Night Knight

Medialogy
Aalborg University
http://www.aau.dk

AALBORG UNIVERSITY
STUDENT REPORT

Title:
Night Knight

Theme:
Human-Machine Interaction

Project Period:
Spring Semester 2024

Project Group:
06

Participant(s):
Erika Brinck Nicolaisen
Mathias Lerche Jaqué
Mathias Sejr Frandsen
Nathalie Conrad Olsen
Phillip Rumpelthiin
Johannes Farmer Knudsen

Supervisor(s):
Georgios Triantafyllidis

Page Numbers: 79

Date of Completion:
November 20, 2025

Abstract:

Feeling unsafe in the nightlife is a pressing concern, especially for women. The route home alone late a night, where they fear facing risks such as attacks and assaults, can be daunting experiences. This project aims to research these hypnotises by creating a safety application to help women feel safer on their way home. Various initiatives have already been taken to address and solve the problem, but this project will also focus on creating a usable application, with the usability and user experience goals in mind. To evaluate the application, the think aloud protocol, semi-structured interview and a System Usability questionnaire were used. Tests where conducted with the target group: women age 18-30. 18 test participants tested the application. The results were positive and scored high on the System Usability Scale. Indicating that a useful and easy to use safety application could be created.

Contents

Chapter 1

Introduction

The feeling of safety is one of the most basic and important needs for a human being. If the safety need is not achieved other needs such as the need for love can not be achieved as well (Martina Raue, 2019). The feeling of safety is extremely important for a human beings life, but even though the need is important, it is not a guarantee for all human beings. Numerous factors and events can create a feeling of not being safe. This project will focus on the nightlife, more specifically the nightlife in Copenhagen. It is a well known problem that there is a variety of events, which can create a feeling of not being safe during nighttime in Copenhagen. Personal experiences or hearing about others personal experiences with violence, assaults or threats is highly described as unsafe events in the nightlife. Men and women tend to feel equally safe during daytime in Copenhagen, with a 88% of the men and 87% of the women. But when the darkness arises at nighttime, the numbers drop to 82% for the men and 73% for the women (for et tryggere natteliv, 2023). Women in the age group 15-29 years are the ones feeling most unsafe during nighttime.

Using this knowledge, this paper aims to research if a safety application can be created for women in the age group 18-30 years. The application will be created with the usability goals, user experience goals and the target group in mind, to see if the application will be useful and easy to use. Moreover, to accomplish their need for at safety application. Other applications with similar purposes will be analysed to see which features can be used and which are missing. The paper will present research about safety, nightlife in Copenhagen and usability, as well as other applications with simi-

lar purposes. Furthermore, it will present the process of designing and implementing firstly a low-fidelity prototype using Figma and later a high-fidelity prototype using .NET Maui. Tests of the application will be conducted with the target group. The results from the tests will be evaluated and discussed, and lastly a chapter with future work.

Chapter 2

Pre-Analysis

In this opening chapter a short introduction to the problem will be presented, by looking at it from a broader perspective. This will help gaining more insight into the problem.

2.1 The text me when you get home movement

In the South of London on March 3th 2021 Sarah Everard went missing, when she was walking home from a friends house late at night. One week later her body was found. Her story started a movement in the United Kingdom, but quickly spread to all around the world. Women began sharing their stories about what they did to feel safer, while walking home late at night. A common point from these stories was *"the text me when you get home"*-message, which they wrote to each other, as a way to make sure their friends got home safe. The goal of the movement was to create awareness around the problem, but also to ensure safety while walking home at night (Raphael, 2021).

As written previously, the movement started in the United Kingdom, but quickly spread to all around the world. This shows that it is a global problem, which women all around the world can recognise.

2.2 Safety on the way home at night in Denmark

The problem with women's safety on the way home at night is a well-know problem in Denmark as well. The case with Mia Skadshauge Stevns in Aalborg received widespread attention. She went missing while walking home late after a night out in one of Denmark's most crowded nightlife streets: Jomfru Ane Gade. Questions to how it could happen in such a crowded place was raised. Women from various parts of Denmark was inspired to tell their stories about feeling unsafe while going home at night. The women shared stories about going home at night with keys between their fingers preparing for an attack. The women stated that they often cycled home or called someone, which created a false safety (Madsen, 2022).

Concerns involving assaults and attacks late at night are a well-know problem to men as well, but not to the same extent. Men recognise hearing about women feeling unsafe and have experienced their partner calling them on their way home(Madsen, 2021).

Based on the research, efforts is already being made to create awareness around the problem. It seems like a world spread problem, which generate more discussion. The problem is, as stated, not only a problem in Denmark but all around the world. We would like to focus on Danish citizens to narrow down our target group. But the application will in the end be possible to use globally.

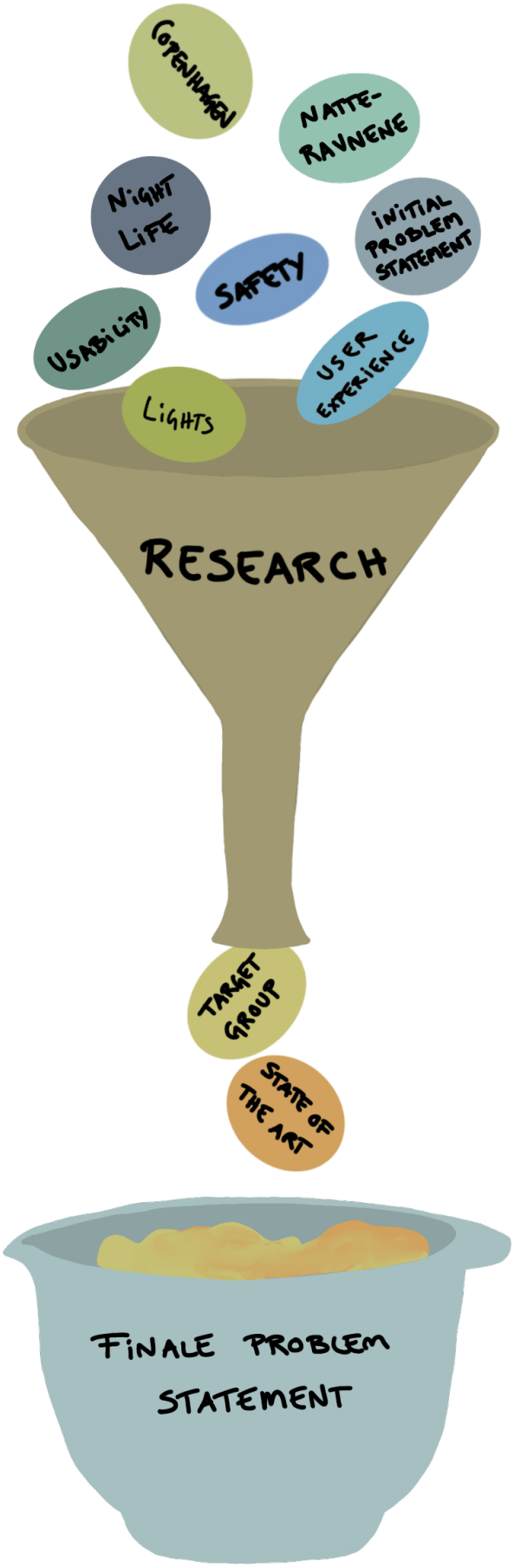
First, it will begin with defining an Initial Problem Statement (IPS), which after the conducted research will be specified:

How can a mobile application help create a safer night life for Danish citizens?

Chapter 3

Analysis

After having defined an IPS, we will now start the research about the feeling of safety, how the lack of the latter is presented in Copenhagen, when, where and who of the Danish citizens feels mostly unsafe, to gather enough information to narrow down to a target group. Moreover, we will research how we should approach the problem with the best solution for a mobile application. And to end the analysis we will present a various of already existing personal safety solutions in the State of the art. All of these parts of the analysis will lead us to the Finale Problem Statement.


COPENHAGEN
NATTE-RAVNENE
NIGHT LIFE
INITIAL PROBLEM STATEMENT
SAFETY
USABILITY
USER EXPERIENCE
LIGHTS
RESEARCH
TARGET GROUP
STATE OF THE ART
FINALE PROBLEM STATEMENT

3.1 Percieved Safety

3.1.1 Psychological Aspect of Safety

The term safety generally refers to a condition of not being in danger (Martina Raue, 2019). There exists a great number of aspects of feeling safe, and the conditions vary as to which kind of safety a person is lacking or trying to acquire.
Safety is one of the most basic and important needs to a human being. According to *Figure 3.1: Maslow's hierarchy of needs* Maslow's Hierarchy of Needs physiological needs, such as hunger, thirst, body temperature and physical needs for survival, is the only need exceeding safety needs. Levels of needs are pursued in order of hierarchy, and higher levels of needs can only be acquired is contingent upon lower levels of needs. Safety needs in Maslow's hierarchy covers for needs such as shelter, financial safety and threats towards personal safety and health (TryghedsFonden, 2023).

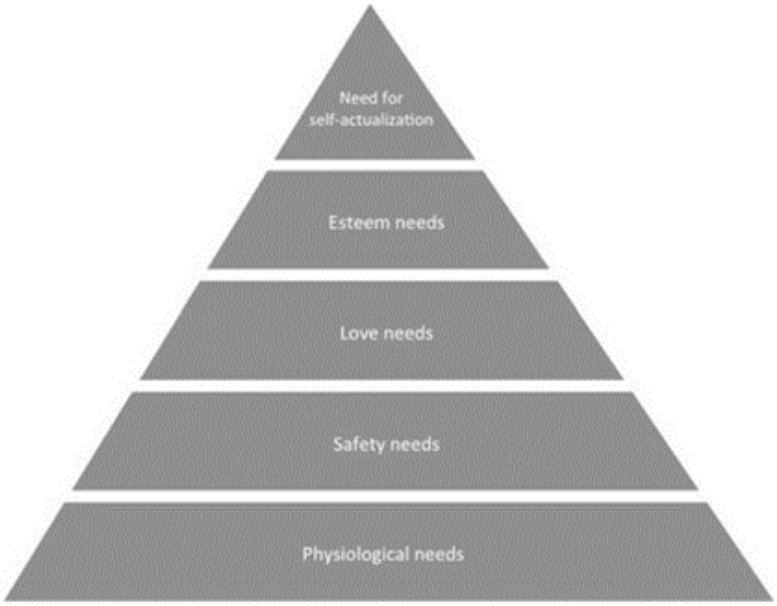


Figure 3.1: Maslow's hierarchy of needs

In a psychological aspect safety is a state of mind, where outside threats do not affect the inner balance or trigger a serious lasting mental strain, according to Tryg-Fonden (TryghedsFonden, 2023).

> *"Tryghed er en tilstand, hvor ydre trusler ikke anfægter den indre balance og udløser en alvorlig eller vedvarende psykisk belastning." "Safety is a state where external do not challenge the iner balance and triggers a persistence mental overload" (our own translation)(TryghedsFonden, 2023)*

In relevancy to this project social safety is the appropriate aspect, and if achieved often described as "Peace of Mind". When moving through nightlife whether it is in your own town during dark hours, or in the city on a Friday/Saturday night, people tend to worry about their safety, because dangers seem to be greater than usual. This is because people often rely on feelings rather than statistical probability. The slightest change of the statistical probability, even from 0 to 1%, of any danger being present, alters a persons perceived safety greatly. By focusing on the unlikely outcome of these dangers, the emotional response of possible danger, changes a person state of mind from "Peace of Mind" to a more uncomfortable and unsafe state (TryghedsFonden, 2023).

3.1.2 Safety in Copenhagen

According to a report created by Epinion Copenhagen for Københavns Kommune (Kommune, 2023b). Men and women feel equally safe in Copenhagen during the day with 87% of women feeling safe and 88% of men. This picture changes during the evening and night with the numbers dropping to 73% for women and 82% for men. During the nighttime it is the women in the age group 15-29 years who feels most unsafe. Of the age group, 75% answered that they feel safe and 16% answered that they feel unsafe, 8% answered that they could not agree to either feeling safe or unsafe. The citizens of Copenhagen generally feel safe. The following figure represents the top 10 events and places were people responded to feel unsafe (Kommune, 2023b).

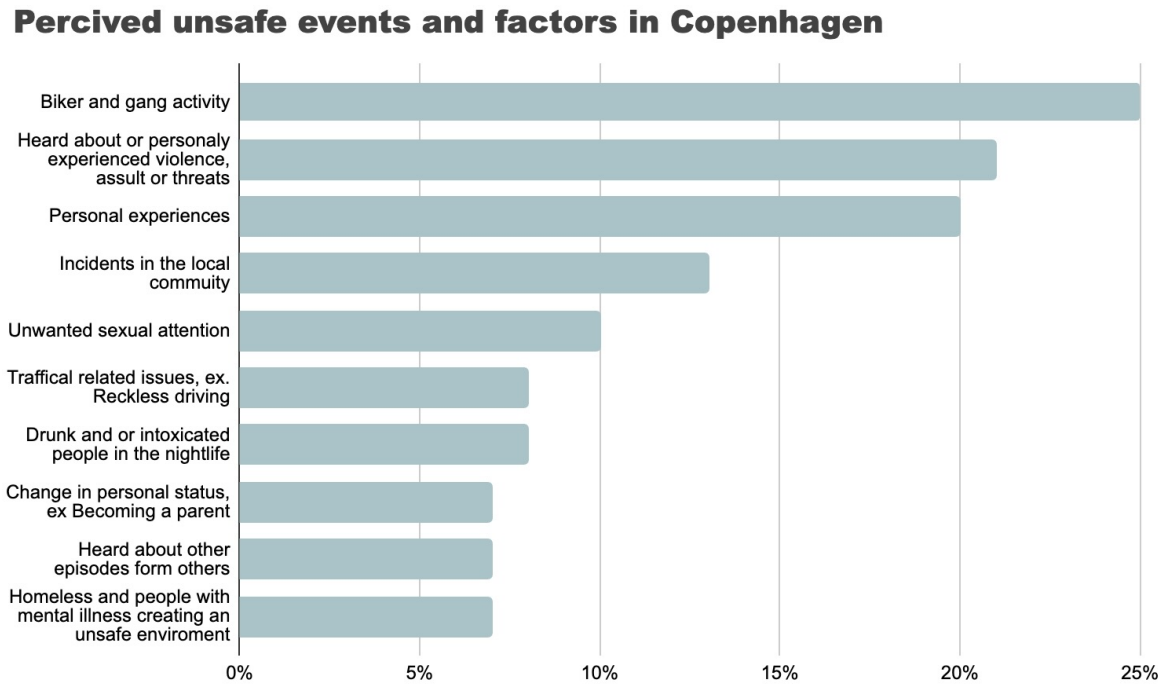


Figure 3.2: Perceived unsafe events and factors in Copenhagen (Kommune, 2023b)

When looking at *Figure 3.2: Percived unsafe events and factors in Copenhagen*, the responders were asked about factors to why they feel unsafe. Gangs, stories about violence and 1st hand experiences with violence, assaults and threats together with personal experiences was the top 3 factors with 25%, 21%, and 20%. The fear of sexual assault is a concern for 10% and drunk people in the nightlife is a concern for 8% of the responders (Kommune, 2023b).

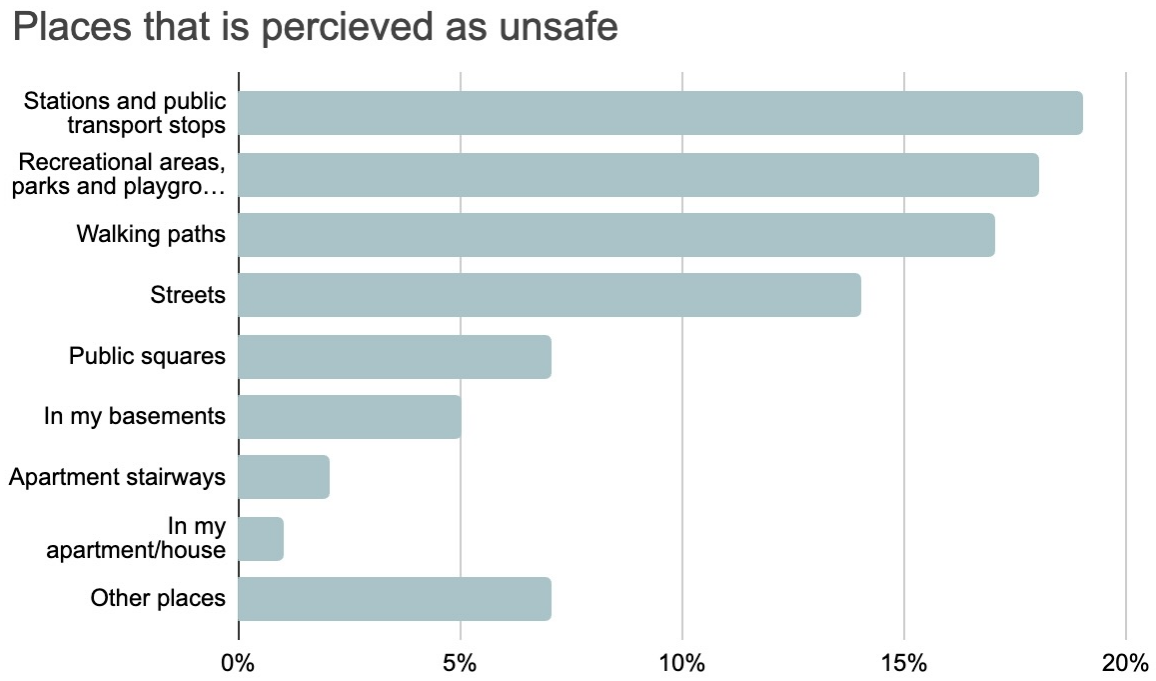


Figure 3.3: Places that the responders percieved as being unsafe (Kommune, 2023b)

According to *Figure 3.3: Places that the responders percieved as being unsafe* the responders feel most safe is in their own apartment or house. 33 % responds that they are concerned or highly concerned about when and where it is safe to move around in Copenhagen. Public transport stations, recreational areas such as parks, playgrounds and paths together with walking on the streets is being perceived as the most unsafe places to be in Copenhagen according to the responders.

One thing is the fear of experiencing one of the previously mentioned events, another thing is the actual chance of it happening. The responders in the report were asked if they have been a victim to any of the events in the last 12 months and if they have reported it to the police. According to the answers 8% have been a victim of threats, but only 1 % reported it to the police. 5% have been victims of sexual misconduct, but no one reported it. 4% had been victims of violence or attempted violence and 1% reported it(Kommune, 2023b).

3.1.3 Light in the night

Illumination of a city's areas or the lack thereof, play a part in citizens reassurance of safety. Copenhagen Municipality has researched whether lighting have a direct impact on the feeling of safety in the evening and night time. In the report *Dybdegående Tryghedsundersøgelse* from 2023 poor or lack of illumination affects citizens visibility and ability to determine the surroundings and other citizens behaviour. Moreover, dark areas such as public parks, small winding streets or the area around train and bus stations seems unsafe during night as they are linked to increased crimes. Especially women tends to feel more vulnerable and anxious of what might *"Gemme sig i mørket" "Hide in the darkness"* (our own translation) (Kommune, 2023a). Women have reported about different strategies to feel more safe when surrounded by dark areas. One of these strategies can be a phone call to a friend or family members, who quickly can respond and call for help if something happens. Another strategy is staying on the part of the road furthers away from the dark areas to reduce and be best prepared for an assault (Kommune, 2023a).

3.2 Natteravnene

Natteravnene (Night Ravens) is a voluntary social organisation. The organisation was established in Denmark back in 1998. Today Natteravnene is the largest security-building effort in Denmark. Every weekend 4000 volunteers from 145 associations tour around the streets during the nighttime creating safety for the danish citizens.

Natteravnenes main task are making the citizens feel safer in the night life. They never actively interfere in violent situations, but they do, however, contact the right authorities, when experiencing the violent situations. They always walk in groups of three, both men and women. A walk is mostly around 3-4 hours (Tutenges Sébastien, 2014).

3.2.1 An interview with Natteravnene

After the research regarding the Natteravnene was conducted, we contacted them to learn more about their individual personal experiences. An interview with Jakob Bové was established. He is a communication consultant at Natteravnene in Copenahgen. He has been a part of the organisation for five years and has been a Natteravn himself.

They work a lot with a term called 'experienced security'. They want people to feel safer, just by seeing a Natteravn. The number of attacks in the nightlife is actually quiet low, compared to what people might think. So by creating the 'experienced security', Natteravnene want to create a feeling of safeness when going out at night. Natteravnene is also not touring around the city where there is already a lot of other security personnel, they tour around the small and darker streets where people might go to throw up or to be alone.

The problems they face the most relates to alcohol. They often help people who have been drinking too much and need help to call someone. They often meet young people who just started going out at night (between 18-19 years old), who can not handle the alcohol yet.

Jakob suggested that it might be more benefecial to focus on the suburbs and cities around Copenhagen. Natteravnene do not experience a lot of people feeling unsafe in the city centre. He mentioned that the observations could be related to Copenhagen being such a big city with tons of people going out every weekend. He mentioned that from his experience, people often feel unsafe when walking home at night. When they do, they tend to move away from the busier parts of the city towards the suburbs, where fewer people around to help if something happens. Sometimes young people asks them to follow them to a nearby station, but they unfortunately can not do that. If they walk one person to the station, they are not looking out for the rest of people in the night life.

3.3 Usability and User Experience

Usability can be described as a question of:

- How well does the product perform?

And the user experience can be described as a question of:

- How does the product feel to use?

3.3.1 Usability

Usability is a way of ensuring that interactive products are easy to learn, enjoyable for the user and effective to use. This will automatically relate to the user experience as well. Usability is a way of optimising an interaction, which the user will have with interactive products.
The term usability is defined by DIN EN ISO 9241, 11:
The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (Usability.de, 2024).
During the fist interaction, users should be able to navigate their way around easily and to an extent where they do not need help from the outside world or any experts. When designing interactive products, usability goals can also be a good idea to keep in mind. Is it...:

- ...effective to use - effectiveness
- ...efficient to use - efficiency
- ...safe to use - safety
- ...having good utility - utility
- ... easy to learn - learnability
- ...easy to remember how to use - memorability

These usability goals will give a comprehensive understanding of the products usability.

The focus should firstly be on how well the design of the product flows in context, so focusing on the product in a whole context, rather than focusing on individual parts (Helen Sharp, 2019).

3.3.2 User Experience

As written before the user experience will also automatically relate to the usability of the product. The user should not only reach the usability goals, but also experience positive feelings. An important thing to know that you cannot design a user experience, you can only design **for** a user experience. The term user experience is described by DIN EN ISO 9241, 11:
"A person's perceptions and responses that result from the use and/or anticipated use of a product, system or service (Usability.de, 2024)."

When designing user experience goal can also be kept in mind: Is it...:

- ...**enjoyable** to use?
- ...**challenging** to use
- ...**fun** to use?
- ...**frustrating** to use?

The user experience goals includes the effects the product has on the user, both before, after and during the interaction with the product (Helen Sharp, 2019).

3.4 Target Group

The demographical features of our main target group for the application are Women (Kommune, 2023b) of the age 18-30 years old (Kommune, 2023b), as they statistically experience more fear and anxiety when going home during dark hours in Copenhagen. Our target group have completed elementary school, high school or shorter educations (Kommune, 2023b) , and lives in “Storkøbenhavn“. The psychographical features of our target group is an enjoyment of going out and being in the city during dark hours, but a feeling of non-safety, anxiety and/or discomfort when travelling home during the dark hours.

To make the best user centred design as possible, the target group is portrayed into two personas. The personas are fictional examples of two individuals within our target group, who has different lives but shares a common problem.

Figure 3.4: Persona 1: Maria

Figure 3.5: Persona 2: Olivia

3.5 State of the art

As presented in the previous research, personal safety is a big concern amongst large groups of the population. This section will present and analyse cutting-edge safety solutions, highlighting their advantageous features. The first part of this section will focus on hardware and alternative solutions to the problem. While the second part of the section will focus on applications that are created for personal safety concerns. For each section a table has been created for the features of respectively alternative solutions, and directly targeting applications.

3.5.1 Apple built-ins

On IPhone 8 or later: When pressing and holding the side button and one of the volume buttons at the same time or pressing the side button five times in a row, an Emergency SOS slider will pop-up. When the sliding starts a countdown and an alarm sound or vibration and blink with the flash in the camera will start as well. After the countdown the user needs to let go of the buttons to finalise the activation of the call (Inc, 2024c).

3.5.2 Smartwatches

Apple Watch

Press and hold the side button for the Emergency SOS slider to pop-up, and just like the iPhone: slide with a finger to activate the call or keep holding the button (Inc, 2024a).

Google Pixel Watch

Uses motion sensors to detect a hard fall and if the person lay still for 30 seconds it calls emergency services. However there is a problem; lots of similar motions in everyday life have some of the same motion patterns. Instinctively when one falls the person would wave their arms, but these movements are not sole identifiers of of a hard fall (Cormie, 2023).

3.5.3 Physical personal safety device

Siréne

Siréne offers a physical personal safety device which can be bought at their website for 499 DKK. The device connects with their free application where the user needs to create a profile. With just one press on the device's button it will send out a call for help through the application. In the application it is possible to choose from who the help should come from, either Runner Connections who are people from the user's contact list or Runners who are volunteers (Denmark, 2024).

Figure 3.6: Siréne safety device (Denmark, 2024)

3.5.4 Already existing applications

Find my iPhone

An application which is pre-downloaded on the iPhone is the applicatoin Find my iPhone. In Find my iPhone you can add all your apple advises (airpods, iPad, Macbook ect.). So if any of it gets lost you will be able to see where they are located. But people also use the app to always have their friends and families location. In the app you can tap on a friend and then it will show you a route to them. You can also notify your friends about your location, when you have arrived and when you leave. You can also choose how often you would like to notify them (Inc, 2024b).

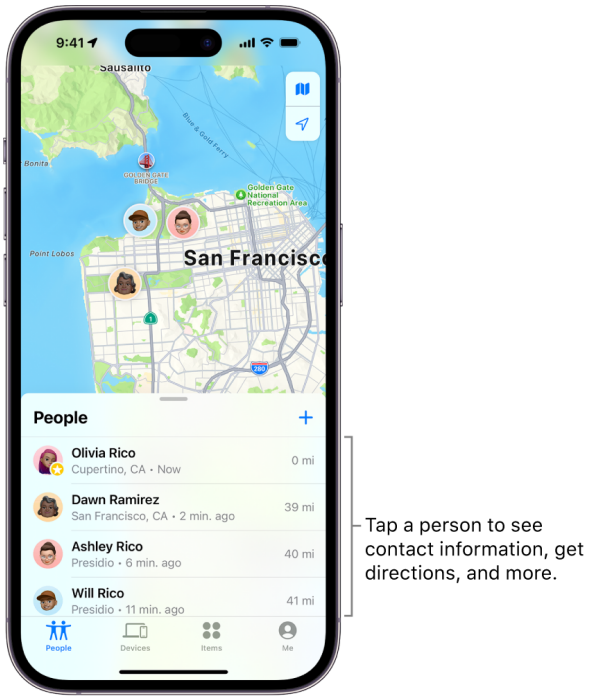


Figure 3.7: Friends location on the app find my iPhone (Inc, 2024b)

Table of features from alternative solutions

All the alternative solutions to the problem of safety concerns, contains different features that the product exploit in order to help the user. The features has been set op in a table, to create a visual overview.

	APPLE BUILT-IN SAFETY FEATURES	SMARTWATCH (APPLE AND GOOGLE)	SIRÉNE SAFETY DEVICE	FIND MY IPHONE
LOCATION TRACKING	✓	✓	✓	✓
LOCATION SHARING	✓	✓	✓	✓
SUDDEN MOVEMENT TRACKING	X	✓	X	X
MANUALLY TRIGGERED	✓	✓	✓	X
SENSOR TRIGGERED ALARM	X	✓	X	X
HELP FROM RUNNERS	X	X	✓	X
FAST ROUTES	X	X	X	✓

Figure 3.8: Table of features from alternative solutions

The Watcher

Watcher is an application where you choose several contacts who can see you location while walking home. The contacts you choose are called watchers. If you go the wrong way, stand still for too long or your headphones are being ripped out, Watcher asks you ”Are You Alright?”. You push a green button with the text ”I’m safe”. If you do not push the button, your watchers will be notified and encourage to contact you. It is not necessary for your watchers to have the application to be notified (Media, 2016).

Figure 3.9: Share your location and route with your watchers (Media, 2016)

The Let Us Know

The Let Us Know Application is a free application and can be downloaded in App Store and Google Play. The application is in many ways similar to other applications we have been looking at. With the application you can also share your location with your friends, but it has another feature called groups. You can create groups with all the contacts you want. In this way you can always see where you group is. So if you get lost at a night out you can always find your group again (Steensen, 2022).

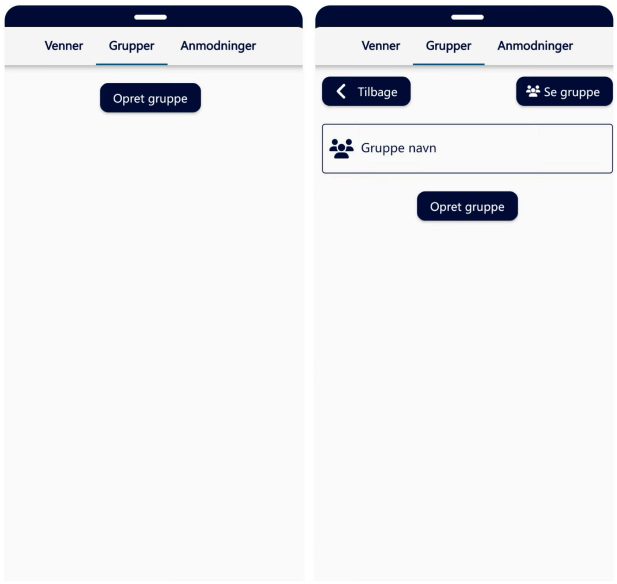


Figure 3.10: Make groups in the Let Us Know Application (Steensen, 2022)

Nabohjælp

The main resource and strength of *Nabohjælp*, is the community consisting of the users neighbours. The idea is to prevent possible breaking and entering, by building and showing that a home is a part of *Nabohjælp* community, which helps and looks out for each other. In the application you can tell your trusted neighbours to keep a look out for your home while on vacation or other absent. The trusted neighbours receives tips and a guide on how to keep the vacant home as safe as possible (Råd, 2024).

SOS Alert

The concept of *SOS Alert* is to have a quick and effective alarm button. The application consist almost only of a SOS Alert button, that when pressed fetches and shares your location to emergency contacts through a text. The users location is stored locally and is only shared once the alert is activated (Play, 2024).

Table of features for Safety Applications

The features from all the Safety Applications is sorted into a table, again to create a visual overview of all the features that each app exploits.

	WATCHER	LET US KNOW	NABOHJÆLP	SOS ALERT
LOCATION TRACKING	✓	✓	X	✓
LOCATION SHARING	✓	✓	X	✓
SUDDEN MOVEMENT TRACKING	X	X	X	X
MANUAL ALARM BUTTON	✓	X	X	✓
SENSOR TRIGGERED ALARM	✓	X	✓	X
EMERGENCY CALLS	X	X	X	✓
FAST ROUTES	X	X	X	✓
COMMUNITY OPPORTUNITIES	X	X	✓	X
GROUPS OF CONTACTS	✓	✓	✓	X
ADJUSTABLE SHARING	X	✓	X	X
SET OF ALARM SOUND	✓	X	X	X
ID REQUIRED FOR SETUP	X	X	✓	X

Figure 3.11: Table of features for Safety Applications

Conclusion of state of the art

From both alternative solutions and from the already established Safety Applications, a variety of features are being exploited. Yet none of the Safety Applications utilises more than six out of the 12 features displayed in the table. To create an original Safety Application, that solves some of the biggest concerns of personal safety, it might require a combination of different features from the individual applications, and the strengths of the alternative solutions. As seen in *figure 3.11 Table of features from alternative solutions* some smartwatches utilises it's sensors to track sudden movement. This feature does not appear in any of the applications which are directly made for personal safety concerns, even though it could track assaults or other emergencies.

3.5.5 From Initial Problem Statement to Final Problem Statement

In this section we will present the process of going from the initial problem statement to the final problem statement.

Target group

To narrow down the initial problem statement we started of by researching the psychological aspect of safety. When looking at the nightlife, people tend to worry about their safety in the dark hours and dangers seem to be greater than usual. At daytime both men and women feel equally safe in Copenhagen, but at nighttime this picture changes. Women tend to feel more unsafe at nighttime and also the lack of lighting have an impact on the them feeling unsafe. The age group who feels most unsafe is the age group 15-29. We chose to focus on women from 18 and not 15, because they can legally go to bars and clubs at the age of 18. Bars and clubs closes at nighttime, therefore the age of 18 widens the problem, target group and possibility to develop a solution. This lead us to narrow our target group to women in the age of 18-30.

Going home at night

When researching about perceived unsafe events and factors in Copenhagen, we learned that gangs, stories about violence and first hand experiences with violence, assaults and threats together with personal experiences was the top three factors. Furthermore, we learned that one thing is the fear of experiencing these events and another thing is the actual chance of it happening. The fear is greater than the chance of people experiencing it. So this led us to wanting to create a safety application, which purpose should be to create a safer feeling when walking home at night. We realised that problem was more about the fear of the events happening rather than the events actually happening. We chose to look at the city centre of Copenhagen at first, but after researching about places that is perceived as unsafe, we realised that they tend to also feel unsafe away from the city centre. This information piqued our curiosity. To back up this information we talked with a Natteravn. He told us that from his perspective the unsafe feeling was not the biggest problem in the centre of the city, but actually on the way home. All this information and research helped us narrow our perspective on the nightlife, to focus on the way home at nighttime.

Usability

Later in the process, we realised that testing for a safer feeling would be difficult. Since this semester theme focus on the human-machine interaction, it makes sense to change the focus to the usability of the application. As we agreed to the new focus, we looked at the *usability and user experience goals,* and how these could help us create an application. The goals *useful* and *easy to use*, seemed as a must when developing a safety application. After this agreement, we began to research already existing applications with the focus to find out the different features these application included. In our research we figured out which features would be suitable for the design and development of a safety application. We wanted to create an application with the best features, but also implement some of our own.

Based on the conducted research, this have lead us to our Finale Problem Statement (FPS):

How can we develop an useful and easy to use safety application for women in the age of 18-30 that triggers an alarm by using motion sensors?

Chapter 4

Requirement Specifications

To answer our Final Problem Statement, guidelines will be sat up for the next step in the process; the design. These guidelines will be the requirements which will guide and help keeping the target group needs in mind for the finale solution. In the beginning of this chapter we will describe a *doable design* that we are able to make a prototype of and later implement, and an *ideal design* that is created with an *everything is possible* mindset. These two designs are devised from the *conclusion of state of the art* and made to kick-start our design brainstorming. Hereafter we will accumulate our requirements.

4.1 Ideal and Doable design

4.1.1 Doable design

The doable design is the expectations for implementations in the application during the course of this project. The doable design is a boiled down version of the ideal design. The application should still be an intuitive, touch android application and should function as a prototype design.

The application will contain a map with the users location and the possibility of creating a desired route to either home, friends or other locations.

The application will use motion sensors and based on data of assault movement patterns detect if an assault is happening and hereafter trigger an alarm to a parried application. If the user is wearing a watch the application will track heart rate as well.

The app will also contain buttons with different functions. A button to start the sharing of location. There will be a help-button which will advise the user on how to use the application, how to get help and how to help the person which alarm was triggered. More than that it will be possible to get information about what else can be done to help prevent fear on the walk home such as built-in android SOS functions. The alarm can be deactivated with a password.

When in use the application will run in the background, and it will not use too much of the mobile battery.

The overall design will be of colours suitable for night-use and enhance calming, safe feelings.

4.1.2 Ideal design

The ideal design is created using the IDEO's Desirability, Viability, Feasibility Framework. It will show what the application would contain, if the project had much more time and resources available. The homepage will consists of a map with GPS, where it will be possible for the user to plug-in a walk-home route.

The walk-home route and the current location can be shared with friends and family, who's current location will be shared as well. Friends and family's location can be seen on the map as small pins. It will be possible to modify the contact list with a limit to x numbers and create groups for different events such as a festival or nights out. The map will show charging stations where the user can charge their phone. The user will always be in control of who and when people are allowed to follow and see their position.

The user can create an account and link up with their friends and family. One of the services the application will provide will be to track the users favourite routes home which will be updated with other users of the app and let the users know if a specific route becomes unsafe. If an attack happens on one of these routes, an alert will be sent out to every phone nearby. All personal data is end to end encrypted and every phone will get an ID number referencing that ID number to every specific phone so positions

and alarms can be sent out anonymously.

The phones sensors will track motion and constantly check with a trained algorithm in assault patterns. If the sensors detect an assault, it will activate the alarm. The application will contact the users chosen emergency contacts and start a sound and video recording to help determine if it is a false alarm or a real attack. If a real attack occurs the receiver can use a one touch link button to call the police that will get an automated call with an updated position link, a report, video and sound file.

The video recording will be on both front and back cameras, sending a frame of every 0.5 second to a server. This service is provided to help identify the attacker, the location of the attack and to get as much information as possible about the attack.

To help dismiss false alarms, the user will receive a message with a countdown. If it is indeed a false alarm, the user will be able to deactivate the alarm. This has to be done with a chosen password.

The application will work together with smartwatches. The build-in heart rate sensor can confirm a prolonged feeling of fear and if the person is still alive. If either the phone or watch loses contact, the one that keeps moving will send the updated information. (The phone will always be master and send its position as long as it is on. The watch will need 4G for this).

In case of low battery. The application will tell the user to close battery consuming apps and give an estimation, depending on the current drainage, of approximately how long the application can run optimally before running out of battery. Moreover, it will give an option to “Find a charge station” on the map closets to the users position. The application will enter a high efficiency mode, by cutting the GPS signal and reducing the frequency of reading motion sensor data. The GPS will only activate when an assault is detected. If the phone is almost about to run out of battery, the GPS will be turned on to send a last known location to the server.

If the user is using a headset which supports sending a signal to the phone and the

headphones are removed while the alarm-mode in on, the app will start a countdown. If the countdown runs out without re-connection to the headphones an alarm will be triggered.

4.2 Usability and User Experience Requirements

The Final Problem Statement focus on *usability* and *feature* with a *function*. The requirements will therefore be based on the *usability and user experience goals*, as well as *the conclusion of state of the art* to help guide our design and implementation to develop a mobile application for our target group.

The requirements are as following:

- The application must be useful.
- The user should enjoy using the application.
- The application must not provide any feeling of frustration or irritation for the user to use.
- The application must be easy and efficient for the user to use.
- The applications pathways and features should be intuitive and memorable.
- The design should be consistent throughout the application.
- Features with a purposefully function should be designed to stand out.
- The application should provide sufficient feedback to the user, in order to not create doubt.
- The design should include constraints to prevent any mistakes from happening when using the application.
- The application must be viable and reliable.
- The data must be securely stored.
- The application must use motion sensor to trigger an alarm.

Chapter 5

Methods

This chapter will go through the different methods used during the project. This is an overall description of the methods that will go into details on how they will be used in the other sections of the rapport.

5.1 Quantitative and Qualitative Data

Complementary methods is a term for when both quantitative and qualitative methods are used. Combining both quantitative and qualitative data gives a deeper and more nuanced understanding of the collected data and research. It also provides the opportunity of different approaches on the same data and research.
Two complementary methods:

- Surveys/questionnaires and interviews
- Surveys/questionnaires and observations

Surveys and questionnaires are used to collect quantitative data of perspectives and viewpoints. Observations and interviews are used to collect qualitative data on behaviour, opinions and experiences. By using these specific methods together a fuller understanding of the researched topic is achieved and new answers to earlier questions might be provided.

It is important to note, that the methods chosen to use must be compatible, so they can be used appropriately and answer the questions as correctly as possible (Björklund, 2021).

5.2 The Iterative Process

The iterative process is used to constantly improve a product or design. Through a problem definition and research of the problem area, a brainstorm of design ideas develops. From the designed ideas a prototype of the best solution is created. The prototype is then tested by the target group to collect feedback which will be analysed and evaluated to help adjust the prototype. The cycle of testing, collecting feedback, analysing and evaluating the feedback to adjust the prototype can be repeated until a final solution is developed.

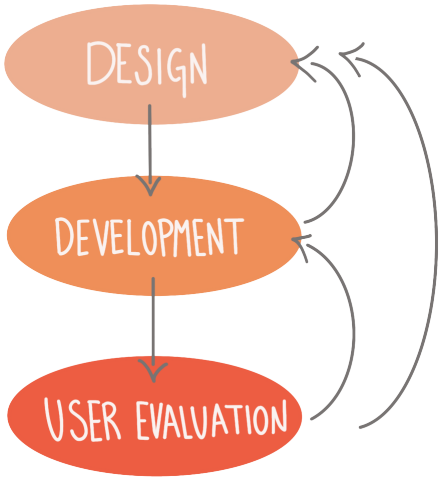


Figure 5.1: The Iterative Process

The cycle of the iterative process is efficient, as it lets you build the product step-by-step. This ensures that when changes are made to individual steps, it will not have an effect on the rest of product. By testing the adjusted prototype repeatably, the process ensures that the expectations and requirements of the target group are constantly in focus, making the process collaborative. In this cycle the usability will be improved and confusion will be eliminated from both sides (Eby, 2019).

5.3 IDEO's Desirability, Viability, Feasibility Framework

Design thinking is a way of innovating products with a human-centred approach. If the design thinking is used, the decisions will be made depending on the users needs. The IDEO's design thinking is parted into three sections, which support each other:

- Desirability: What makes sense for the user?
- Feasible: What is actual possible technically?
- Viability: What is likely to implemented economically?

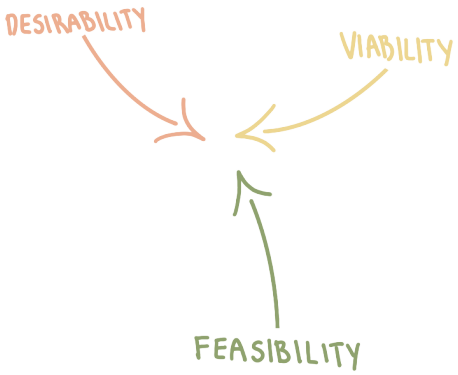


Figure 5.2: IDEO's Desirability, Viability, Feasibility Framework

By using these guidelines and questions, a product can be implemented with the users needs in mind.

5.4 Low-fidelity Prototyping

When making a prototype of the product, different approaches can be done and one of them is low-fidelity prototyping. There is two different ways of low-fidelity prototyping: paper prototypes, where different parts of the product is drawn on paper, and digital prototypes, where the prototypes are designed using a digital tool. Both ways focus on appearances and not the functionality. This is a quick way of prototyping and it provides more freedom to edit the prototype. This will also provide perspective on whether or not the concept of the product is clear.

It is important not to use colours and too many details in the low-fidelity prototype, as this can distract the test participants. You only want to test the concept of the product.

The testing of the low-fidelity prototype is done at an early stage of the design process. This is a way of confirming that the product is starting off in the right direction. It is recommended to test the the prototype on the target group, as they are the ones the product is designed for. It is also recommended to test the prototype on more than seven people (Tan, 2021).

5.5 High-fidelity Prototyping

Where the low-fidelity prototype focus on the early stages of the design process and to gather enough feedback in order to confirm and improve the design idea, the high-fidelity prototype is for the more finale stages of the design process. This prototype looks and feels like the finale product, and the elements and functions gives a more full and realistic user experience when tested. Below in *Figure: 5.3: Low-fidelity Prototype vs. High-fidelity Prototype* a representation of the difference between the low-fidelity and high-fidelity prototype.

The High-fidelity prototype developed for an application is a software system, and it can be created in different programs and program languages such as Unity, Xcode, Xamarin, Android Studio, or Visual Studio.
In the iterative cycle, of evaluating and redesigning the prototype and the higher the fidelity, the collected feedback may not be sufficient for further redesigns, as test participants might see the high-fidelity prototype as an almost finished solution and therefore be less critical. This should be taken into account when evaluating the prototype and discussing the results (Helen Sharp, 2019).

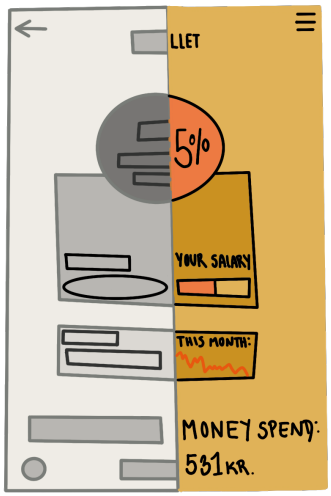


Figure 5.3: Low-fidelity Prototype vs. High-fidelity Prototype

5.6 The Wizard of Oz

The Wizard of Oz method is used as user-research method. The user will interact an interface which is to some extent controlled by a human. The Wizard of Oz method is a way of testing designs, which will require higher technical solutions with lower cost technologies.

5.7 The Think Aloud Test

With the think aloud test, the test participants are asked to express their thoughts on what they see, do and feel while testing the product. Different tasks will be provided for the participant, to execute in the product.When testing with the think aloud method, two different protocols are used: Concurrent Think-Aloud, where the participants talk about their thoughts during a task and Retrospective Think-Aloud, where the participants talk about their thoughts after a task.

Figure 5.4: Think Aloud Test

While performing the tasks, the participants are also being observed and notations about their behaviour can be written down. This can also lead to subjective observations, therefore other methods should be used to back up the data from the observations (Panagiotidi, 2021).

5.8 Semi-structured interviews

In semi-structured interviews some of the questions have been prepared, whereas others are not. The questions that are prepared is asked, but the interviewer can, for instance, as about certain details or part of the answer, in order to achieve other or more qualified answers. The semi-structured interview can be seen as a mix between the structured and the unstructured interview. A problem with the semi-structured interview could be bias-research, where the interviewer by mistake will ask leading questions. If this is not the case semi-structured interviews can also lead to more detailed information (George, 2023).

5.9 System Usability Scale

The System Usability Scale (SUS) is a questionnaire with 10 items. Each item has five scale steps from strongly disagree to strongly agree. The odd-number items has a pos-

itive tone and the even-numbered items has a negative tone. The test participants are given the questionnaire after they have tested the product. The participants should answer the SUS questionnaire before any interview or discussion. The system usability scale is reliable and is tested to give consistent results. It is used to provide overall information about the usability (Jeff Sauro, 2012).

	The System Usability Scale Standard Version		Strongly disagree				Strongly agree
			1	2	3	4	5
1	I think that I would like to use this system.		○	○	○	○	○
2	I found the system unnecessarily complex.		○	○	○	○	○
3	I thought the system was easy to use.		○	○	○	○	○
4	I think that I would need the support of a technical person to be able to use this system.		○	○	○	○	○
5	I found the various functions in the system were well integrated.		○	○	○	○	○
6	I thought there was too much inconsistency in this system.		○	○	○	○	○
7	I would imagine that most people would learn to use this system very quickly.		○	○	○	○	○
8	I found the system very cumbersome to use.		○	○	○	○	○
9	I felt very confident using the system.		○	○	○	○	○
10	I needed to learn a lot of things before I could get going with this system.		○	○	○	○	○

Figure 5.5: The System Usability Scale (Jeff Sauro, 2012)

Studies show that SUS provides consistent results when it is used. So, if different people test the same system with SUS, they are likely to give similar evaluations of how user-friendly the system is. SUS is sensitive to different changes and will detect them as well. So, if the system has been changed to make it easier or more difficult to use, the SUS will detect these changes. The ability to detect these changes makes SUS valid and reliable, the changes you make will always be represented in the answers from the participants. Making it easy for you to see if the changes are negative or positive. With a reliability at or a bit above 0.90 when testing a larger group of people, making the SUS not only an overall usability test but highly reliable as well. The SUS's ability to detect changes and the consistency with the results makes it a reliable and valid tool for testing the usability of the product (MED206, 2024).

5.9.1 Sample size and the representation of it

When testing it is important to look at the sample size and the representation of it. The sample size needs to be of a size big enough to be able to get a valid and reliable evaluation of the data. This does not equal to a sample size as big as possible. Moreover it is important that the sample size represent the intended target group. For example, a testing of a snowshoe will not give adequate results if tested on sample size of 1000 people how surf. If the snowshoe is tested on a representing target group such as Arctic explores and if the sample size is 10, the results will be valid and reliable, despite the much smaller sample size (Jeff Sauro, 2012).

5.9.2 Repressentativeness vs. Randomness

An ideal sample size consists of randomly choosing within the population.

It's ideal that the sample size is also chosen randomly from the population, but this can be difficult. People who participate in tests, surveys and studies have different personality traits and qualities compared to people who doesn't participate in such things. Therefore it is also important to understand the bias of the data you collect. Always aim to minimise any possible biased decisions. It is also important to remember that repressentativeness is overall more important than randomness (Jeff Sauro, 2012).

5.9.3 Calculation of the SUS score

The System Usability Scale is calculated with a SUS score. The average SUS score is 68. Anything below 68 is considered to be below average and anything above is considered to be above average. It is important to note, that the SUS consists of both positively and negatively worded items. The items must be converted first when calculating the data:

- For the positive worded items, which are the odd-numbers, we must subtract one from the user response: x-1.

- For the negative worded items, which are the even-numbers, we must subtract the user response from 5: 5-x.

The converted user responses are added up and multiplied by 2.5. The reason for multiplying is to get the range from 0-100 instead of 0-40 (Jeff Sauro, 2012).

When the SUS score is calculated the 95% confidence interval can be calculated as well. The 95% confidence interval is in some ways similar to margins of error. It is actually twice the margin of error. Confident intervals are used to provide a measure of the uncertain parameters and give a 95% confidence that the data lies between the parameters. The degrees of freedom is also calculated with the 95% confidence interval, where the sample size is subtracted by 1 and calculated from that to take out a potential outlier (Jeff Sauro, 2012)(MED206, 2024)

5.9.4 The SUS Score Range

Depending on how high or low the SUS score range is, a product can be given a grade from F to A+. In the table below it is shown what SUS score range determines the grade and the percentile range (Jeff Sauro, 2012).

Table 8.6 Curved Grading Scale Interpretation of SUS Scores

SUS Score Range	Grade	Percentile Range
84.1–100	A+	96–100
80.8–84	A	90–95
78.9–80.7	A–	85–89
77.2–78.8	B+	80–84
74.1–77.1	B	70–79
72.6–74	B–	65–69
71.1–72.5	C+	60–64
65–71	C	41–59
62.7–64.9	C–	35–40
51.7–62.6	D	15–34
0–51.7	F	0–14

Figure 5.6: The SUS score Range (Jeff Sauro, 2012)

Chapter 6

Design

In this chapter the process of working on the intended design and the low -fidelity prototype will be presented along with how the design principles were included. Thoughts of the low-fidelity test and an ideal iterative design process will be discussed. A link to the low-fidelity prototype can be found in Appendix A.1: Figma Prototype.

6.1 Design principles

In the iterative process of brainstorming design ideas, the design principles were kept in mind. The following principles were examined for use: *visibility*, *feedback*, *constrains*, *consistency* and *affordances*. These design principles determine the interface and functionality of an interactive product.

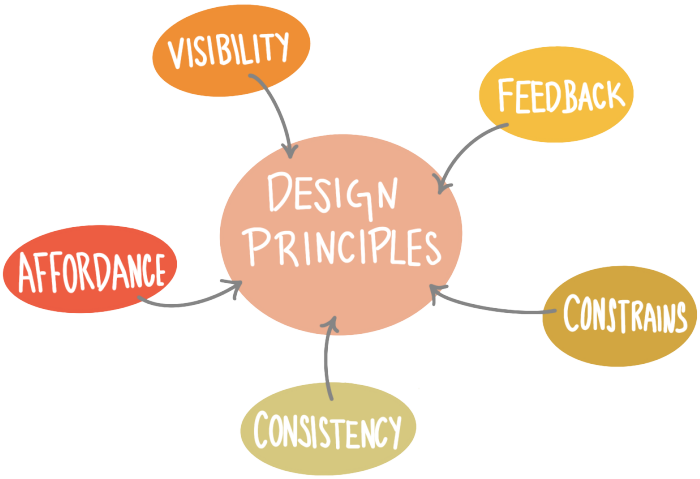


Figure 6.1: The Design Principles

6.1.1 Visibility

It is important that the functions are presented clearly with no confusion, and that the users are able to find all the functions (Helen Sharp, 2019). In the application a clear representation of every feature is prioritised, to make sure that everything is visible for the user.

6.1.2 Feedback

Feedback is the design principle of when a user i told whether a task have been completed or not. When giving feedback to the user, it is also important that it is not with a delay. This will confuse the user and make them question, whether the task have been completed or not (Helen Sharp, 2019).
When clicking on the red button at the bottom of the screen, a red square appears around the screen and the button says ”stop” instead of ”start”. This provides visual feedback for the user, in order to let them know that the task has been done and accomplished. In general when clicking on different buttons, the user will be directed to the clicked page with no delay, this also gives feedback to the user, letting them know the tasks have been done quickly.

6.1.3 Constraints

Constraints restricts the user for when interacting with the product. The design of the product prohibits the user of doing something unwanted (Helen Sharp, 2019). Since it is a prototype, the feature of calling authorities or an actual phone number is unwanted. Therefore screenshots of fake calls will be presented, while the users are not able to actually call anyone.

6.1.4 Consistency

Consistency means designing similar elements that need to do similar task (Helen Sharp, 2019). In this application consistency is sought for when designing UI-elements. When adding safe routes, friends and groups a similar plus sign is presented.

6.1.5 Affordance

Affordance is an attribute of the object, allowing the user to create another form of usage for the product than the indented purpose (Helen Sharp, 2019). For the application the purpose of the it should be clearly informed, in order to keep user from misusing the application.

6.2 First Iteration

6.2.1 Our Low-fidelity Prototype

In terms of the iterative design process, a low-fidelity prototyping method was used, to design a simple prototype, which could quickly test if the intended design would be useful and easy to use. One of the benefits with a low-fidelity prototype is that its functions and elements easily and quickly can be modified to improve the design idea or try out different design ideas. These easy and quick modifications is an important step of our iterative design process to develop a final solution.

6.2.2 Figma

The design process started with prototyping in Figma, which is a prototyping tool. In Figma elements can quickly be changed and altered along with, text and pages, there-

fore we decided that it was a good idea to use, for creating the low-fidelity prototype. We created a Figjam board from our doable design to quickly visualise our ideas for the app, focusing on function rather than visual design. This also means that we did not focus on colours, since it is not important when we are low-fidelity prototyping. When we were done with the Figjam board we created the different elements in a design file where we were able to make it interactive and testable. It is important to note that when designing the Figjam board, the requirements created from the usability goals and user experience goals were kept in mind to always make sure that the target group was in our consideration. We had our target group in mind and what they required, to again make sure that the prototype was designed for their needs.

6.3 The first test of the prototype

We wanted to test the low-fidelity prototype as quickly as possible. We were interested in collecting feedback about the applications functionality and to see if the idea was clearly presented. We therefore decided to test the prototype on our classmates. We chose to aim for a sample size of 10 participants. First we tested with both men and women, but could quickly conclude that we had to test only the target group. The rest of the tests was with women in the age of 18-30 years. The participants were asked to solved some tasks given by us, moreover they were asked to *Think Aloud*. While testing the prototype we made observations. After the test they were asked to answer the SUS questionnaire. All of the methods are described in the *Method* chapter.

6.3.1 Changes made after the first test

After testing our Figma protoype, we made some quick changes. We have presented the visual changes in this table:

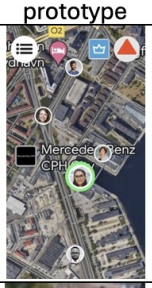
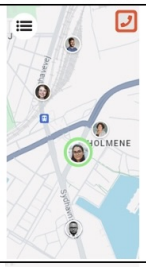
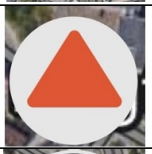
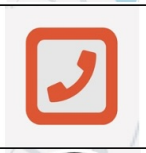
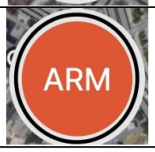
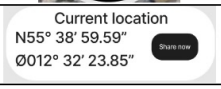
	The tested prototype	Changes made after the test
The Map		
Emergency Button		
Alarm/Tracking Button		
Current Location		

Figure 6.2: The prototype before and after the first test

6.3.2 Map

When testing, we quickly figured the importance of a less confusing map. Too many not important elements were taking the focus, for instance, small icons. We learnt that a simpler map would create less confusion for the user and create more visibility of the other functions.

6.3.3 Tracking button

We changed the text on the tracking button from ”ARM” to ”START”. Some of the test participants commented that they were unsure about the purpose of the feature. It was not visible enough for them, which created confusion. They thought they were going to warn their friends about being in danger. The purpose of the button is to start and stop the users own tracking when going home at night. We were aiming to create visibility, and therefore had to change the text on the button. By changing the text, the feature of the button were presented more clearly.

6.3.4 The emergency call icon

After the test we looked at the design principles again. The emergency button was not visible for the user, the feature was not presented clearly. This resulted in people getting confused when asked to call an emergency contact. We changed the map to make the emergency call button stand more out and we also changed the icon to be a red phone, making it visible and clear for the user.

6.3.5 Renaming

The test participants commented on the ”emergency info” page. Some where confused to whether it was their information or someone else. Others were confused about why it was located in settings. Again, looking at the design principle: visibility, we knew it should be more visible to minimise any confusion. We renamed it to ”my emergency info” and put it under my profile instead of settings, so it was easier to understand and find.

6.3.6 A second test?

As written in the beginning of this chapter, we would have liked to have a proper iterative design process. Ideally this would mean, that we tested our updated prototype, to see if the changes we made minimised the confusion found in the first test. But according to time restrictions we were not able to do a second test. Instead we have made the *doable design* to an *intended design*, containing all the changes we collected on the first test. The *intended design* will be tested later on in our *Evaluation* chapter.

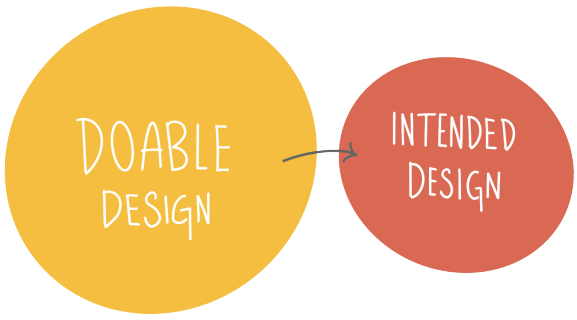


Figure 6.3: From *doable design* to *intended design*

6.4 Intended design

To ensure we followed our requirements and developed an application with the changes from the first test, we made a flow chart in Figma to visualise the intended design. With the flow chart (see chart below and in Appendix A. 2: Flowchart) we were able to better visualise some of the requirements and see the flow of the intended application. In this visual representing we could see if we were missing any important features in advance of implementing the design. In the next chapter we will decide on a suitable program for implementing the intended design, which will be the *high-fidelity prototype*.

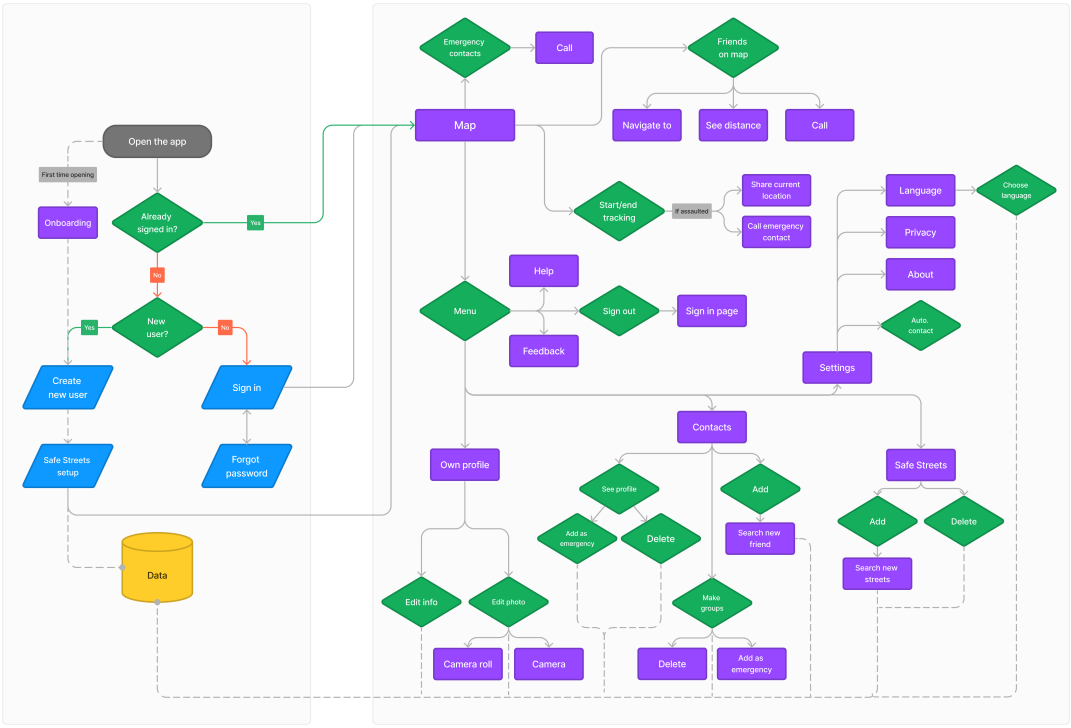


Figure 6.4: Flow chart of the intended design idea

Chapter 7

Implementation

In this chapter it will be presented how the implementation of the design and the technical parts of the application is created. The MAUI framework is used to implement as much as the design from the Figma prototype as possible through code as well as a interactive map and an alarm button. The implemented code was inspired by the use of AI-tools, such as CoPilot and can be seen with a link to a vidoe from Appendix: A.3: Video walkthrough of .NET Maui prototype. The GitHub repository can be found in Appendix A.4: Night Knight Repository.

7.0.1 The high-fidelity prototype

The *high-fidelity prototype* is created with a suitable program for developing an application. The *high-fidelity prototype* can not be changed as easy as the *low-fidelity, which* is important to note before beginning the development. When designing a *high-fidelity prototype*, colours can now be a bigger part of the design. We created a colour pallet in Figma.

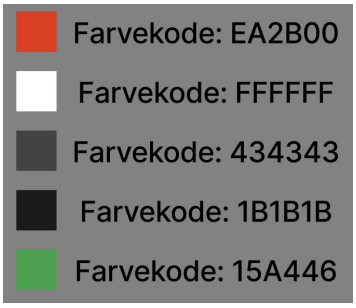


Figure 7.1: The colours used for the high-fidelity prototype

7.1 .NET Maui vs Unity

We initially thought Unity would be a sufficient and efficient way to create the application since Unity has a build in function to create mobile application. We quickly learned that even though it is possible, Unity is a game engine as we felt that creating an application not meant for gaming would be forcing something on Unity that it was not build for. Another main reason was that a key function in the application - The map was hard to implement using Unity because the few map SDK's which is build for Unity have a focus on gaming, meaning that it was difficult to do what we wanted to do. We therefore decided to shift to the .NET Maui framework that is build for creating cross-platform apps and using the C# language.

Variable	**Unity**	**.NET Maui**
Focus	Games	Apps
Language	C#	C# and Xaml
Editor	Yes	No
Group platform knowledge	Medium	None
Arc Gis Map	Very limited	Supported

Table 7.1: Unity vs .NET Maui

7.2 .NET Maui

.NET Maui (.NET Multi-platform App UI) is a recently launched framework that is deprived from Xamarin. It is launched by Microsoft and therefore utilises the C# language for functionality and XAML for markup of the UI. The .NET MAUI is a cross-platform and the idea is that it can create applications for multiple platforms from a single code base and include specific code parts and dependencies for Android, iOS and Windows. As a benefit, the UI elements compile down to use the target platforms native controls (“What is .NET MAUI”, 2024).
.NET MAUI works by having two layers of code that builds different parts of the application. C# scripts which consists of classes, methods and variables and XAML (Extendable application markup language) - Based from XML that deals with UI and graphical representation. C# is therefore in the .NET MAUI framework also referred to as the ”code behind” (“What is .NET MAUI”, 2024).

7.3 Intended design vs possible design

With our designed elements in our Figma low-fidelity prototype, we could implement the applications features and the visual starting point into .NET Maui. The design created in Figma was, as described in the *Design* chapter, the *doable design*. Here features such as an *onboarding page* for when the application was opened for the first time was created. After reading this page it lead to a *sign in page* with the possibility to press on buttons if the user had *forgot password,* needed to *sign in*, or *create new profile*. After the first test of the *low-fidelity prototype* we made the *intended design*. The *intended design* included design such as; must have an implemented *mobile application backend* to handle *data processing, storage and security* of the user profiles. Moreover, the *intended design* should have a *map* with different features, a *menu* with features and pages useful for personalised setup, and the application should be able to *run in the background*.
With a new program to learn it was only assumed that it would be a challenge implementing the application. As the challenges turned into bigger holes, to get out of, the course was changed and the *intended design* became the *possible design*.

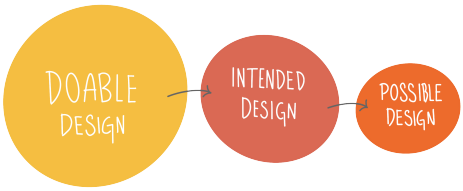


Figure 7.2: From *doable design* to *intended design* to *possible design*

The *intended design* and what was possible for us to implement to .NET Maui is listed below and can be seen in Appendix A.5: Intended vs. possible design. The possible design will provide a functionality given prototype, which can be tested with the target group to collect data to help answering the FPS.

The green check mark indicates what has been possible to implement. The red marks indicates what has not been possible to implement. The green check mark with parentheses means what has been implemented, but is not not fully working as intended. The red marks with parentheses means what has been implemented, but not possible to work with the finale high-fidelity prototype as intended.

INTENDED DESIGN	POSSIBLE DESIGN
Onboarding page (first time opening the app)	X
Sign in page	(X)
Create new profile page	(X)
Forgot password page	(X)
Safe Streets set-up page (first time using the app)	X
Start/end tracking	✓
Map	✓
Map functions:	
• Compass	✓
• Show current location	✓
• Show friends as pins	(✓)
• Show friends location	X
• Click on friends for more options	X
Click on friends for more options:	
• Navigation to button	X
• See distance	X
• Call button	X
Emergency contact:	
• Call buttons for chosen contacts	✓
Menu	✓

1

INTENDED DESIGN	POSSIBLE DESIGN
Menu functions:	
• Own profile	✓
• Map page	✓
• Contacts page	✓
• Safe Streets page	✓
• Settings page	✓
• Help button	X
• Feedback button	X
• Sign out button	X
Edit own profile and information	(X)
Contacts:	
• Add friends	(✓)
• See friends profile and other options	✓
• Create groups and other options	(✓)
• Delete friends and groups	X
Safe Streets:	
Add routes	X
Delete routes	X
Settings:	
• Language page	X
• Privacy page	X
• About page	X

2

INTENDED DESIGN	POSSIBLE DESIGN
In case of assault automatically:	
• Send message of assault to chosen contacts	X
• Send current location to chosen contacts	X
• Call chosen contacts	X
Mobile app backend:	
• Data processing	(X)
• Storage	(X)
• Security	(X)
General saved settings	X
Run in the background	X

3

Figure 7.3: Intended design and what was possible to implement

7.4 Alarm tracking

For the alarm-function the initial though was to create an alarm, which should only be triggered if an actual attack was detected. This would be analysed from machine learning data from previously recorded video from assaults. Quickly we learned that doing that it would take too long. Therefore a possible solution was chosen instead. In order to get the alarm feature a button was implemented on the map. When the button is pushed it starts reading the phones accelerometer for suddenly high spikes in the data. If five incidents of high movements occur IncidentDetected will be invoked and the alarm will trigger. The implemented code can be found in Appendix A.6: Alarm Tracking 1 and A.7: Alarm Tracking 2.

This is the alarm button in the .NET Maui prototype of the application. The button has been created in Figma and implemented in .NET Maui afterwards.

Figure 7.4: Alarm Button created in Figma

7.5 Map

Implementing the map in the application was more difficult than first anticipated. Firstly a wish was to make use of Mapbox, but learned that the SDK did not support .Net Maui. A decision to use ArcGIS Map was made. Aalborg University have a licence agreement with ArcGIS Map, but running into difficulties when implementing the online functions was not avoided. Functions like turn by turn navigation, share location and showing the friends displayed on the map as interactive pictures were the priorities at fist. Settling for the minimum possible implementation because of time restrictions, ended

up being the solution. Functions such as: showing a map with the location and creating a route to a location tapped on the map and then using the wizard of oz method to show pictures of the friends as icons which was not interactive or live locations of real friends. The code for getting the current location, handling taps on the map and creating routes can be found in Appendix A.8: Map 1, A.9: Map 2 and A.10: Map 3.

This is the final map with the current location, a friend and a created route:

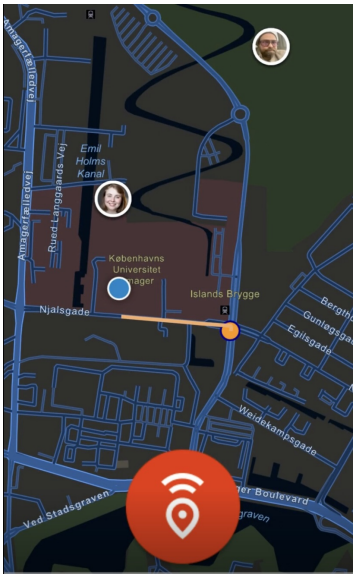


Figure 7.5: The map

7.6 Applications designed in XAML

The UI design of the entire application was made with XAML code. XAML is a XML based coding language, it stands for Extensible Application Markup Language, and is made for .NET framework and thereby .NET Maui. This means that every UI element such as colours, placement, frames, menubar ect. has been created with XAML code. The XAML for the contact page, can be found in Appendix A.11: Contact Page.

This is the contact-page, with pictures of the friends and buttons:

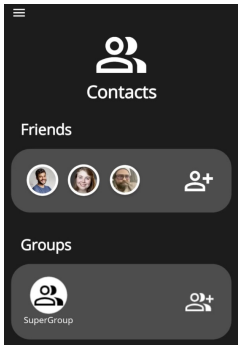


Figure 7.6: The contact-page

7.7 Functions created with Figma

A great part of the different functions were created with Figma, for instance, buttons and other similar features. This was a quick way of changing the functions again if needed. Even though the .NET Maui prototype is the high-fidelity prototype, we still wanted to be able to change functions and buttons quickly. This is some of the functions we designed using Figma:

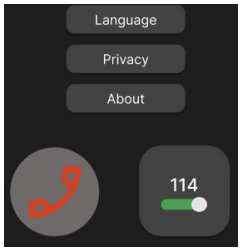


Figure 7.7: Functions created with Figma

Most of the icons in the application were implemented from Google Fonts (Google, 2024), according to time restrictions. This is some of the icons we implemented in the .NET Maui prototype:

Figure 7.8: Icons from Google Fonts (Google, 2024)

Chapter 8

Evaluation

After implementing our high-fidelity prototype in .Net Maui we need to test if the application fulfils our target groups needs. In this chapter we will explain how we will conduct the tests in terms of preparation for the tests, the testing, and an evaluation of our test results. Firstly, we will introduce our motivation for testing our high-fidelity prototype of the application.

8.1 Motivation and evaluation method

The Final Problem Statement states the usability goals; *useful* and *easy to use*, and function *triggers an alarm* with the feature of *using motion sensor*. Our motivation for testing on our target group is to answer our FPS. We therefore want to collect data to acknowledge and understand if the design solution for a safety application derived from the *usability and user requirements* has been accomplished.

To collect test data we will use the methods; *The Think Aloud Test* and *Observation* together with a *SUS* questionnaire, moreover we will conduct a *semi-structured interview*. The use of both qualitative methods; *The Think Aloud Test*, *Observation* and *semi-structured interview*, and a quantitative method; the *SUS* will give us a greater understanding of the collected data to help answer the FPS.

8.2 Preparation for the test

Before the test we have prepared a protocol of how to conduct the tests, this protocal can be found in Appendix A.12: Test protocol. The test protocol is used to make sure that the tests are done as consistently as possible. We aim to collect a sample size of minimum 15 test participants. Preferable do the testing in one day, but depending on the collecting of sample size, more test days must be considered. It is important that we have a high representativeness of our target group to get valid and reliable result to help answer the Final Problem Statement. The protocol is listed in the appendix B.

8.3 The tests

We did four rounds of testing on four days. The test took between 10 and 25 minutes depending on how much feedback the participants shared in the semi-structured interview.

In total we gathered 18 results. All participants were women in the age range of 18-31 years old, and suitable for our target group. The test participants were mostly chosen by randomness. A few test participants were family members or friends of some in the project group, and therefore not chosen by randomness.

8.3.1 Day 1

We went out to The University of Copenhagen on Amager (KUA) to test our high-fidelity prototype. We found a place in one of their buildings with cafe chairs and tables next to an entry with lots of people working nearby and people coming in and out of the building. By two of the tables we put up two testing-stations; including one phone with the prototype which recorded screen touch and audio, another phone with an onboard message, a third phone to backup recording of audio (this was only on one of the testing-stations), print out of prepared protocol, an interviewer, an observer. and cold sodas as thanks for participating in the test. We made sure to have some space in between the testing-stations to not influence the test outcome.

The choosing of the onboard message on another phone, was a minor last-moment thought and we therefore did not have the time to implement the onboarding to the prototype.

The target group were chosen by randomness as the university students passed by we approached them and asked if they had time to test, introduced the test and prototype. The test participants sat at one of the tables, they were then given important information regarding the test. After the information given and the reading of the onboarding message, they were handed the phone with the prototype and we conducted the rest of the protocol.

We collected a sample size of 14 this day. Four of the test participants were friends of some in the project group. The four friends were tested by non-friends of the project group to create as non-biased results as possible. The circumstances of testing is presented in *Figure 8.1: Circumstances of tests*:

Test Subject ID	Location of the test	Acquaintances	Tested by
Test ID: 1	Københavns Univeristet Amager	No acquaintances	Director: Erika Observing: Mathias F.
Test ID: 2	Københavns Univeristet Amager	No acquaintances	Director: Erika Observer: Mathias F.
Test ID: 3	Københavns Univeristet Amager	Friend of Mathias F.	Director: Erika Observer: Mathias F.
Test ID: 4	Københavns Univeristet Amager	No acquaintances	Director: Erika Observer: Mathias F.
Test ID: 5	Københavns Univeristet Amager	No acquaintances	Director: Erika Observer: Mathias F.
Test ID: 6	Københavns Univeristet Amager	No acquaintances	Director: Erika Observer: Mathias F.
Test ID: 7	Københavns Univeristet Amager	No acquaintances	Director: Erika Observer: Mathias F.
Test ID: 8	Københavns Univeristet Amager	Friend of Erika	Director: Mathias J. Observer: Philip
Test ID: 9	Københavns Univeristet Amager	No acquaintances	Director: Mathias J Observer: Nathalie & Johannes
Test ID: 10	Københavns Univeristet Amager	No acquaintances	Director: Philip Observer: Johannes
Test ID: 11	Københavns Univeristet Amager	No acquaintances	Director: Nathalie Observer: Johannes
Test ID: 12	Københavns Univeristet Amager	No acquaintances	Director: Nathalie Observer: Johannes
Test ID: 13	Københavns Univeristet Amager	Friend of Mathias F.	Director: Nathalie Observer: Johannes
Test ID: 14	Københavns Univeristet Amager	Friend of Mathias F.	Director: Nathalie Observer: Johannes
Test ID: 15	At group members home	Friend of Nathalie	Conducted by Nathalie
Test ID: 16	At group members home	Friend of Nathalie	Conducted by Nathalie
Test ID: 17	At group members home	Friend of Nathalie	Conducted by Nathalie
Test ID: 18	Aalborg University Sydhavn	Sister of Erika	Director: Nathalie Observer: Erika

Figure 8.1: Circumstances of tests

8.3.2 Day 2

Two tests were conducted this day. Both participants were tested at home, in an apartment building, by one of the group members. One of the participants were tested in a common area, same test setup as the test at KUA, but without an observer, extra phone for voice recording and a thank-you soda. The other participant were tested in the group members home with same test setup as the first. This participant was a friend of the group member.

8.3.3 Day 3

One participant was tested this day. The test setup was as day 2, but the test was conducted at the participants home. This participant was a friend of the group member who conducted the test.

8.3.4 Day 4

Back at Aalborg University (AAU), our own campus, we conducted the finale test. This participant was a family member of on of the group members. The test was conducted by an interviewer, who was not the family member of the participant, and an observer, who was the family member of the participant.

8.4 Calculation of the SUS score

We calculated the SUS score using Jupiter Notebook. Firstly, we searched for outliers and mistakes; this resulted in removing row 16. Our decision for removing row 16 will be discussed further in the *Discussion chapter*.

The collected data from the questionnaire was converted and calculated as described in the *Method chapter*. The sample mean of the SUS score was 85.88. Comparing the sample mean to the average score of 68, it ends up being almost 16 above the averages score. As the calculated sample size lies between 96-100%, it grades the usability of the application an A+ (Jeff Sauro, 2012).

In the table below, the SUS score calculations from the Jupyter Notebook is shown.

Our SUS score	85.88
Average score	68
Lower 25%	72.5-82.5
50%	82.5-92.5
Upper 25%	92.5-97.5
Median	87.5
The 95% confidence interval	82.10 - 89.65

Table 8.1: Data from the Jupyter Notebook

Below is a visual representation of the distribution of the SUS score in a box plot graph. Here it is shown that:

- The lower 25% of the scores is between 72.5 and 82.5.
- The 50% of the scores are between 82.5 and 92.5.
- The upper 25% is between 92.5 and 97.5.

The median is represented as the orange line at 87.5.

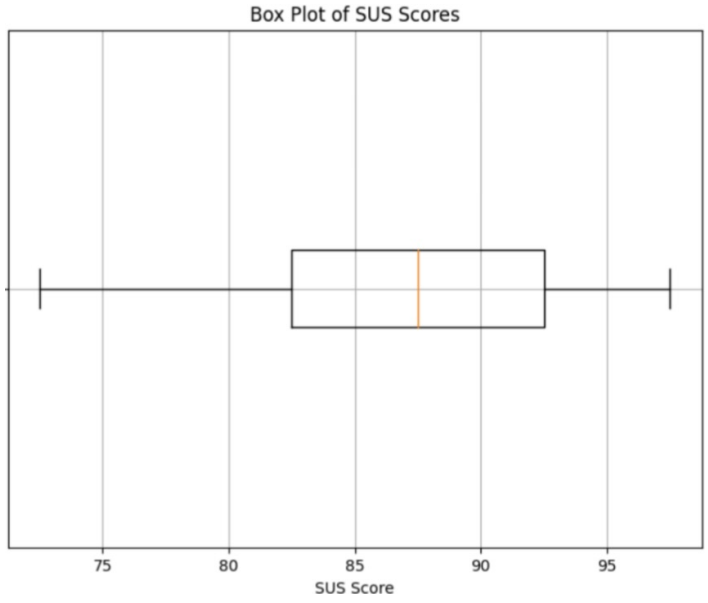


Figure 8.2: Box Plot of the SUS score

8.4.1 Noteworthy SUS questions

The SUS has shown to be a valid method to collect data upon our *usability and user experience requirements*. As the Final Problem Statement states the usability goals; *useful* and *easy to use*, the following three questions asked in the SUS is significant to take a closer look at:

- I think that I would like to use this system frequently.
- I found the system unnecessarily complex.
- I thought the system was easy to use.

This is the results from the first question:

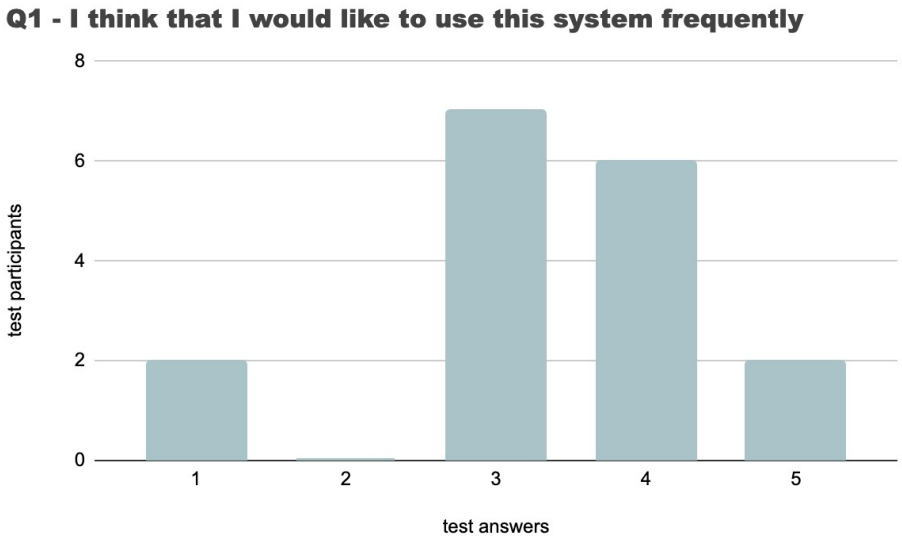


Figure 8.3: Question 1 from the System Usability questionnaire. Answers from strongly disagree to strongly agree.

The second question backs up the third question, and therefore have we included both of them. The result from the second question is as follows:

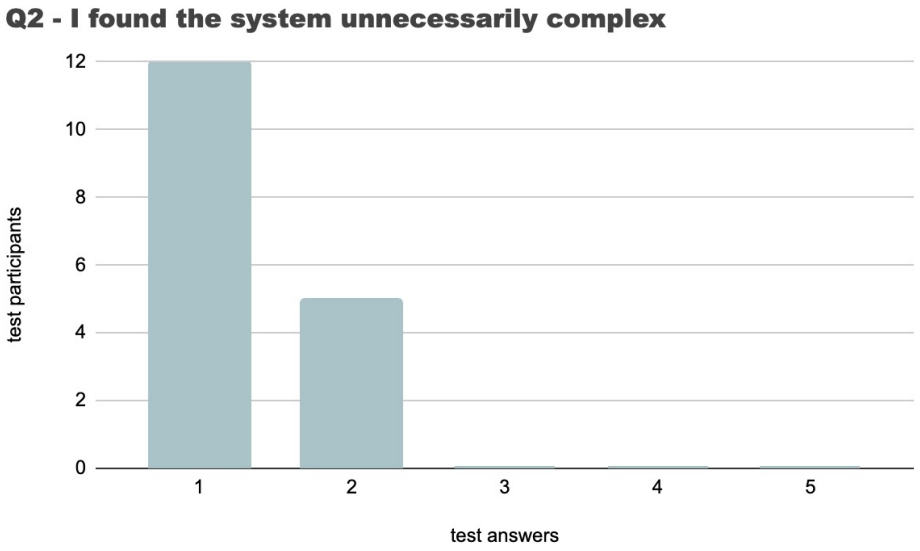


Figure 8.4: Question 2 from the System Usability questionnaire. Answers from strongly disagree to strongly agree.

The results from the third question:

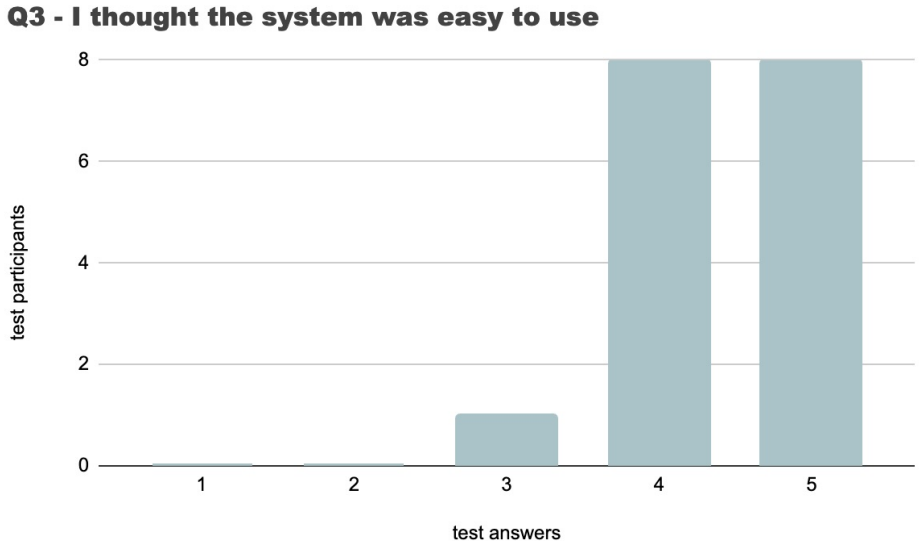


Figure 8.5: Question 3 from the System Usability questionnaire. Answers from strongly disagree to strongly agree.

8.5 Interview

The last part of the test consisted of a semi-structured interview, asking the test participants about their thoughts of the experience and the application. Statements from these interviews were collected afterwards, and sorted into negative or positive statements on certain subjects. The statements were put together in a table, in effort to convert the qualitative answers into quantitative data. The table can be seen below, and will be discussed in the *Discussion* chapter.

Themes		Frequency	Quote examples
App Navigation	Positive	7	ID 11 "The app was very intuitive and finding things and pages was easy"
	Negative	0	
Location tracking	Positive	8	ID8: "It was great that you can see the location of friends, and check if they made it home"
	Negative	0	
Concept of App	Positive	5	ID3: "A very good alternative to the classic "Text me when you're home" method"
	Negative	0	
UI Design	Positive	4	ID 7: "It is great that the alarm button is big and visible, and that the entire app is simple and manageable"
	Negative	4	ID 10: "I felt unsure whether the alarm button was active or not, because the icon on the button was confusing"
Contacts and friends	Positive	12	ID 7: "Very nice that you can keep track of your friends, makes much more sense to have in such an app, rather than using Find my iPhone"
	Negative	1	ID 6: "It would be nice to add emergency contacts, before you start using the tracker for the first time"
Map feature	Positive	8	ID 13: "I liked the map function and that I can see my own and my friends location"
	Negative	4	ID 6: "The map is a bit confusing, and it does not create the fastest route possible, which is not very cool if you are scared or uncomfortable"
Conveying why a person should download the App	Positive	0	
	Negative	3	ID 18: "I think that some kind of On Boarding info would help a lot, I feel like I missed an intro for the app"

Figure 8.6: Table of qualitative statements

Chapter 9

Discussion

When testing a prototype various challenges can emerge which can affect the test results. To ensure that the collected results are valid and reliable, we will in this chapter discuss the potential biases and how the results might have been affected by such.

9.0.1 Digging into the tests

Surroundings of the test

The surroundings of the tests were mainly caused by the desire to avoid testing other students at AAU. The reason for this is that all studies and groups of each semester are testing their project at the same time, which causes students to get used to being tested multiple times a day, and maybe growing weary of it. Therefore, we decided to conduct the tests at the KUA, to ensure that our subjects were as unbiased and representative of our target group as possible. The tests were only conducted on women in the ages of 18-30 years, to make sure that they were a part of our target group.

These were the main preset conditions of the test, made to achieve representative results of our target group. In some cases, the test might have been interrupted or there could have been distractions in the surrounding area of where the tests were executed, because we tested in a public place and we cannot guarantee this has not had an influence on the tests. The lack of a private test room with no influence of external factors was justified by the desire for unbiased results by subjects that are not over tested in their everyday. But to get more accurate data, an improvement in the experimental de-

sign would be a private test room in which we could conduct the test, without the test subjects being affected by external factors, such as by passers or another test being conducted nearby (MED206, 2024).

In the beginning of each test, the participant were specific told that they were testing a prototype, and if something seemed difficult, it would most likely be because of the prototype and not their abilities. This was to said in effort to try and make the participants more comfortable and less scared of trying the application. Telling the participants that it was a prototype was also a part of trying to get more honest answers, because most people tend to be less critical of a high-fidelity prototype, in order to not hurt the developers feelings. By telling the participants that they should *Think Out Loud* when testing, we encouraged the need for their feedback. These factors might have had the wished effect, so that participants became more honest. But there is a possibility that it had the opposite effect on some of the participants, resulting in less honest feedback, since they either thought it was not a finished product, or that they possibly did not pick up that it was a prototype.

Target Group

During the test of the participants, we did encounter a few test participants who did not feel unsafe or uncomfortable when travelling at night. This means that some of the tests were done on participants who did not fulfil a criterion from the *target group*. To improve this a larger sample size of test participants would make the result be less affected by removing the test participant that did not meet the criteria. Another improvement could be to ensure that the test participants fulfil all criteria before the testing. By doing so it might exclude possible outliers.

Other lacking or missing preparation in protocol or testing

Various factors were lacking or missing, which we have reflected and discussed on how to improve. In the table below the various lacking and missing factors are presented with an idea on how to improve.

What was lacking or missing?	Improvement
Missing Audiofiles.	Always have a backup phone recording.
Some tests were done in english.	Only test Danish citizens to avoid a language barrier.
Some test participants were known by people in the group which might have created biases.	Don't test people we know.
Different interviewers and observers might have given different results.	The same people should test, to prevent differences in testing.
Multiple "participant 1	Give the test participants numbers.

Figure 9.1: Table of lacks and improvements

As mentioned in the *evaluation*, we set up two testing-stations, one of which included*a third phone to backup recording of audio*. This was done in case of the recordings on the *phone with the prototype* were compromised. Moreover, the observer wrote down details when testing. At the other test-station we did not record backup audio with a third phone, this was a miscommunication in the group. Furthermore, we decided to pause the recording while the test participants answered the SUS questionnaire. A few times this resulted in us forgetting to start the recording again. Therefore, we are missing some audio files from the interview part of our test, and we have not been able to listen to the interview again to see if we may lack some information or to check if something is misinterpreted by the observer. Next time we should make sure to always have a back up phone to record audio at all test-stations and set up rules for the recording.

A couple of the tests were done in English and the rest of them in Danish. This can have had an impact on especially the English test participants, since English was not any of the involved native language and there is a possibility of a language barrier. An improvement might be to only test on Danish participants.

Some of the participants were known to members of the group, which could have had an impact on the answers to the test being more positive than it would have been otherwise. In most cases we tested the application on people we did not know personally, but an improvement might been to never test anyone known personally, as they might be potential biases.

Furthermore, we might have had an influence on the participants during the tests

and since we used different interviewers and observers from the project group during testing this was not consistent throughout all the tests. Differences in how we have worded the tasks and questions, and how the participants understood the tasks and questions can have had an impact on the success or failure of them being able to give valid and reliable feedback. For example, we had some issues with the participants having difficulty differentiating between *contacts* and *emergency contacts* in the application. As well as some misunderstandings when asked the task; *make a route to a friend,* a pin on the map, some of the participants wanted to find their own friends addresses on the map. An improvement would be that the interviewer and the observer are the same for each test, to make all parameters as similar for each test as possible.

In the test preparation there were a couple of things we did not anticipate would be a problem for ourselves in the evaluation of the test. For example, we asked the participants to jump during the testing and because we recorded from the test-phone the audio got loud and scrambly during so. This was more a fault of not thinking about making it joyable for ourselves to listen to later in the process, than a flaw in validity or reliability of the data. Another example is that we did not give the participants a ID number which got a bit confusing afterwards since we had multiple "participant 1". This minor, but time consuming, mistake, could have been prevented if we had prepared a testing sheet with ID numbers.

9.0.2 The SUS method

Introducing the SUS questionnaire

It might have been a good idea to make a short introduction of the SUS to the test participants, before them answering the questionnaire. In the book (Jeff Sauro, 2012) they suggest introducing the test participants to the questionnaire, so they for instance are aware about the questions changing from negative to positive. Though the SUS questionnaire is proven to be reliable and valid, we did encounter an outlier. Multiple factors will determine why outliers are possible when conducting the SUS, we do not have the answer as to why this SUS result specifically became an outlier. Some of the test participants explained why they answered as they did, while answering the questions. If all test participants had explained their reasoning for their answers, it could have

helped us understand why the outliers came to be. A consequence of all participants explaining their answers can be that they might incline to not tell us the truth. Therefore, an introduction to the SUS and understanding of the changing positive and negative questions, can be the best solution to ensure no outliers. It is important to note, that the test participants who explained their answers, where not encourage by us to do so.

Outlier

The encounted outlier answered five to the first three questions, which means they strongly agreed to that they *found the system was easy to use* while also answering that *the system was unnecessarily complex*. This is a common mistake, where people mean to answer correctly but forgets to reverse their score and therefore accidentally agreeing to a negative question (Jeff Sauro, 2012). As written before, this outlier could possible had been avoided if the SUS questionnaire had clearly been introduced for the test participant. It is possible that there could be even more outliers, who we have not detected as they did not create a noticeable pattern like the outlier we did remove.

The SUS score

The finale SUS score ended up being 85.88, with a 95% confidence interval between 82.10 - 89.65. As written in the *Evaluation* chapter it is 15.88 above averages. It lies between 96-100% and gives the usability of the application an A+ grade. This is the highest grade on the SUS score range, and needs to be taken into consideration. From the book written by Sauro & Lewis, they explain the SUS is sensitive to users' experience with a product. As seen here on page 200:

"There is also evidence from multiple sources that the SUS is generally sensitive to differences in the magnitude of users' experience with a product such that users with more product experience tend to provide more favorable ratings" (Sauro & Lewis, 2016).

We did not ask users for their experience with applications like this, so we cannot rule out if there is more favorable ratings because of this, but we tried to counter this by getting test participants from KUA instead of AAU where we know that people tend to have more experience with apps and tests like these in general. This could still lead to potential biases with the SUS score.

9.0.3 Usability goals: *Useful* and *easy to use*

A partial state in the FPS, was to make the application *useful* and *easy to use*. As presented in *Noteworthy SUS questions* in the *Evaluation* chapter, the SUS questions measured the partial state. To check whether or not people found the application *useful,* we evaluated question one seen in the figure below. Here the participants where asked the question *I think I would use the system frequently.* The average answer were 3,6 out of five, which showed that people to a greater extend found the application useful. The question of usefulness is a perspective of how useful they think the concept of the application is, which could change depending on how the participants fulfil the criteria. A few participant said that they did not feel unsafe when going home at night, and perhaps as written earlier; if ensuring the test participants fulfil all criteria, would the test result then had been different?

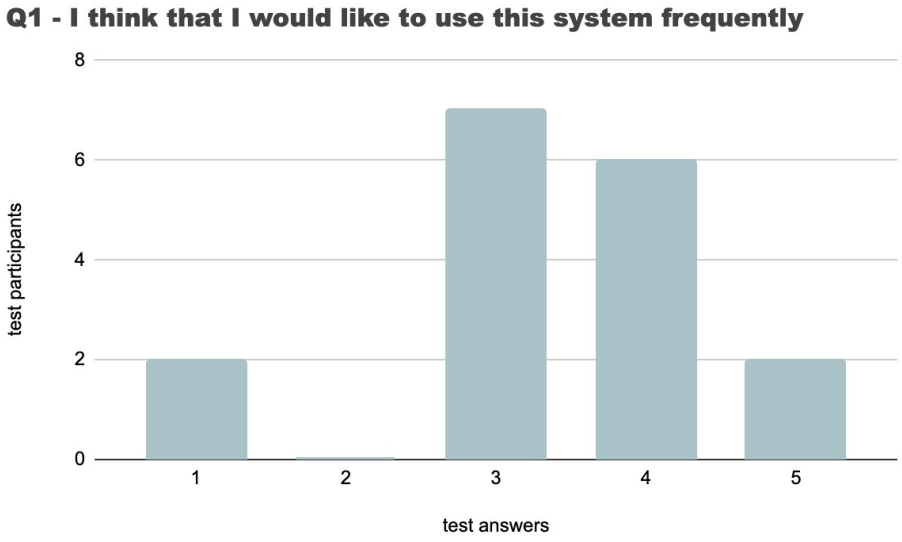


Figure 9.2: Figure of question 1 from *Noteworthy SUS questions*

As seen in the two figures below, the participant did not *find the system unnecessarily complex*, and all except one participant rated the application four or five out of five on *I thought the system was easy to use*. These two questions shows that the test participants in general found the application easy to use.

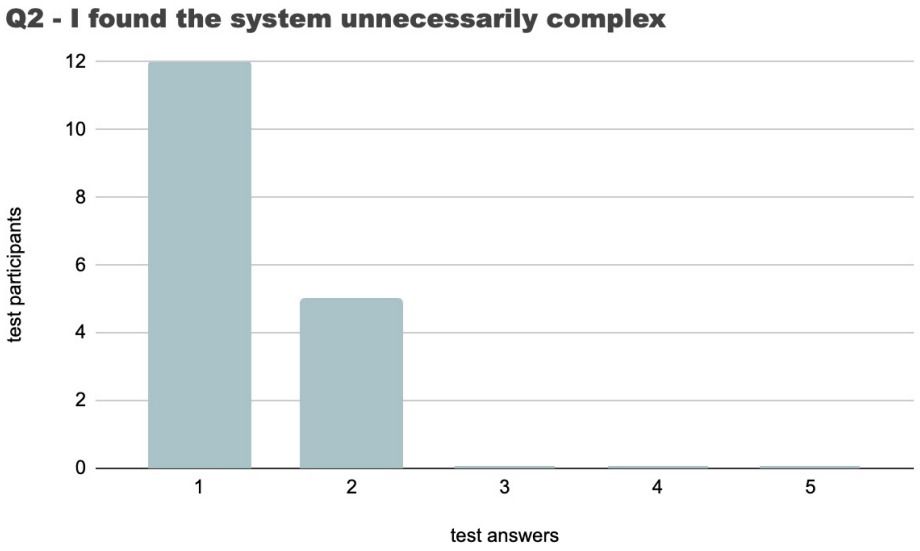


Figure 9.3: Figure of question 2 from *Noteworthy SUS questions*

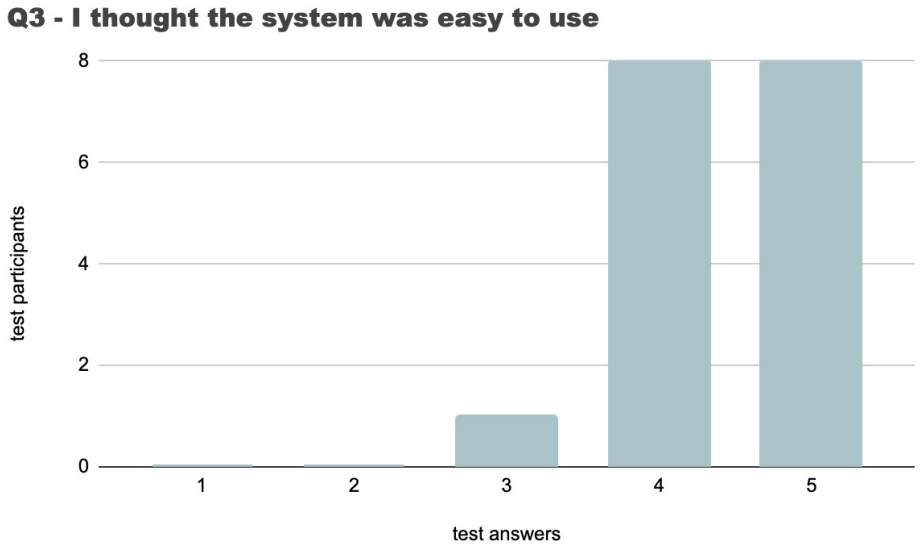


Figure 9.4: Figure of question 3 from *Noteworthy SUS questions*

9.0.4 The semi-structured interviews

During the interviews a pattern started to become more clear, and many test participants made statements on the same subjects. Both the positive and negative state-

ments on the application were in some ways similar. As mentioned in the *Evaluation* chapter, we will discuss the statements in the *Table of qualitative statements* in more details in the following sections.

Themes		Frequency	Quote examples
App Navigation	Positive	7	ID 11 "The app was very intuitive and finding things and pages was easy"
	Negative	0	
Location tracking	Positive	8	ID8: "It was great that you can see the location of friends, and check if they made it home"
	Negative	0	
Concept of App	Positive	5	ID3: "A very good alternative to the classic "Text me when you're home" method"
	Negative	0	
UI Design	Positive	4	ID 7: "It is great that the alarm button is big and visible, and that the entire app is simple and manageable"
	Negative	4	ID 10: "I felt unsure whether the alarm button was active or not, because the icon on the button was confusing"
Contacts and friends	Positive	12	ID 7: "Very nice that you can keep track of your friends, makes much more sense to have in such an app, rather than using Find my iPhone"
	Negative	1	ID 6: "It would be nice to add emergency contacts, before you start using the tracker for the first time"
Map feature	Positive	8	ID 13: "I liked the map function and that I can see my own and my friends location"
	Negative	4	ID 6: "The map is a bit confusing, and it does not create the fastest route possible, which is not very cool if you are scared or uncomfortable"
Conveying why a person should download the App	Positive	0	
	Negative	3	ID 18: "I think that some kind of On Boarding info would help a lot, I feel like I missed an intro for the app"

Figure 9.5: Table of qualitative statements

Map features

The applications navigation, location tracking and the general concept of the application received only positive comments, and was broadly accepted by the participants. The supporting SUS question one; *I found the system unnecessarily complex* the participants answered one or two, and the SUS question two; *I thought the system was easy to use* they answered four or five. This may also be a frequent comment, because they were forced to create an opinion on it, when answering the questionnaire.

Sensor triggered alarm button

The design of the application was divided equally in positive and negative statements, yet still a feature that was on the mind of many test participants, even though they were not asked directly to form an opinion on the matter. The statements on the UI design was mostly regarding the alarm activation button. Three out of four negative loaded statements on the UI design was confusion of whether the alarm button was activated or not. The alarm buttons different states can be seen in *Figure 9.6: The alarm button on and off states*. Three out of four positive statements said the the alarm button was very visible and direct. This means that the current design of the alarm button is not entirely wrong, and that most people would understand how to use it. But in order to make it as understandable and obvious as possible, a change of design might be necessary.

Alarm button on

Alarm button off

Figure 9.6: The alarm buttons on and off states

During the interviews there were made statements towards the functionality of the alarm. Some of the test participants showed fascination with the sensor triggered

alarm. The idea of the application automatically contacting the right authorities and chosen contacts when the alarm has been triggered was received with joy amongst participants. One of the statements was 7 saying *"It's smart that the app contacts your emergency contacts automatically, rather than you have to call them up yourself"*. This amongst other statements confirmed the likes of having an application that automatically make calls.

Contacts & Friends

According to the interview a majority of the test participants liked the features from contacts and friends, where 12 positive loaded statements were made, and the only negative loaded statements were regarding an upgrade for how the emergency contacts are added. This means that a community in the app, consisting of friends, family or alike, might be a very important feature for feeling safe.

Chapter 10

Conclusion

In this chapter a closer look will be taken at the Final Problem Statement (FPS) to see if it fulfilled its expectations. An examination of the project will be conducted in effort try to conclude the most relevant results. Based on the conducted research a prototype of an application was created, which was tested on the target group at Copenhagen University on Amager (KUA). The results from these tests were analysed and a System Usability Scale (SUS) score was calculated. Finally the results, potential biases and future work was discussed.

The Final Problem Statement is as follows: *How can we develop an useful and easy to use safety application for women in the age of 18-30 that triggers an alarm by using motion sensors?* We would have liked to create an useful and easy to use application. The requirements for the application was based on the usability and user experience goals. This was the reason behind choosing the SUS to help answering the FPS as correctly as possible. The requirements were used to guide the design process and ensure that the target group was kept in mind. The SUS was used to calculate if the requirements were fulfilled, and conclude on the FPS.
’

When testing the application, the SUS questionnaire was used. The application was tested with the target group; women age 18-30. The SUS score of the application was calculated to 88.85, which scores an A+ grade on the SUS score Range. From the SUS score, we can tell that the application has a high usability, based on the results from our tests.

When looking at the three questions focusing more on usefulness and if the application is easy to use the results are clear. The test participants states that the application is easy to use and not complex, but there is room for improvement with the usefulness part. The majority of the test participants answered three out of five on the question; *I think i would like to use this system frequently*. Stating that they do not either strongly agree or strongly disagree with the question. This part was also discussed in the discussion, stating that if the test participants were told more about the purpose of the application, the results might have been different.

A motion sensor was implemented, which triggered an alarm by shaking the phone. The motion sensor got positive feedback from the test participants, even though the idea behind it was not fully developed. They found it nice that the alarm was triggered when a movement was detected. This information will be noted in our future development of the application.

In conclusion the Final Problem Statement was effectively addressed with the results from the SUS indicating that an useful and easy to use safety application could be created for women in the age of 18-30. Furthermore, the application has shown a potential on how to create an application that triggers an alarm by using motion sensor.

Chapter 11

Future Work

In this chapter we will look at which kind of future work can be done. A part about the *ideal design*, the *intended design* and what we learned from our tests will be looked closer upon. The concept of the different designs are the same as earlier chapters in the report, but some changes and updates have been made along with the testing and development of the application. Therefore the sections of future work should be seen as design development, depending on how much extra time an resources could be spend on the project.

11.1 Ideal design

If the circumstances made it possible to keep working on the application, some features would be more defining for the application than others, in order to create the *ideal design*. Some of the following features and implementations are the same as from the *ideal design* in the *Requirement specifications* chapter. Others are upgrades based on comments received during the test of the application.

One thing we learned from the tests of the product, is response time for creating a route on the map is too slow. Along with this feature, an upgrade for the route creation is needed, so that the route always will be as quick and easy as possible, whilst taking transportation method into consideration.

A big part of the application which still needs to be fully implemented, is the sign

in system. This should be fully functional for the *ideal design*, and it should also be possible to add friends and emergency contacts, as a part of this flow before going to the main page.

Another important and time consuming which need to be implemented, is the assault activated alarm, which needs a lot of time and machine learning in order to be fully implemented. It is the feature that will take the majority of the time and resources to implement, yet also maybe the most important one. The alarm should be able to tell the difference between a fall and an assault. If an assault is detected, and alarm message will also be send to emergency contacts. The message for emergency contacts should contain information of location and time of assault along with a guide on what the emergency contact should do and how to act on the emergency.

11.2 Intended design

During development of the prototype there were some things we did not have time to implement. This was, for instance, a fully functional sign in-system with sign in and out possibilities, a way to recover the password of the user and to create a profile that is added to a database. Right before creating a profile an onboarding page should also be presented, as in the prototype, to present the user to the application and give context to how it can help/be used, when feeling unsafe.

A feature that we also had in the low-fidelity prototype was a pop-up page for friends on the map. The idea is that it is possible to click on friends, and through a pop-up page either create a route to them, tell them that you feel unsafe, call them, or go to their profile for more information.

Lastly to get the application a little further, all pages in the flyout menu should be fully implemented. The pages that are set up in the application, but lack content and full implementation is Safe Streets, Profile, Contacts, Settings and pages under settings. The implementation of these pages does take some time, but could fairly quickly be implemented compared to other feature upgrades from ideal design.

All of these functions would help giving the application a more finalised feeling, and pushing it a step closer to the ideal design.

11.3 Takeaways from evaluating the application

Through the evaluation we learned that the icon for tracking was not intuitive, clear or easily recognisable as on or off. This is something we would like to change should we pick up this project again in the future. We have seen this done with a *play* and a *stop* button in the application *Let us know*. This would probably be the next iteration and something we would have to test again to see if it would make the tracking button more intuitive and clear to use.

It was not clear for the test participants that they were able to find their friends on the map. A possible solution to this could be to make the icons a bit bigger and/or might also be solved by having onboarding page for first time users when opening the application.

When participants were asked to create a route on the map, many of them tried to draw a line or got confused when the application did not respond immediately. For future work the response time of creating a route should be shorter, and the route should be as efficient and quick as possible. In general more features should be introduced in the application, which will happen with an onboarding, when a user opens the application for the first time.

Statements on the overall design of the application from the tests were very ambiguous, but it will need some more time and originality, which was not prioritised when developing the application the first time around.

Bibliography

Jeff Sauro, J. R. L. (2012). *Quantifying the user experience*. Elsevier Inc.

Tutenges Sébastien, H. M., Krøll Lea Trier. (2014). Forbyggelse i nattelivet. *Center for rusmiddelforskning*. https://pure.au.dk/ws/files/84855428/Forebyggelse_i_nattelivet_2_.pdf

Media, E. (2016). Watcher følger dig sikkert hjem. https://www.elektronista.dk/watcher-foelger-dig-sikkert-hjem/#comments

Eby, K. (2019). The power of iterative design and process. Retrieved May 8, 2024, from https://www.smartsheet.com/iterative-process-guide

Helen Sharp, Y. R., Jennifer Preece. (2019). *Interaction design: Beyond human-computer interaction, fifth edition*. John Wiley & Sons, Inc.

Martina Raue, S. E. L., Bernhard. (2019). *Perceived safety - a multidisciplinary perspective*. Risk Engineering.

Björklund, E. A. (2021). 5 reasons to combine qualitative and quantitative research. Retrieved May 9, 2024, from https://www.questback.com/blog/5-reasons-to-combine-qualitative-and-quantitative-research/

Madsen, F. S. (2021). Min kæreste ringer til mig, når hun er på vej hjem fra byen. Retrieved May 20, 2024, from https://nyheder.tv2.dk/samfund/2021-03-18-min-kaereste-ringer-til-mig-naar-hun-er-paa-vej-hjem-fra-byen

Panagiotidi, M. (2021). Think-aloud testing for usability: How to get more out of your data. Retrieved May 8, 2024, from https://uxspot.io/think-aloud-testing-for-usability.html

Raphael, S. (2021). Text me when you get home posts go viral after sarah everard's death. Retrieved May 20, 2024, from https://www.edinburghnews.scotsman.com/news/people/text-me-when-you-get-home-meaning-of-instagram-message-that-went-viral-following-sarah-everard-disappearance-3164168

Tan, F. (2021). The differences between low fidelity vs. high fidelity prototyping. Retrieved May 8, 2024, from https://www.protopie.io/blog/low-fidelity-vs-high-fidelity-prototyping

Madsen, F. S. (2022). Kvinder er utrygge, når de skal hjem fra byen – klar til at ringe 112 og bruge nøgler i selvforsvar. Retrieved May 20, 2024, from https://nyheder.tv2.dk/samfund/2022-02-11-kvinder-er-utrygge-naar-de-skal-hjem-fra-byen-klar-til-at-ringe-112-og-bruge-noegler-i-selvforsvar

Steensen, M. (2022). Datalogistuderendes nye app følger dig sikkert hjem. https://www.sdu.dk/da/om_sdu/institutter_centre/imada_matematik_og_datalogi/nyt_fra_imada/letusknow

Cormie, A. (2023). How google pixel watch knows when you fall. *Google: The Keyword*. Retrieved February 29, 2024, from https://blog.google/products/pixel/google-pixel-watch-fall-detection-ai/

for et tryggere natteliv, A. (2023). *Diskrimination og grænseoverskridende adfærd i det københavnske natteliv*. Retrieved February 29, 2024, from https://sexogsamfund.dk/files/media/document/Rapport%20%20-%20Diskrimination%20og%20gr%C3%A6nseoverskridende%20adf%C3%A6rd%20i%20det%20k%C3%B8benhavnske%20natteliv%20-%202023.pdf

George, T. (2023). Semi-structured interview | definition, guide & examples. Retrieved May 8, 2024, from https://www.scribbr.com/methodology/semi-structured-interview/

Kommune, K. (2023a). *Dybdegående tryghedundersøgelse af belysning og tryghed i aften- og nattetimerne 2023*. Epinion Copenhagen. Retrieved May 22, 2024, from https://www.kk.dk/sites/default/files/2023-06/Dybdeg%C3%A5ende%20Tryghedsunders%C3%B8gelse%20af%20belysning%20og%20tryghed%20i%20aften-%20og%20nattetimerne%202023.pdf

Kommune, K. (2023b). *Københavns kommunes tryghedsundersøgelse 23*. Epinion Copenhagen. Retrieved February 13, 2024, from https://www.kk.dk/sites/default/files/2023-06/Tryghedsunders%C3%B8gelsen%202023_0.pdf

TryghedsFonden. (2023). *Trygfondens tryghedsmåling 2023*. Retrieved February 14, 2024, from https://www.tryghed.dk/viden/tryghedsmaalinger/download-tryghedsmaaling-2023

Denmark, S. (2024). Siréne. Retrieved May 21, 2024, from https://wearesirene.dk/

Google. (2024). Google fonts. Retrieved May 22, 2024, from https://fonts.google.com/icons

Inc, A. (2024a). Brug af nødopkald sos på dit apple watch. Retrieved May 21, 2024, from https://support.apple.com/da-dk/108374

Inc, A. (2024b). One app to find it all. Retrieved May 21, 2024, from https://www.apple.com/lae/icloud/find-my/

Inc, A. (2024c). Use emergency sos on your iphone. Retrieved May 21, 2024, from https://support.apple.com/en-is/104992

MED206, G. (2024). *Ux mini project* (tech. rep.). Aalborg University.

Play, G. (2024). Sos alert | emergency safety. Retrieved May 21, 2024, from https://play.google.com/store/apps/details?id=com.rghvsapp.android.sosalert&hl=da&gl=US

Råd, D. K. (2024). Nabohjælp - fordi naboskab bare virker. Retrieved May 21, 2024, from https://nabohjaelp.dk/

Usability.de. (2024). It is the user who decides on the success of your products. Retrieved May 9, 2024, from https://www.usability.de/en/usability-user-experience.html

What is .net maui. (2024). https://learn.microsoft.com/en-us/dotnet/maui/what-is-maui?view=net-maui-8.0

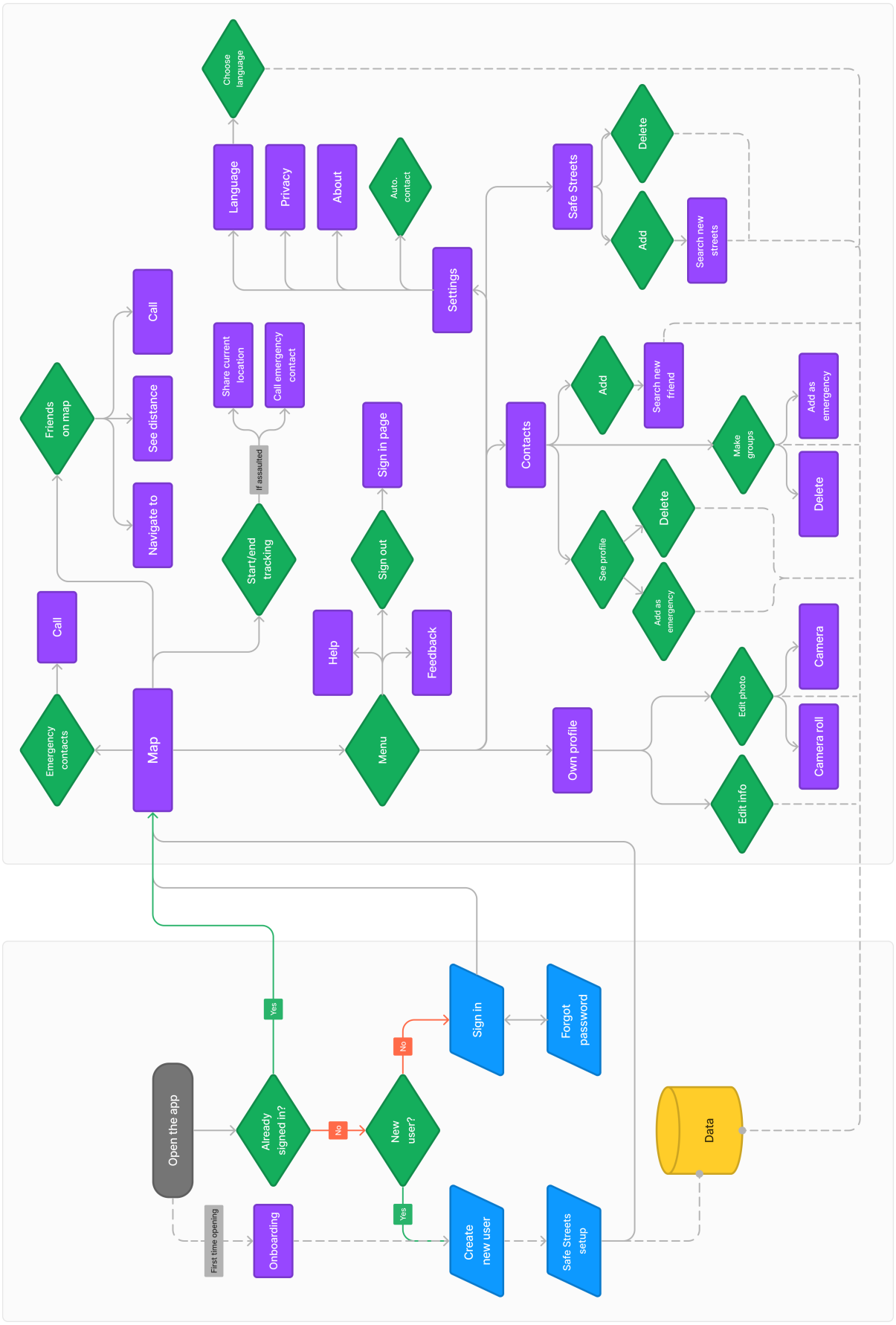
Appendix A

Design, Implementation and Tests

A.1 Figma Prototype

https://www.figma.com/proto/Ht09IAgzTYmHFiUl61V64m/Anden_test_Prototype?node-id=
112-1144&t=5a8bSXN7im2xF3Cq-1&scaling=scale-down&page-id=0%3A1&starting-point-node-id=
112%3A1144&show-proto-sidebar=1

A.2 Flowchart



A.3 Video Walk-through of .Net Maui Prototype

https://f.io/91zZc2hJ

A.4 Night Knight Repository

https://github.com/natconrad/NightKnight.git

A.5 Intended vs. possible design

INTENDED DESIGN	POSSIBLE DESIGN
Onboarding page (first time opening the app)	X
Sign in page	(X)
Create new profile page	(X)
Forgot password page	(X)
Safe Streets set-up page (first time using the app)	X
Start/end tracking	✓
Map	✓
Map functions: • Compass • Show current location • Show friends as pins • Show friends location • Click on friends for more options	 ✓ ✓ (✓) X X
Click on friends for more options: • Navigation to button • See distance • Call button	 X X X
Emergency contact: • Call buttons for chosen contacts	✓
Menu	✓

INTENDED DESIGN	POSSIBLE DESIGN
Menu functions: • Own profile • Map page • Contacts page • Safe Streets page • Settings page • Help button • Feedback button • Sign out button	 ✓ ✓ ✓ ✓ ✓ X X X
Edit own profile and information	(X)
Contacts: • Add friends • See friends profile and other options • Create groups and other options • Delete friends and groups	 (✓) ✓ (✓) X
Safe Streets: Add routes Delete routes	 X X
Settings: • Language page • Privacy page • About page	 X X X

e

INTENDED DESIGN	POSSIBLE DESIGN
In case of assault automatically: • Send message of assault to chosen contacts • Send current location to chosen contacts • Call chosen contacts	 X X X
Mobile app backend: • Data processing • Storage • Security	 (X) (X) (X)
General saved settings	X
Run in the background	X

A.6 Alarm Tracking 1

```
private void Accelerometer_ReadingChanged(object sender,
AccelerometerChangedEventArgs e)
{
    // Update UI Label with accelerometer state

    circularBuffer.Add(e.Reading.Acceleration.Length());
    double mean = circularBuffer.GetMean();

    if (Math.Abs(e.Reading.Acceleration.Length() - mean) > 2)
    {
        incidentCount++;
    }

    if (mean > meanMax)
    {
        meanMax = mean;
    }

    if (incidentCount > 5)
    {
        IncidentDetected?.Invoke();

    }
}
```

Figure A.3: AccelerometerReadingsChanged

A.7 Alarm Tracking 2

```
private void StartTracking()
    {
    Debug.WriteLine("Start Tracking");
    motionAnalyser = new MotionAnalyser();
    motionAnalyser.IncidentDetected += OnIncidentDetected;
    isMonitoring = true;
    ToogleTrackingButtonGreen.IsVisible = true;
 //ToogleTrackingButton.Text = "Stop Tracking";
 ToogleTrackingButtonRed.IsVisible = false;
    }


private void StopTracking()
{
if (motionAnalyser =/= null)
    {
    motionAnalyser.IncidentDetected -= OnIncidentDetected;
    motionAnalyser.ToggleAccelerometer();
    }

isMonitoring = false;
//ToogleTrackingButton.Text = "Start Tracking";
AccelAlarm.IsVisible = false;
ToogleTrackingButtonRed.IsVisible = true;
ToogleTrackingButtonGreen.IsVisible = false;
}
```

Figure A.4: Start & stop tracking

A.8 Map 1

```
public async Task<MapPoint> GetCurrentLocation()
    {
        try
        {
            var location = await Geolocation.GetLastKnownLocationAsync();

            if (location ≠ null)
            {
                return new MapPoint(
                    location.Longitude,
                    location.Latitude,
                    SpatialReferences.Wgs84
                );
            }
        }
        catch (FeatureNotSupportedException fnsEx)
        {
            // Handle not supported on device exception
        }
        catch (FeatureNotEnabledException fneEx)
        {
            // Handle not enabled on device exception
        }
        catch (PermissionException pEx)
        {
            // Handle permission exception
        }
        catch (Exception ex)
        {
            // Unable to get location
        }

        return null;
    }
}
```

Figure A.5: GetCurrentLocation

A.9 Map 2

```
public async Task HandleTap(MapPoint tappedPoint)
{
    switch (_currentState)
    {
        case RouteBuilderStatus.NotStarted:
            ResetState();
            _startGraphic.Geometry = await GetCurrentLocation();
            _currentState = RouteBuilderStatus.SelectedStart;
            break;
        case RouteBuilderStatus.SelectedStart:
            _endGraphic.Geometry = tappedPoint;
            _currentState = RouteBuilderStatus.SelectedStartAndEnd;
            await FindRoute();
            break;
        case RouteBuilderStatus.SelectedStartAndEnd:
            // Ignore map clicks while routing is in progress
            break;
    }
}
```

Figure A.6: handletap

j

A.10 Map 3

```
public async Task FindRoute()
{
  if (_startGraphic.Geometry == null || _endGraphic.Geometry == null) return;
     var stops = new[] { _startGraphic, _endGraphic }.Select(graphic =>
    {
        var geometry = graphic.Geometry as MapPoint;
        return new Stop(geometry!);
    });

    var routeTask = await RouteTask.CreateAsync(
        new Uri("https://route-api.arcgis.com/arcgis/rest/services/World
            /Route/NAServer/Route_World"));
    RouteParameters parameters = await
    routeTask.CreateDefaultParametersAsync();
    parameters.SetStops(stops);
    parameters.ReturnDirections = true;
    parameters.ReturnRoutes = true;

    var result = await routeTask.SolveRouteAsync(parameters);

    if (result?.Routes?.FirstOrDefault() is Route routeResult)
    {
        _routeGraphic.Geometry = routeResult.RouteGeometry;
        Directions = routeResult.DirectionManeuvers.Select
        (maneuver => maneuver.DirectionText).ToList();
        _currentState = RouteBuilderStatus.NotStarted;
    }
    else
    {
        ResetState();
        throw new Exception("Route not found");
    }
  }
}
```

Figure A.7: FindRoute

A.11 Contact Page

```
<Frame
      BorderColor="#434343"
      BackgroundColor="#434343"
      Margin="15"
      Padding="20"
      CornerRadius="30">

 <VerticalStackLayout>
      <Image
          Source="group_add.png"
          HeightRequest="60"
          WidthRequest="90"
          HorizontalOptions="Start" />
      <Label
          Text="Create Group"
          TextColor="White"
          FontAttributes="Bold"
          FontSize="16" />
 </VerticalStackLayout>
</Frame>
```

Figure A.8: Contacts.xaml

A.12 Test protocol

Vi tester ca. 15 testpersoner

Huskeliste til os selv:

- Build på telefonen
- Optag skærm + lyd

- Snacks og vand, både til os selv og testpersonerne?
- Husk briefingen og ikke hjælpe under testen
- Vær opmærksom på fejlkilder fx om vi kender dem vi tester osv.
- En interviewer + en observatør
- Vis dem onboarding siden først

Vigtigt!! Sig alt det her inden testen starter: Vi har udviklet en prototype af en app hvor idéen er at bidrage til et tryggere natteliv.

Vi sætter stor pris på hvis du bare er 100% ærlig, det hjælper nemlig os med at forbedre appen, så du må gerne bare sige lige hvad du tænker.

em Det er en tænke-højt test, så du skal snakke højt imens og sige hvad du tænker og gør. Vi tester vores app og ikke dig, så du kan ikke gøre noget forkert, hvis der er noget som er utydeligt eller svært er det vores fejl.

Hvis det er okay med dig, vil vi gerne optage skærmen og lyden imens du tester. Må vi det? Testen bruges kun i forbindelse med vores opgave og eksamination og du vil selvfølgelig blive anonymiseret.

Vi kommer til at stille dig nogle opgaver, som du på bedstevis skal forsøge at løse, derfor hjælper vi heller ikke under testen.

Når testen er færdig har vi et lille spørgeskema som du skal svare på og et par uddybende spørgsmål.

Opgaver:

- Læs on-boarding siden
- Start tracking
- Tag telefonen i lommen og hop tre gange
- Stop tracking
- Lav en rute til en af dine venner
- Ring til en emergency contact
- Find dine kontakter

- Kig på en ven´s profil
- Tilføj denne ven som emergency contact
- Tilføj en ny kontakt
- Gå ind på din egen profil
- Find safe streets
- Find indstillinger
- Kan du udforske indstillingerne?

Lad dem svare på SUS spørgsmål på Google forms! https://docs.google.com/-forms/d/e/1FAIpQLSdITqmdTtyGXykdacs9aDfopUrIMXqSajsA0Ju1WUNEQ3fSoA/view-form?usp=sf_link

Spørgsmål efter test:

- Har du nogensinde følt dig utryg i nattelivet? Hvis ja, hvornår/hvilke situationer?
- Er det tydeligt for dig hvad appen kan?'
- Er det tydeligt for dig hvad appen skal bruges til?
- Var der noget der skabte frustration for dig ved brug af appen?
- Er der noget du synes der mangler?
- Er der noget du synes kan forbedres?
- Hvad kunne du bedst lide ved appen?