 - EVALUATION OF FUNCTIONAL REQUIREMENTS (1)

Requirement Reference	**Description of requirement**	**MoSCoW Category**	**Completed? Yes / No**
FR1	The user will be able to register an account in the application	MUST	YES
FR2	The user will be able to log onto their account	MUST	YES
FR3	The user can view and click an alert on the homepage, and be taken to the alerts page	MUST	YES
FR4	The user can see their friends locations on the map	SHOULD	YES
FR5	The user can create and submit an alert	MUST	YES
FR6	The user can call emergency services using the SOS button	MUST	YES
FR7	The user can search and add friends	SHOULD	YES
FR8	The users can message friends and family from the application	COULD	NO
FR9	The users can view and update their profile	COULD	YES

FR10	The user can look at requests and accept friends	SHOULD	YES
FR11	The alerts posted are cleared when they have been resolved or are no longer there	COULD	YES
FR12	The users can call friends or family from the application	WILL NOT	NO

The mobile application has been successful in meeting the functional requirements because all the must requirements have been satisfied and all the should requirements have been fulfilled. The must requirements being fulfilled means that the application should function as expected and have the core functionality that is needed in the application. As well as that all the could requirements except **FR8** were fulfilled, these requirements are extra to the application so the addition of them means that the app should exceed its expectations. FR8 was not fulfilled because adding a messaging feature would make the application have too much going on.

PROTOTYPE 2

TABLE 8 - EVALUATION OF FUNCTIONAL REQUIREMNTS (2)

Requirement Reference	**Description of requirement**	**MoSCoW Category**	**Completed? Yes / No**
FR1	The user will be able to view their home page	MUST	YES
FR2	The user can select the menu icon at the top left corner	MUST	YES
FR3	The user can click the SOS button and the SOS page appears	MUST	YES
FR4	The user can view their contacts and add a new contact	MUST	YES
FR5	The user can access the settings page and choose their primary contact	MUST	YES
FR6	The user can edit their profile	SHOULD	YES

FR7	The user can turn their location services off	SHOULD	YES
FR8	The users location is shared with their primary contact	SHOULD	YES
FR9	The user can see if they have notifications	SHOULD	YES
FR10	The user can send messages to their contacts	COULD	YES
FR11	The user can view contacts locations	WILL NOT	NO

Prototype 2 meets all the functional requirements including the must, should and could and the will not requirement is also fulfilled as that feature has not been implemented. This means that the prototype can be viewed as a success however, this does not mean that there are not improvements that can be made. After feedback from the user, there could be design or functional suggestions for improving the device when it is developed in the future.

PROTOTYPE 3

TABLE 9 - EVALUATION OF FUNCTIONAL REQUIRMENTS (3)

Requirement Reference	**Description of requirement**	**MoSCoW Category**	**Completed? Yes / No**
FR1	The user can call the emergency services by tapping three times on the cuff of the jacket	MUST	YES
FR2	The user can swipe to answer calls	MUST	YES
FR3	The GPS can accurately determine the location of the jacket	MUST	YES
FR4	The smart- jacket can connect to the application	MUST	YES
FR5	The hand commands will be easy to learn	SHOULD	NO
FR6	The user can use the application to view and share location	COULD	NO

The functional requirements for prototype 3 have all been met, there are only six functional requirements, but this is because the prototype is a concept and a relatively new piece of technology. This means that there is the potential for there to be new requirements and adjustments to these after the initial feedback and early development stages. The application which will be connected to the smart jacket has not yet been designed and prototyped but requirements **FR5** and **FR6** are related to this application. Therefore, I can't confirm that they have been fulfilled yet, however once the application has been designed these requirements will be satisfied. So, for the completion status right now they will be given a 'NO' until these can be completed.

USER EVALUATION THROUGH QUESTIONNAIRE

To gain feedback from the potential users of the prototype, I created and distributed a questionnaire. I used the online tool Qualtrics to create the questionnaire, the questions cover all three of the prototypes and requires the user to answer the same questions on each of them. The user can provide feedback, improvements of the prototypes, and if and where they would use one of the proposed solutions. To form the questions, I used the UEQ (user experience questionnaire) and adapted some of the questions to suit my research. The UEQ measures both usability and user experience aspects such as efficiency, dependability, and originality [19]. It uses pairs of contrasting attributes that may apply to the prototype and the user can express their agreement by selecting the circle closer to the attribute that reflects their impression. As not all the pairs of words were relevant to my questionnaire, I removed some. Before the user could take part in the questionnaire, due to the ethics, they must read the participant information and accept that they give consent for the questionnaire. This participant information and consent form can be found in appendix B. The full Qualtrics questionnaire is provided in appendix C.

RESULTS

One method that would be useful to analyse the results would be to use affinity diagramming. This is a technique used to externalise, make sense of, and organise qualitative data [20]. It is all about bundling and grouping information so you can draw connections between these individual elements and develop new and deeper insights [21]. Affinity diagramming is typically done as workshops in person and with a group of different people with different perspectives, for example, a designer and a psychologist. Although, I have not been able to conduct this type of evaluation method, it can be performed in the future of this project. This will be discussed in further detail in the future work section of this report. As for analysing the results of the user questionnaire the UEQ Data analysis tools that have been provided with the UEQ questionnaire, this is an excel spreadsheet that allows you to put the values in from the users questionnaire then interpret the results. With the long answer questions where the users have provided qualitative data, I will be using standard content analysis. This will allow me to analyse the presence of certain words, themes or concepts provided by the qualitative data. I can then use this to determine the steps that can be taken to improve the prototypes and discuss these in the conclusions section.

PROTOTYPE 1 – MOBILE APPLICATION

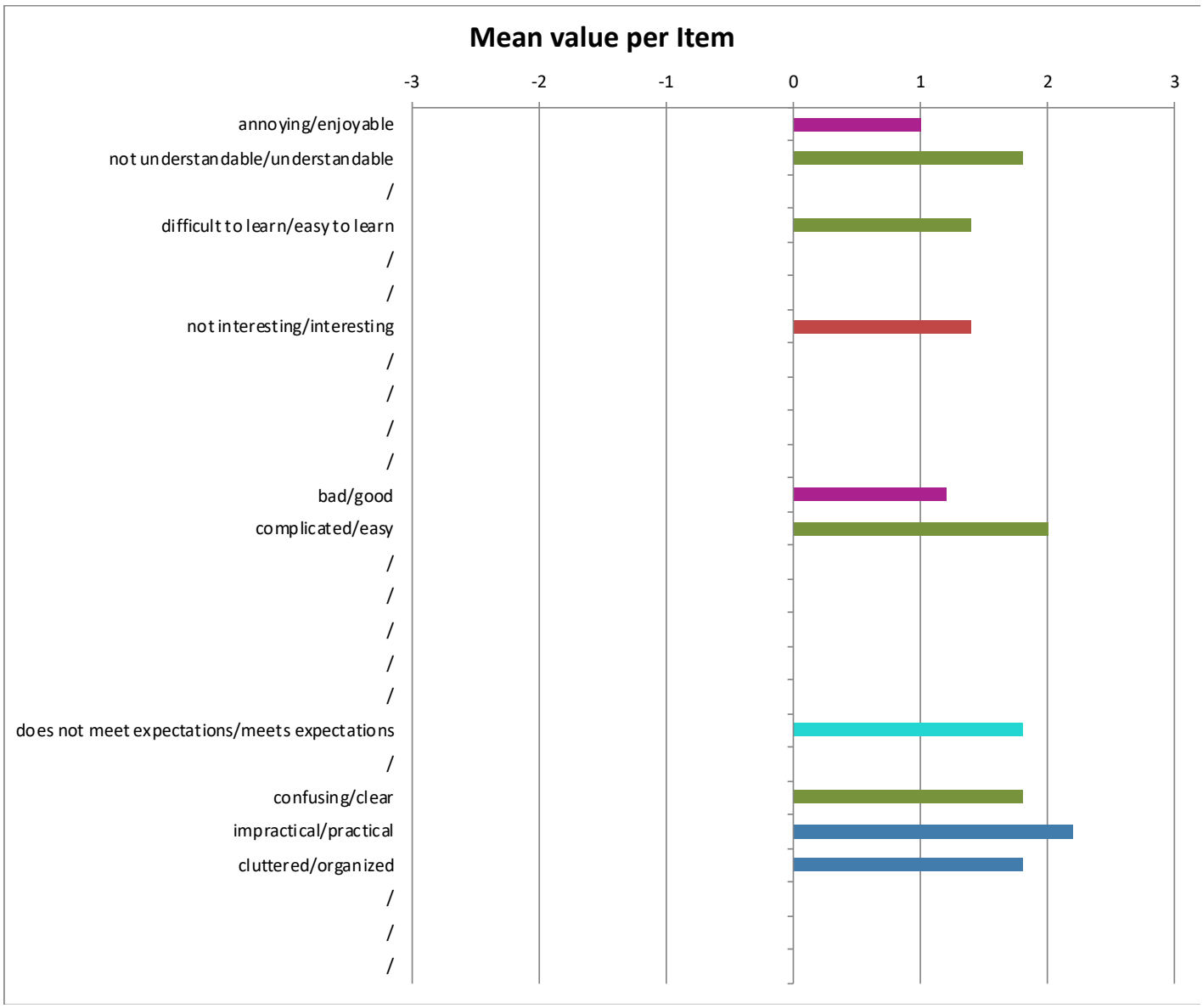


FIGURE 28 – MEAN VALUE PER ITEM PROTOTYPE 1

Firstly, in figure 28 above, on the vertical axis the words that were not used in the questionnaire have been removed and replaced with dashes. The chart uses a scale that goes from -3 (horribly bad) to +3 (extremely good) to represent how the participants answered for each of the word pairs. From this we can see that all for all the word pairs the users viewed prototype 1 in a positive way with the most positive result being for practicality.

These word pairs can be further categorised into different sections that measure the attractiveness, perspicuity, efficiency, dependability, and stimulation and novelty. Below is the graph that represents this for prototype 1.

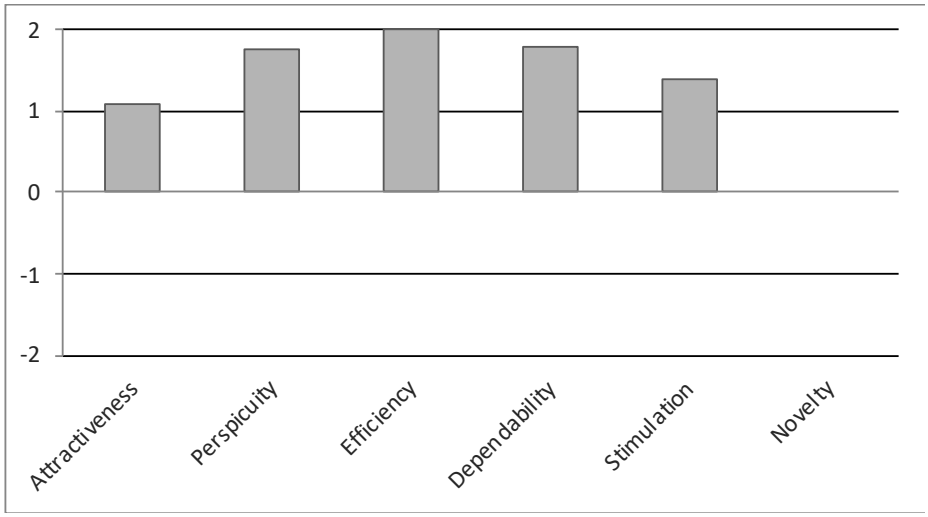


FIGURE 29 - UEQ SCALES MEAN PROTOTYPE 1

From figure 29 above, we can see that the mean for prototype 1 was the highest for efficiency. Meaning that it had the most positive responses for the word pairs that relate to efficiency such as impractical / practical, and cluttered / organised. As we can see that there is no mean for the section novelty, this could be due to the fact that I didn't use all the word pairs from the original questionnaire. In this graph the mean scales go from -2 to +2 this is because in real applications, only values in a restricted range will be observed. It is due to the calculation of means over a range of different people with different opinions and answer tendencies (for example people avoiding extreme answer categories) it is extremely unlikely to observe values above +2 or below -2.

PROTOTYPE 2 – SMARTWATCH

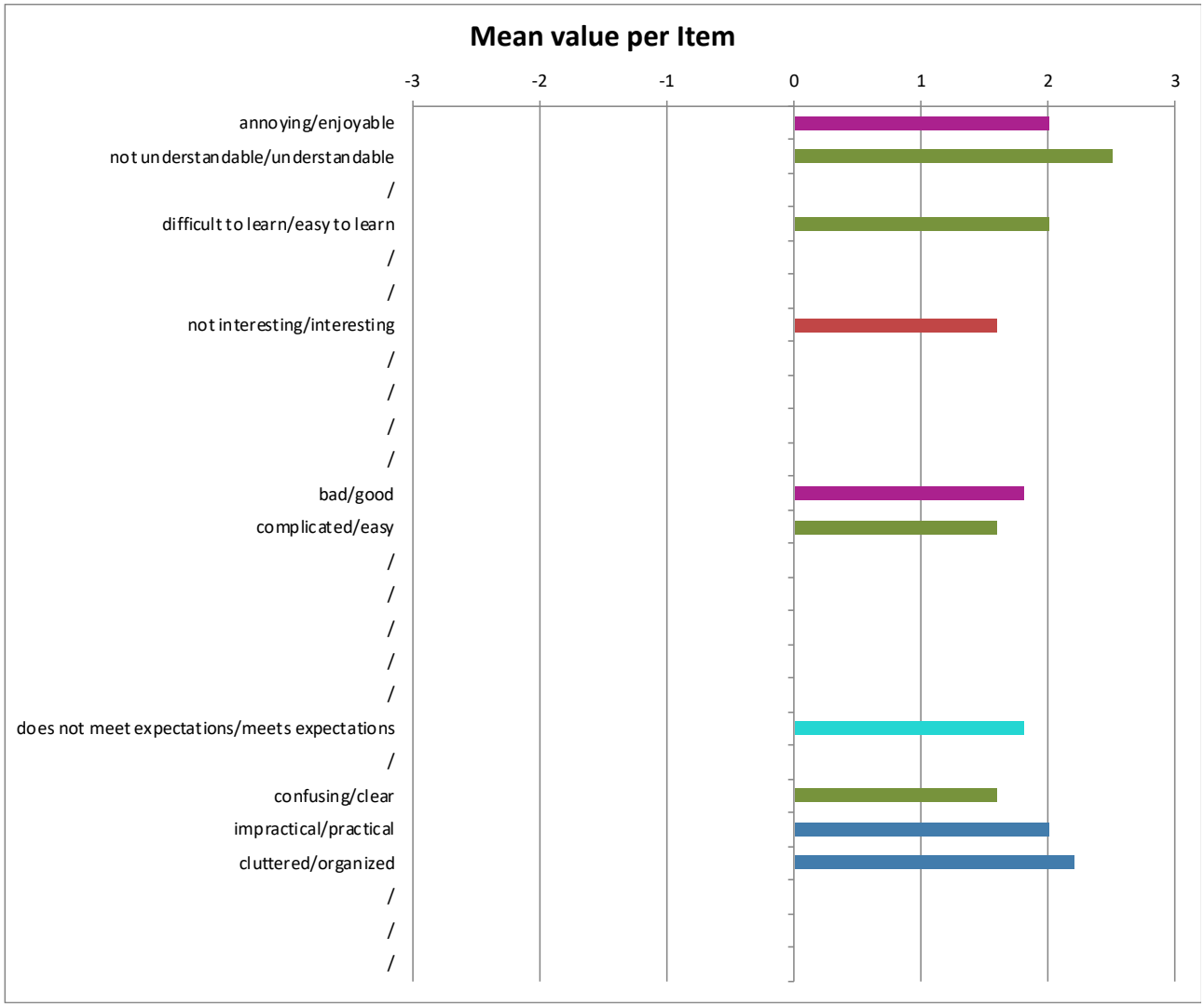


FIGURE 30 – MEAN VALUES PER ITEM PROTOTYPE 2

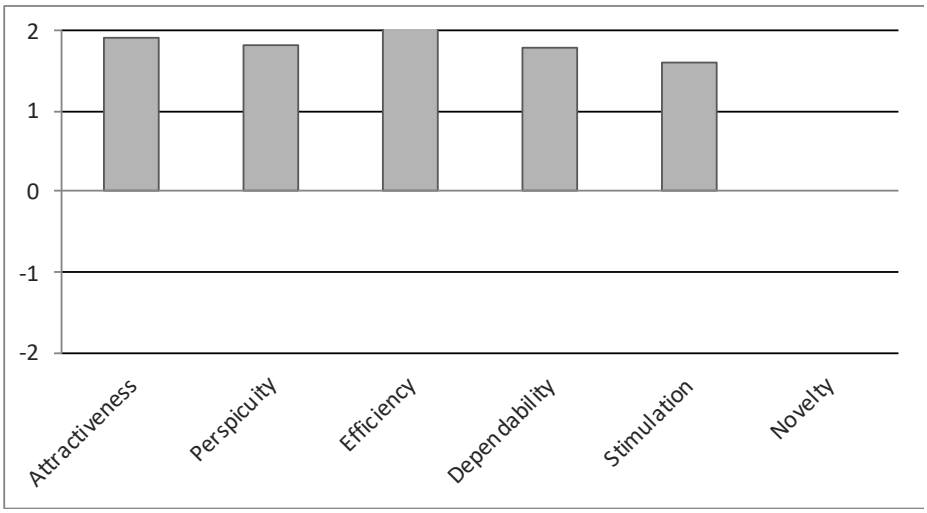


FIGURE 31 – UEQ SCALES MEAN PROTOTYPE 2

For prototype 2, looking at the mean value per item we can see that many of the users think that this solution is understandable and organised. As well as that in figure 31, it shows that attractiveness scored a higher mean, so we can interpret that the users think that the interface of this solution is designed well. Perspicuity refers to the qualities of clearness and lucidity, this also scored highly as it relates to the understandability of the solution. The efficiency, perspicuity, and dependability can be grouped into pragmatic quality. This describes tasks related aspects and relates to the practicality and functionality of a solution.

PROTOTYPE 3 – SMART JACKET

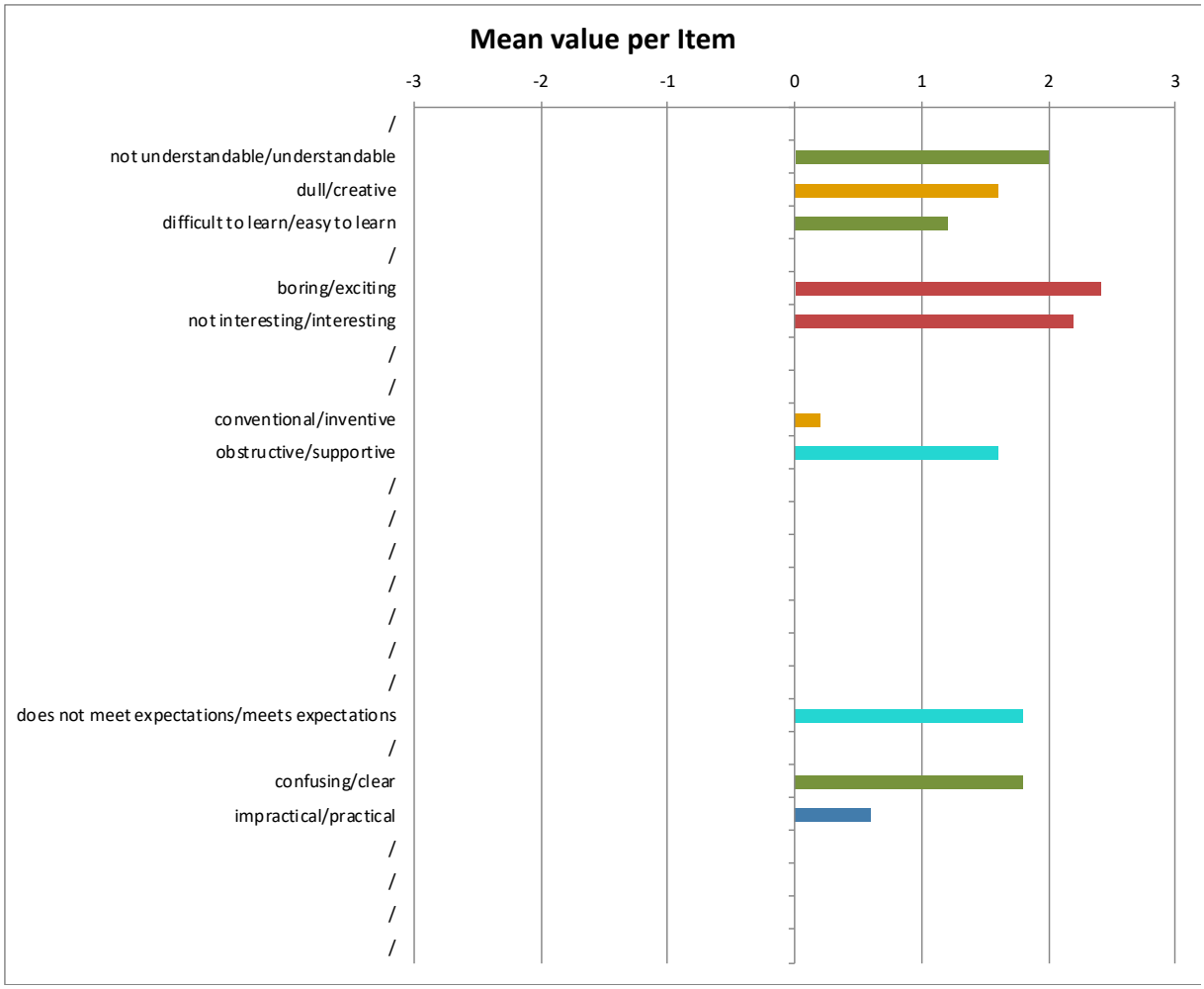


FIGURE 32 - MEAN VALUE PER ITEM PROTOTYPE 3

As prototype 3 is a conceptual prototype and does not have a user interface for the users to evaluate, the word pairs chosen are varied from that of prototype 1 and 2. In figure 32 above the highest mean value is for the terms exciting and interesting, this highlights that the potential users of the solution find the concept of this design intriguing and would be interested in it. Second highest mean is for understandability, the concept of the solution is clear to the users, which is supported by the mean for the users who find the solutions clear over confusing.

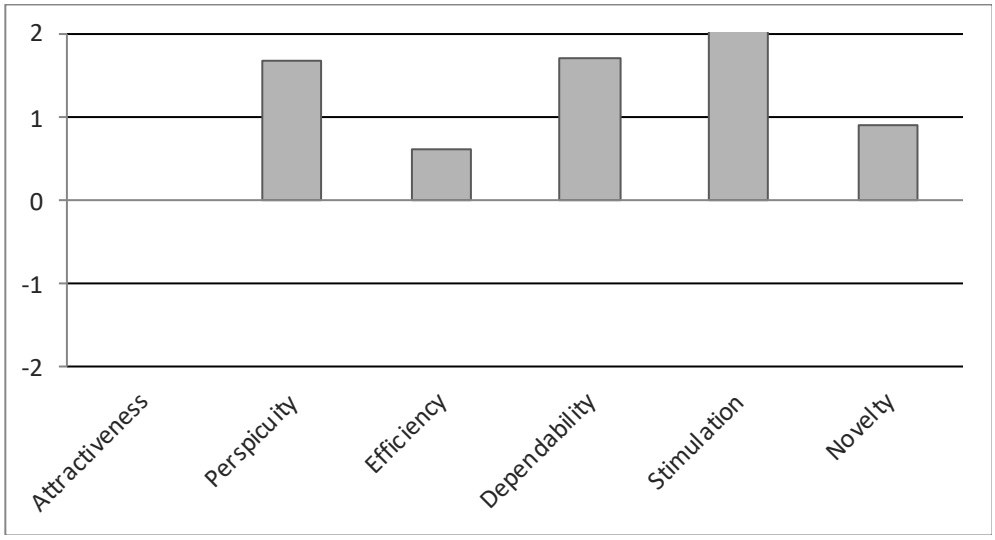


FIGURE 33 - UEQ SCALE MEAN PROTOTYPE 3

The attractiveness of this prototype was not measured through this user questionnaire as it not as relevant in this stage of the process for this solution. At the testing stages, the materials and appearance of the solution can be evaluated. This happens before the solution is refined and retested. The efficiency mean scored relatively low, with a score of 0.66. This score represents a more or less neutral evaluation of the efficiency for prototype 3. This could be because the solution would be a new concept to many users therefore, they are likely to be unsure about the performance of the solution.

FOCUS GROUP ACTIVITY

Initially, the focus group activity was meant to be with experts working around women's safety such as in charities and NGO's who work with victims of domestic abuse. However, due to the challenges faced with delays in receiving an approval from ethics, recruiting experts as participants was unsuccessful, as it was too short notice and too difficult to organise. To adapt to these challenges and work around it, I conducted the focus group activity with users instead of experts to gain more perspective of their opinions on the solution and evaluate the potential strengths and weaknesses. In order to comply with ethics, the participants signed consent forms and read the participant information sheet. I do believe that speaking to the experts is still important, so this is something that can be conducted in the future for these solutions, which will be discussed further in the future work section. The participants in this activity are potential users of the solution and had also completed the questionnaire. To conduct this activity, I followed the same structure as I planned to with the experts. I used the same PowerPoint presentation; however, this version was carried out in person rather than online. Below is the PowerPoint that will be shown to the participants when conducting the activity, the aim of this activity is to have an informal general discussion about what situations these solutions can be used and some of the issues that can arise with them.

Safah Ahmed – Cardiff University

1

Welcome & Introduction

- This project aims to identify the role of technology on women's safety by looking at and analysing three different kinds of prototypes and how they can be used in real life situations.
- The first prototype is a mobile application, the second one is a wearable device and the third is smart clothing.

2

FIGURE 34 - INTRODUCTION SLIDES FOR FOCUS GROUP ACTIVITY

Prototype 1

https://balsamiq.cloud/sulwj9l/plww4ec/r6F15?f=N4IgUiBcAMA0IDkpxAYWfAMhkAhHAsjgFo4DSUA2gLoC%2BQA%3D

3

Prototype 2

https://balsamiq.cloud/sulwj9l/prbn8nk/r2278?f=N4IgUiBcAMA0IDkpxAYWfAMhkAhHAsjgFo4DSUA2gLoC%2BQA%3D

4

FIGURE 35 - DEMONSTRATION OF PROTOTYPE 1 & 2

Prototype 3

- This prototype uses a small IoT device in the sleeve of the jacket that connects to a smartphone to enable the user to be connected.
- Interactive Cuff – This allows the user to use different hand commands to interact with the jacket, the mobile app that is connected to the device shows the user these hand commands so they can become familiar with them.
- **Main Features:**
- User taps three times to call emergency services – this can be discrete so in a dangerous situation the user can call the police without alarming a potential attacker.
- Swipe to answer calls – the jacket is connected to a smartphone and can notify when a call is incoming.
- GPS location tracking which can be seen from a smartphone and is shared with selected people.

5

Activity 1

Identify and describe a scenario demonstrating a safety issue for women. E.g., walking alone at night

Situate each of the three prototypes in this scenario – how they would be used.

What are the strengths of each prototype?

What are the weaknesses of each prototype?

6

FIGURE 36 - DESCRIPTION OF PROTOTYPE 3 & ACTIVITY 1

Activity 2: Group Discussion

- What are the improvements that can be made to each of the prototypes?
- What cases (providing examples) could each of these prototypes be used?
- What are some of the potential negative consequences of these prototypes and the technology used?
- How can these negative consequences be minimised?

7

Thank you!

8

FIGURE 37 - ACTIVITY 2 & END OF PRESENTATION

The activity starts with a brief introduction and the aims of the project, so the participants are aware of what to expect with the activity. Figure 35 shows the next two slides which are a talk through demonstration of prototypes 1 and 2, this allows me to fully explain the features and functionality to the participants so they can have a better understanding when answering questions. In figure 36, slides 5 and 6 it moves on to the description of prototype 3 and activity 1. For activity 1, the participants were asked to think about and write down their opinions on the four questions: identify and describe a scenario demonstrating a safety issue for women, situate each of the three prototypes in these scenarios – how would they be used, what are the strengths of each prototype? and what are the weaknesses of each prototype? After this the participants share their responses and move on to activity 2 which is a group discussion on what improvements can be made to these prototypes, some of the potential negative consequences of the technology used and how these consequences can be minimised. The question about which cases could these be used was removed as it was tailored towards the experts opinion and experiences not for users as well as that the last question in activity 2 about minimising the negative consequences was aimed at getting the expert opinion on this so the users were not expected to know much about this.

RESULTS

The responses provided by the participants were recorded to produce in this report and will be useful for evaluating and forming conclusions on what most users thought needs to be improved on these solutions in the future. Below I have bullet pointed some of the points the participants mentioned for each of the questions in the activities.

ACTIVITY 1:

Identify and describe a scenario demonstrating a safety issue for women:

- A woman walking back from work alone in the evening and is on an empty and quiet route.
- Leaving a friend's house late and going alone in the taxi or uber – can sometimes feel unsafe being alone in a taxi when it is late.
- Someone following you when you are out alone and keeps watching you – could be a potential attacker, unsure of what they are capable of.
- A woman in a toxic / abusive relationship and is in a dangerous situation with the perpetrator.

Situate any of these prototypes in this scenario – how would it be used?

- She can use the mobile application whilst she is walking and choose a route that doesn't have any alerts, also she can view her friends locations to see if anyone is near her.
- In this situation it might be useful to use the application or the wearable device as they both have an SOS button, and the woman can easily call emergency services. The watch might be better because she can call a primary contact if the situation is not serious but for reassurance.
- I think the watch could be used to call the emergency services if the person comes closer as it would be a scary situation. The jacket could also be used as it is discrete

so if the person is an attacker the woman can call the emergency services by tapping three times, without access to a phone or device.
    - In the situation where the woman in danger is in a home environment, I think the smart watch device would be useful because they can call the emergency services like police discretely, also the device will audio record. So, they have evidence if they need it. The mobile application might be obvious and could aggravate the perpetrator.

What are the strengths of the prototypes?

- The application shares live location with friends and family so it would be reassuring to know that they know where I am if I'm travelling alone.
- With the application, knowing what areas to avoid when walking is a good feature and posting alerts to support other females also travelling that way.
- The smart watch device makes calls easier and faster than reaching for a phone.
- Smart jacket - the potential attackers would be unaware that the person can place a call from their jacket so they can potentially 'trick' the attacker as police would be on the way.

What are the weaknesses of the prototypes?

- Sending messages on a smart watch screen would be quite difficult because of the screen size and would also take long to type the message out. Maybe using a voice to message feature would be better.
- You can't message or make calls to friends or family on the application, so you would have to do this externally.
- There is limited option to select from the drop-down box, there might need to be additional space to write something different or include 'other' then the user writes a description.
- You could end up in a dangerous situation once you've taken off the smart jacket, will it still work when it not worn or is there a possibility it can be included in other clothing.

ACTIVITY 2: GROUP DISCUSSION

What are the improvements that can be made to each of the prototypes?

- Using Face ID or fingerprint ID to open the application
- Measuring other features to determine stress such as heart rate, with the smart watch
- Potentially adding audio or video recordings in the smart jacket
- Clearer explanation of how location is shared with the smart watch, is it shared to an app or directly to their device?
- The chip in the smart jacket being able to be moved to other compatible pieces of clothing
- Way to minimise the risk of calling the emergency services by mistake
- Adding an alarm feature which sets of a loud alarm in case you are in a situation where making noise may help you to escape

What are some of the potential negative consequences of these prototypes and the technology used? (Ethical considerations)

- The solution being used in the wrong way – if a predator or perpetrator gains access to the information such as live locations this is counterproductive as they could use this to cause harm or for stalking.
- Abusive relationships – in a toxic relationship the partner could use the features in a negative way such as GPS live location as a method of exerting control.

How can these negative consequences be minimised?

- Monitoring – checking how these solutions are being used an assessing what can be done to ensure they are used for the right purpose
- Support services – there is a report button, that allows users to speak to professionals and get the help and support they require.

HEURISTIC ASESSMENT

Another form of evaluation I will be conducting on the prototypes is usability heuristics, defined by Nielsen [22]. Following the experimental procedure of the paper 'Usability Analysis of Shared Device Ecosystem Security: Informing Support for Survivors of IoT-Facilitated Tech-Abuse' [23]. I will be analysing the usability characteristics of prototypes 1 and 2 using Nielsen's 10 general principles, produced below:

1. Simple and natural dialogue: Dialogues should not contain irrelevant information; information should appear in a logical order

2. Speak the user's language: Use words, phrases, and concepts familiar to the user, rather than system-oriented terms

3. Minimise the user's cognitive load: There should be no need to remember information from one dialogue to another

4. Consistency (in meaning): Users should not need to wonder if different words, situations, or actions are the same

5. Feedback: Always keep users informed about what is going on, in reasonable time

6. Clearly marked exits (from unwanted states): A clearly marked "emergency exit" that avoids an extended dialogue
7. Shortcuts (to speed up interaction): 'Accelerators' which may speed up interaction for more experienced users who know about them

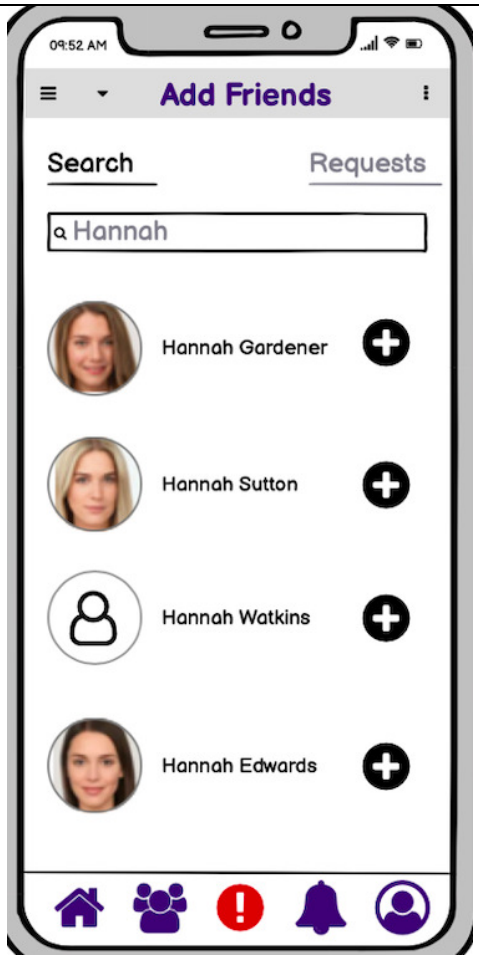
8. Good error messages: Expressed in plain language (no codes), and constructively suggest a solution

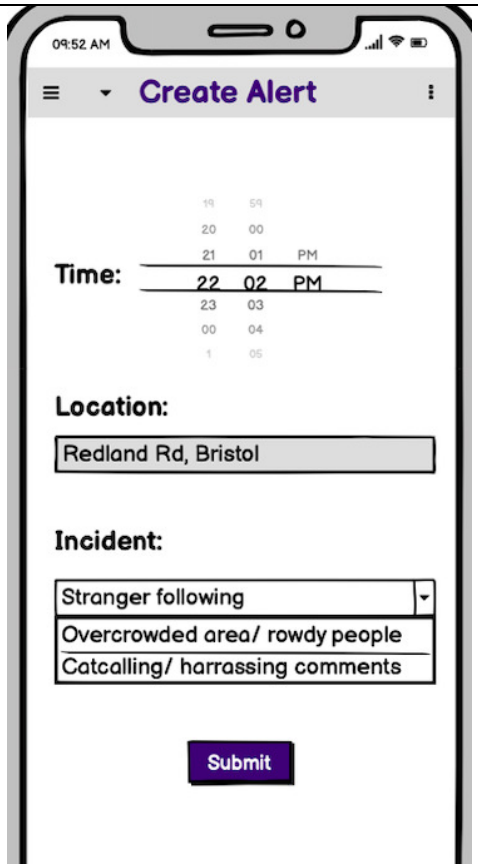
9. Prevent errors: A careful design which prevents problems from occurring in the first place

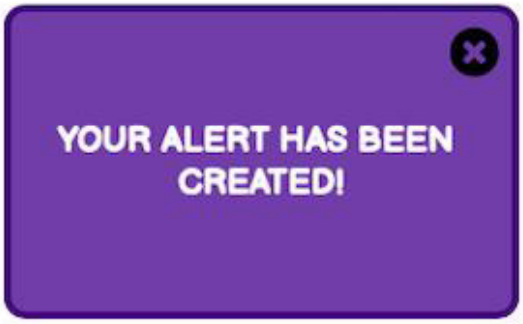
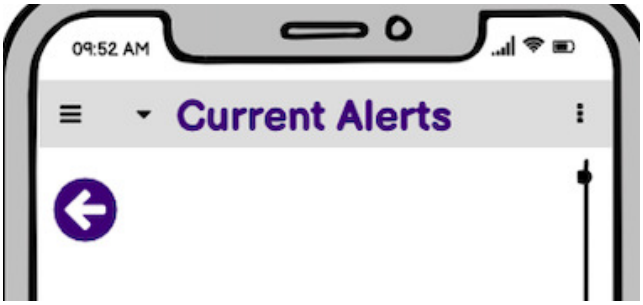
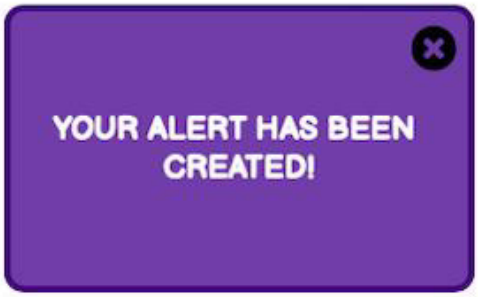
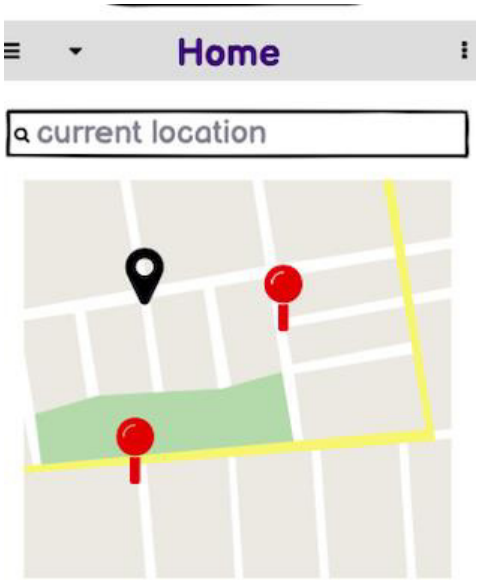
10. Help and documentation: Any necessary documentation ought to be easy to navigate, focused on the user's task, and provide concrete steps.

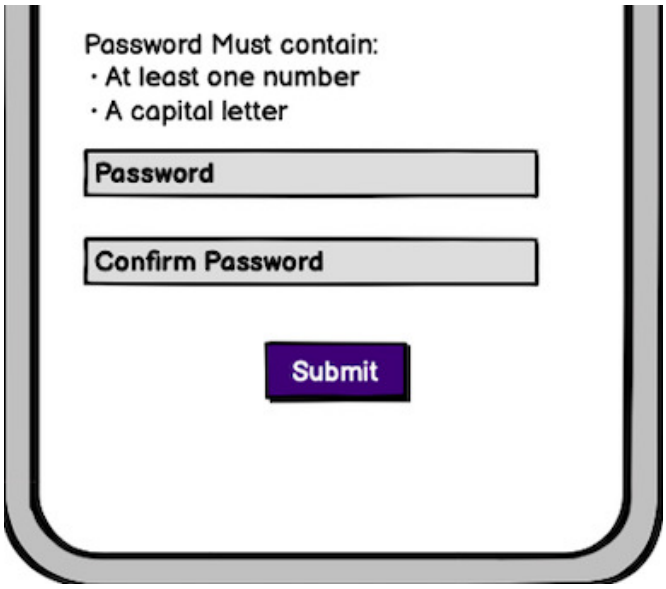
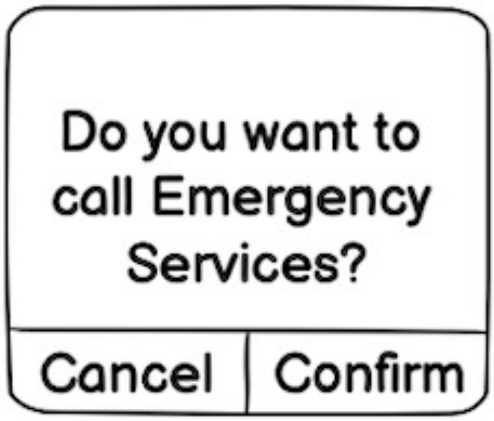
PROTOTYPE 1

TABLE 10 - HEURISTIC EVALUATION PROTOTYPE 1

Heuristic	Evidence	Explanation
1. Simple and natural dialogue		On this page, there is no information that is irrelevant as it is organised and kept simple. There is a search bar which produces a list of the results once the user has entered something. The search and requests tabs are separate to avoid over cluttering the page and not appearing in a logical order.

2. Speak the user's language		When the user is creating an alert, the language used is all very simple and straight to the point. It should be understood by the user without the need for explanation or a tutorial.
3. Minimise the user's cognitive load		the icon menu is placed in the same place on every page, so the users should know which icon takes them to which page through recognition of the icon.
4. Consistency		Each page has a consistent layout, from the colour theme to the fonts and text sizes. The headings of the pages all have the grey bar and the title of the page.

5. Feedback		In response to the user creating an alert the pop-up box appears on the screen as feedback to the user that the task they completed was successful.
6. Clearly marked exits (from unwanted states)	 	With most tasks the user does, there is a back arrow or an exit arrow that allows the user to get back to the screen that they were in before.
7. Shortcuts (to speed up interaction)		As a shortcut to get to the alerts page, the user can click the red pins to view the alerts and be directed to the 'current alerts' page.

8. Good error messages		When the user is registering an account, they are given criteria to fulfil when creating a password. If these are not fulfilled the user will be presented with an error message.
9. Prevent errors		When the user presses the emergency call button, the message on the left appears to confirm that they want to make the call. If they pressed it by mistake the user can press cancel to go back to the homepage or they can press confirm to place the call. As well as that, the use of buttons throughout the prototype means the user can avoid mistakes as they don't have text inputs.
10. Help and documentation		On the profile screen of the application the user can find a help section which should answer any

		queries the user has. However, this heuristic can be improved by adding more help and documentation throughout the application, such as labels in certain areas and question mark icons to explain what certain functions do.

EVALUATION OF HEURISTICS AND TECH-ABUSE – ETHICAL CONSIDERATONS

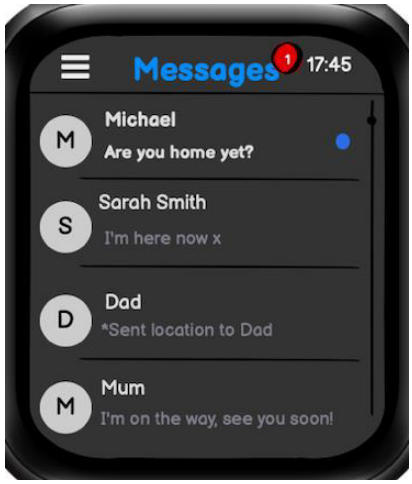
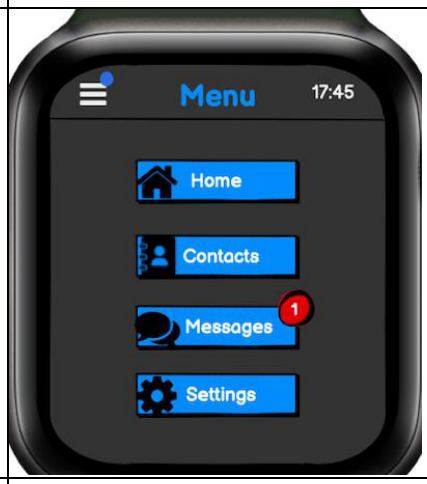
Features of digital technologies may be misused, opening up avenues for a perpetrator of domestic abuse and intimate partner violence, to monitor, coerce, or control another person. We refer to this here as 'tech-abuse' [23].

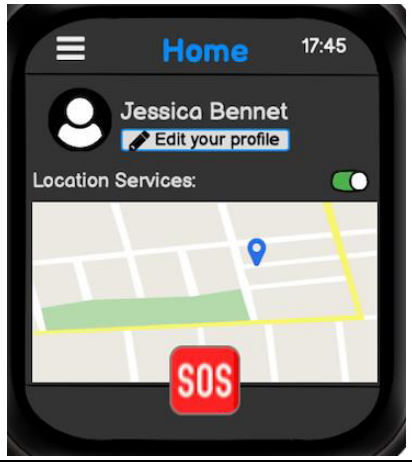
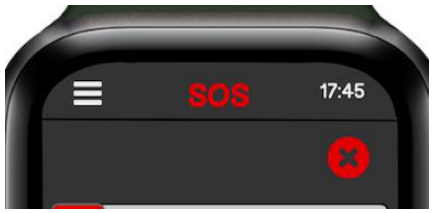
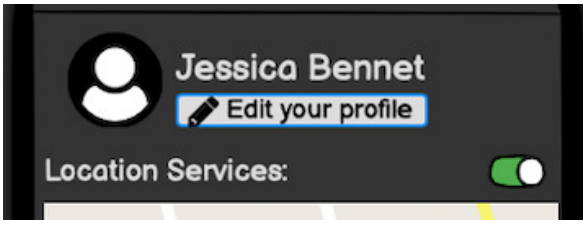
Although for many of the heuristics, there are no identifiable usability violations however, a lack of violations means that usability does benefit a perpetrator as much as a survivor. The paper [23] evaluates these heuristics and the challenges of them with tech-abuse and I will be applying their findings to my prototypes to evaluate.

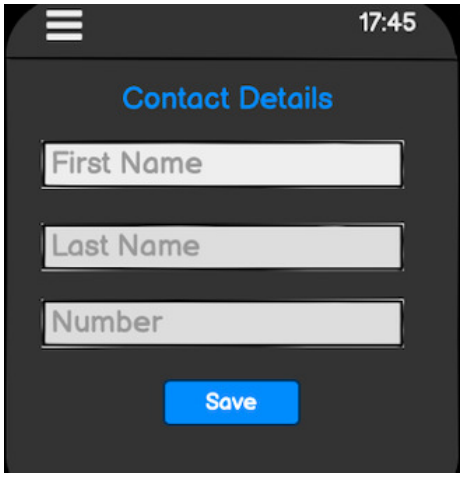
The findings show that one heuristic which has notable challenges is 'help and documentation'. It requires clear signposting and access to actionable advice (through not just online, but local channels), though this does risk being visible to a perpetrator [23]. This could include the SOS button that is in both the mobile application and the smart watch as they are very visibly emergency buttons, which would be able to be seen by a perpetrator. Therefore, local law enforcement and voluntary services such as charities, would need to be able to act or reach a survivor quickly.

The 'feedback' heuristic sees violations across most phases of abuse, one main one being 'escape', major and minor usability violations have been observed [Table 2, 23]. If activity notifications are not produced, it may give a survivor the chance to enact escape. In these prototypes the live location is shared with friends and family, and they receive the feedback by viewing this on an application, however this could be used as a method of control by a perpetrator. This reduces the capacity to escape abuse as the perpetrator would know that the survivor has stopped sharing their location. To minimise the impacts of these violations it is important to get support from technology specialists, to determine how these solutions have been co-opted for tech-abuse and what can be done to prevent it as much as possible.

PROTOTYPE 2

Heuristic	Evidence	Explanation
1. Simple and natural dialogue		The messages screen does not contain any irrelevant information, it shows a blue dot next to the new message to help the user. As well as that it is in chronological order as the newest message is at the top of the screen.
2. Speak the user's language		The menu is very easy to understand by the user because it has uses labels for each button and icons that demonstrate the action the button does.
3. Minimise the user's cognitive load		The user can recognise the menu icon, firstly it is a widely used icon and secondly, it is on all screens, so it becomes familiar.

4. Consistency		All of the screens have consistent formatting and layout. With a matching colour theme and the screen headings at the top next to the menu icon.
5. Feedback		When the user saves the contacts details, they are redirected to the 'contacts' page so they can see that the number has been saved.
6. Clearly marked exits (from unwanted states)		The exit button is clear and in red as this is what colour they generally are. Meaning that the user will be able to easily recognise it.
7. Shortcuts (to speed up interaction)		The user can turn on/off the location services from the home screen and don't need to go to settings.
8. Good error messages	N/A	There are no error messages included in this prototype.

9. Prevent errors		When the user presses the SOS button from the home screen it is not called straight away, so the users can press cancel or swipe to call either their primary contact or the emergency services.
10. Help and documentation		The text boxes provide label with what the user needs to input in the box. There is also the button that has the word 'save' on it so it is clear that saves the contact details.

PROTOTYPE 3

As prototype 3 does not yet have an interface to evaluate, Nielsen's heuristics can't be applied to it effectively. Therefore, I will be evaluating this solution with a model proposed in the paper [23]. It describes IoT facilitated tech-abuse from the perspectives of the survivor and the perpetrator. Below is the image of the model:

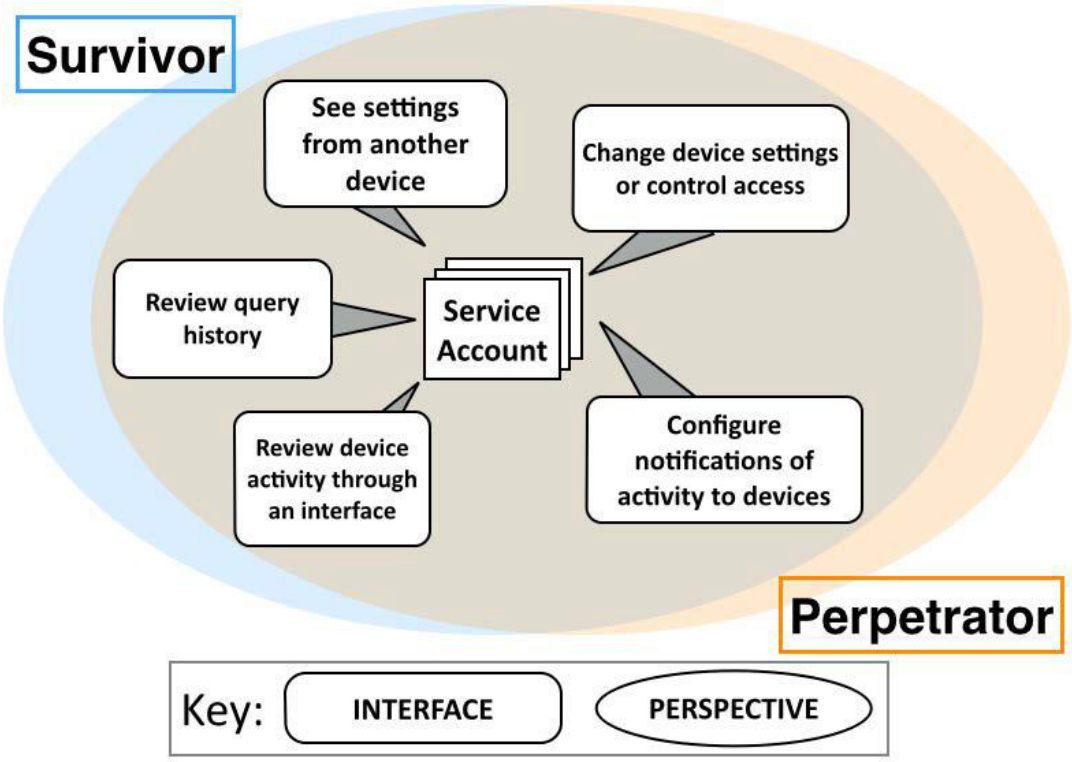


FIGURE 38 – IOT FACILITATED TECH-ABUSE

The Smart Jacket is an IoT facilitated device that can be used by a survivor as a safety wearable. The survivor is able to make emergency calls by tapping the cuff of the sleeve and share location with people they choose. These features which aim to provide safety to a survivor can be manipulated and used in unintended ways to cause harm and distress by monitoring and controlling another person. From the perspective of the survivor with this solution they are able to 'view settings from the application', and 'choose who to share location with from the application'. The perpetrator can use this to 'change the settings from the application', 'change the settings of who can view the location', and 'configure the notifications of the wearable through the application'. These are some of the things that need to be considered with the development of this prototype, by involving relevant stakeholders such as law enforcement, when there are incidents. Manufacturers and developers to consider changes that can be made to the devices themselves [23]. Another method is providing guidance and support for end-users on these devices within their specific context of use.

FUTURE WORK

The completion of this project has shown me that there is a lot of room for new technological solutions to improve women's safety as it is an issue that has been ongoing for many years and will continue to do so unless there is a change in attitudes towards violence against women and girls. Through extensive research with users, and other stakeholders such as policy makers, law enforcement, designers, and developers to refine the solutions. I think there could be huge positive consequences of these solutions. Below are some of the suggestions for what needs to be done for the future of this project:

- CONDUCTING FEEDBACK WITH EXPERTS

  As I had mentioned previously, in this project I aimed to conduct a focus group activity with experts from women's safety charities and people who have experienced working with victims of abuse. However, it was not feasible to organise this in the amount of the time I had. I believe that it would be useful in order to gain valuable insights to evaluate the current solutions and make adaptations to the prototypes. After doing more research throughout this project, I think that it would be useful to also get feedback and have discussions with other stakeholders and experts such as developers and designers who can suggest ways to improve the solutions and minimise risks of tech-abuse. As well as that local law enforcement, as they will be involved when an incident occurs.

- GAINING FEEDBACK AND SUGGESTIONS FROM VICTIMS OF ABUSE

  In addition to gaining insights from experts, I think it is also important to speak with survivors of abuse, who will be willing to evaluate the features of the solutions and provide their opinions on whether they think the solution would be useful in real life situations that they have experienced. Having this research will provide more accurate understanding of what will work well in the solution and what can be removed or adapted as it is coming from potential users who have experienced these real-life situations. Due to the nature of the topics covered, I would not have been able to conduct this research in my project. The ethics application would be an even lengthier process as it is sensitive information and considering the timeline of this project it wouldn't be feasible. However, in the future developments of this project there would be enough time to get an ethics approval and find and recruit participants for this research.

- AFFINITY DIAGRAMMING WORKSHOP

  Affinity diagramming is a great method to help you make sense of all your information when you have a lot of mixed data, such as facts, ethnographic research, ideas from brainstorms, user opinions, user needs, insights, and design issues [21]. I think this would be useful in this project as it is a collaborative tool and can be used to evaluate the solutions with a variation of users and others such as designers or psychologists to gain different perspectives.

- DESIGN APPLICATION INTERFACE FOR PROTOTYPE 3

  Prototype 3, the Smart Jacket is interconnected through an application that is on a smartphone device. Which allows the user to view and perform some of the basic activities. For the future work of this project, when prototype 3 is being developed the application interface also needs to be designed and developed. The prototype right now is conceptual so, this will need to be done when it gets to the further stages. As there could be changes that are made with the device and features which will be reflected in this application design.

- CONDUCT TESTS FOR NON-FUNCTIONAL REQUIREMENTS

  When the solutions have been developed the non-functional requirements will be able to be properly tested by the users to measure how efficiently they were met.

- DEVELOP THE PROTOTYPES

  Lastly, the main future work of this project would be to develop these prototypes into the final solution. There are still a few things that need to be considered before the development stages such as revisions to the design and functionality, cost of development and feasibility of the final solution.

CONCLUSIONS

GENERAL CONCLUSIONS

The objective of this project was to research and analyse the role of technology on women's safety, I believe I have done a good job on achieving this objective by designing and evaluating three different technological prototypes as well as providing clear steps for future work on this project. Through conducting different research methods such as a user questionnaire and user focus group I was able to gain valuable insights of suggestions for improvements and follow a human-centred design approach that is based around the needs and requirements of the user. Below are the suggestions for improvements that can be made to each of the prototypes from the potential users:

CHANGES TO PROTOTYPE 1 – MOBILE APPLICATION

- Add a feature of showing photo ID proof to confirm identification when the user is making an account. This is to improve the security of the application and ensure that only verified users are on the application and not fake account that can be misused.

- Add a forgot password button – there is currently no option to press 'forgot password' so there is no way for the user to reset their password. This is a small detail that was missed in the prototype but can be added in the future modifications of the prototype.

- Using Face ID or fingerprint ID to log into the application – if the user logs out of the application to log back in, they can use Face ID / fingerprint instead of typing their password. This is a quicker and more efficient process.

CHANGES TO PROTOTYPE 2 – SMART WATCH

- Measuring other features to determine stress – the watch could measure heart rate or breathing rate to determine if the user is in a stressful situation and providing assistance to the user.

- Changing the messaging feature to a calling feature – a user suggested that the messaging feature may not be as practical in a dangerous situation.

CHANGES TO PROTOTYPE 3 – SMART JACKET

- Allowing the chip of the smart jacket to be moved into other pieces of compatible clothing – the user won't always be wearing a jacket, taking into consideration the different seasons.

- Adding a safety alarm feature – an alarm that produces a loud sound in case the user is in a situation where a loud alarm could help them escape.

- Adding audio or video recordings – the jacket is able to make audio recordings in a dangerous situation or potentially contain a camera that records the situation and can later be used as evidence.

REFLECTION ON LEARNING

Overall, in this project I think I have performed well, despite some of the challenges faced. Due to these challenges I had to adapt and change certain aspect which I was able to do and work within a different timeframe that the one I had suggested in my initial plan.
The main challenge faced was the delays with the ethics application, due to having to make edits and send it back and then waiting for approval. This took many weeks and led to delays with other parts such as distributing the questionnaire and recruiting participants for the focus group study. When I had received the approval from the ethics committee it was not enough time to arrange a meeting with a couple of experts to conduct the activity. My supervisor reached out to a few people but there was no response so instead I adapted the activity slightly and conducted the focus group with potential users of the solutions. This allowed me to gain valuable suggestions for changes to make to the solutions that have been included in the conclusions section.
Another challenge I faced was being unwell, which meant that I was unable to work on my project for a while, so I had to take a two-week extension. Due to this I had fallen behind on my initial time plan, but I had adapted it to make up for the time that I lost. By setting myself deadlines I was able to get back on schedule for finishing by the 27th of May.
Regardless of these challenges, I was able to complete almost all the objectives I had set out in the initial plan. These can be seen in table 11 with the completion status and an explanation.
With the support of my supervisor (Dr Carolina Fuentes Toro) I was able to fulfil the objectives of this project to a high standard. At the start of the project, we had decided to set weekly half hour meetings, sometimes these would need to be rescheduled due to other things coming up, but we had effective communication to change the date or time of the meetings. During the meetings I was able to share my progress and discuss potential ideas and suggestions for my project. I found these meetings very helpful with planning what to do next and for setting myself personal deadlines/ targets to complete by the next week.
I have learnt valuable skills throughout this project such as time management, report writing and communication. Which are essential skills that I will carry forward into life outside of university.

TABLE 11 - COMPLETION OF OBJECTIVES

Objective	**Completed?**	**Explanation**
Research the scope	Yes	Background research into the problem was completed.
Complete and submit ethics application	Yes	Although there were delays, the application was submitted and received an approval in the end.

Create sketches of prototypes	Yes	Before I create my prototypes quick hand sketches of them, so I knew what to include on each screen.
Create mock-ups of the prototypes	Yes	The prototypes were created using balsamiq.
Review the prototypes	Yes	In my meeting with my supervisor, I showed her the prototypes.
Evaluation of prototypes with expert feedback	No	This was unable to be organised, however I did get feedback from users instead.
Conduct surveys and interviews	Yes	User questionnaires were conducted, interviews were not conducted but I used data from a previous interview in my background research as mentioned.
Suggestions and recommendations for improvements	Yes	Included in the conclusions section, the suggestions that the users provided for the three solutions. These can be developed on for future versions.
Comparison with existing solutions	No	There is comparison throughout however not a dedicated section on it.
Adjust the Final Report	Yes	The required sections of the report were written.
Finalise and submit the Final Report	Yes	I read through the report before I submitted it.

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APPENDIX

APPENDIX A: QUESTIONS AND ANSWERS FROM INTERVIEWS

Names of the participants have been abbreviated for confidentiality

Participant 1

1. What is your name & age?

JA, 21

2. How would you describe your gender? Male, Female or Prefer not to say

Female

3. How has your day been?

Okay, busy with revision

4. How did you travel to Uni building?

Drove in

5. In terms of feeling safe, how would you say you felt on your commute?

Very safe, because I drove in but normally, I park further away and walk in which takes 25 minutes, due to it getting dark earlier and walking by myself I parked closer today.

6. Do you typically travel alone? Are there any reasons that would affect this?

When I drive in, I travel alone, when I walk, I walk in with my course mate.

7. What situations would cause you to feel unsafe in public?

If I am walking by myself and it is dark, when there is a lot of crowds

8. Do you have any experiences you would like to share, where you have felt unsafe?

General feelings when walking alone, and if someone is walking close behind

9. How do you feel physically and emotionally while travelling alone in public during the day and when it is dark? [for male ppts - … compared to how a women might feel travelling at those times]

When it's dark – weary and alert compared to during the day

10. What do you find helpful / comforting when you feel you are in an unsafe situation?

Ring someone to talk to whilst walking, or with someone or if there are other people around.

11. Do you have any suggestions for a potential new development that would be helpful to make women feel safer in public?

Tracking device app, with friends to access their locations when you know you will be alone.

Participant 2

1. What is your name & age?

HA, 21

2. How would you describe your gender? Male, Female or Prefer not to say

Male

3. How has your day been?

Okay, tiring

4. How did you travel to [location of interview]?

Walked, less than 10 minutes

5. In terms of feeling safe, how would you say you felt on your commute?

Safe

6. Do you typically travel alone? Are there any reasons that would affect this?

Yes typically, no reason that would affect this

7. What situations would cause you to feel unsafe in public?

Dark alleyways

8. Do you have any experiences you would like to share, where you have felt unsafe?

Walking back from a night out – especially streets without streetlights.

9. How do you feel physically and emotionally while travelling alone in public during the day and when it is dark? [for male ppts - … compared to how a women might feel travelling at those times]

A lot safer during the day compared to the dark – due to more people being around
Compared to women who might experience cat calling and stuff during the day as well compared to me.

10. What do you find helpful / comforting when you feel you are in an unsafe situation?

Text someone

11. Do you have any suggestions for a potential new development that would be helpful to make women feel safer in public?

Not anything that's not already available
Walking women back so they are walking most of the way with someone.

Participant 3

1. What is your name & age?

ET, 20

2. How would you describe your gender? Male, Female or Prefer not to say

Male

3. How has your day been?

Been good, average day

4. How did you travel to [location of interview]?

Walked, about 10 – 15 minutes

5. In terms of feeling safe, how would you say you felt on your commute?

Felt safe, for the most part travelling back I feel safe, stick to more lit streets at night.

6. Do you typically travel alone? Are there any reasons that would affect this?

Yes, typically travel alone, no specific reason to not travel alone, more cautious.

7. What situations would cause you to feel unsafe in public?

At night, drunken crowd, someone following

8. Do you have any experiences you would like to share, where you have felt unsafe?

Followed by homeless people, drug dealers

9. How do you feel physically and emotionally while travelling alone in public during the day and when it is dark? [for male ppts - … compared to how a women might feel travelling at those times]

Feel a lot safer, don't feel like being alone would stop me from going out – compared to women who prefer larger groups
More cautious with headphones

10. What do you find helpful / comforting when you feel you are in an unsafe situation?

Keep my phone on me and not low on charge
Listen to music when walking but if I feel uncomfortable, If I felt unsafe, I would lower the music to hear what's going on.

11. Do you have any suggestions for a potential new development that would be helpful to make women feel safer in public?

An alert system, e.g., someone being creepy on a particular road could warn other people
Groups that walk people back to where they live
Make sure people aren't walking home alone – write them a message to check up on them.

Participant 4

1. What is your name & age?

SH, 21

2. How would you describe your gender? Male, Female or Prefer not to say

Female

3. How has your day been?

Stressful

4. How did you travel to [location of interview]?

Walking, about 25 – 30 minutes

5. In terms of feeling safe, how would you say you felt on your commute?

I felt pretty safe
When it is night after this class, it feels quite unsafe due to it being dark.

6. Do you typically travel alone? Are there any reasons that would affect this?

Usually with sister and friend, to classes normally alone
When it's dark I wouldn't be comfortable enough to travel alone

7. What situations would cause you to feel unsafe in public?

People who are drunk, males – feeling like being followed – aware of surroundings.

8. Do you have any experiences you would like to share, where you have felt unsafe?

Recently, someone was hitting on my sister, felt uncomfortable and annoying to deal with.

9. How do you feel physically and emotionally while travelling alone in public during the day and when it is dark? [for male ppts - … compared to how a women might feel travelling at those times]

In the day – safer – air pods in the day
In the night – more unsafe – don't use air pods to be aware of surroundings

10. What do you find helpful / comforting when you feel you are in an unsafe situation?

Consider calling a male friend, or a serious situation calling the police.
Being an international student, you don't have family around not as easy to just call someone.

11. Do you have any suggestions for a potential new development that would be helpful to make women feel safer in public?

An application that updates location every 5- 10 minutes
In case of emergency there is a button to call emergency contact or police
My live location is being sent to that person (emergency contact)
-helps you feel safer if you know someone is aware of your exact whereabouts.

Participant 5

1. What is your name & age?

HU, 21

2. How would you describe your gender? Male, Female or Prefer not to say

Male

3. How has your day been?

It's been okay – tired

4. How did you travel to [location of interview]?

Taxi – 30 minutes

5. In terms of feeling safe, how would you say you felt on your commute?

Very safe in a taxi
Feel safe on journey back

6. Do you typically travel alone? Are there any reasons that would affect this?

Typically, I travel alone

7. What situations would cause you to feel unsafe in public?

In big crowds

8. Do you have any experiences you would like to share, where you have felt unsafe?

No specific experiences

9. How do you feel physically and emotionally while travelling alone in public during the day and when it is dark? [for male ppts - … compared to how a women might feel travelling at those times]

It makes no difference
Women – feel scared

10. What do you find helpful / comforting when you feel you are in an unsafe situation?

Leave the situation

11. Do you have any suggestions for a potential new development that would be helpful to make women feel safer in public?

App – s.o.s button – alert
Keep your distance – when walking in public
Siblings – walking them to places
IoT device – wearable technology – emergency button to police and have GPS data

APPENDIX B: PARTICIPANT INFORMATION AND CONSENT FORM FOR QUESTIONNAIRE

The Role of Technology on Women's safety

You are being invited to take part in this user questionnaire. Before you decide whether to take part, it is important for you to understand why this is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish.
Thank you for reading this.

What is the purpose of this user survey?

The purpose of this evaluation is to complete a questionnaire to identify the strengths and weaknesses of 3 prototypes. For this purpose, you will have to complete the User Experience Questionnaire which requires you to choose the best answer to describe your opinion about the prototype.

Why have I been invited to take part?

You have been invited because you are a student at Cardiff University and a potential user of the prototype.

Do I have to take part?

No, your participation in this user evaluation is entirely voluntary and it is up to you to decide whether to take part. If you decide to take part, we will discuss the task with you and ask for your consent. If you decide not to take part, you do not have to explain your reasons and it will not affect your legal rights. If participants are Cardiff University students, it should be made clear that involvement in this evaluation will have no effect on their education or progression through a degree course.

You are free to withdraw your consent to participate in the research project at any time, without giving a reason, even after signing the consent form.

What will taking part involve?
Taking part in this user evaluation will involve answering a questionnaire about the prototypes, which will be viewed using the link provided in the questionnaire. Using the User Experience Questionnaire to describe your opinions on each of the three prototypes and suggest any improvements.

Will I be paid for taking part?
The chance of winning a £10 Love2Shop voucher out of the two that will be raffled.

What are the possible benefits of taking part?
Your contribution to this research project could help to identify additional features that could be added to the prototype and improve the solution.

What are the possible risks of taking part?
There are no likely risks arising when taking part in this evaluation.

Will my taking part in this research project be kept confidential?
All information collected from (or about) you during the research project will be kept confidential and any personal information you provide will be managed in accordance with data protection legislation. Please see 'What will happen to my Personal Data?' (below) for further information. What will happen to my Personal Data? Personal data, according to the General Data Protection Regulation (GDPR) means any information relating to an identifiable living person who can be directly or indirectly identified by reference to an identifier. This may include information such as an individual's name, address, email address or date of birth. If your research project is using personal data (and note that any research project involving the use of written consent forms will be using personal data), describe the person data that will be collected/used and the arrangements for anonymising it (e.g. use of a research project number). Personal data is not anonymous where researchers have, or are likely to have in the future, access to a key, or other means, which would enable re-identification of the individual to which the personal data relates.
Cardiff University is the Data Controller and is committed to respecting and protecting your personal data in accordance with your expectations and Data Protection legislation. Further information about Data Protection, including:
- your rights
- the legal basis under which Cardiff University processes your personal data for research
- Cardiff University's Data Protection Policy
- how to contact the Cardiff University Data Protection Officer
- how to contact the Information Commissioner's Office
may be found at https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection
Participants personal data will be processed through the research aspect of the entire

project. After one year, the research team will anonymise all the personal data it has collected from, or about, you in connection with this research project, except for your consent form, including details of any other person data which must be retained. Your consent form [including details of any other personally identifiable information which must be retained] will be retained until the completion of the project. Anonymised information will be kept for a minimum of one year but may be published in support of the research project and/or retained indefinitely, where it is likely to have continuing value for research purposes.

What happens to the data at the end of the user evaluation?
At the end of the research project, the data collected could be shared within the university as it will be a part of the project. All personal data will be removed before anything is shared.

What will happen to the results of the user evaluation?
It is our intention to include the results of this research project in academic journals and present findings. Participants will not be identified in any report, publication, or presentation. We intend to use verbatim quotes from participants interviews if needed.

What if there is a problem?
If you wish to complain or have grounds for concerns about any aspect of the manner in which you have been approached or treated during the course of this research, please contact Carolina Fuentes Toro. If your complaint is not managed to your satisfaction, please contact School of Computer Science ethics committee. comsc-ethics@cardiff.ac.uk If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

Who is organising and funding this user evaluation?
The research is organised by academic supervisors: Carolina Fuentes Toro in Cardiff University.
Who has reviewed this user evaluation? This research project has been reviewed and given a favourable opinion by the Computer Science School Research Ethics Committee, Cardiff University.
Further information and contact details
Should you have any questions relating to this research project, you may contact us during normal working hours:
Name: Safah Ahmed
Email Address: ahmeds75@cardiff.ac.uk

I confirm that I have read the information above
I confirm that I have understood the information above and that I have had the opportunity to ask questions and that these have been answered satisfactorily.
I understand that my participation is voluntary, and I am free to withdraw at any time

without giving a reason and without any adverse consequences (e.g. to medical care or legal rights, if relevant).
I understand that if I withdraw, information about me that has already been obtained may be kept by Cardiff University.
I understand that data collected during the research project may be looked at by individuals from Cardiff University or from regulatory authorities, where it is relevant to my taking part in the research project.
I give permission for these individuals to have access to my data.
I consent to the processing of my personal information, Age and Gender for the purposes explained to me.
I understand that such information will be held in accordance with all applicable data protection legislation and in strict confidence unless disclosure is required by law or professional obligation.
I understand, who will have access to the personal information provided, how the data will be stored and what will happen to the data at the end of the research project.
I understand that after the research project, anonymised data may be made publicly available via a data repository and may be used for purposes not related to this research project.
I understand that it will not be possible to identify me from this data that is seen and used by other researchers, for ethically approved research projects, on the understanding that confidentiality will be maintained.
I understand that anonymised excerpts and/or verbatim quotes from my questionnaire may be used as part of the research publication.
I understand how the findings and results of the research project will be written up and published.

Do you give consent for this questionnaire?

Yes No

APPENDIX C: QUALTRICS QUESTIONNAIRE FOR USERS

What is your age?

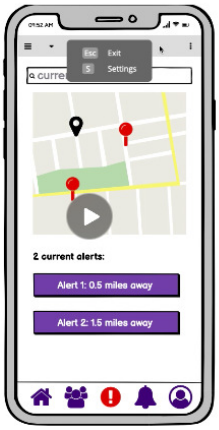
- 18-20
- 21-23
- 24+

What is your gender?

- Male
- Female
- Prefer not to say

→

Please watch the video below for a demonstration of Prototype 1, then answer the following questions:



Decide which terms better describe the prototype, please select one circle per line. There is no "right" or "wrong" answer, only your opinion counts!

Annoying	○	○	○	○	○	○	○	Enjoyable
Not understandable	○	○	○	○	○	○	○	Understandable
Not interesting	○	○	○	○	○	○	○	Interesting
Easy to learn	○	○	○	○	○	○	○	Difficult to learn
Good	○	○	○	○	○	○	○	Bad
Complicated	○	○	○	○	○	○	○	Easy
Meets expectations	○	○	○	○	○	○	○	Doesn't meet expectations
Clear	○	○	○	○	○	○	○	Confusing
Impractical	○	○	○	○	○	○	○	Practical
Organised	○	○	○	○	○	○	○	Cluttered

How do you think Prototype 1 can be useful in improving women's safety? Please elaborate

What are some improvements you would suggest for Prototype 1?

Please watch the video below for a demonstration of Prototype 2, then answer the following questions:

Decide which terms better describe the prototype, please select one circle per line. There is no "right" or "wrong" answer, only your opinion counts!

Annoying	○	○	○	○	○	○	○	Enjoyable
Not understandable	○	○	○	○	○	○	○	Understandable
Not interesting	○	○	○	○	○	○	○	Interesting
Easy to learn	○	○	○	○	○	○	○	Difficult to learn
Good	○	○	○	○	○	○	○	Bad
Complicated	○	○	○	○	○	○	○	Easy
Meets expectations	○	○	○	○	○	○	○	Doesn't meet expectations
Clear	○	○	○	○	○	○	○	Confusing
Impractical	○	○	○	○	○	○	○	Practical
Organised	○	○	○	○	○	○	○	Cluttered

How do you think Prototype 2 can be useful in improving women's safety? Please elaborate

What are some improvements you would suggest for Prototype 2?

Please read the description of Prototype 3 below, then answer the following questions

Prototype 3 – Smart Clothing

This prototype uses a small IoT device in the sleeve of the jacket that connects to a smartphone to enable the user to be connected.

Interactive Cuff – This allows the user to use different hand commands to interact with the jacket, the mobile phone app that is connected to the device shows the user these hand commands so they can become familiar with them.

Main Features:

- User taps three times to call emergency services – this can be discrete so in a dangerous situation the user can call the police without alarming a potential attacker.
- Swipe to answer calls – the jacket is connected to a smartphone and can notify when a call is incoming.
- GPS location tracking which can be seen from a smartphone and is shared with selected people.

Decide which terms better describe the prototype, please select one circle per line. There is no "right" or "wrong" answer, only your opinion counts!

Boring	○	○	○	○	○	○	○	Exciting
Not understandable	○	○	○	○	○	○	○	Understandable
Not interesting	○	○	○	○	○	○	○	Interesting
Seems easy to learn	○	○	○	○	○	○	○	Seems difficult to learn
Conventional	○	○	○	○	○	○	○	Inventive
Creative	○	○	○	○	○	○	○	Dull
Meets expectations	○	○	○	○	○	○	○	Doesn't meet expectations
Clear	○	○	○	○	○	○	○	Confusing
Impractical	○	○	○	○	○	○	○	Practical
Obstructive	○	○	○	○	○	○	○	Supportive

Do you think Prototype 3 can be useful in improving women's safety? Please elaborate

What are some improvements you would suggest for Prototype 3? This could include additional features.

Can you think of a situation where you would use one of the three prototypes? If so, please describe.

Please provide an email address to be included in the raffle for a £10 Love2Shop voucher

We thank you for your time spent taking this survey.
Your response has been recorded.