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Designing Mobile Applications to Facilitate Citizen Information Sharing with the Police

Proposing Design Recommendations to Streamline Communication and Emergency Response Measures

Master's thesis in Computer science and engineering

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Abstract

Technological advancements and the widespread use of mobile devices have transformed how citizens interact during emergencies. Mobile applications now play a crucial role in public safety, offering functionalities like embedded cameras and GPS to enhance communication between citizens and law enforcement. However, many existing mobile solutions focus on large-scale crises rather than everyday emergencies, which also require effective communication tools. This thesis is conducted in collaboration with the Swedish Police Authority, and through a user-centred design process, examines current emergency call processes and how they can be improved to enable timely and efficient police response measures. The research began with a literature review of existing studies, followed by qualitative interviews with UX designers, police officers, and emergency operators to identify challenges and user needs in gathering information from citizens. Based on these findings, a requirements list was developed, which served as the foundation for creating a semi-functional app prototype. Key features of the prototype include real-time media sharing, automatic GPS positioning, crowdsourcing, and the reporting of tip-offs. The prototype was evaluated with civilians through usability testing and interviews to 1) assess its usability and overall effectiveness in facilitating emergency communication and 2) discuss it from an ethical standpoint. Overall, participants found the prototype easy to use and saw its potential in practical application. However, concerns regarding user privacy and potential misuse were raised. The study resulted in 11 design recommendations aimed at creating user-friendly mobile applications for emergency communication. These design recommendations are exemplified through the prototype to better demonstrate their use.

Keywords: emergency response, crisis management, mobile applications, design recommendations, crowdsourcing, the Swedish Police Authority, usability, interaction design, computer science, user-centred design.

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William Hugo, Aziz Ibrahim, Gothenburg, 2024-07-09

Acronyms

EN Emergency notification

GDPR General Data Protection Regulation

HCI Human-computer interaction

HIG Human interface guidelines

IxD Interaction design

ISO The International Organization for Standardization

RLC Regionledningscentral (Regional command centre)

UCD User-centered design

UX User experience

UI User interface

W3C The World Wide Web Consortium

WCAG Web Content Accessibility Guidelines

Definitions

Cards Cards refer to containers used in user interfaces to present information in a structured and visually appealing format. They typically contain concise content such as text, images, and sometimes interactive elements, allowing users to quickly grasp information without overwhelming them with excessive detail.

Crowdsourcing Crowdsourcing is the practice of obtaining input, services, or ideas from a large group of people, typically via the internet, to leverage the collective intelligence or skills of the crowd. It is often used by organisations to gather diverse contributions for problem-solving, content creation, or innovation.

Dialog A dialog is a modal interface component that prompts users to make a decision or provide input, temporarily blocking interactions with the main application until the dialog is addressed. It typically includes buttons or fields for user responses, such as 'OK', 'Cancel', or text input.

Emergency response Emergency response involves the coordinated actions taken by first responders, government agencies, and communities to address and manage the immediate effects of disasters or emergencies, such as natural disasters, accidents, or public health crises. Its goal is to protect lives, minimise damage, and restore normalcy as quickly as possible.

Emergency/disaster application An emergency/disaster application is a mobile or web-based tool designed to assist citizens during emergencies or disasters by providing critical information, resources, and communication channels. These applications often offer features such as real-time alerts, emergency contacts, navigation to safe locations, and the ability to report incidents or request assistance.

Modal view A modal view is a user interface element that temporarily blocks the main application screen to focus the user's attention on a specific task or decision. It typically appears as a popup window or overlay, requiring the user to interact with it before returning to the main content.

Regionledningscentral (Regional command centre) Regionledningscentralen (RLC) is a central function within Swedish emergency services and civil protection, tasked with coordinating and directing regional responses to serious

incidents and crises, while collaborating closely with multiple agencies including the police, healthcare providers, and local authorities.

Toast notification A toast notification is a brief, non-intrusive message that appears on the screen to provide users with feedback or updates, and it automatically disappears after a short time without requiring user interaction. Typically, toast notifications are used to inform users of events like received messages, system updates, or completed actions.

User interface A user interface (UI) is the means through which a user interacts with a device or software application. It includes visual elements such as screens, menus, buttons, and icons, as well as navigational components that enable users to interact effectively and intuitively with the system.

User-centred design User-centred design (UCD) is a design philosophy and process that places the end user at the forefront of the design and development process. It aims to create products, systems, or services that are tailored to meet the specific needs, preferences, and limitations of the end users. UCD is iterative, meaning it involves continuous testing and refinement based on user feedback throughout the design lifecycle.

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Introduction

During an emergency, citizens can significantly support emergency centres and police officers involved in response efforts. In an era characterised by rapid technological advancements and an increasing reliance on mobile communication, the role of mobile applications in enhancing public safety has never been more important. The proliferation of smartphones has transformed how individuals interact with each other and their environments, offering new avenues for real-time information sharing and emergency response. With functionalities such as embedded cameras and GPS receivers, citizens can quickly and easily share detailed information about unfolding situations in emergencies [1]–[3]. In this context, the relationship between citizens and law enforcement agencies can be significantly strengthened through mobile solutions that facilitate timely and efficient communication.

During large-scale crises, such as natural disasters or terrorism, popular social media applications like Twitter and Facebook experience a surge in traffic due to the large amount of photos, videos, and locations being shared. These platforms have proven to be effective tools for gathering and disseminating information [1], [2]. At the same time, the development of mobile applications specifically aimed at crisis and emergency communication is increasing. Crisis communication is shifting from being authority-centric, where the public acts as passive recipients of information, towards a paradigm that actively engages with the public through crowdsourcing [1]. However, mobile inventions today mostly focus on large-scale crises rather than everyday emergencies [2]. Therefore, a solution that considers both aspects could be beneficial for effectively addressing the diverse spectrum of emergency situations and assisting police response measures.

1.1 Problem Statement

The Swedish Police Authority has an ongoing pilot project aimed at developing a web system that enables citizens to share photos related to an incident during a call with an emergency operator. Currently, this functionality is available only in certain regions of Sweden. The system works by having citizens receive a web link on their phone from the emergency operator, through which they can then upload photos. It is also possible to retrieve location data from the metadata of the photos; however, this assumes that the user had enabled location services at the time the photos were taken. Similarly, a separate web system exists for sharing location data. It operates

in the same manner by requiring users to receive a web link.

In emergency situations where every second counts, separate systems could potentially slow down communication and police response measures, as citizens may need to perform additional steps to share vital information. Furthermore, the use of web links can pose significant privacy threats to individuals through fake websites designed to mimic legitimate ones, thereby deceiving users into providing sensitive information [4]. Given that high-stress situations like emergencies can diminish users' cognitive abilities [3], users may be more easily deceived to provide sensitive information.

Dedicated emergency mobile applications with added functionality, such as crowdsourcing, could further facilitate communication between citizens, emergency operators, and police officers, ultimately assisting in police response efforts. To develop such applications, several factors must be taken into account, including usability, cognitive load, and accessibility [2], [3], [5]. As such, specific design recommendations should be followed to streamline the design process and ensure the applications are effective and user-friendly.

1.2 Research Question

This thesis aims to investigate emergency call communication and police response measure approaches to identify challenges that hinder information gathering during emergencies. Based on these learnings, the goal is to define a list of requirements that will lay the foundation for the design of a semi-functional prototype. Subsequently, a set of design recommendations will be created to contextualise the prototype, aiming to benefit both practitioners and researchers. A vital part of the process is also to understand citizens' viewpoints towards the adoption of such applications and their ethical implications. The study addresses the following research question:

RQ. *What design recommendations can be proposed for a mobile application aimed at enhancing civilians' ability to share and process vital information during emergency situations?*

Designing a prototype is a central part of the project, aimed at effectively demonstrating the use of the design recommendations. While many studies emphasise data-oriented functionalities — addressing how data is sent out, gathered, and processed, as well as communication-oriented functionalities that encourage interaction between different stakeholders — there is a notable lack of attention given to the visualisation and interface capacities of emergency apps [1].

1.3 Delimitations

During emergencies, emergency operators serve as crucial intermediaries between civilians and the police. Although the aim of this project is to streamline police response measures, the primary focus will be on investigating how emergency communication can be improved between civilians and emergency operators, thereby

indirectly assisting police officers. Therefore, specifically examining the interaction between police officers and emergency operators will not be undertaken.

Since the Swedish Police Authority currently does not have an emergency mobile application directed towards civilians, this project will focus on designing a semi-functional app prototype and providing design recommendations for this purpose. Consequently, no changes to their current web-based systems for gathering information from civilians will be proposed. The final prototype will not be implemented in code, as this would significantly increase the project's complexity and detract from other important aspects such as data gathering, ideation, and evaluation.

Given that high-stress situations like emergencies can diminish users' cognitive abilities [3], the prototype would benefit from being evaluated by simulating the stress users feel during an emergency. However, since the prototype will be limited in its interactions and due to the time constraints of planning and executing a simulated emergency situation with multiple participants, the prototype will mainly be evaluated through usability testing and interviews.

2

Background

This chapter provides relevant contextual information about the project and factors influencing the research. The first section gives a brief explanation of the Swedish Police Authority and an overview of current processes related to the problem area. The following sections covers ethical considerations and the security vetting required for carrying out work within the Swedish Police Authority.

2.1 The Swedish Police Authority

The Swedish Police Authority plays a crucial role in ensuring public safety and reducing crime. Their primary objectives include preventing crime, monitoring public order and safety, conducting reconnaissance, and carrying out criminal investigations. Through crime prevention initiatives, the police aim to decrease the occurrence of criminal activities while enhancing the resolution of crimes. Each year, the government guides the police mission through appropriation directions, setting specific goals to be achieved. The National Police Commissioner, provides strategic direction for implementing these goals, interpreting the mission based on government directives and highlighting priority areas for police work. This collaborative approach underscores the commitment of the Swedish police to maintaining a safe and secure environment for the public [6].

2.1.1 Tools for Enabling Civilians to Share Information

The Swedish Police Authority's current and new approach to enabling citizens to share photos during an emergency is through a web-based system. When citizens call the emergency number 112 and speak with an emergency operator, they can receive a web link via SMS if the operator requests photos of the situation. Through this link, citizens can access a page to upload their photos. A similar system allows citizens to share their GPS position, working in essentially the same way. Since these are separate systems, if both photos and the exact location need to be shared, two different links must be sent. However, with the new system, it is possible to retrieve the exact location data from the photo metadata, but only if the user had location services enabled when the photos were taken. The functionality of the newly developed system is planned to be expanded in the future to also enable sharing of other forms of media, such as videos and audio files.

Another way for citizens to share information is through tip-offs. Tip-offs are for non-emergent situations and can be reported on the official website of the Swedish Police Authority or by calling the national telephone number of the Swedish police, 114 14. This number is intended for matters that do not involve ongoing or recently occurred crimes and incidents.

2.2 Ethical Considerations

As this thesis is conducted in collaboration with the Swedish Police Authority, adhering to their guidelines and restrictions is essential for proper handling of confidential information and protecting participant privacy. This is especially important during the data gathering phase, which may include interview recordings. Therefore, a significant portion of the research will be conducted within the authority's network and stored on their local computers, rather than on external cloud services. Additionally, internal tools will be utilised for recording remote interviews with employees from the Swedish Police Authority and distributing questionnaires. Authorised personnel will manage these processes, ensuring compliance with established protocols and safeguarding sensitive data.

Furthermore, any data gathering involving civilians outside of the authority's network will be conducted with informed consent, in accordance with laws and ethical principles governing research. This involves informing participants about the purpose of the research, the type of information expected from them, and how audio and video recordings will be stored and when or if they will be destroyed [7].

The Swedish Police Authority is subject to laws regarding the tools used, personnel, and the collection and storage of data. Primarily, the police are regulated by the EU General Data Protection Regulation (GDPR). Their processing activities within law enforcement are also subject to the Law Enforcement Directive (2018:1177) and the Act (2018:1693) on the processing of personal data by the police within the scope of the Law Enforcement Directive. These regulations aim to safeguard fundamental rights, facilitate secure information exchange among law enforcement agencies, and ensure that individuals are informed and able to exercise their rights.

2.3 Security Vetting

Before conducting this study, security vetting and training for individuals involved in security-sensitive activities need to be completed [8]. The objective is to ensure that only trustworthy individuals with sufficient security knowledge participate in such activities. Vetting procedures entail a comprehensive assessment of loyalty, reliability, and vulnerabilities, with security level 3 being relevant for this study. Security vetting involves interviews, document verification, criminal record checks, and a personal investigation. Criminal record checks are conducted by the Swedish Security Service. Security clearance is granted after completion of the background check.

3

Theory

This chapter introduces the theoretical aspects of the study. The first section defines Interaction Design and some of its key components, such as user experience, usability, and accessibility. The subsequent section reviews pertinent research that underlies this project. Topics covered include an overview of current mobile emergency app technologies, the role of crowdsourcing in public safety and crime prevention, and the benefits of dedicated apps for small-scale versus large-scale emergencies.

3.1 Interaction Design

Interaction design (IxD) involves designing interactive products and services with a primary focus on how users will interact with them [9]. This goes beyond just creating the physical or digital item itself; it encompasses understanding users' needs, behaviours, contexts, and limitations to tailor the design accordingly. By closely examining these aspects, designers can create interfaces and experiences that are intuitive, efficient, and effective in meeting users' specific requirements and expectations. In essence, interaction design aims to optimise the interaction between users and products/services, ensuring a seamless and satisfying user experience.

Interaction design and human-computer interaction (HCI) are closely intertwined [10]. Historically, HCI had a narrow focus, primarily on the design and usability of computing systems. In contrast, interaction design was seen as broader from its inception. It encompassed not only the design and usability aspects of computing systems but also extended to the theory, research, and practice of designing user experiences across various technologies, systems, and products. However, over time, HCI has evolved significantly, leading to considerable overlap with interaction design.

Interaction design plays a crucial role across various disciplines and fields that focus on developing and researching computer-based systems intended for human use [10]. Figure 3.1 illustrates the core areas involved, alongside interdisciplinary fields such as human-computer interaction that combine aspects of these disciplines.

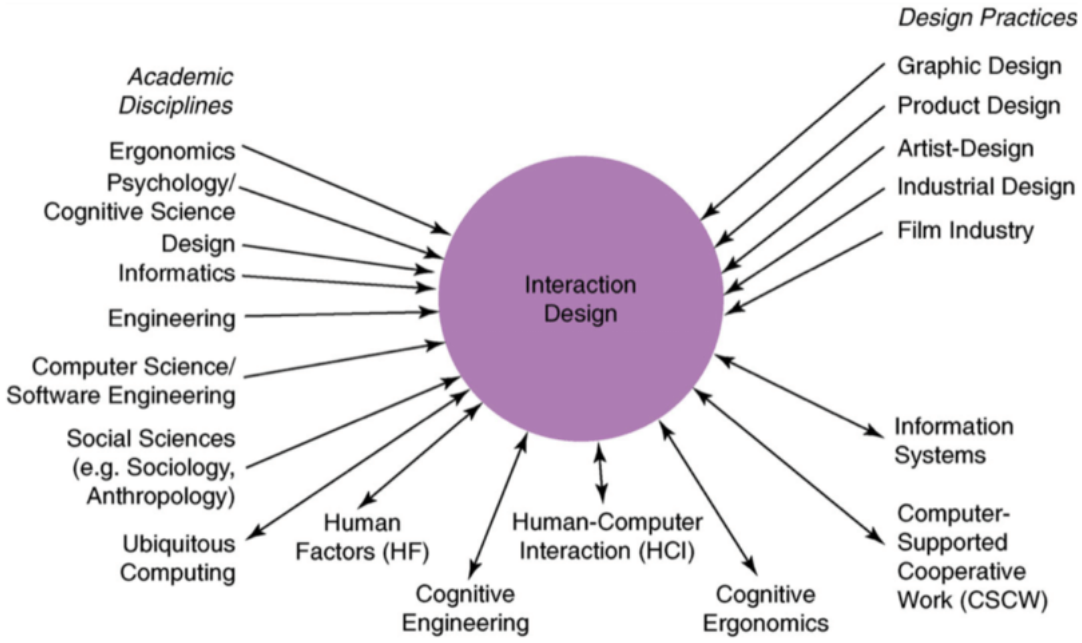


Figure 3.1: Core areas involved with IxD alongside interdisciplinary overlapping fields [10].

3.1.1 User Experience

User experience (UX) refers to the overall experience a user has with a product, including how satisfying and pleasurable it is to use, how intuitive and easy it is to use (usability), and the value it provides. To achieve a good user experience, one has to design with the exact needs of the user in mind. The same design but used in a different context could lead to a different user experience, including a different level of usability [11]. The International Organization for Standardization (ISO) defines user experience as:

> *"Person's perceptions and responses that result from the use and/or anticipated use of a product, system or service."* [12]

Roto et al. [13] explains that UX does not only apply to active use of a product but also to the context in which the product exists. UX can be divided into four time spans: anticipated, momentary, episodic, and cumulative UX. These time spans are visualised in figure 3.2. Anticipated UX refers to the user's expectations of a product before using it, momentary UX concerns the user's feelings during an interaction with the product, episodic UX refers to the user's appraisal of a specific usage episode, and lastly cumulative UX concerns the user's views on a product as a whole, after having used it for a while. Thus, UX includes all the users' emotions, preferences, perceptions, and behaviours that occur before, during, and after using a product, and over time accumulates into a greater experience [12].

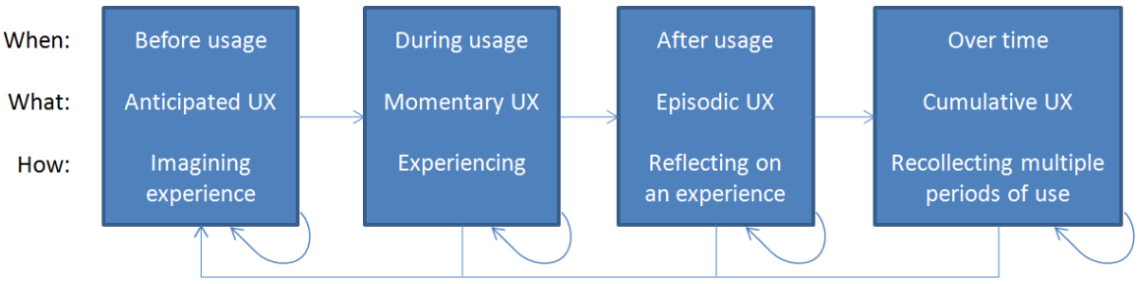


Figure 3.2: The various time spans of user experience [13].

3.1.2 Usability

Usability refers to how easy it is to learn and/or use a product and is vital for ensuring a good user experience. ISO defines usability as:

> *"The extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."* [14]

Usability is defined by five quality components: learnability, efficiency, memorability, errors, and satisfaction [15]. Learnability refers to how easily users can accomplish basic tasks when encountering the design for the first time. Efficiency concerns how quickly users can perform tasks once they have become familiar with the design. Memorability assesses how easily users can return to the design and complete tasks after a period of not using it. Errors refers to how many errors the users make, how severe these errors are, and how easily they can recover from them. Lastly, satisfaction reflects how pleasant it is to use the design.

3.1.3 Accessibility

Accessibility refers to the design of products or services to ensure that they can be used by all people, including those with disabilities [16]. It concerns whether all individuals can access an equivalent user experience, regardless of how they encounter a product or service. There are different types of accessibility issues, including visual, motor/mobility, auditory, seizures, and learning/cognitive. While accessibility features primarily assist users with disabilities, they often benefit all users. For example, accessibility issues can also arise from incidental factors (e.g. sleep deprivation) as well as environmental conditions (e.g. using a mobile device underground). Consequently, many users, regardless of their abilities, may face challenges due to demanding contexts.

The World Wide Web Consortium (W3C) has established standards for accessible design in its Web Content Accessibility Guidelines (WCAG) [17]. Originally created for websites, WCAG has become the best-practice standard for all types of digital interactions, including mobile apps. WCAG guidelines are organised under four principles: perceivable, operable, understandable, and robust. Additionally, the guidelines are categorised into three levels of conformance (success criteria) in order to meet the needs of different groups and different situations: A (lowest), AA (mid

range), and AAA (highest). Over the years, WCAG has been updated to keep pace with evolving technology. Version 2.0 was published in 2008 and is widely adopted today, while versions 2.1 and 2.2 are more recent updates published in 2018 and 2023, respectively. There are currently no separate guidelines for mobile accessibility, but a working draft on how WCAG 2.0 and other W3C guidelines apply to mobile was published in 2015 [18].

3.2 Previous Research

This section presents the findings from the literature review conducted at the start of the project. A detailed explanation of the literature review process is provided in section 5.2.

3.2.1 Mobile Apps in Emergency Response

Tan et al. [1] explain that mobile applications are playing an increasingly crucial role in crisis informatics by managing and improving emergency responses. These applications aim to facilitate interactions that minimise uncertainty and bolster response capabilities. Tan et al. highlight two broad categories of apps used in emergencies: general-purpose apps and emergency-specific apps.

General-purpose apps, such as social media platforms and news apps, are used by the public to find information pre-, during-, and post-emergency events [1]. The interactions of these apps are generally *one-to-one*, *one-to-many*, or *many-to-many*. Twitter and Facebook are some of the most popular and widely used social media apps during emergencies since people favor platforms that are familiar or used on a daily basis. However, authorities involved in handling emergencies remain cautious towards promoting their use due to concerns regarding privacy, information quantity, and content quality. To address these issues, multiple efforts have been made to develop apps tailored specifically to meet the emergency information needs of the public and authorities.

Emergency-specific apps serve one of the following primary objectives: *crowdsourcing*, *collaboration*, *alert and information dissemination*, *information collation*, and *user-generated notification* [1]. The first three objectives focus on enhancing situation awareness by involving the public in the gathering of information, while the last two focus on proper delivery of critical information between authorities and the public. In the case of crowdsourcing for emergency-specific apps, interactions include *one-to-many-to-one* and *many-to-one-to-many*.

Crowdsourcing involve citizens receiving information from a command centre and providing information back to the command centre [1]. Collaboration-oriented apps, on the other hand, allows communities to work together during emergencies and are used as platforms to encourage self-help initiatives. Alerting and information dissemination apps usually have a one-way interaction that consists of authorities sending information to the public. Information collation apps analyse and present information obtained from social media in a digestible format without requiring direct

public involvement. Notification-centric apps make it possible for users to notify others of their situation in the face of an emergency, often incorporating automatic GPS positioning.

Understanding the motivations and adaption patterns of the public towards emergency response apps is crucial. Tan et al [1] underscore the prevalent approach in existing literature, which tends to focus on an authority-centric, command-control perspective rather than considering the public as the primary users. This necessitates research into how emergency-specific apps can better align with and cater to the needs and preferences of the general public.

Another vital area for improvement lies in enhancing the usability of mobile interfaces in emergency-specific apps [1]. While many studies concentrate on data-oriented functionalities: how data is sent out, gathered and processed or 2) communication-oriented functionalities: how interaction will be encouraged between different stakeholders or both, little attention is paid to the visualisation and interface capacities of these apps. A comprehensive emergency-specific app should seamlessly integrate data management, communication functionalities, and user-friendly interfaces to ensure effectiveness during crisis situations. Usability assumes even greater significance in emergency situations since people react differently to stressful situations and thus have different decision-making qualities.

3.2.2 Crowdsourcing for Public Safety and Crime Prevention

Crowdsourcing-specific applications are typically designed for crowdtasking activities, where a crowdsourcer, such as a command centre, delegates parts of the problem-solving process to the crowd [1]. In situations requiring real-time information, volunteers or 'crowdsourcees' may be activated as standby participants — individuals who have previously expressed their willingness to volunteer or contribute. Decision makers in an operations centre could initiate crowdsourcing processes in emergencies to support and enhance their decision-making processes [19].

Past research has explored how crowdsourcing can be leveraged to enhance public safety and crime prevention [20]. Crime can be explained to arise from the confluence of three factors: an offender, a victim or an attractive target, and the presence of social control. Social control can be categorised as either formal or informal. Formal social control is exercised by institutions and professionals entrusted with providing monitoring, safety, or control duties. In contrast, informal social control is exerted by individuals or organisations without the legal authority to act against crimes. The insights provided by informal social control mechanisms can in many cases be crucial for enabling the police to respond efficiently.

One major challenge identified with crowdsourcing is the difficulty in keeping the public engaged over long periods, particularly when the tasks require witnessing crimes, which are infrequent for most people. Some platforms attempt to mitigate this by offering additional functionalities beyond crime reporting, helping to keep the crowd involved and the platform relevant [20]. Ernst [19] explains that organisations must be aware of relevant location-based information and changes to it. When emer-

gency services use crowdsourcing to approximate the current situation in emergency situations, they must recognise both new opportunities and potential problems, such as the quality of crowdsourced information. According to Estellés-Arolas [20], the relatively low rate of formal collaboration with law enforcement agencies suggests an area for potential improvement. Effective partnerships could enhance the impact and sustainability of these crowdsourcing initiatives.

3.2.3 Large-scale and Small-scale Emergencies

Nass et al. [3] state that in large-scale emergencies with a high density of people, typical problems involve overloaded communication lines of the command centre, hindering individuals from seeking assistance or sharing crucial information about the situation, and delays in pinpointing the exact position of the incident, which may exacerbate the severity of the situation. Moreover, inadequate information regarding the number of affected individuals and the physical situation can impede the efficacy of the emergency response plan and endanger its success.

Nass et al. [3] explain that, traditionally, the perception has been that civilians react instinctively in emergencies, displaying behaviours that might appear irrational to observers, such as antisocial behaviour or panic. However, they further note that recent research suggests that such views lack empirical support. Analyses of past emergency incidents reveal that people engage in deliberate decision-making, often exhibiting altruistic acts and maintaining composure while prioritising the safety of themselves and others within their social circles. Nass et al. explain that the presence of others can nonetheless influence decision-making, particularly in crowded situations. In such scenarios, individuals are more prone to deferring responsibility and assuming that others will take action, leading to phenomena like the bystander effect or pluralistic ignorance.

Various stressors can impair cognitive function, particularly diminishing the effectiveness of working memory. This effect is pronounced when individuals have low self-efficacy in managing the perceived threat. Stress-induced reductions in working memory capacity are partly due to the physiological changes associated with the fight-or-flight response. Since decision-making during emergencies relies heavily on working memory, stress can significantly influence both the process and execution of decisions in such situations [3].

While social media applications like Twitter have proven valuable for sharing large amounts of information during large-scale events, Romano et al. [2] argue that existing research mostly focuses on large-scale events where information flow is abundant. However, such information is not easy to utilise in small-scale events where the amount of information generated on social networks is low. Therefore, dedicated emergency notification (EN) applications are advocated to ensure the authorities are informed about small-scale emergencies as well [2]. EN systems enable the collection of real-time data from the incident scene, often utilising inputs from citizens who act as human sensors. This data can include geolocated photos, videos, and text messages, which are essential for forming an accurate understanding of the situation. Consequently, EN systems ensure that accurate and updated information

about emergencies is quickly relayed to both affected individuals and emergency response teams.

3.2.4 Usability Guidelines for Emergency Response Apps

Usability guidelines can be used to create more user-friendly digital products and support the iterative design process by ensuring adherence to best practices from the beginning. Usability guidelines come in many forms, with levels of detail ranging from general design principles to specific usability guidelines and detailed recommendations [21]. In essence, the majority of guidelines are rooted in the general principles of the International Organization for Standardization (ISO), Nielsen's ten usability heuristics, or Shneiderman's eight golden rules on interactive design [5]. These are general principles and can be used in different applications.

While general principles provide a solid foundation for interface design, specific usability guidelines reflect the needs and challenges within specific domains. Tan et al. [5] developed twelve usability guidelines to cater specifically to public-facing disaster apps. The proposed usability guidelines consider concerns raised by end-users and are based on three overarching themes: *make critical information salient*, *account for cognitive load*, and *build trust*.

Make Critical Information Salient

When an emergency occurs, notifications with varying levels of importance may flood in simultaneously, potentially causing users to miss a critical message. Therefore, emergency apps should be designed to ensure that users are not overwhelmed with too much new information. Notifications should be prioritised to give users quick and easy access to important information. According to Tan et al., this can be achieved in different ways, such as through *typographical emphasis*, *accentuating interface elements*, *length of content*, *top-to-bottom structure*, and *audio and sensory stimulus* [5].

Typographical emphasis includes using bold font weight, varying font size, using capital letters, and changing font colour to highlight critical words or information. Similarly, accentuating interface elements through colour helps draw attention to critical information. It is essential to consider accessibility concerns, such as using a colour palette that accommodates users with colour-blindness [5].

Maintaining an appropriate length of content is vital for readability during emergencies. Messages should be short and concise, but not to the extent where important information is left out and the user is forced to find information in other places of the application. Additionally, organising information in a top-to-bottom structure ensures critical information is easily accessible. Highly critical information can be pinned on top so that even if the user scrolls down to read other details, they can still see the pinned message [5].

Audio and sensory stimuli can also aid in alerting users to critical information However, sound notifications should only be used for severe warnings and with an appropriate sound level. A small sound accompanied by vibrations is sufficient for

grabbing attention without overwhelming users. Continuous or loud sounds can be deemed annoying and unnecessary, and users should have the option to mute or adjust sound settings [5].

Account for Cognitive Load

As mentioned in section 3.2.3, stress can diminish the effectiveness of working memory and significantly impact decision-making. Tan et al. [5] mentions different ways to account for cognitive load, including using familiar interface elements, balancing text and imagery, and incorporating maps.

In the event of an emergency, whether the user is returning to the emergency app or using it for the first time, the interface should be familiar and easy to use. One way of achieving familiarity is by utilising existing interfaces that are familiar to users, such as those found in social media applications. The overall design of the application should be simple and minimalistic, avoiding unnecessary information. Additionally, it is helpful to minimise the need for user input; typing can be difficult during times of stress, and too many options and buttons can get confusing and time-consuming [5].

Another way to alleviate cognitive load is to balance text and imagery. Images can attract attention effectively, so whenever possible, textual information should be replaced with images to aid users in digesting information. However, it is important that these images are meaningful and provide added value in conveying content. Additionally, icons can be used rather than just text headlines to enhance user navigation [5].

Maps should also be considered as a replacement or addition to textual alerts. During large-scale events, maps can improve communication of affected areas, evacuation directions, closed roads, and congestion, thereby enhancing situational awareness. Moreover, the application can also provide preparedness details through the use of multi-media to make it more engaging [5].

Build Trust

This theme addresses how to build trust with users to prevent them from uninstalling or not using the application. The challenge lies in establishing trust with an application that may have infrequent interactions [5].

When communicating an emergency, participants initially seek three pieces of information: time, location, and severity of the event. Therefore, it is good practice to communicate critical information concisely and to display the content's origin. Users trust the app and its content when they trust the information source. Furthermore, content feels more relevant when contextualised and personalised. For example, providing recommendations on what to do rather than solely offering general warnings enhances user engagement [5].

The primary reason for users to uninstall an emergency app would be if they perceive it as unreliable. To mitigate this, developers should strive to minimise the impact of

errors and reduce loading time, provide visible system status to indicate that the app is functioning and up-to-date, and show regard to user privacy [5].

4

Methodology

This chapter introduces the various methods used throughout the project, structured according to the different phases of the Double Diamond design process: Discover, Define, Develop, and Deliver.

4.1 The Double Diamond

The Double Diamond is a specific user-centred design (UCD) process. It was popularised by the Design Council in 2004, a British institution aimed at actively advocating for great design and providing skills and knowledge about design [22]. The Double Diamond involves exploring a problem widely (divergent thinking), and at each phase, taking focused action (convergent thinking). It consists of four phases: *Discover*, *Define*, *Develop*, and *Deliver*. The first two phases are part of the first diamond, and the last two are part of the second diamond, as seen in figure 4.1. An important aspect of the Double Diamond is that it is not a linear process, but rather encourages several iterations and allows for continuous improvement.

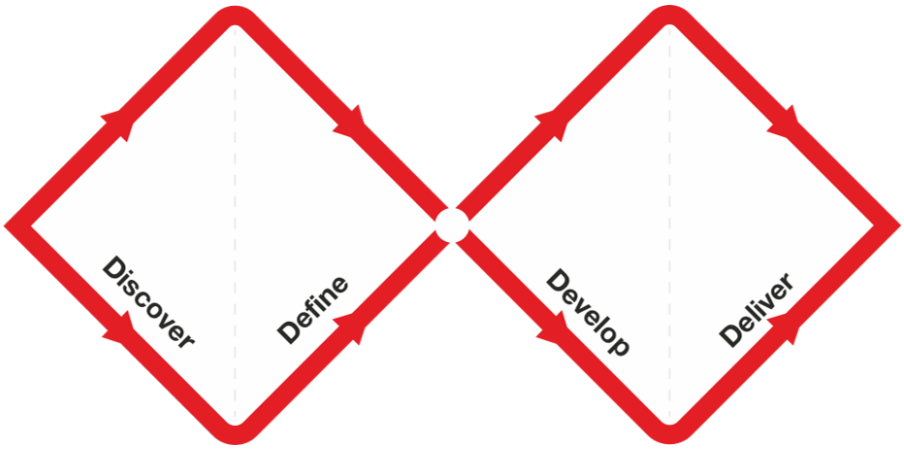


Figure 4.1: The Double Diamond Design Process [22].

Two other user-centred design frameworks that can be used in place of the Double Diamond are the Design Sprint Methodology [23] and Design Thinking [24]. Both frameworks share similarities with the Double Diamond in that they are iterative and emphasise understanding users' needs firsthand. The main difference is that the Design Sprint Methodology and Design Thinking separate ideation and prototyping,

emphasising each phase individually, whereas these stages are included indirectly in the 'develop' phase of the Double Diamond. Additionally, the Design Sprint Methodology includes an extra phase called 'decide,' which focuses on selecting a single idea after the ideation phase.

4.1.1 Discover

Discover is about gaining a comprehensive understanding, rather than assuming, the context of the problem. This is achieved by gathering necessary information central to the issue, and includes speaking to people who are affected by the problem. The Discover phase is an important first step to lay the foundation for the project and ensure that subsequent steps are set up for success.

Literature Review

Literature reviews are a fundamental part of academic papers and can serve as a valuable component for design projects, providing a comprehensive summary and synthesis of a research topic to inform an ongoing project [25]. The goal of literature reviews is to extract the parts that capture the essence of previous research and projects and bring this information together to create a cohesive understanding of the material.The content in literature reviews are usually organised by research category and selected from credible sources that are relevant to the project.

One way of conducting systematic literature reviews is by using a snowballing approach, which is proposed by Wohlin [26] among others. Backward snowballing is the process of going through the reference list of a paper to identify new papers to include in the literature study, while forward snowballing involves identifying papers that cite the paper being examined to include in the study. Before starting the snowballing procedure, the first step is to identify a starting set of literature, for example by using Google Scholar. According to Wohlin, a good start set has the following characteristics:

- Includes papers from diverse communities.
- Not too small of a size (depends on breadth of study area).
- Includes highly cited papers.
- Is diverse in terms of publishers, years, and authors.
- Is compiled from keywords in the research question as well as synonyms to avoid missing papers.

With the identification of the start set, the iterative snowballing procedure can commence [26]. Backward snowballing first involves going through the reference list of a paper and excluding papers that do not fulfil a selection criteria (e.g. language and publication year), as well as papers that have already been examined through either backward or forward snowballing in a previous iteration. The remaining papers are candidates for inclusion. The next step is to examine each paper based on its title, publication place, and the author's previous publishing history in the area of study. It may be more likely for a paper to be included if the authors regularly publish in the area of study, and the publishing place of the paper can reveal important information

about the actual contents of the paper being examined. Once this information has been examined, the next step involves a more detailed examination of the paper to make a conclusive decision on inclusion or exclusion. This includes reading the abstract as well as other relevant sections of the paper.

Forward snowballing is done in a similar fashion to backward snowballing, but the steps are instead performed on the papers that cite the examined paper. Citations are typically identified using citation-tracking features available in large online databases like Google Scholar.

Interviews

Interviews serve as a fundamental research method, providing valuable insights into personal experiences, opinions, and attitudes. In their work, Sharp et al. [10] describe different types of interviews: unstructured-, structured-, semi-structured-, and group interviews. These differ in how much the interviewer steers the conversation. If the purpose is to gain first impressions, an unstructured interview proves beneficial. Conversely, when soliciting feedback, a structured interview may be more appropriate. Semi-structured interviews combines closed questions with the opportunity to explore responses further.

The nature of unstructured interviews, being exploratory, permits flexibility as discussions can take different directions [10]. This is because the interviewer does not expect a specific answer and engages in *probing* by asking follow-up questions. Despite being exploratory, unstructured interviews require some level of preparation regarding topics to cover during the session. A notable advantage is the generation of rich data, revealing insights that the interviewer might have overlooked. Some drawbacks are more time-consuming and harder to analyse.

Structured interviews are based on a predetermined set of questions, ensuring that identical questions are asked for every participant and in the same order [10]. Questions should be concise and clearly worded, and responses should be given from a predefined set of alternatives. Structured interviews are beneficial only when the study objectives are well-defined, and specific questions can be identified. Some advantages include being less time-consuming, easier to control in terms of questions, and easier to analyse. A disadvantage is that they may be perceived as formal and impersonal.

4.1.2 Define

The Define phase is about using the insights gained from the Discover phase to turn these insights into a more approachable problem. Defining the challenge provides additional context to the problem and opens up more possibilities for finding potential solutions. The Define phase involves analysing and synthesising research data and scoping the problem.

Thematic Analysis

Braun and Clarke [27] introduce thematic analysis as a six-step method for analysing qualitative data to identify patterns or themes. Thematic analysis can either be *inductive* or *deductive*. Inductive thematic analysis, known as a 'bottom-up' approach, involves exploring data without predetermined categories or theories. It begins with immersing oneself in the dataset, allowing themes to emerge organically from the data itself. Deductive thematic analysis, known as a 'top-down' approach, relies on theory to guide the exploration of data. It involves applying one or more theoretical frameworks to identify and analyse themes systematically.

Thematic analysis consists of the following six steps: familiarisation with the data, generating codes, searching for themes, reviewing themes, defining and naming themes, and producing a report [27].

Step one involves becoming familiar with the data. This may involve transcribing audio, and reading through the text and taking initial notes.

Step two involves coding the data by highlighting sections of the text and creating shorthand labels or 'codes' to describe their content. Codes should capture interesting features of the data that are relevant to the research question and can be developed at both semantic and latent levels.

Step three involves generating themes, which should capture broader patterns of meaning within the data. Codes with similarities or overlaps are grouped together to form themes, while more complex codes may directly become themes. The identified themes can encompass various aspects, such as behaviours, specific user groups, particular events, the locations or situations where these events occur, and other related factors [10].

Step four involves reviewing the themes by comparing the codes against the full data set. This includes checking if anything is missing, if the themes are truly present in the data, and what changes can be made to improve the themes. If problems arise, themes might need to be split, discarded, or redefined.

Step five consists of defining and naming themes. Names should be concise and capture the essence of each theme. This process helps create a coherent analytical narrative.

Step six involves presenting the findings in written form, though it may also include further analysis and interpretation. It is important to provide clear and compelling evidence to support the analytic claims made about the data.

Affinity Diagramming

Since thematic analysis is often viewed as an umbrella term that encompasses various methods for examining qualitative data, affinity diagramming — also known as the KJ method — can be considered a specific technique within thematic analysis [10].

While affinity diagramming and thematic analysis are relatively similar methods for analysing qualitative data, there are some key differences. Like thematic analysis,

affinity diagramming typically begins with familiarising oneself with the data, such as by transcribing it and breaking it down into subtopics and categories. This is followed by grouping similar data into clusters and labelling the groups [28]. However, affinity diagramming is often a collaborative process and does not involve coding in the same way as thematic analysis. Due to its collaborative nature, this method encourages discussion and may lead to more insights being drawn from the data. Affinity diagramming can be executed either physically, using tools like post-it notes, or digitally [28].

Affinity diagramming is an inductive approach where, instead of grouping data into predefined categories, the process begins from the bottom up by first clustering specific elements into groups. These groups then form the basis for identifying broader, overarching themes and patterns [25].

Defining and Prioritising Requirements

Requirements are statements that specify what a product should be able to do or achieve [10]. These requirements serve as the foundation for the entire development process, ensuring that the final product aligns with the stakeholders' expectations. The process of discovering requirements is iterative, as the understanding of the problem domain and user needs may evolve. This evolved understanding can lead to refinements in the requirements. Requirements typically come in two different forms: functional and non-functional. Functional requirements describe what the product or system should do in terms of specific functionalities or interactions. Non-functional requirements describe the constraints of the product or system, often relating to qualities such as performance, security, and usability. Requirements may also be accompanied by acceptance criteria that specify when a requirement has been fulfilled.

The MoSCoW prioritisation technique is commonly used in project management to help prioritise requirements, tasks, or features [29]. The method categorises items into four groups based on their importance and urgency and stands for 'Must-have', 'Should-have', 'Could-have', and 'Won't-have'. 'Must-have' refers to requirements essential for the project's success and must be included in the final deliverable. 'Should-have' refers to requirements not necessary for immediate project success but add significant value. 'Could-have' refers to desirable requirements that would be nice to include if possible but are not essential. "Could-haves" can enhance the user experience or provide additional functionality but are not critical to the core purpose of the project. 'Won't-have' refers to the lowest priority requirements that will not be included in the current project scope.

User Flows

User flows are diagrams that outline the steps a user can take to accomplish a particular task or goal while interacting with a product [30]. They serve as valuable tools for understanding how users engage with a system and for identifying areas of improvement that can better align with users' needs. User flows are typically depicted using flowcharts, which employ symbols to illustrate the relationships between pages

or screens and the interactive possibilities. For example, rectangles might represent app screens or webpages, lines with arrows indicate the direction of user movement, and diamonds denote decision points where users must make choices.

User flows prove especially beneficial in the ideation phase to explore potential interactions and to evaluate the efficiency of a design in terms of flows that involve too many steps or lead to dead ends [30]. Additionally, they are valuable for identifying potential problems before advancing to the prototyping stage, and for facilitating communication of ideas to stakeholders.

4.1.3 Develop

The Develop phase is about generating ideas and creating potential solutions for the defined problem. Similar to the Discover phase, which involves broad research, the Develop phase encourages exploring diverse solutions to the problem and may involve other people in the design process.

Sketching

Hartson and Pyla [11] describe sketching as the creation of freehand drawings that convey initial design concepts, prioritising concepts rather than details. Sketches play a vital role as long-term design documentation, aiding team members and designers retain understanding of the design and its details during the prototyping and implementation phases. The progression of sketches serves as a timeline of a thought process. However, sketching transcends the mere act of drawing with pen and paper. It isn't solely about creating a visual representation to document a design. Rather, it embodies a dialogue between the designer and the artefact. A sketch serves as a medium to facilitate communication among members of the design team.

According to Buxton [31], the ambiguity inherent in a sketch adds value by allowing room for imagination, even for the person who drew it. He further explains that integrating visualisation into ideation enhances cognitive processes and elevates creativity by engaging additional human senses. This encourages us to view sketching as more of an activity rather than just the act of creating an artefact, and to value the journey of reaching a sketch more than the final product.

Prototyping

The fields of human-computer interaction, software engineering, and design commonly use the term *prototype* to describe a specific kind of object used in the design process [32]. Prototypes prompt reflection, guiding designers in framing, refining, and exploring possibilities within a design space. When prototyping is centred around delineating and investigating a design domain, the crucial aspect is not pinpointing or meeting requirements through prototypes but rather uncovering a representation that in its simplest form encapsulates the qualities designers are concerned with, without distorting the understanding of the whole. Prototypes can be defined by their level of fidelity.

Low-fidelity prototypes are preliminary representations of a product that lack the exact appearance and functionality of the final version [10]. They typically take the form of concept sketches and storyboards, or are constructed with materials like cardboard, paper, metal, and wood. Low-fidelity prototypes are valued for their simplicity, affordability, and quick production time, making them ideal for early-stage development where various ideas are being explored.

High-fidelity prototypes are more polished and closely resemble the final product in terms of appearance, feel, and functionality [25]. They play a crucial role in later stages of development for evaluating aesthetics, interaction, and usability. Examples of high-fidelity prototypes include software systems developed using programming languages or interactive user interfaces created with design tools.

4.1.4 Deliver

The Deliver phase is about testing solutions with users to understand which ones work and which ones do not, and improving those that indicate a positive effect. Testing is conducted on a small scale to identify any potential issues before the full product release. This is important to ensure that the work is moving in the right direction and that the final product aligns with the goals of the project and the stakeholders.

Think Aloud

Think-aloud is a method that requires participants to describe what they are thinking and doing out loud while carrying out tasks, and is one of the most common methods used at the evaluation stage [25]. The think-aloud method helps researchers understand what aspects of a product, digital or physical, that pleases, confuses, and frustrates users so they can be corrected or improved. However, depending on various factors such as the participant's personality or the complexity of the task, the participant may have to be repeatedly reminded to think out loud while performing the tasks. According to Hanington and Martin, a well-structured think-aloud session should prioritise the evaluation of individual aspects rather than providing an evaluation on the usability of the entire product [25]. While this method is predominantly employed for evaluating low- or high-fidelity prototypes, it can also be used to evaluate finished products in the public domain.

Questionnaires

Questionnaires are another form of collecting survey data, with interviews being the alternative method. Similar to interviews, questionnaires can include both open and closed questions. However, a key advantage of using questionnaires is their ability to be distributed to a large number of participants with minimal effort, allowing a substantial amount of data to be collected in a short time period [10]. Additionally, questionnaires enable the participation of individuals from various locations and those unable to attend an interview at a specific time. Since questionnaires are completed individually without the presence of anyone to clarify ambiguities, it is

essential to formulate specific and clearly worded questions and response options. This prevents misunderstandings and ensures an accurate data representation. This necessity is one of the reasons why some may prefer conducting structured interviews instead.

When designing questionnaires, one should ask close-ended questions when possible and provide diverse answer options. Furthermore, negative questions should be used carefully as they can be confusing and may lead to false information. According to Hanington and Martin [25], asking participants to rank their choices by order provides a better indication of preferences than a single checked response. They also explain that Likert scales are recommended when seeking to understand the degree to which participants agree or disagree with a statement, rather than just asking if they agree or not.

5

Process

This chapter outlines the execution of the Double Diamond design process presented in chapter 4. The first phase involved a literature review and interviews with UX designers, police officers, and emergency operators. The second phase included analysing the data from interviews and, combined with the findings from the literature review, defining requirements. The third phase consisted of an ideation session that involved sketching, creating user flows, and developing a sitemap. Additionally, a semi-functional prototype was designed. The final phase involved evaluating the prototype with civilians through usability testing and interviews.

5.1 Redefining the Scope

Initially, the goal of this thesis was to investigate the use of smartphones within police field operations, with police officers as the primary user group. The scope was broad, aiming to explore alternative forms of interactions to those currently associated with smartphone use in police field work, particularly iPhones, that could support police officers in high-stress situations. As such, the aim was to identify current challenges with smartphone use in police field work, and explore potential solutions. The initial research questions were:

1. *What are the main challenges faced by the Swedish police when using mobile technology during field operations in complex settings?*
2. *What is a set of design principles for mobile interactions to streamline police field operations during complex settings?*

To answer the first research question, interviews were conducted with UX designers from the mobility section of the police IT department and police officers. Since UX designers work closely with police officers when designing applications, the goal of interviewing them was to understand the considerations essential for designing applications tailored to police needs. Additionally, insights were sought regarding technology that the UX designers considered to have been requested by police officers.

The goal of interviewing police officers was to understand their current work process in the field, challenges they have faced, and similarly, to understand their perspectives on requested technologies. However, after interviewing both UX designers and police officers, and learning from both of them that there was a wish to facilitate easier information sharing for civilians in emergency situations with the police, the decision

was made to shift the direction of the thesis and narrow down its scope. According to some of the police officers, there may be delays when civilians call 112, resulting in the loss of valuable time. Consequently, they expressed the importance of receiving information, including images, in advance.

The focus was redirected towards emergency applications with civilians as the primary users, while still considering police officers as stakeholders. Due to changing the scope of the thesis, the decision was made to change the research question (see 1.2), perform a new literature review, and conduct additional interviews. This time, the interviews would involve regional command centre operators, who serve as crucial intermediaries between the public and the police. The literature review focused on the use of mobile applications for emergency and crisis communication, and on crowdsourcing in emergencies.

5.2 Literature Review

The process of designing an emergency app for civilians began with a literature review to summarise existing research on the topic and identify overarching themes. The search for relevant academic publications was done through Google Scholar, chosen for its popularity and extensive database of academic literature across various disciplines and publishing formats. The search was initiated using the phrase 'mobile emergency response app' to find a starting set of papers, which returned a total of 275,000 results. From this set, a search string composed of relevant keywords was derived. The search string was iteratively refined refined to ensure both broad coverage and relevance. The final search string was as follows:

'*mobile AND (application* OR system*) AND (emergency* OR disaster* OR crisis*) AND ("user experience" OR UX OR usability OR crowdsourcing) AND ("command center" OR "emergency center" OR "operation center" OR "operations center" OR authority*) AND (stress* OR critical)*'

This returned approximately 23,000 total results, which is considerably less than the phrase that was used to initiate the search.

The next step involved defining a study selection criteria to filter relevant papers. These were defined as follows:

- Include papers thoroughly discussing interactions for mobile emergency applications.
- Exclude papers not covering relevant emergency situations.
- Exclude papers not concerning civilians as primary users.

Papers were manually processed by applying the criteria until a couple of relevant papers were identified. However, due to the impracticality of examining all 22,000 papers, only the first 50 were reviewed. A summary of the findings is presented in table 5.1 and the papers are brought up in section 3.2.

Table 5.1: Summary of the literature review. The papers are brought up in section 3.2.

#	Citation	Year	Title	Source
1	Tan et al. [1]	2017	Mobile applications in crisis informatics literature: A systematic review	International Journal of Disaster Risk Reduction
2	Tan et al. [5]	2020	Understanding end-users' perspectives: Towards developing usability guidelines for disaster apps	Progress in Disaster Science
3	Romano et al. [2]	2016	Designing Mobile Applications for Emergency Response: Citizens Acting as Human Sensors	Physical Sensors
4	Nass et al. [3]	2018	Interaction Modes for Emergency Mobile Apps	Mobile Information Systems
5	Ernst et al. [19]	2017	Collaboration and crowdsourcing in emergency management	International Journal of Pervasive Computing and Communications

5.3 UX Designer Interviews

At first, the plan was to conduct interviews with police officers before UX designers. However, since police officers were initially difficult to reach, UX designers from the mobility section of the police IT department were interviewed in the meantime to gather some initial data.

As explained in section 5.1, the scope of the thesis changed after conducting interviews with UX designers and police officers. This lead to a shift in the primary user group from police officers to civilians, while still considering police officers as stakeholders. The UX designer interviews aimed to address the original research question 1, see section 5.1. However, it became apparent after changing scope that many of the discussion points with UX designers remained relevant for the new scope and could be applied to civilians as well.

The purpose of interviewing UX designers, as related to the initial scope, was to understand the current work process involved in designing interactions for police field officers, as well as to identify aspects they have found to be particularly significant to consider for this user group. Additionally, there was an intention to gain insights into interactions for the police that have been experimented with or discussed for future development. See appendix A for the interview protocol.

5.3.1 Procedure

Five UX designers at the Swedish Police Authority were interviewed in total, with some of them having the additional role of requirements analyst or product owner. Participants were recruited by email. All interviews were conducted online with the internal video application of the authority, ranging from 45 to 60 minutes.

Since at this stage no access had been given to work computers and the premises of the authority, the interviews were held on personal computers with the interviewee having to initiate the video call from their end. Due to security reasons of not being able to store any potential classified information on personal computers, audio or video recordings were not permitted and notes had to be taken using pen and paper. Both of the researchers took notes but only one researcher was in charge of asking questions while the other researcher could chime in anytime during the interview to ask follow-ups. The interviews were naturally held in Swedish since every participant spoke Swedish.

5.3.2 Analysis

Affinity diagramming was conducted to interpret the data more effectively. It is important to note that in this section, the target user group was police field officers, not civilians. Due to the change in scope, some of the initially derived themes were deemed irrelevant and were thus removed. While the remaining themes were initially conceived with police officers as the primary user group, they are still considered relevant within the new scope and have been adjusted accordingly. As such, *users* in this case can apply to both civilians and police officers.

The procedure consisted of extracting key points from the notes taken during each individual interview and manually transferring them to post-it notes. Then, similar post-its were grouped together until all belonged to a group, and relevant themes were then derived. The following themes remain relevant for the study: *design guidelines*, *broad user group*, *cognitive load*, *context of use*, and *current and future technologies*.

Design Guidelines

The UX designers stated that they today mainly use the Human Interface Guidelines (HIG) [33] for iOS when designing applications since police officers only use iPhones. Additionally, they sometimes combine the HIG with their own in-house developed design guidelines. Using some form of design guidelines aligns with the prevalent approach in application development, whether it is for police officers or civilians.

Broad User Group

An important aspect to consider with a broad user group is the varying levels of technological literacy and experience. Older people tend to be less updated with technology and may require a simpler UI. Moreover, prioritising accessibility for users with disabilities, such as those with weak eyesight or colour blindness, is essential to help them navigate through an interface. This can be done by using clear contrasts and providing users with the option to adjust text size according to their preferences.

Cognitive Load

In high-stress situations such as emergencies, users often experience a high cognitive load. Multiple events can occur simultaneously, and time is often critical. Users

may also need to interact with their phones while moving or running, which significantly affects how applications should be designed to accommodate these scenarios. Furthermore, fine motor skills are often impaired under stress, making it difficult for users to perform precise movements necessary for interacting with their phones. These tasks include tapping icons, typing messages, pinching to zoom, and swiping to navigate between screens.

Context of Use

User needs are also influenced by a specific context of use, which may impose certain constraints. For instance, users might face limitations in their interactions due to factors like high stress, necessitating careful consideration. Accordingly, navigation should be intuitive and straightforward, with critical information easily accessible. Furthermore, buttons should be prominently sized, clearly labelled, and consistently positioned. Ideally, performing tasks should be quick with minimal steps involved. Textual forms, in particular, can pose challenges as text input demands greater attention and time; thus, they should be used sparingly. Moreover, information should be organised and prioritised according to its significance.

Current and Future Technologies

Another topic of discussion revolved around haptic technology, specifically in the form of vibrations. However, it was agreed that such features should be used sparingly and reserved primarily for warning users of potential dangers. Another mentioned technology was automatic GPS positioning, which was expressed to facilitate locating individuals efficiently. Furthermore, voice assistants were highlighted as a future technology being beneficial in high-stress scenarios, aiding in reducing cognitive load. Additionally, a system aimed at enabling citizens to easily share information during emergency situations, thereby streamlining police operations, was mentioned.

5.4 Police Officer Interviews

As detailed in section 5.1, the thesis underwent a scope adjustment following interviews with UX designers and police officers. This transitioned the focus from primarily addressing police officers to prioritising civilians as the primary user group, while still acknowledging police officers as stakeholders. Similarly to the UX designer interviews, the police officer interviews aimed to address the original research question 1, see section 5.1.

As previously mentioned, police officers were initially scheduled for interviews before UX designers. However, since UX designers were easier to book interviews with than police officers on short notice, they were interviewed first. Two police officer interviews were still conducted alongside the UX designer interviews, which quickly validated the identified needs established by the UX designers. For the remaining police interviews, the interview protocol was adjusted to reflect the change in scope.

The purpose of interviewing police officers, as related to the initial scope, was to

understand what their work process in the field looks like, the challenges they have faced, and the technologies they have desired. However, the focus of the interviews later shifted from a broader perspective to concentrating more on officers' thoughts and opinions regarding facilitating real-time information sharing for civilians through media during emergencies, including what they would find helpful and what concerns they might have. Nevertheless, many of the discussion points from the first police officer interviews remained relevant to the new scope and could be applied to civilians as well.

5.4.1 Procedure

Four police officers were interviewed in total, all of whom were response police officers, commonly referred to as "ingripande poliser". Participants were recruited via email. All interviews, except for one, were conducted online with the internal video application of the police and lasted between 30 to 45 minutes. Similar to the UX designer interviews, one researcher was responsible for asking the questions, while the other researcher could chime in with follow-up questions as necessary. For the first two interviews, work computers had not yet been provided, so notes still needed to be taken using pen and paper for security reasons. In the last two interviews, access to work computers had been granted, allowing notes to be taken digitally. Both researchers took notes during all interviews. The questions asked can be seen in appendix B.

5.4.2 Analysis

Thematic analysis was performed to interpret the data more effectively. As access to work computers had been granted at this point, the analysis could be conducted digitally. Due to the change in scope, some discussion points that were had in the first two interviews were deemed irrelevant to the new scope and were thus excluded from the analysis. The presented themes are those considered relevant to the new scope, focusing on cases where civilians are primary users and police officers secondary users. While civilians directly interact with a system, police officers are still affected by and benefit from its use.

Similar to the UX designer interviews, the procedure involved extracting key points from the notes taken during each individual interview and manually transferring them to post-it notes. These post-its were then grouped together until all belonged to a group, and relevant themes were derived. What was found was an overarching positive attitude toward the possibility of civilians being able to share information more easily in real-time. The following themes were derived: *emergency situations*, *real-time information sharing*, and *non-emergent civilian contribution*.

Emergency Situations

The current emergency call procedure is as follows: civilians call the emergency number and are connected with an SOS operator who asks questions to determine the required resources, such as police, ambulance, or firefighters. If police resources

are deemed necessary, the caller is redirected to a regional command centre operator, who further assesses the situation's severity and determines the required police officers and resources. If necessary, an intervention channel is created where regional command centre operators directly communicate with police officers.

In large-scale events, that is, emergencies that involve a significant number of civilians and multiple entities like the aforementioned police, ambulance, and firefighters, operations become more complex. There is a heightened need for communication, and time pressure increases. Furthermore, emergency call volumes greatly increase during such events, flooding operators with a continuous stream of information.

Real-Time Information Sharing

Attitudes towards receiving real-time media from civilians were positive. In emergency situations, images are particularly useful, whereas verbal descriptions, such as those of a person or vehicle, are generally more vague. It is common for police officers to gather data, such as images, from potential witnesses at the location upon arrival, and time could potentially be saved if this information could be sent to the regional command centre in advance. However, the interviewees stated that there is sometimes a lack of compatibility between the iPhones used by police officers and other phones civilians may have, which can make the process of sharing media more difficult and slow down police work. Therefore, facilitating the sharing of information across different platforms would be helpful. Concerns were also raised about real-time information sharing: police officers expressed the need for some form of limitation to prevent users from indiscriminately sending information.

The idea of enabling civilians to instantly share their location during an emergency call with the regional command centre, instead of verbally describing it, was deemed highly beneficial. It is not uncommon for callers to be uncertain or confused about the names of their locations, which can delay response efforts. Finding the exact location promptly could save crucial time, as every second counts during emergencies.

The interviewees perceived a potential advantage in allowing video calls during emergencies: it could aid the regional command centre in assessing severity and resource needs more accurately. However, there was a preference for images, particularly if the caller was aware of capturing them in advance. Some concerns were raised regarding video calls, as they might consume more time and potentially complicate operators' extraction of necessary information.

Non-Emergent Civilian Contribution

Facilitating the reporting of non-emergent incidents through media and sharing one's location directly from a phone was viewed positively. The interviewees expressed that receiving information regarding any suspicions is always an advantage and could help prevent and combat crimes. By enabling civilians to easily report non-emergent incidents with their phone, it will be possible to do so directly at the scene, increasing the chances of better remembering details.

5.5 Regional Command Centre Operator Interviews

Give that communication between civilians and the police is routed through the regional command centre, commonly referred to as "regionledningscentralen" (RLC), there was a need to gather insights from the operators stationed there. These operators gather information from callers and assess the severity of situations to determine required resources, such as whether a patrol should be dispatched or not, and to lead operations. Consequently, the perspectives and opinions of RLC operators on potential future solutions hold significant value and make them essential stakeholders in the project.

The main objectives of interviewing RLC operators were 1) to understand how information sharing by civilians can be facilitated in emergency situations through the use of media and GPS positioning, and 2) to gather opinions on the potential implementation of a crowdsourcing functionality: whether it could be beneficial for information gathering in special emergency situations and how it could work in practice. See appendix C for the interview protocol. The underlying idea is that by enabling civilians to share information effectively, the police are provided with improved conditions, thereby streamlining their operations.

5.5.1 Procedure

Two RLC operators were interviewed in total, both of which were conducted in person at the IT-department of the police and lasted between 30 to 45 minutes each. Participants were recruited via email. As with the previous interviews, one researcher was responsible for asking the questions, while the other researcher could chime in with follow-up questions as necessary. Both researchers took digital notes.

5.5.2 Analysis

Affinity diagramming was performed in a similar fashion to previous interviews: key points in the collected data were transferred to post-it notes and then grouped together based on relevance to form themes. A total of four themes were derived: *sharing media - current process*, *sharing media - considerations for enhancement*, *information sharing - additional functionality*, and *crowdsourcing*.

Sharing Media - Current Process

To be able to send media to RLC today, civilians need to first receive a link to their phone from an operator. Pressing this link takes the user to a web-based application where media can be uploaded. The decision to send a link largely depends on the kind of case and if it is deemed that relevant info can be gained from it. Both of the interviewees expressed a positive attitude towards the current system; however, they wished for support for video and sound recordings. Additionally, they stated that it puts some demand on the public to know how it works, especially elderly people.

> *"It requires the public to understand how to do it. Some users, like elderly people, do not manage it as well as others because they are worse with technology."*

Sharing Media - Considerations for Enhancement

Both RLC operators expressed concerns that allowing media uploads without first calling 112 and receiving a link from RLC could lead to abuse, risking the possibility of people sending in unnecessary information. Since all the information that is received would need to be processed, it would not be feasible if people could freely send in information without restriction. Moreover, sending media directly without first calling does not allow the operators to ask follow-up questions as they would during a phone conversation, making it more difficult to understand the situation. The consensus was that operators should have control over when media can be sent. However, the interviewees also expressed that when there are many incoming calls, it is easy to miss important information since each operator can only handle one call at a time.

Information Sharing - Additional Functionality

The RLC operators were also positive about automatic GPS positioning. Currently, retrieving the caller's position is done similarly to media retrieval by sending a link, but works as a separate system. However, this process can be slow and requires several steps. One of the interviewees suggested additional improvements to the current system, such as incorporating video calls and potentially integrating it with the SOS Alarm [34] app.

Crowdsourcing

Regarding crowdsourcing, the RLC operators expressed that it could be beneficial for gathering information quickly in certain situations, such as shootings, when a perpetrator is on the loose, or in case of missing persons. Currently, police officers often have to knock on doors and speak with civilians directly to gather information about a situation, which can be tedious and time-consuming. However, they also expressed concerns about the risk of the crowdsourcing function being used inappropriately, which could lead to the spread of incorrect information and potentially scare the public.

> *"It might be used at the wrong stage. You have to be sure if it is going to help the operation or harm it. It should be used sparingly, and its purpose should be carefully considered beforehand."*

Tip-Offs

Another discussion point that was raised with the RLC operators was whether civilians should be able to send tip-offs to the police through an app. They expressed that it could be beneficial since people always have their phones with them and would be more likely to report incidents on the spot when the details are fresh in

their memory, rather than waiting until they return home and potentially forgetting to report it. This would also spare users from having to navigate the police website and search for the tip-off form.

5.6 Defining Requirements

The next step involved using the findings from the interviews and literature review to define a list of requirements. The purpose of creating these requirements was to gain a clearer understanding of what the prototype should include, essentially establishing a foundation for a more well-defined goal. Additionally, the requirements list can serve as an initial blueprint for the implementation of an app.

5.6.1 Procedure

Requirements were informed and refined iteratively as the understanding of the problem domain and user needs evolved throughout the process. The initial version of the requirements list was based on insights from the literature review and interviews with UX designers and police officers. Later, when it was decided to also interview regional command centre operators, the requirements list was updated to include these new findings.

Top-level requirements were first formulated. If these were considered too broad, sub-requirements were added to clarify the specific components needed to fulfil each top-level requirement. By adhering to the MoSCoW method, requirements were categorised as either Must have, Should have, or Could have, effectively communicating their order of priority. Deciding how a requirement should be categorised was based on the criticality of its fulfilment for the successful use of the application in practice. The literature study facilitated these decisions by providing context on the core functionalities and user expectations, helping to prioritise features that aligned with established best practices and documented user needs. As such, requirements considered crucial for the implementation of the app were defined as Must have, while those that were seen as adding value or being nice to have, but not essential, were defined as Should have or Could have.

5.6.2 Requirements List

Table 5.2 lists the final version of the requirements list. The requirements list consists of both functional and non-functional requirements. The rows representing top-level requirements are marked in blue for the sake of readability. Each requirement includes a description to clarify its purpose. The 'source' column indicates whether the requirements were informed by literature, interviews, or a combination of both. Those informed by literature are marked with an 'L', while those informed through interviews are marked with 'U' (UX designers), 'P' (police officers), or 'O' (emergency operators).

Table 5.2: Requirements table.

#	Requirement	Description	Source
1	The system **should** enable information sharing through crowdsourcing	Through crowdsourcing, volunteers can provide important information and help facilitate police response measures [19], [20].	L
1.1	The interaction of the system **should** be many-to-one-to-many	Users should be able to contribute information based on requests from the emergency centre. The emergency centre can then aggregate this information and send updates back to the users [1]. This functionality assumes that users have enabled location services.	L
2	The system **should** enable reporting of tip-offs to the police	This enables users to report tip-offs directly on the spot and provides more data for the police.	P+O
3	The system **must** enable users to store their contact information	A registered telephone number allows RLC operators to automatically retrieve user positions. A default home address enables users to receive alerts regarding their home city.	L
4	The system **could** enable users to contact SOS directly without needing to call first	Nervousness, shyness, uncertainty, or privacy-related issues could deter someone from making a call and providing information that could be important during an emergency [2]. However, this does not replace traditional phone calls but rather functions as an alternative for civilians to share information. In cases where the system detects that the mobile network is unstable, the user is advised to make a call instead.	L
5	The system **must** be based around alerts	Alerts function as a way of getting a user's attention during an emergency. This functionality assumes that users have enabled notifications.	L
6	The system **must** enable accurate real-time information sharing during emergency calls	Media and location sharing can strengthen verbal descriptions and facilitate police work.	L+P+O
6.1	The system **must** enable media sharing in the form of images and videos	Images and videos often provide a more accurate description of a person or situation than verbal descriptions, which tend to be vague [2].	L+P+O
6.2	The system **must** enable automatic GPS positioning	Users must be able to share their location data during emergency calls.	L+P+O
6.3	The system **could** enable media sharing in the form of audio files	In cases where it's not possible to take a photo or make a video, audio files can serve as an alternative.	L+O
7	The system **must** be designed with accessibility in mind	This includes users with disabilities such as colour blindness and weak eyesight, as well as situational disabilities that may arise in high-stress situations.	L+U
7.1	The system **must** have clear contrasts	Clear contrasts are important for ensuring good visibility for text and UI elements. Additionally, the choice of colours should accommodate users with visual impairments.	L+U
7.2	The system **must** have a large enough touch target size for buttons	In high-stress situations, impaired fine motor skills can hinder precise movements [3], [5].	L+U
8	The system **must** use appropriate language	Wordings should be clear to avoid confusion [5].	L
9	The system **must** account for cognitive load	Under high stress, the resources allocated to working memory are reduced [3], [5].	L+U
9.1	The system **must** be simple and minimalist, and include elements of familiarity	Unnecessary information should be avoided to simplify use during stressful situations. Familiar UI elements can be used to facilitate the use of the system [5].	L+U
9.2	The system **must** have short and direct navigation	Emergency apps should be simple to communicate information quickly. One way of achieving this is through simple navigation, as critical information can be retrieved with fewer steps [5].	L+U
9.3	The system **must** include a map overview of emergency situations	A map can be more efficient than text alerts for communicating emergencies and provide better situational awareness [5].	L
9.4	The system **should** include icons with text headlines	Having icons next to text headlines can enhance user navigation [5].	L
9.5	The system **should** minimise textual input	Textual input demands greater attention and time. As images can be efficient in attracting attention, textual information should be replaced or complemented with images where relevant to help users digest information [5].	L+U

10	The system **must** provide direct feedback from the UI	Confirmations must be given to users when actions have been successfully executed, especially during information sharing [2], [3], [5].	L
11	The system **could** enable users to automatically gather and prefill information in forms	The ability to automatically fetch information when possible would speed up the process of filling out forms.	L
12	The system **must** make critical information salient	As the purpose of the application is to inform the user of emergencies and give them the option to help provide more information if possible, it is of great importance that users can quickly and easily identify critical information [5].	L+U
12.1	The system **must** highlight critical information through typographical emphasis	During emergency situations, a lot of information might cause users to miss important details if they are not highlighted.	L
12.2	The system **must** accentuate interface elements	Accentuating interface elements through colours helps draw attention to critical information.	L
12.3	The system **must** maintain an appropriate textual length for content	This is important for readability during moments of high stress. Messages should be short and concise, but not to the extent that important information is omitted and the user is forced to find information elsewhere.	L
12.4	The system **must** present critical information in a top-to-bottom structure	Given the potential for large amounts of information, it is important to establish various levels of priority based on importance.	L
12.5	The system **must** alert users of critical warnings through audio and sensory stimulus	Audio and sensory stimuli can efficiently alert users of critical warnings. Sound alerts should not be too loud and can be accompanied by vibrations. Users must have the option to mute and adjust sound settings.	L
13	The system **should** provide preparedness information	Educating users on how to handle emergencies can make them more prepared and help them make the most out of the system [5].	L
14	The system **must** build trust with users	In most cases, an emergency application will have infrequent interactions by users, making it important to build trust to prevent them from uninstalling or not using the application [5].	L
14.1	The system **must** provide contextualised content	Information is deemed more relevant to users if it is contextualised rather than just presented as static warnings.	L
14.2	The system **must** show regard to user privacy	Whenever the application gathers user data, users must first have the option to consent and be informed about exactly how the data will be used.	L
15	Foster public awareness and understanding of the system	Authorities must inform the public about the existence of the system and how it can affect them [1].	L+P+O
15.1	Communicate ethical use of the system to users	Authorities must communicate the ethical use of the system to ensure that it is used appropriately and laws are not broken.	P+O

5.7 Ideation

The ideation phase consisted of using the previously formulated requirements as the foundation for generating potential solutions. The phase was initiated with a sketching session, resulting in two initial concepts. These concepts were then discussed and elaborated upon to determine a definitive concept. Subsequently, user flows and a sitemap were created to visualise the interaction and navigation of the application.

5.7.1 Sketching

The sketching process was a form of low-fidelity prototyping using pen and paper. During this session, sketches were kept simple, aiming to generate as many ideas as possible rather than focusing on details or aesthetics. While the sketching session was open for exploring different ideas, it was restricted to the requirements list. However,

as the requirements lacked specific implementation or design details, considerations for usability and UI best practices were still taken into account during the sketching phase. Initially, sketches were done individually to explore unique solutions, which resulted in two different concepts.

The sketches were, in a sense, very similar, with the main difference being how they portray the notification alerts. Sketch one (figures 5.1c and 5.2a) uses the design pattern *alternative views* [35], which allows users to switch between different views; in this case a 'list view' of alerts and a 'map view' of alerts. This screen is represented by the 'home' icon in the navigation bar (figure 5.1a). The alternative views offer access to the same information, but allow users to view the information according to their preferences and context of use. The design pattern also makes it clear that the information from the two views is similar since they are contained within the same space. Sketch two (figures 5.1b and 5.2b), on the other hand, has two separate screens for the map view and list view. These screens are navigated to through the 'map' and 'alerts' icons, respectively. The remaining screens depicted in the sketches include a dialog for requested information for crowdsourcing, a screen for current and past cases related to tip-offs or crowdsourcing, and a detailed screen of the tip-off form (figure 5.3).

Upon having a discussion about the sketches, the following decisions were made for the final concept:

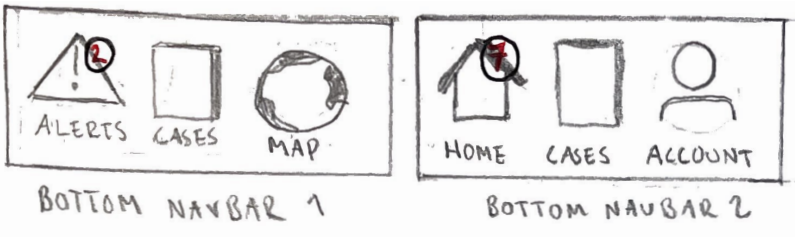
- Keep the map and alerts screens separated.
- Add a dedicated screen for calling 112.
- Remove the screen for current and past cases.

The decision to keep the map and alerts views separate was primarily aimed at maximising user intuitiveness. It was considered clearer to provide two distinct buttons in the navigation bar for accessing these views, rather than displaying a default view and requiring users to press a smaller button or tab to access the temporarily hidden view.

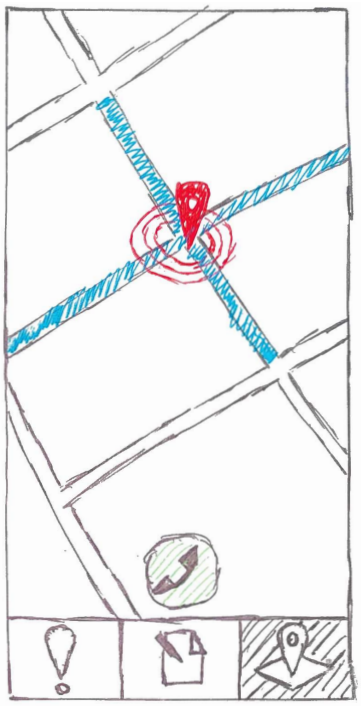
Initially, the idea was for a user to call 112 outside the app, receive a notification from the app confirming the call to 112, and upon entering the app, the app would connect to the call and display a view with options for starting a video call, sending media, or sharing a position. However, it was deemed better to have a dedicated view for calling 112 accessible through the navigation bar. In this view, users are presented with information about the process of calling 112 but do not have access to the previously mentioned functionalities. This approach aims to better prepare users for what to expect when calling 112, rather than having the view appear unexpectedly within the app.

Initially, the idea of having a view for current and past cases was to enable users to follow their cases related to a tip-off, information request for crowdsourcing, or an emergency call, for example, if they wanted to provide more information. However, it was later deemed unnecessary to include cases for these scenarios since users often do not need to follow or review past cases, especially in emergency situations, as they are handled directly. Additionally, from a security perspective, it was considered

better for the application to not store this type of information, as adversaries could easily gain access to it and abuse it.



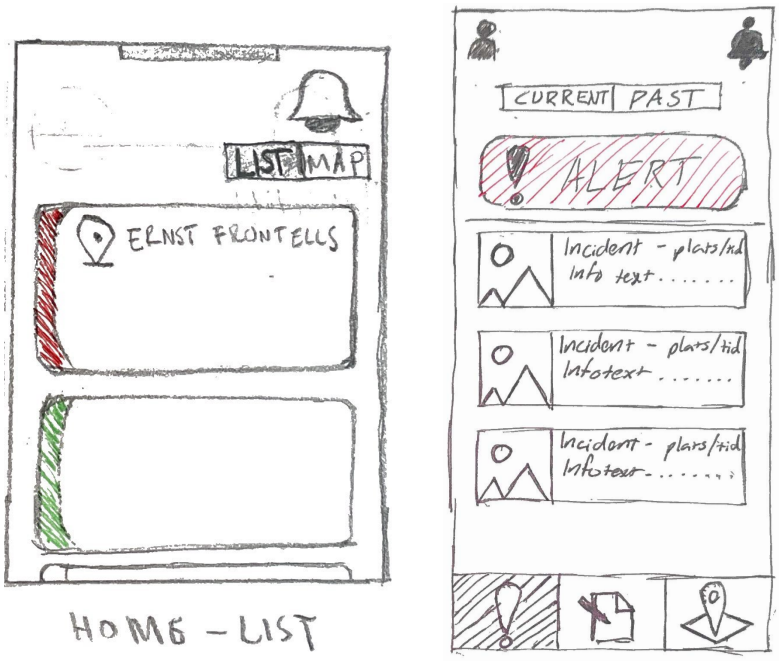
(a) Two examples of a bottom navigation bar. In the left example, the alerts and map view are separate. In the right example, the alerts and map views are combined into a single home view.



(b) A map overview.

(c) Detailed map view of a specific alert. 'Map' is selected in the tab (alternative views pattern). The sketch shows an example of a closed area.

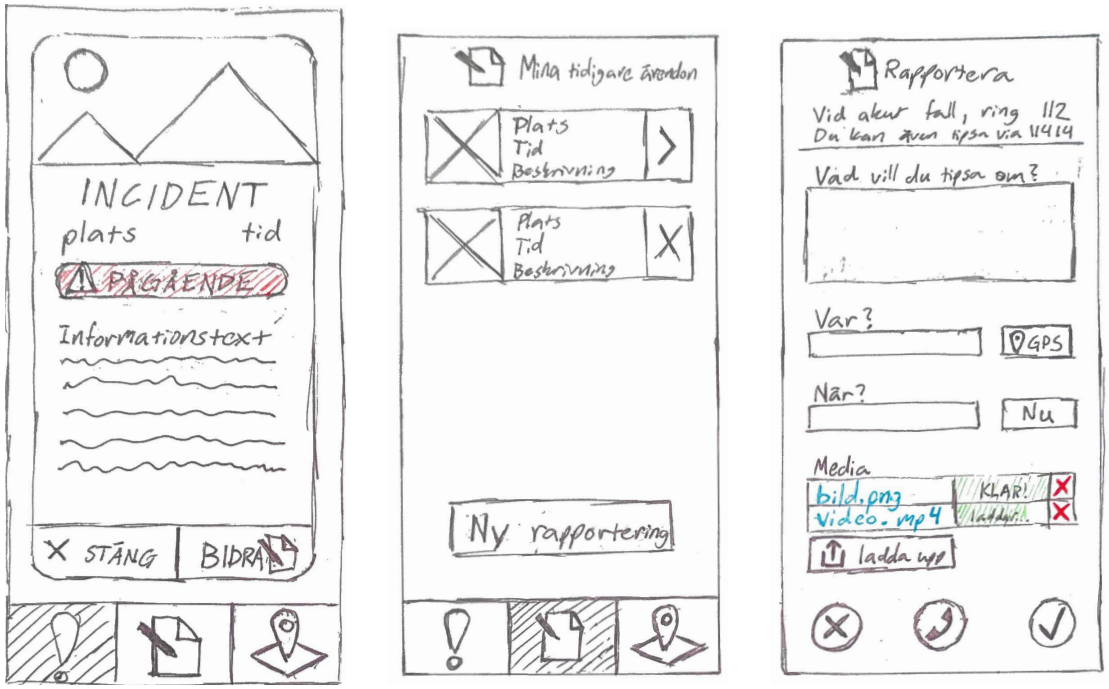
Figure 5.1: A map view of alerts.



(a) A alerts feed that can be navigated to by selecting 'List' in the tab (alternative views pattern).

(b) An alerts feed that can be navigated to through a dedicated 'alerts' icon.

Figure 5.2: Two different sketches of a list view of alerts.



(a) A dialog that information for a specific incident is being requested.

(b) A screen for current and past cases related to tip-offs or crowdsourcing.

(c) A form where users can report tip-offs.

Figure 5.3: Additional screens: crowdsourcing, cases, and a tip-off form.

5.7.2 User Flows

To address the changes decided upon in the sketching session and to model how users may move through the application to complete tasks, three user flows were created for the main functionalities: sending requested information for crowdsourcing, sending media during an emergency call, and sending a tip-off. Since some relevant details had not been considered during the sketching session, the process of creating the user flows involved carefully reviewing the sketches and discussing potential additions that would result in an adequate flow.

Interactions must be designed to allow users to easily achieve their goals in the system, without unnecessary elements that could interrupt the interaction [36]. User flows served as a valuable tool for refining ideas, laying an important foundation before creating the high-fidelity prototype: the process ensured that interactions within the application are intuitive and encouraged consideration of how different users within the user group would approach tasks. It also facilitated the identification of potential issues, preventing them from arising during the design of the high-fidelity prototype and saving time in the process.

Contributing Information in Crowdsourcing

Figure 5.4 visualises the flow of providing information for crowdsourcing. There are two scenarios for this flow: either the user is outside of the app, in which case they receive a notification that information is being requested, or they are actively using the app, where they have to click on “read more” on the alert card to be able to access the “provide information” button. In the notification scenario, clicking on the notification takes the user directly to the description. In the crowdsourcing view, the user then has to confirm that they are aware of the type of information being requested before being able to fill in the form and send the information.

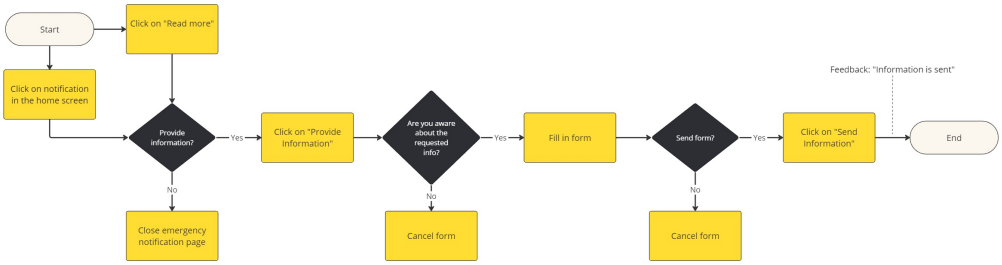


Figure 5.4: Flow of contributing information for crowdsourcing purposes. A larger version can be found in appendix F, figure F.1.

Sharing Media During Emergency Calls

Figure 5.5 visualises the flow of sharing media during an emergency call. This flow assumes that the user has already called 112 and that the app has connected to the

call and provided access to sharing media. After pressing the “share media” button, the user then has the option to take a photo/record a video or use existing media before sending it.

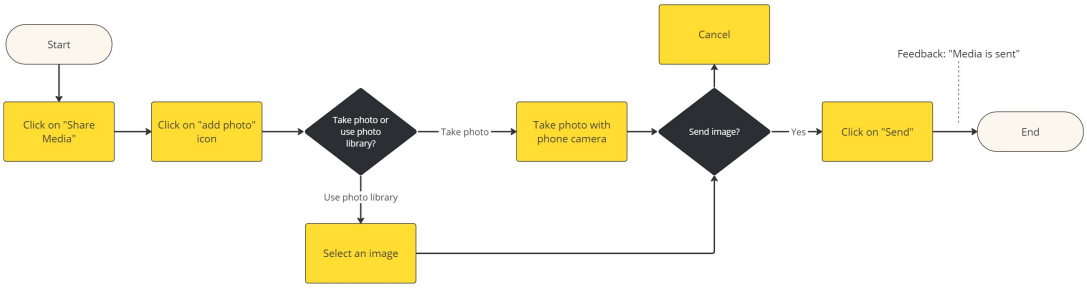


Figure 5.5: Flow of sharing media during a call with an RLC-operator. A larger version can be found in appendix F, figure F.2.

Sending a Tip-Off

Figure 5.6 visualises the flow of sending a tip-off to the police. Citizens can send a tip-off in two ways: either by navigating to the tip-off view through the navigation bar, or by clicking on the “tip-off” button in the detailed view of an alert that allows users to make a tip-off. Some alerts do not have the option to make tip-offs and thus do not display the “tip-off” button. Once all the required information in the form has been filled in, the form can be sent.

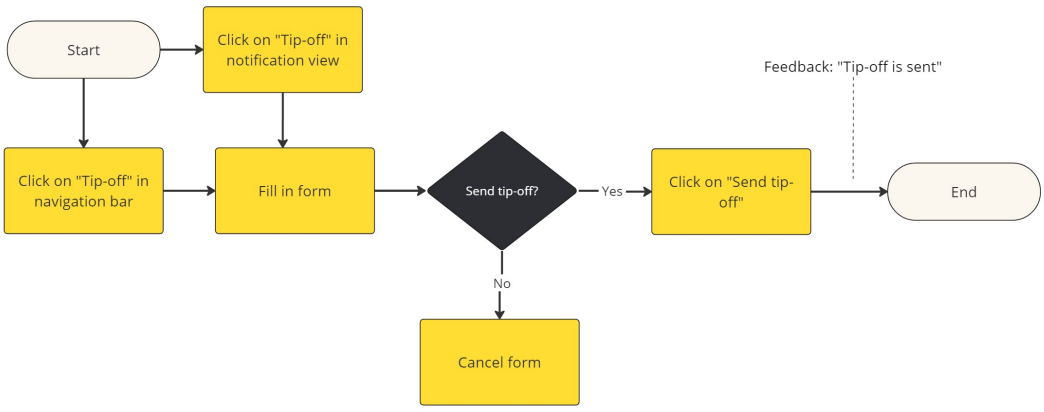


Figure 5.6: Flow of reporting a tip-off to the police. A larger version can be found in appendix F, figure F.3.

5.7.3 Sitemap

Following the creation of sketches and user flows, a sitemap was created to provide a visual representation of the information structure and organisation within the application, see figure 5.7. Although the application is not complex, the sitemap

helped in understanding the navigation hierarchy better, thus contributing to a better user experience. The sitemap includes the following overarching screens: alerts, map, call, tip-off, and more/profile. Depending on the user's navigation depth, the map and alert screens may contain additional views. Additionally, users can seamlessly switch between the map and alert screens to view a specific instance of an alert in either the map view or the detailed view. The sitemap also features a "more/profile" screen, which would be essential for tasks such as setting a default home address, phone number, and managing notifications. However, this screen was not included in the high-fidelity prototype, as it was deemed less important for the final evaluation compared to the other screens.

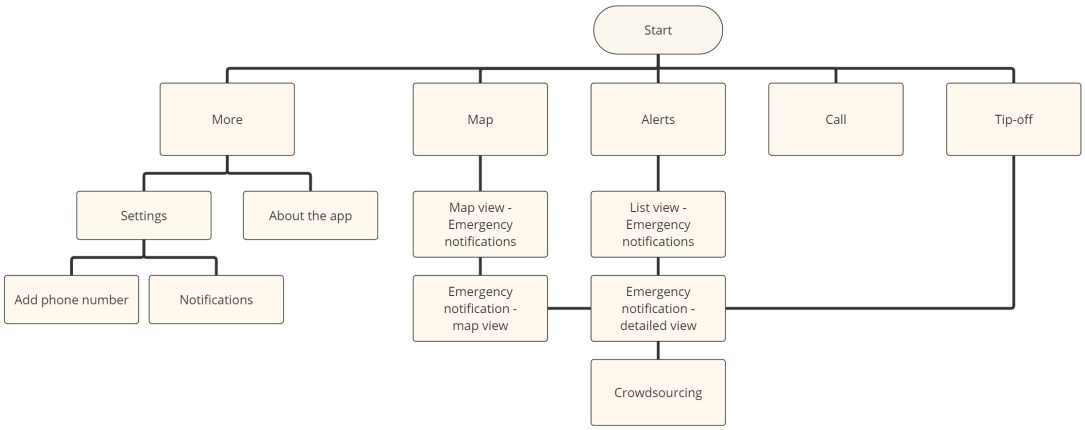


Figure 5.7: Sitemap of the application.

5.8 Mid-Fidelity Prototyping

The next step was to apply the ideas from the ideation phase, along with the requirements list, to create a semi-functional prototype. This section primarily provides a high-level overview of the prototyping process rather than a detailed explanation of the final prototype. The prototype includes the following:

- A view for emergency calls (figure 5.8).
- A feed for alerts and a corresponding detailed view of an alert (figures 5.10a and 5.10b).
- A map overview and a corresponding detailed view of an alert on the map (figures 5.10c and 5.10d).
- A view for reporting tip-offs and a view for contributing information for crowdsourcing purposes (figures 5.9a and 5.9b).

Since these are the central views of the app, they need to be easily accessible and were therefore included in the global navigation. For a more in-depth explanation of the different screens and functionalities of the prototype, see section 6.1.

In the prototyping stage, the goal was to develop an interactive prototype that could visually demonstrate how the requirements might be addressed and could later be

tested with civilians. The prototype falls between low-fidelity and high-fidelity, thus it is considered medium-fidelity. It is an interactive representation of the initial sketches but lacks the detailed elements necessary to consider it a high-fidelity prototype ready for implementation. The prototype was developed in Figma and took around two weeks to complete from start to finish. Since a considerable amount of time was dedicated to forming requirements as well as creating and discussing sketches, the transition to a semi-functional prototype was facilitated.

During the prototyping stage, additional ideation and discussion was had since some things were not explored in the sketches: this includes the exact process of how media sharing works, the exact process of how to provide information during crowdsourcing, and how updates will be communicated to civilians during crowdsourcing. For media sharing, it was decided that this functionality should be as simple as possible since users will be talking to an emergency operator on the phone while completing the task. As such, it was decided that when pressing 'Share media', the user is not directed to a new view, but rather can share the media in the same call view through a modal view (figure 5.8). Media sharing was also designed to require users to make an emergency call. This decision was based on interviews with command centre operators, who believed it was necessary to ensure a conversation could take place. This would allow them to ask the caller questions about the media shared and help prevent people from misusing the app with spam or inappropriate media.

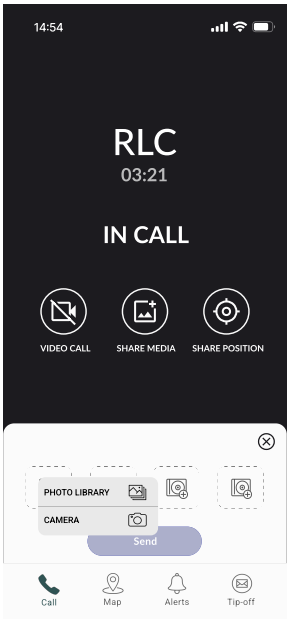
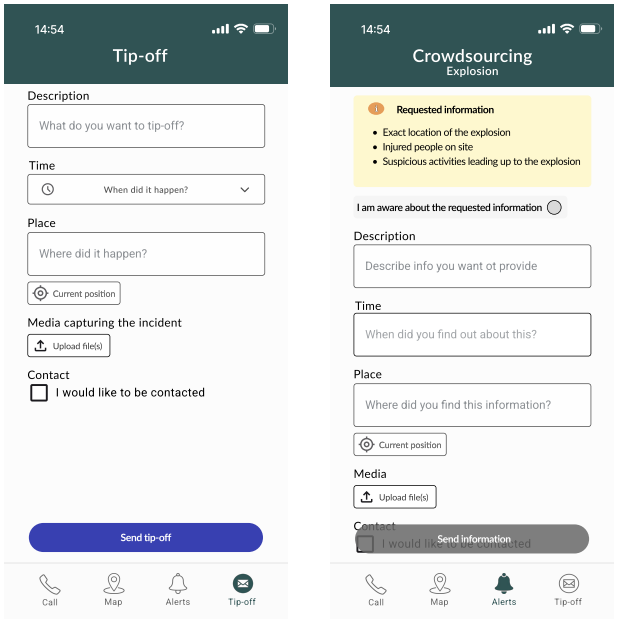


Figure 5.8: A call view where users can start a video call, share media, or share their location.

Regarding contributing information for crowdsourcing purposes, it was decided that, for consistency, this should have the same format as the reporting of tip-offs, utilising a text form (figure 5.9b). The key difference is that there is no dedicated view for crowdsourcing since crowdsourcing-related alerts are connected to specific cases that the authority is requesting information for. Instead, a 'Provide Information' button is included in the detailed view of alerts tagged with the crowdsourcing alert type

(figure 5.10b). Additionally, the crowdsourcing text form includes an information box that users must confirm they have read before proceeding to fill out the form.



(a) A form where citizens can report tip-offs related to non-emergent situations.

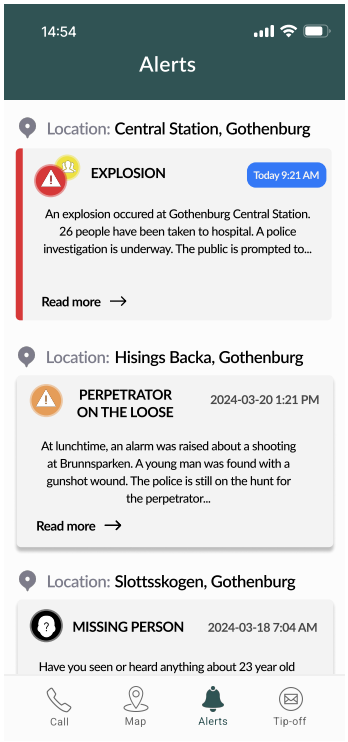
(b) A form where citizens can contribute information about specific incidents.

Figure 5.9: Forms for providing information.

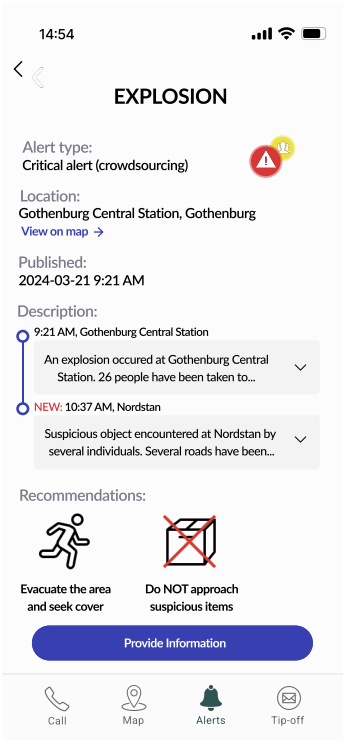
In contrast, a dedicated view for reporting tip-offs was created because tip-offs pertain to non-emergent situations not linked to a specific incident. The format of the text forms was largely based on the current tip-off form available on the Swedish Police Authority's website. An additional feature added to these forms is a button that allows users to insert their current location, which could be particularly useful in cases where users are reporting tip-offs on the spot. For future implementations, the current method for contributing crowdsourcing information could be combined with a dedicated view that aggregates all crowdsourcing alerts, making them easier to navigate.

Regarding the communication of updates, the initial idea was to use a dedicated notifications view accessed through a bell icon in the app. However, it became apparent that this would not provide a comprehensive visual overview of an unfolding incident. Therefore, it was decided to include a timeline in the detailed view of an alert, showing updates from the first report to the most recent (figure 5.10b). For future implementations, combining both approaches could be beneficial, especially when multiple incidents occur simultaneously. Collecting updates in a single location could help users quickly see which incidents are being updated and how many times they have been updated.

A colour scheme was created to maintain design consistency. When selecting colours, it is important to ensure that contrasts are easily discernible to preserve readability

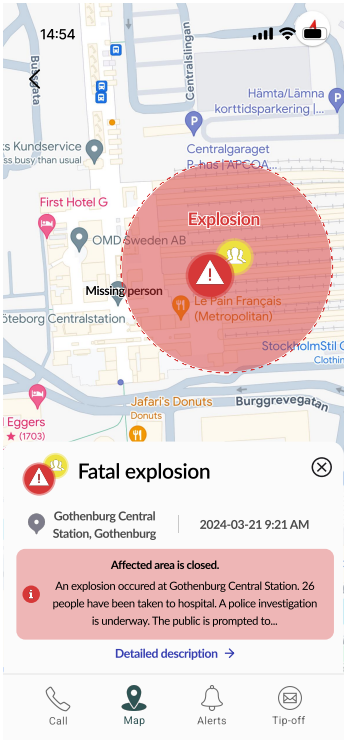


(a) Alerts feed/list.



(b) A detailed view of a specific alert.

(c) A map overview of alerts.



(d) A detailed view of a specific alert. Depending on the type of incident, it may contain additional information, such as the exact affected area.

Figure 5.10: Two different ways of viewing alerts: through a list/feed or a map.

and ensure accessibility is considered. Contrast checker web tools were used to verify that the contrasts meet WCAG requirements.

Two versions of the prototype were created: a standard English version and a version translated into Swedish. Apart from the language, there are no visual differences between these two versions. The Swedish version was primarily developed for the evaluation stage and can be seen in appendix E.

5.9 Evaluation with Civilians

The evaluation phase involved testing the high-fidelity prototype with civilians and consisted of two parts: a usability test followed by a questionnaire and an interview. A total of eleven civilians were recruited, primarily through convenience sampling. Eight evaluation sessions were conducted in person, while the remaining three were held online via Zoom. When recruiting participants, the goal was to include a diverse age range and varying levels of technological proficiency, considering that the application is intended for smartphone users across different demographics. Therefore, it was essential to account for these factors in the evaluation process.

Before each session commenced, participants were asked to consent to being recorded for later analysis. Notes were also taken throughout the evaluation. Each session began with a usability test where participants completed predefined tasks within the prototype. This was followed by a brief questionnaire to assess the application's usability and usefulness. Finally, participants engaged in an interview focused on the ethical aspects of the app. Usability testing aimed to provide insights into the prototype's practical usability, while the interviews sought to offer a more holistic perspective from an ethical standpoint.

5.9.1 Usability Testing

The first part of the evaluation consisted of usability testing. The purpose of usability testing was to gain insights into the prototype's practical usability, such as how easy the interface was to understand, if the navigation was straightforward, and if the different functionalities were easy to learn. Additionally, the goal was to see how pleasant the participants found the app to use.

Procedure

The usability testing began with a brief introduction to the application without showing it, overall aiming at verifying the learnability degree of the application with no preliminary training on it. Participants were then presented with the prototype and instructed to complete three tasks, each corresponding to a core functionality: reporting a tip to the police, sharing their position and an image during a call, and providing the requested crowdsourcing information. Participants were encouraged to think aloud or ask questions while completing the tasks, both to gain insight into their thought process and to uncover potential issues.

The online and in-person usability tests were conducted similarly. The main difference is that participants in the in-person usability testing performed the tasks by interacting directly with a touch screen, while in the online usability testing, participants were instead sent a web link to the prototype. In-person usability testing tends to uncover more nuanced usability issues because it is easier for facilitators to read users' body language and recognise appropriate times for probing or follow-up questions [37], [38]. However, remote moderated usability testing can deliver high-quality findings comparable to in-person moderated usability testing, with the added benefit of being more flexible [37], [38].

In this study, only eleven participants took part in the evaluation, and of those, only three participated online. Therefore, it is unlikely that the final outcome of the evaluation was significantly affected. Additionally, the prototype is not complex and involves simple interactions. It is noted that remote testing is particularly useful for tasks that do not require complex interactions with physical products or environments [39].

Analysis

The analysis began with manually transcribing the think-aloud comments of the participants. Affinity diagramming was then conducted digitally to interpret the data gathered from the usability testing, including qualitative data related to the UI from the questionnaire. This process involved transferring key points from the transcribed text, notes, and qualitative UI data onto post-it notes. These notes were grouped based on similarities until all belonged to a group, from which relevant themes were derived. The following themes emerged: *layout*, *language*, *accessibility*, *functionality,* and *design elements*.

Layout
In general, participants found the app easy to navigate, with a low barrier to entry. However, multiple participants noted the absence of a home button in the global navigation, which would allow users to return to a starting point. They suggested prioritising the icons in the navigation bar based on their importance, with the most crucial screens placed farthest to the left, to enhance the visual hierarchy of the navigation.

Additionally, two participants mentioned that centering the text in the cards of the alerts feed is not optimal because people typically read from left to right. They suggested left-aligning the text instead. These participants also noted that if the location information is placed outside the cards, it becomes difficult to prioritise the cards based on their importance. For instance, critical events occurring at different locations might not be properly highlighted. They recommended placing the location information inside the cards to resolve this issue.

Language
Some feedback on the prototype was related to language use. Participants tested the Swedish version of the prototype, so the comments were specifically about Swedish words translated from English. For example, multiple participants found the term

'Larm' ('Alarm') in the global navigation inappropriate, as they associate it with personal emergencies rather than general warnings.

In the tip-off form, one participant found the option 'Det händer hela tiden' ('It happens all the time') confusing when choosing when the incident happened. However, this option was included since the form in the prototype was based on the same tip-off form that can be found on the Swedish Police Authorities website. Additionally, one participant suggested that the phrase 'Vill du bli kontaktad?' ('Do you want to be contacted?') could be rephrased to 'Får vi kontakta dig?' ('Can we contact you?') for clarity.

Participants also noted some minor errors. For instance, in the top bar of the alerts view, the term 'Notifikationer' ('Notifications') did not match 'Larm' in the global navigation. They also found the meaning of 'RLC' unclear and pointed out that some words had not been translated into Swedish.

Two participants expressed a desire for an explanation of the different alert types and their corresponding icons, as understanding their implications was not straightforward. This was included in the requirements list but was not added to the initial prototype due to time constraints.

Although participants were given a brief explanation of the prototype before starting the usability testing, some were still confused by the term 'crowdsourcing' and did not fully understand how it differed from the tip-off functionality. A likely reason for this confusion is that the crowdsourcing and tip-off text forms were identical.

Accessibility
Some participants noted that using both orange and red could be challenging to distinguish for colour-blind individuals. Additionally, they mentioned that switching between the detailed map view and the detailed alert view for an alert was difficult because the navigation link was too small.

Functionality
Regarding the alerts feed, one participant suggested that filtering options, such as by time or priority, could be beneficial.

In terms of reporting tip-offs, participants generally found the process clear and simple. One participant mentioned that it could be helpful to have different categories of crimes to report, with questions in the form tailored to the chosen category. This customisation would make it easier for users to complete the form.

In the call view, some participants expressed that sharing media involved too many steps. They suggested that the modal view should immediately offer options for sharing media via the photo library or camera, rather than requiring users to click on the '+' icon first.

Design Elements
Participants also suggested improvements to current design elements or new additions. For example, the field displaying the time of publication of an alert was thought to resemble too much like a button. One suggestion was to remove the blue background and only keep the text. Additionally, participants suggested that displaying only the

day and month as the time of publication would suffice, and suggested removing the year for alerts that were not published recently to save space.

In the call view, one participant also felt that there should be a dialog with feedback confirming that the position has been shared after pressing the 'Share position' button, instead of just changing the button's colour.

Questionnaire

After the tasks were completed there was also a questionnaire as the final step of the usability test. The questionnaire mainly consisted of quantitative questions, with some having follow-up questions where participants could further explain their experience. Introductory questions were focused on demographic, while following questions were about their experience with the app in the test and if they found it useful.

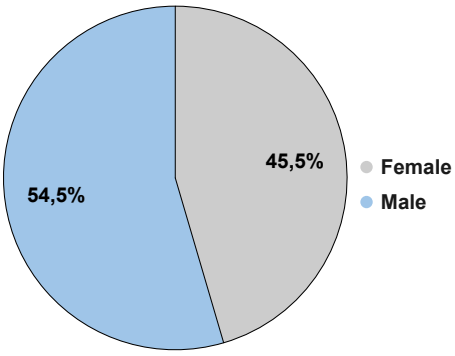
Figure 5.11 presents the demographic distribution as well as the self-perceived technological proficiency of participants. The gender distribution was almost equal between men and women. Regarding the age distribution, the majority of participants were between 18 and 24 years old, with the remainder almost equally distributed among the age groups of 25 to 34, 45 to 54, and 55 to 64 years old. Overall, a reasonably diverse age range was represented. Participants' self-perceived technological proficiency was predominantly rated as a 5, the highest possible rating. This is unsurprising given the predominantly younger age of participants. The remaining participants rated themselves as 2, 3 or 4, which aligns with the age distribution. No participant rated themselves as 1.

Figure 5.12a presents the distribution of ratings from 1 to 5 regarding the ease of use of the interface. Participants rated the ease of use either as 4 or 5, indicating that they found it easy to understand. This aligns with observations from the user tests, confirming that none of the participants had difficulty understanding the interface.

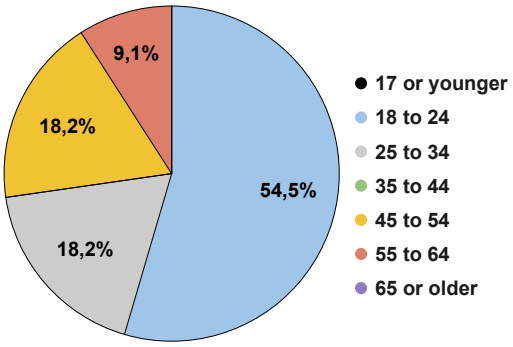
Figure 5.12b displays the distribution for how easily participants could distinguish between the emergency call, tip-off, and crowdsourcing functionalities. During the user tests, no participant expressed uncertainty regarding these functionalities. However, the questionnaire revealed that one participant was unsure about what crowdsourcing referred to, and two participants confused the crowdsourcing and tip-off functionalities. Possible reasons for this confusion could include unclear explanations of the app before the start of the user tests or the similarity between the tip-off and crowdsourcing views in terms of them using the same text-form.

Participants were also asked more general questions regarding how useful the application would be in practice, see below:

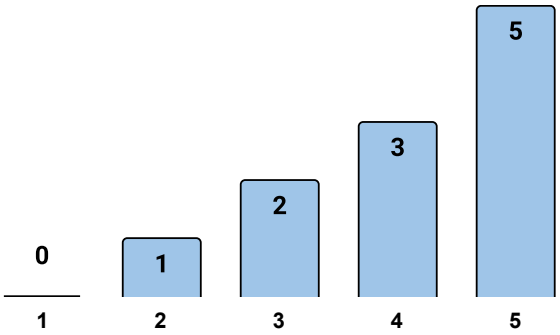
- *Do you think the app would make the police's work more efficient?*
- *Do you believe the app would make it easier for civilians to get help in emergencies?*
- *Do you think the app would encourage vigilance to avoid potential dangers?*



(a) Gender distribution.

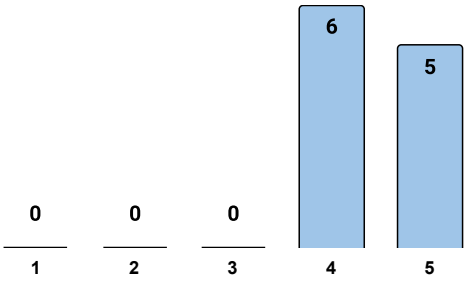


(b) Age distribution.

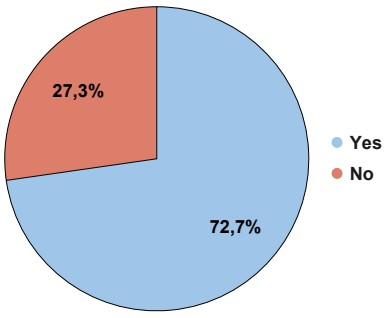


(c) Self-perceived technological proficiency.

Figure 5.11: Demographic distribution charts.



(a) How easy was it to understand the interface?



(b) Were the emergency call, tip-off, and crowdsourcing functions easy to distinguish?

Figure 5.12: Usability charts for the prototype.

All participants believed that the app would make the police's work more efficient. All participants but one replied 'yes' to whether they believed the app would make it easier for civilians to get help in emergencies. Although one participant answered 'yes', they also added the following comment:

> *"Actually a yes, but at the moment I believe it strongly depends on the individual and the level of panic the person experiences in an emergency. My thought is that you do what you are accustomed to and call 112 using the regular phone function in your mobile phone. For milder cases, the app is likely to be very useful."*

All participants but two replied 'yes' when asked if they believed the app would encourage vigilance to avoid potential dangers. Those who answered 'no' were asked a follow up question about what could give the app potential to do so. Both participants responded that it has to do with them as individuals and not the app itself, with one of the them stating the following:

> *"It has nothing to do with the app, but with me as a person. I'm not a particularly vigilant person."*

Lastly, participants were asked to rate one a scale 1-5 how likely it is that they would download the app if it existed, seen in figure 5.13. The majority of participants rated either a 3 or 5, with the remaining participants rating a 4. Not a single participant putting it on the lower end shows a fairly positive response.

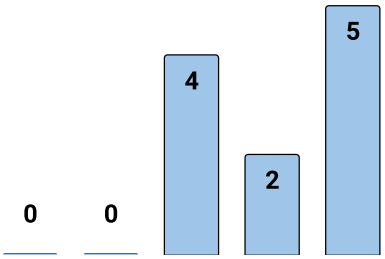


Figure 5.13: Participants' self-accessed likelihood to use an app like the prototype.

5.9.2 Interviews

After usability testing, semi-structured interviews were conducted with the same participants. The interviews were divided into two parts. The first part consisted of five questions, aimed at gathering the participants' general views on an emergency app similar to the prototype, with a focus on its usefulness and ethical aspects. The second part involved presenting three scenarios, which were used to provide concrete examples of situations that might occur, to provoke thoughts and generate more specific answers.

Since civilians are the end users of such an app, understanding their perspective was crucial to the project. By this stage, participants had developed a sense of what an emergency application for civilians could look like and what its adoption might entail,

based on their experiences during the usability testing and questionnaire. This prior exposure was beneficial for prompting reflection even before the interviews.

Procedure

Before the interviews began, participants were informed that they did not need to share personal experiences that could be sensitive, as such data should not be gathered and handled by students. Instead, they were encouraged to keep their answers more general or related to the provided scenarios. The questions were qualitative and open-ended to encourage discussion and gather opinions from participants regarding the potential implementation, use, and consequences of an application like the presented prototype. The interviews were conducted in Swedish, as all participants spoke Swedish. The original questions in Swedish can be found in appendix D, while the translated questions are provided below. The first five questions pertain to the initial part of the interview, whereas the last three questions address the scenarios. These scenarios were used to give a more concrete examples of situations that might occur in order to provoke thoughts and generate more specific answers.

Interview Questions

1. What are your thoughts on the potential implementation of an app like this?
   (a) Do you see any potential advantages with an application like this?
   (b) Do you see any potential risks?
   (c) What do you think should be considered to prevent potential misuse of such an application if it were to be implemented?
2. Do you think an app like this would provide a sense of security?
   (a) Why or why not?
   (b) Do you think there's a risk that it might increase anxiety instead?
3. Do you think there's a risk that an application like this could be intrusive to privacy?
   (a) If so, how and why?
4. Would you personally consider using such an application if it were available?
   (a) Do you currently use any other emergency apps?
5. What are your thoughts on an application like this...
   (a) ... in a democratic society?
   (b) ... in an authoritarian state?

Scenarios

1. You are out for a walk and you notice an unknown object that you suspect might be dangerous, but you're uncertain.
   (a) What would you do...
      i. ... if it happened today?
      ii. if this app was available?
2. Imagine an incident where someone is a victim of purse theft. How would you feel about a witness recording the event?
   (a) Do you think this application encourages people to take photos or record crimes to gather evidence?
   (b) Does this increase the responsibility of witnesses?
      i. If yes, do you think it is fair to place this responsibility on witnesses?

3. Imagine this application has been fully implemented and is available to everyone. Do you think it's risky to have such tools ready for use in case the country takes a political turn?
   (a) Is it ethical to use the app to report all types of crimes?
   (b) What are your thoughts on this technology in states that you consider to have unethical laws?
   (c) Do you think this application could lead to a society of informants?

Analysis

To analyse the interview data, the recordings were first manually transcribed and combined with the notes. The data related to the interview questions were then coded based on similar responses to understand the distribution of responses for each question. For instance, contrasting responses — positive or negative — were highlighted using different colours: green represented a positive view, and red indicated a negative view. This information was then summarised along with the rest of the data under each interview question. Although the data analysis process resembled a thematic analysis, it did not include deriving overarching themes, as the 'themes' in this case were the interview questions themselves. The result of the analysis is summarised for each interview question below.

What are your thoughts on whether an app like this should be implemented for real?

All participants expressed positivity regarding the potential implementation of such an app, while nine of these participants also expressed some form of concern. Generally, participants favoured the idea of receiving notifications about incidents in their vicinity and being able to share their position and media in emergencies. This could, for example, help them know if they should avoid a certain location at a certain time. They believed that sharing information through media and automatic GPS positioning would also be advantageous for the police, as verbal descriptions of incidents and locations might not be as detailed or accurate.

> *"[...] there are many times when you hear loud noises or a lot of activity and try to understand if something is happening, but you don't know exactly where to find information related to this, so you end up looking through many different news sites to find relevant information."*

Most participants liked the idea of a tip-off function in the app, stating that it would make it more convenient for civilians to report tips directly on the spot and increase the chances of the police receiving information from civilians, thereby providing access to more data.

Overall, the app was seen positively for its potential to increase perceived safety, improve communication for both civilians and the police, provide better situational overviews for the police, making it easier for witnesses to help, and be especially useful in non-emergency cases.

However, participants also raised some concerns. Some stated that continuously

receiving notifications about incidents in their vicinity could be unsettling and potentially increase fear among people. They expressed that there might not be a need to receive notifications about all types of incidents as they occur. Furthermore, they highlighted that since the app makes it more readily available to share information and allows for anonymity, the police might receive an abundance of unnecessary or false information. This could strain resources and potentially compromise the effectiveness of the app for law enforcement.

> *"[...] it can be a double-edged sword. Since it becomes so easy to report issues, the police might receive a lot of unnecessary information. More resources will be needed to process all of the information."*

One participant also expressed concerns regarding older individuals' ability to understand and use the app, as well as potential accessibility issues, such as whether disabled individuals would be able to use speech-to-text functionality.

In terms of mitigating potential abuse of the app, participants expressed that this could be difficult to achieve if the app allows users to remain anonymous. Suggestions included educating people to take reporting more seriously, requiring some form of identification for reporting tips or crowdsourcing information, such as BankId, and clearly specifying the type of information being requested in cases of crowdsourcing. One participant noted that requiring identification would enable police officers reviewing reports to identify patterns in the information provided by users, such as biased reporting targeting specific groups of people.

> *"It's difficult to prevent abuse if the app is to be anonymous. One can educate the population to take it more seriously."*

> *"To combat abuse, it shouldn't be anonymous. You could use BankID to keep track of users. All information submitted can be stored so that the authorities can detect patterns in the information submitted. For example, a pattern might be that a person only reports immigrants. Non-anonymity could also pose problems, though, as the police could abuse the app."*

Do you think an app like this would provide a sense of security?

All participants expressed positivity regarding the potential of the app to create a sense of security if it were to exist, while nine of these participants also expressed some form of concern. Generally, participants mentioned that receiving notifications about warnings, such as locations to avoid in case of a fire or to be more vigilant of dangers, such as a perpetrator on the loose, could be comforting as it would help individuals stay safe. This sentiment is particularly relevant for large-scale events. Two participants believed that while the app could create a sense of security, it was difficult to determine if it would actually make any difference. Another participant suggested that the app could act as a deterrent for criminals if they knew that civilians could easily report incidents. Additionally, one participant believed that the app could provide a sense of security for individuals who are hesitant to report issues and may increase the number of tip-offs.

> *"Many would probably feel safer, or feel a perceived safety, but it's difficult to say if it would make any real difference."*

Several concerns were also raised, with the most common being that the app could cause worry and increase stress by constantly notifying people about incidents in their vicinity. This could potentially deter them from going out, especially if they live in areas with high crime rates. Some participants suggested that people may be better off not knowing everything.

One participant mentioned that in larger cities, individuals typically only know about incidents occurring in their immediate vicinity, so being aware of incidents in other parts of the city could be unsettling but also beneficial. Other concerns included potential negative impacts on businesses such as restaurants or cafes if people became more aware of frequent incidents at their locations, and worries about the app falling into the wrong hands or leading people to prioritise its use over providing physical help in emergencies.

> *"A little bit of both. Nice to be able to get information about warnings, for example, places to avoid or to be more vigilant, but it's also scary if you know that something has happened where you are, so you can feel a bit unsafe if you can see how much is happening around you."*

Do you think there is a risk that an application like this could be invasive of privacy?

Seven participants expressed that, for the most part, the app would not be an invasion of privacy; if it were, it would be for people's own good. The remaining four participants expressed concerns that it could be. Generally, most participants did not see how the app would invade privacy if it only stored information about users' positions. If it were to require some form of identification, it could be beneficial as it would help mitigate false or unwanted information. Additionally, one participant noted that since most apps today require some form of identification, this app would not be any different.

> *"Spontaneously, I don't quite see how, because I would guess that you wouldn't log user information, except for the position. There was nowhere I saw that the app could be invasive of privacy, maybe when sending in pictures but not even then, as it concerns the police."*

Concerns about invasion of privacy included the potential offensiveness towards those being reported, particularly when sharing images, risks of prejudice (e.g., reporting youths without cause), and issues related to the storage of position data and GDPR compliance.

Would you yourself consider having such an application if it were available?

Ten participants stated that they would download or possibly download the app if it was available. However, three out of these participants stated that they would not actively use the app and only have it in the background for notifications about

serious incidents. One participant stated they would not download the app. Eight participants stated that they do not have any apps for emergencies downloaded today. One participant used a built-in function in their phone that sends information to pre-selected contacts in case of emergencies. The remaining three participants either used CoSafe [40], SOS Alarm [34], or Sms-livräddare [41].

> *"Don't know. Could be good to receive notifications about incidents, but not sure if I would download it. Feels like you could get extra scared if you see things happening all the time. I could imagine downloading it and having it in the background to receive notifications, but I wouldn't actively use it where I go in and, for example, provide tips."*

What are your thoughts on an application like this in a democratic society and an authoritarian state, respectively?

Ten participants expressed positive views regarding the application's use in a democratic society, although two of them also voiced concerns. Additionally, one participant stated that it could potentially be used to monitor civilians. Generally, most participants did not perceive it as detrimental to democracy, arguing that innocent individuals should have nothing to hide. They believed that as long as no laws are violated, the application could benefit both civilians and law enforcement by enhancing information accessibility and awareness. However, there are still concerns, including the potential for camera surveillance, the possibility that it might provide only a false sense of security, and the risk of individuals being wrongly accused of being informants.

> *"It doesn't seem to infringe on democracy in any way because you should always work to prevent crime. It doesn't raise any red flags for me."*

> *"It's necessary to compromise on privacy a bit; innocent people have nothing to hide."*

Eight participants expressed negative views regarding the application's use in an authoritarian society. Two participants did not have an opinion on this matter, and one participant believed it would not make a significant difference beyond simply facilitating reporting. Generally, participants highlighted the risk of the police gaining excessive power and potentially abusing the app. Concerns included the possibility of information censorship, encouragement to act as informants, and potential monitoring and data gathering of users.

> *"In an authoritarian regime, there would be even more bias. It would be scary because they could control the information that gets released."*

> *"It feels like a typical "snitch on your neighbour" scenario in an authoritarian state. But you can already do that now by reporting tip-offs on a website. So, in reality, it doesn't change anything; it just makes it easier to provide information to the police."*

Scenario 1

> You are out on a walk and see an unknown object that you suspect might be dangerous, but you feel unsure.
> (a) What would you do...
> i. ... if it happened today?
> ii. ... if this app was available?

Six participants expressed that if they encountered a suspicious object today, they would primarily call the police number 114 14. One participant stated that they would call the emergency number 112. The remaining participants indicated that they would probably not react to the object.

Two participants mentioned that reaching a police officer when calling 114 14 usually takes a long time, and they were unsure if they would consider it important enough to call the police. One of these participants also pondered whether the police would process reported tip-offs the same day or after a week. Another participant stated that their response largely depends on the object's appearance; even if it seemed suspicious, they were uncertain if they would perceive it as dangerous. They also mentioned being less inclined to report a tip-off through the website while on the move.

> *"It depends on how strange it looked, maybe if I was unsure about what it was. But I'm not sure; it always takes so long to get through to 114 14. I wouldn't have the patience to wait in line there, and I'm not sure if I would think it's important enough to call the police. So, unless it was something really odd, I would have just walked by. "*

However, all participants agreed that if the application existed today and was encouraged to be used, they would be more likely to report a tip-off. Generally, participants expressed that they would find it easier and more convenient to use an app since they could easily take a photo and share their location directly on the spot.

> *"But if I had an app installed, it would have been easier and more convenient to send a tip-off. However, I wonder whether they would look at the tip today or like in a week. "*

Scenario 2

> Imagine an incident where the victim has their handbag stolen. How would you feel about a witness recording the incident?
> (a) Do you think this application encourages crimes to be photographed or recorded to gather material?
> (b) Does this lead to increased responsibility of witnesses?
> i. If so, do you think it is fair to place this responsibility on witnesses?

All participants expressed that the application would not encourage more crimes to be filmed or photographed than what is already being done today. Additionally, most participants believed that witnesses would not bear increased responsibility if the app existed. Generally, participants found the app to be a helpful tool for

witnesses as it facilitates the sharing of information through media, eliminating the need to rely solely on verbal descriptions and memory. Consequently, the police may receive higher quality evidence, aiding them in solving crimes more efficiently. Several participants noted that people will inevitably film incidents regardless of whether there's an app, and that it is much worse to do nothing with the information.

> *"[...] people will film whether you want it or not. I don't think that witnesses would bear increased responsibility, it's way worse not to do anything with the information."*

Furthermore, one participant suggested that multiple people sharing media of an incident could make it harder for witnesses to lie. Overall, participants agreed that as long as the media is not distributed unnecessarily, the app benefits both civilians and the police.

Scenario 3

> Imagine that this application has been fully implemented and available to all. Do you think it is risky to have tools like these ready to use in case the country would take a political turn?
> (a) Is it ethical to use the app to report all types of crime?
> (b) What are your thoughts on this technology in states you consider to have unethical laws?
> (c) Do you think this application could lead to an informant society?

Seven participants expressed that they do not believe the application would pose significant risks if the country underwent a political shift. However, the remaining participants believed that it could potentially be risky. Generally, participants stated that even if such a scenario were to occur, the risks would not outweigh the benefits of having the app, especially in a democratic country. One participant noted that the app would not fundamentally change the current state of affairs, as people already have the option to report tips via browser or by calling emergency services. The app would simply streamline information sharing. Another participant suggested that the app's acceptability would depend on prevailing societal norms; if the politics were deemed inappropriate, it would reflect society rather than the app itself. They emphasised that people would report tips regardless of the app's existence.

> *"Depending on what is considered as acceptable today, the app will follow the politics and adapt to society. In that case, the politics is wrong and not the app. People will call or report tip-offs if they really want to, regardless of the app."*

Other participants proposed measures such as requiring application approval to download the app to mitigate potential abuse. They also expressed confidence that the app would not have negative consequences, as its usage would be voluntary and motivated by a desire to enhance safety and stay informed about potential dangers. Most participants stated that it is not ethical to use the app to report all kinds of incidents, and that ethical considerations also depend on established laws. For instance, reporting children or neighbours for minor infractions, or a mother and her

child seeking shelter from rain on private property, could be deemed unethical. There are therefore grey areas, and all information can be taken out of context. Reporting unnecessary incidents would also increase the workload for the police.

> *"No, some things don't feel ethical to report. [...] it can become very black and white, and then immorality comes in."*

All participants expressed negative views regarding the use of the app in countries with laws that may be considered unethical. Concerns were raised about potential issues faced by innocent people or minorities, as well as the possibility of abuse of the app. Additionally, many individuals may choose not to strictly adhere to specific laws that they perceive as unethical. Furthermore, most participants did not believe that the app would lead to a society of informants.

> *"In states with unethical laws, it doesn't feel right. For instance, some states have very strict rules about how one should behave, but that doesn't necessarily mean the laws are just. I can imagine that many people don't adhere to those laws because they aren't considered fair. In Sweden, on the other hand, it seems more suitable for having such an app. It's doubtful that the app would lead to a society of informers, though maybe in extremely corrupt countries, it could. "*

6

Results

This chapter presents the results of the project. The results consist of two parts: a semi-functional prototype and design recommendations. The goal of the prototype is to exemplify how the design recommendations can be practically applied when designing a mobile emergency application directed toward civilians. Together, these two components answer the following research question:

What design recommendations can be proposed for a mobile application aimed at enhancing civilians' ability to share and process vital information during emergency situations?

6.1 Semi-Functional Prototype

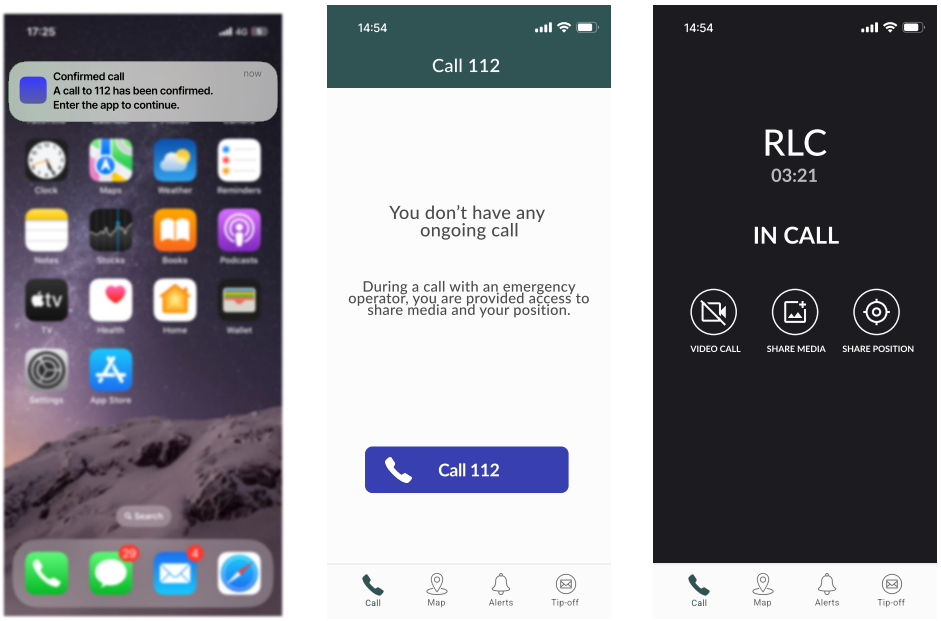
A semi-functional prototype was created to provide an example of how emergency mobile applications aimed at civilians can be designed. The requirements that were informed by data from interviews and literature (see table 5.2) served as the foundation for the development of the the prototype. The prototype features three main functionalities that citizens can use to share information: real-time media sharing and automatic GPS positioning during emergency calls, crowdsourcing, and reporting of tip-offs. The first two functionalities are focused more on emergencies, while the reporting of tip-offs is intended for non-emergent situations. A central component of these functionalities is the alerts feed and alerts map overview, which provide necessary updates about incidents to help users make informed decisions.

6.1.1 Real-time Media Sharing and GPS Positioning

There are two scenarios for users to initiate a call with the emergency centre. In the first scenario (figure 6.1a), users call the emergency number 112 outside of the app and then receive a notification from the app confirming the call. Once the user enters the application at this point, the app connects to the call and displays the ongoing call screen (figure 6.1c). In the other scenario (figure 6.1b), users call the emergency number 112 directly from the dedicated call screen in the app. In the ongoing call screen, users are then granted the options to share media and their position, or start a video call. A dedicated call screen was added clearly inform users that when they call the emergency number, they will be able to share media and their position.

To share media, users can click 'share media' to open a modal view. When the modal

view is opened, a dialog pops up asking the user if they want their most recently taken media to be automatically loaded into the app (figure 6.2a). Depending on how time-critical the emergency is, automatically loading the most recently taken media into the app can help save time. However, this assumes that the media is related to the emergency. Additionally, the user would still have to verify the media to ensure its correct. If the user does not want to automatically load media into the app, they can proceed by either selecting an existing photo or video or taking a photo or video on the spot (figure 6.2b). Once the media has been loaded into the app, users can choose to add more media, or they can remove or send the current media (figure 6.2c).



(a) A notification that a call to the emergency number has been confirmed.

(b) Calling the emergency number directly from the app.

(c) Ongoing call with an emergency operator.

Figure 6.1: The process of initiating a call with the emergency centre.

(a) A dialog asking the user if they want to automatically load their most recently taken photos or recorded videos into the app.

(b) Choosing whether to share existing media from the photo library or taking a new photo/recording a new video.

(c) Media that has been selected and is ready to be sent.

Figure 6.2: The process of sharing media.

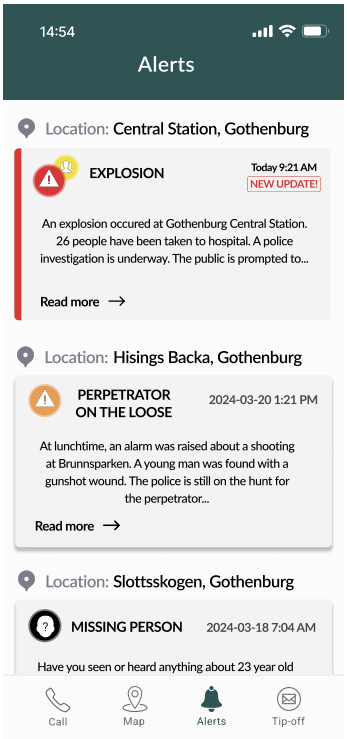
6.1.2 Emergency Alerts

Emergency alerts are a central component in the app that informs citizens about incidents. Through these alerts, users can see what is happening in their proximity or city and what recommendations they should follow to keep safe. Alerts can be accessed in two ways: through the alerts feed and through the map.

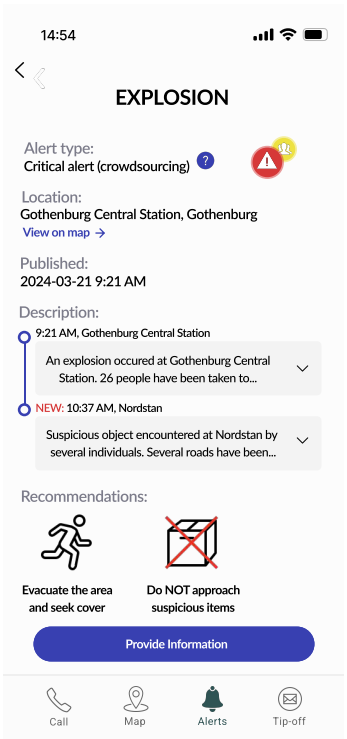
Alerts Feed

Alerts contain the following information, condensed in a card format: a header, the incident's location, the data and time of publication, a short description, an icon indicating the type of alert, and in critical cases, a red strip on the side to accentuate the alert (figure 6.3a). Each alert also has a 'read more' navigational link that takes users to the detailed alert view.

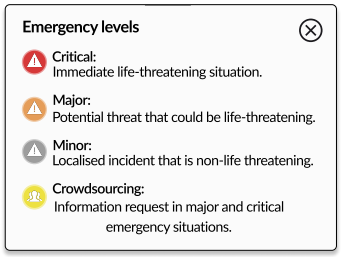
The detailed alert view generally includes the same information as the card format but may also provide a more in-depth description of the incident through a timeline of updates as well as recommendations (figure 6.3b). The timeline ensure users receive a complete narrative of the incident as it unfolds, helping them understand its evolution and current status. This chronological sequence clarifies how the situation started,



(a) An alerts feed providing citizens with information about different incidents in their proximity or city.



(b) A detailed alert view that includes a timeline of the incident, recommendations, and the ability to contribute information (crowdsourcing).



(c) A tooltip providing additional context about the various emergency types and their corresponding icon.

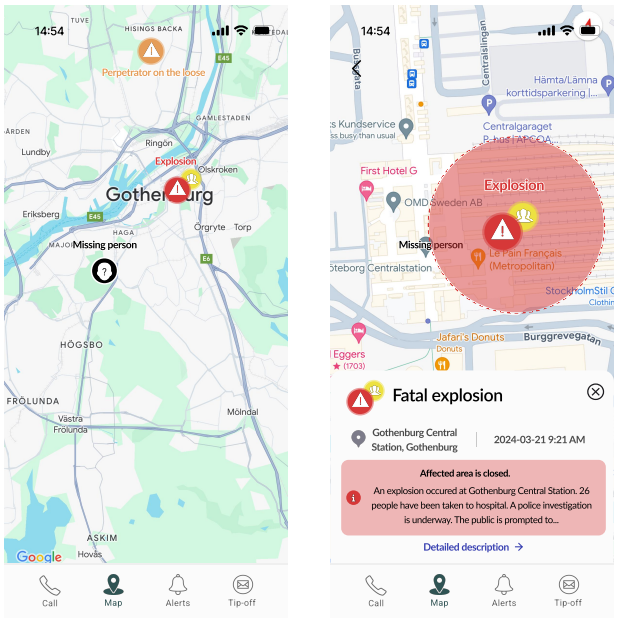
Figure 6.3: Communicating alerts through a feed / list view.

what was changed, and what might happen next, allowing users to make informed decisions based on the latest developments. The detailed alert view also includes a tooltip that explain the various emergency types and their corresponding icon, which can be accessed through the question mark icon (figure 6.3c). Additionally, the detailed alert view may allow users to contribute information in cases where the alert is of the crowdsourcing alert type.

Alerts - Map Overview

The map provides an alternative way to view alerts compared to the alerts feed. Including a map improves the communication of information like affected areas, evacuation directions, and road closures, which are less intuitive to convey through text [5]. Pressing the map icon in the global navigation takes the user to a complete map overview that displays all current incidents (figure 6.4a). Incidents on the map are communicated in the same way as in the alerts feed, with a header and a corresponding icon.

Pressing an icon on the map directs the user to a detailed map view, which includes additional information not found in the detailed alert view, such as the exact affected area (figure 6.4b). To facilitate seamless navigation between the detailed map view and the detailed alert view, the navigation links 'Detailed description' and 'View on



(a) A map overview of different alerts. This provides an alternative way to view alerts.

(b) A detailed map view of a specific alert. Depending on the type of incident, it may provide additional information compared to the alerts feed, e.g. how large the affected area is.

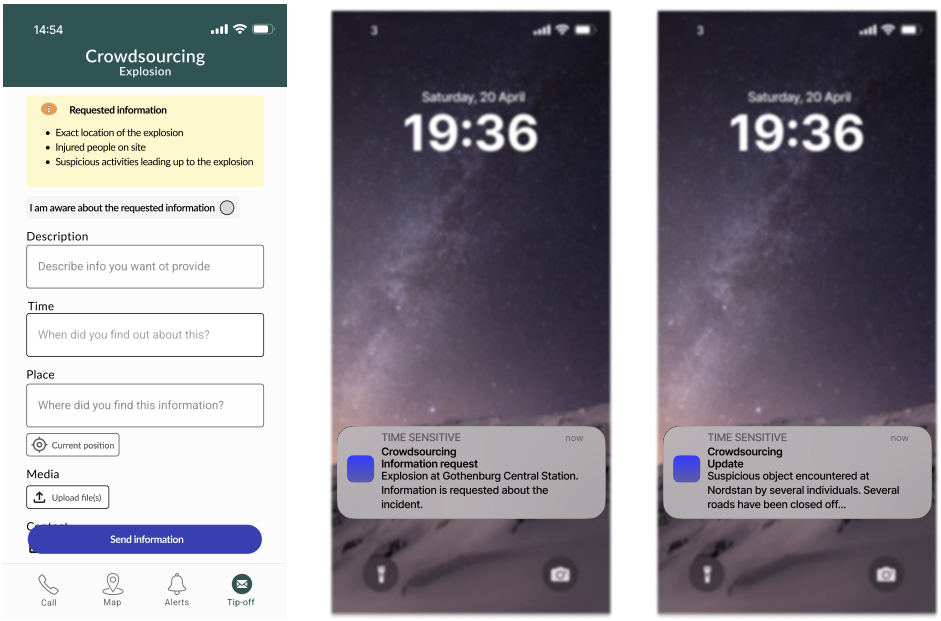
Figure 6.4: Communicating alerts through a map.

map' are included in each respective view. These links help prevent the user from performing unnecessary navigational steps.

Crowdsourcing

For certain alerts, such as those regarding critical incidents, users can contribute information about the situation. The aim of the crowdsourcing functionality is to delegate parts of the problem-solving process to the crowd. The information provided by citizens can support the decision-making processes of emergency operators and facilitate police response measures [20]. This is particularly effective since emergency operators serve as crucial intermediaries between the public and the police.

To contribute information about a situation through the app, an alert must be of the crowdsourcing alert type. This is indicated by a yellow crowdsourcing icon and the text 'crowdsourcing' under 'alert type' in the detailed alert view (figure 6.3b). Additionally, alerts related to crowdsourcing feature a 'Provide information' button. Pressing the 'Provide information' button directs the user to the crowdsourcing form (figure 6.5a). On this form, users must first confirm that they have read the information in the yellow box by selecting the corresponding radio button. After confirming, they can proceed to fill out the form. Figures 6.5b and 6.5c illustrate examples of notifications for an information request and an update, respectively. An update notification is sent out once emergency operators have received information from citizens about a situation. These updates are then communicated in the detailed alert view through the timeline (figure 6.3b).



(a) A crowdsourcing form to contribute information to the emergency centre.

(b) A notification that the emergency centre is requesting information about an incident.

(c) A notification that an update has been made regarding an incident.

Figure 6.5: The crowdsourcing process.

6.1.3 Reporting a Tip-off

The goal of the tip-off functionality is to facilitate information sharing for citizens in non-emergent situations. Interviews with police officers and emergency operators revealed that there is always a need for information about any suspicions, as this could help prevent and combat crimes. They also indicated that an integrated tip-off functionality may make it easier for citizens to report suspicions on the spot when the information is fresh in their memory, which could prevent them from postponing and eventually forgetting about it. Currently, citizens have to use the website of the Swedish Police Authority to report a tip-off. However, interviews with civilians revealed that they would be less likely to report a tip-off through the website as it is not as convenient as using an app.

Reporting a tip-off works in a similar fashion to the crowdsourcing functionality. Users fill out a form with details such as a description, time, location, media (figure 6.6). They also indicate if they want to be contacted. If they choose not to be contacted, their report is completely anonymous.

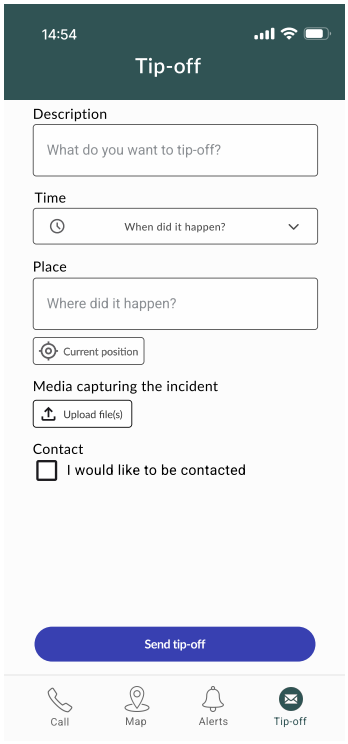


Figure 6.6: A tip-off form to contribute information about non-emergent situations.

6.2 Design Recommendations

This section presents the main result of the project; a set of eleven design recommendations for a mobile application aimed at enhancing civilians' ability to share and process vital information during emergency situations. The recommendations are based on data collected from interviews, literature, and, to some extent, the evaluation. As such, they can be tied back to the previously defined requirements (see table 5.2). Each recommendation includes an explanation of its rationale, detailing the related requirements and their alignment. The design recommendations are abbreviated as 'DR' for easier reference, and requirements noted with 'E' are derived from the evaluation. Additionally, each design recommendation is illustrated with a design proposal derived from the semi-functional prototype, offering a visualisation of its practical application. The design recommendations are presented in table 6.1.

Table 6.1: A summary of the design recommendations.

#	**Recommendation**
1	Integrate real-time media sharing and automatic GPS positioning
2	Enable information sharing through crowdsourcing
3	Integrate tip-off functionality
4	Highlight crucial information
5	Minimise cognitive load
6	Account for accessibility
7	Communicate emergency updates
8	Provide appropriate feedback for actions
9	Use appropriate language
10	Provide contextualised content
11	Communicate transparency and ethical use

1. Integrate real-time media sharing and automatic GPS positioning

Relevant requirements

6.1. The system must enable media sharing in the form of images and videos

6.2. The system must enable automatic GPS positioning

Based on interviews with police officers and civilians, it was expressed that enabling real-time information sharing in the form of media and automatic GPS positioning during emergency calls is beneficial. Verbal descriptions often lack precision, causing delays in response times. Furthermore, simulations of emergency situations have shown that the use of images and user positions provide more accurate information compared to relying solely on verbal communication between emergency operators and citizens [2].

Integrating real-time media upload and automatic GPS positioning within the system has one main advantage: it could save crucial time in emergency situations. During

emergencies, time becomes of utmost importance and could significantly affect the success of police operations. Facilitating the process of information sharing for civilians could streamline the workflow of emergency operators and become key in ensuring swift and effective police response, ultimately enhancing public safety.

Figures 6.1c and 6.2 illustrate how sharing media and position data could be designed. When users call the emergency number and are connected to an emergency operator, they can initiate a video call, share media, or share their position (figure 6.1c). Selecting 'share media' opens a modal view, offering options to automatically load media, upload existing media from the photo library, or take new photos/record new videos. Modal views take a minimum amount of screen space and allow users to perform tasks without losing track of their previous context [42]. Sharing position is less complicated and only requires pressing the 'share position' button.

2. Enable information sharing through crowdsourcing

Relevant requirements

1. The system should enable information sharing through crowdsourcing

Crowdsourcing enables the rapid collection of real-time data by leveraging the collective knowledge of a large group of individuals, which is essential for making informed decisions during emergencies [1], [19]. Based on interviews with RLC operators, the interviewees expressed that crowdsourcing could be beneficial in certain emergency situations as it can help make police work more efficient.

To enable users to provide information, an alert must include the text 'crowdsourcing' in the alert type and be accompanied by a crowdsourcing icon representing a group of people (figure 6.3b). Figure 6.5a illustrates an example of how to design the crowdsourcing view. Initially, users are presented with information regarding the type of information requested. Before proceeding to input information about the situation, they must first confirm their understanding of the requested information by clicking the radio button. The 'send information' button remains deactivated until this confirmation is given. Once confirmed, users can provide a description, time, location, and media, with the additional option to choose to be contacted.

When implementing this functionality in practice, consideration must be given to who should be able to provide information. Currently, it is assumed that anyone in the proximity of an incident can provide information and thus receive a notification on their phone from the emergency centre requesting information (figure 6.5b). However, the functionality could also be controlled further by restricting it to individuals who volunteer to assist in emergency situations.

3. Integrate tip-off functionality

Relevant requirements

2. The system should enable reporting of tips to the police

Based on interviews with RLC operators and civilians, integrating tip-off functionality into the system could be beneficial since people would be more likely to report incidents on the spot when details are fresh in their memory, rather than waiting until they are home and potentially forgetting crucial information. This functionality would also eliminate the need for individuals to navigate the police website and search for the tip-off form, making the reporting process more convenient. Consequently, the police would likely receive more information from civilians, providing access to more data. Additionally, it was believed that the app could provide a sense of security for individuals who are hesitant to report issues as it might be more widely accepted and used.

Figure 6.6 illustrates an example of how to design the tip-off view. Like the crowdsourcing view, users can provide a description, time, location, and media, with the additional option to choose to be contacted. A consistent layout has been chosen to simplify the interface for users. The main difference between reporting a tip and providing information for crowdsourcing is that tips are for more general matters and do not pertain to emergency situations.

4. Highlight crucial information

Relevant requirements

12.1. The system should highlight critical information through typographical emphasis

12.2. The system must accentuate interface elements

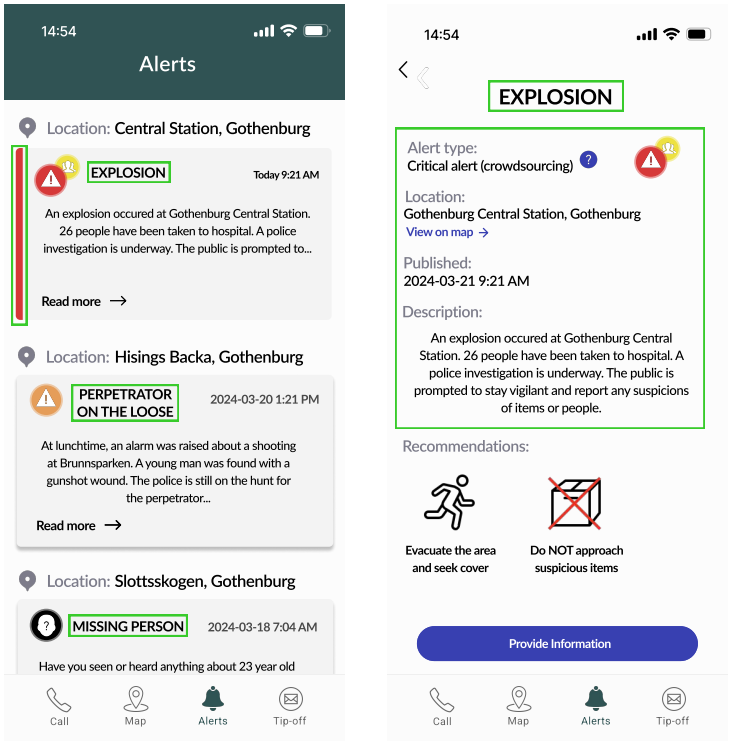
12.3. The system must maintain an appropriate textual length for content

12.4. The system must present critical information in a top-to-bottom structure

During emergency situations, many updates with varying levels of importance may come in simultaneously, causing users to miss critical information [5]. This can especially be the case during critical events, where extreme time pressure and high stakes can create conditions of high stress, which may degrade individuals' information-processing and decision-making abilities [1]. This point was also emphasised by the UX designers in previous interviews. Therefore, it is paramount to highlight crucial information during emergencies.

Highlighting crucial information can be achieved in several ways: using a top-to-bottom structure, maintaining an appropriate textual length for content, accentuating interface elements, and using typographical emphasis [5]. Figure 6.7a shows an example of how alerts can be presented in a top-to-bottom structure using cards. Cards are effective for grouping information and allow for flexible layouts [35], [36]. Presenting information as a single digestible unit makes it easier to consume. Additionally, cards can be accentuated with a colour strip on the side based on their level of importance. In this case, red is used to highlight critical situations such as explosions.

Figure 6.7b shows additional examples of how to highlight crucial information. To maintain an appropriate textual length for content, information can be divided into smaller sections to make it easier to digest. Additionally, typographical emphasis can be used to capitalise headlines to make them stand out.



(a) Top-to-bottom structure using a card layout. Cards can be accentuated with a color strip and headings are capitalised to make them stand out.

(b) Maintaining an appropriate amount of text. Information is divided into smaller sections to make it easier to digest.

Figure 6.7: Highlighting crucial information.

5. Minimise cognitive load

Relevant requirements

9.1. The system must be simple and minimalist, and include elements of familiarity

9.2. The system must have short and direct navigation

9.3. The system must include a map overview of emergency situations

9.4. The system should include icons with text headlines

9.5. The system should minimise textual input

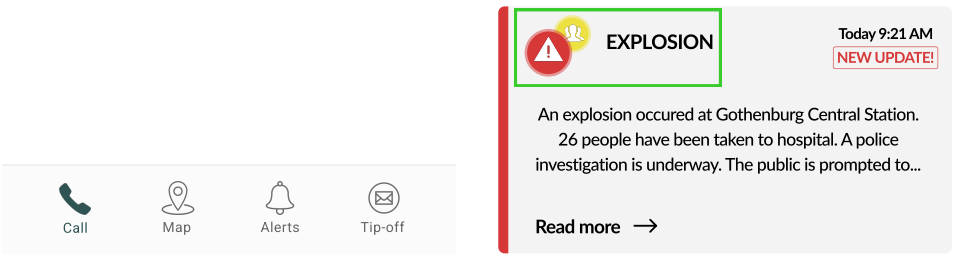
When under stress, the resources allocated to working memory are reduced, partly because of the physiological changes associated with the fight-or-flight response [3].

Since decision-making occurs within working memory during emergencies, stress can negatively impact the decision-making process and its execution. Therefore, the degree of stress an individual experiences when confronted with a threat can diminish their cognitive abilities and performance [3].

Based on the interviews with UX designers, users frequently experience high cognitive load and impaired fine motor skills in high-stress situations, such as emergencies, where multiple things can happen simultaneously and time is limited. Therefore, applications should be designed to accommodate these scenarios.

To minimise cognitive load, Tan et al. [5] and the UX designers suggest that textual input should be limited as it demands greater attention and time, and that navigation should be simple. Tan et al. mention additional ways to minimise cognitive load, including using a map to communicate emergencies, using familiar UI elements, and including icons with text headlines.

For straightforward navigation, a flat visual style can be used by putting access to more screens directly in the global navigation [35]. This minimises the levels of hierarchy in the app and keeps users from having to do extra navigational steps. An example of this is shown in figure 6.8a.



(a) Global navigation: All essential functionalities are located here for easy access.

(b) Each card features a headline paired with an icon, which helps users locate information more easily.

Figure 6.8: Minimising cognitive load through easier navigation and icons.

Using icons with text headlines is also effective in enhancing navigation [5]. Icons provide context to headlines, helping users locate information more easily (figure 6.8b).

In emergency apps, specifically, maps can be effective in reducing cognitive load. They allow information to be presented visually rather than verbally, which can be particularly useful for conveying complex data [5], [35]. As mentioned in section 6.1.2, in the case of emergency apps, they can help improve communication of affected areas, evacuation directions, and closed roads. Figure 6.4 provides an example of how to use maps: icons offer an overview of different incidents (figure 6.4a), and clicking on an icon reveals detailed information about a specific incident, such as affected areas (figure 6.4b).

Another way to minimise cognitive load in emergency apps is by enabling users to automatically upload their most recently taken photos and videos into the app during a call with an emergency operator (figure 6.2a). If users know that their most recent

media is relevant to the emergency and the situation is time-critical, this feature can help expedite the process of getting assistance.

6. Account for accessibility

Relevant requirements

7.1. The system must have clear contrasts

7.2. The system must have a large enough touch target size for buttons

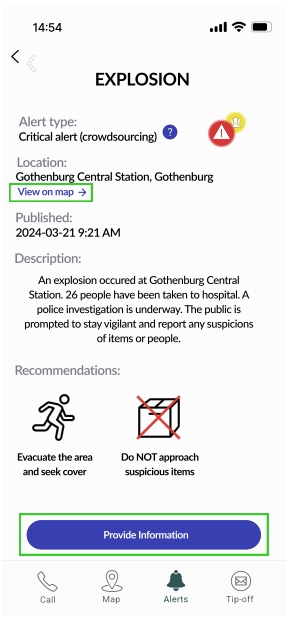
9.2. The system must have short and direct navigation

Emergency mobile applications have a broad user group, making it paramount to consider accessibility for users with disabilities, such as colour blindness and weak eyesight. However, users may also experience situational disability [16]. For example, high-stress situations can cause users to run or walk quickly, hindering their ability to make precise movements. This was also brought up during interviews with UX designers.

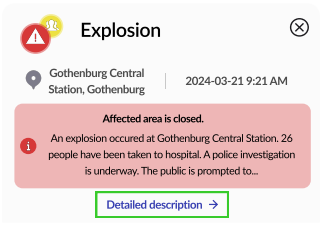
Accessible design can be achieved in several ways. According to the UX designers, this includes using clear contrasts, ensuring buttons have a large enough touch target size, and implementing simple navigation. Tan et al. [5] state that emergency apps should be minimalistic to communicate information quickly, which includes having short and direct navigation. Moreover, according to WCAG 2.0 [18], components that are repeated across multiple screens should be presented in a consistent layout. This includes using consistent navigation (level AA).

Figures 6.9b and 6.9c show an example of how repeated components that communicate different information have a consistent layout. As discussed in DR#5, a short and direct navigation is important for minimising cognitive load. This principle also applies for accessibility. In this case, the modal view and detailed alert view include navigation links labeled 'Detailed description' and 'View on map', respectively. These links allow users to quickly switch between the detailed view and map view of an alert and minimises unnecessary navigation (figure 6.9).

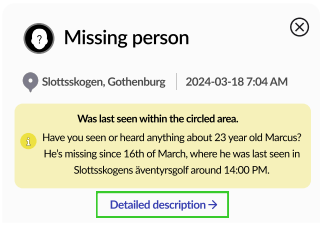
Figure 6.9a shows another example of good design for accessibility: using a large touch target size for buttons. These buttons almost extend the entire screen, making it clear for users that they can be clicked to perform a task. According to WCAG 2.0 [18], touch targets should be at least 9 mm high by 9 mm wide.



(a) A navigational link 'View on map' to facilitate navigation to the detailed map view, and using large buttons for actions.



(b) Example 1 of a specific alert.



(c) Example 2 of a specific alert.

Figure 6.9: Accounting for accessibility through large buttons and a consistent layout.

7. Communicate emergency updates

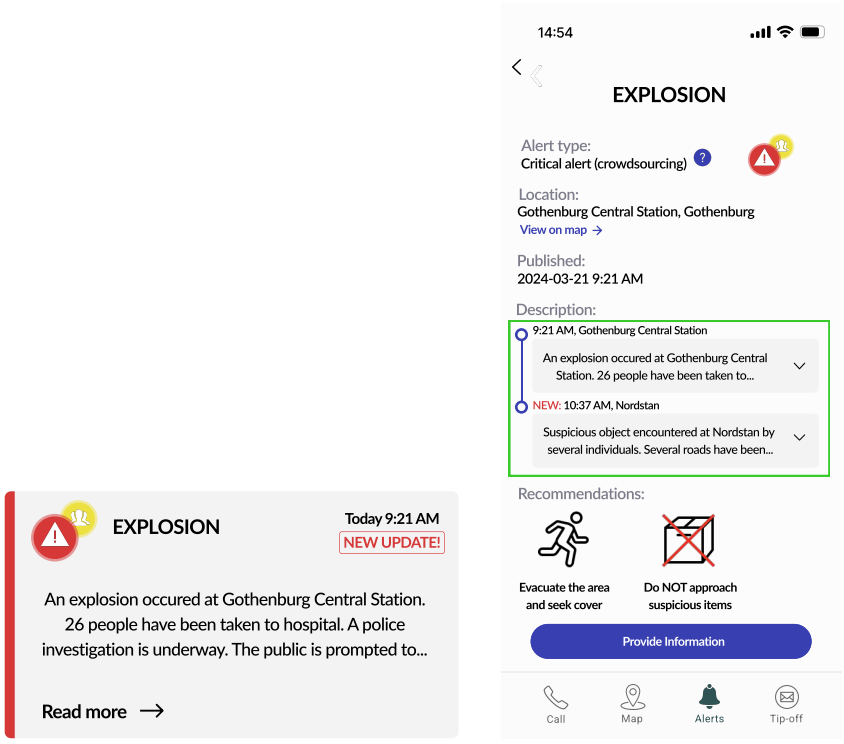
Relevant requirements

1.1. The interaction of the system should be many-to-one-to-many

Tan et al. [1] explain that for applications with crowdsourcing functionality, a many-to-one-to-many interaction fosters mutual interaction between civilians and emergency operators by redistributing the aggregated information to the public. This makes the application public centric rather than authority centric, and treats the public as sensors or volunteers rather than simply as receivers of information or as victims needing help. As such, a two-way communication between the public and authority can be efficient to gain better awareness of emergency situations. This makes DR#7 directly connected to DR#6.

Figure 6.5c illustrates an example of how emergency updates are communicated. When the emergency centre receives information about a situation from the public, any pertinent information is compiled and updated in the app for public access. When an update occurs, users are first notified on their phone. In the alert view, users can then see that an alert has been updated when it displays the text 'NEW UPDATE!' (figure 6.10a). The detailed alert view provides additional information in the form of a timeline, spanning from the first update to the latest update, to facilitate users' understanding of the unfolding situation and the associated recommendations (figure 6.10b). Using a visual timeline allows updates to be divided into sections, providing

a better overview of a situation compared to presenting the description as one long text.



(a) The 'NEW UPDATE!' text indicates that an alert has been updated with new information.

(b) A timeline that provides users with a comprehensive account of the incident as it progresses, allowing them to grasp its development and current state.

Figure 6.10: Communicating emergency updates.

8. Provide appropriate feedback for actions

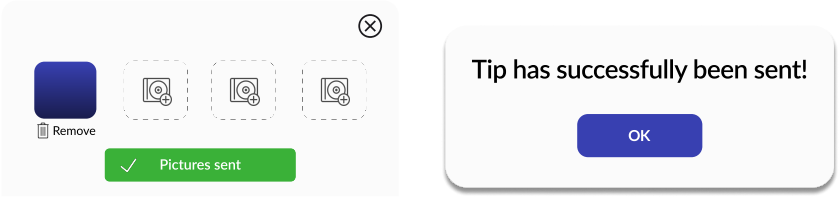
Relevant requirements

10. The system must provide direct feedback from the UI

According to Romano et al. [2] and Nass et al. [3], providing feedback in the UI is paramount for emergency applications in order for users to know that the information they sent through the app has been successfully shared with the authority. During traditional calls, users can be reassured by the voice of an operator, however, in cases where the user reports a tip or crowdsourcing information, this will not be the case.

Providing feedback can be done with transient messages called toast notifications or with more prominent feedback such as dialogs, depending on the type of action [43]. Figure 6.10 illustrates an example of how to provide feedback for actions. When a user sends media during an emergency call, a toast notification with the text

'Pictures sent' appears for a few seconds and then disappears (figure 6.11a). However, when reporting a tip or providing information for crowdsourcing, a dialog appears instead, as these tasks are larger in scope (figure 6.11b). During an emergency call, toast notifications are preferred since they are more discreet and will not interrupt the user while communicating with an emergency operator.



(a) Transient message in the form of a toast notification.

(b) Prominent feedback in the form of a dialog.

Figure 6.11: Providing feedback for actions.

9. Use appropriate language

Relevant requirements

8. The system must use appropriate language

(E) Use clear text formulations that minimise the potential for misunderstandings

To ensure a system is used as intended, the language within the system should be clear and minimise the potential for misunderstandings by using relatable wording [2]. It is especially important to clarify words related to emergency management and authorities [5], as most users may not be familiar with them. Additionally, the evaluation showed that translations between different languages should be done carefully to accurately capture the correct meaning and avoid confusion.

Figure 6.3c illustrates an example of how to clarify terms related to emergency management and authorities. In the detailed alert view, a tooltip overlay can be triggered by clicking on the 'help' icon. This overlay contains descriptive text explaining the different alert types. Tooltips provide contextual help when needed and are effective for initial learnability [36], [44].

10. Provide contextualised content

Relevant requirements

14.1. The system must provide contextualised content

According to Tan et al. [5], providing contextual information in the case of emergency apps is important for building trust with users. Contextual content, such as actionable steps for emergency situations, can help users respond appropriately compared to static warnings. Additionally, the content can be personalised depending on the user's location or other factors.

Figure 6.3b shows an example of how to provide contextualised content. In addition to describing the emergency, various recommendations can be offered to guide users in acting appropriately and staying safe. These recommendations can be further personalised to enhance their effectiveness.

11. Communicate transparency and ethical use

Relevant requirements

14.2. The system must show regard to user privacy

15.1. Communicate ethical use of the system to users

(E) Establish transparent policies

When developing emergency applications, it is essential for authorities to be transparent about data usage and to clearly communicate appropriate app usage to ensure ethical use. Based on interviews with police officers, RLC operators, and civilians, it is evident that easier access to functionalities like real-time media sharing, tip-offs, and crowdsourcing could potentially pose problems. For instance, individuals might oppose being filmed or photographed in emergency situations, even if it is to support police response matters. Additionally, large amounts of misinformation might be submitted through tip-offs and crowdsourcing, requiring unnecessary resources. Therefore, it is important for authorities to educate the public on how to ethically use the system.

Interviews with civilians also revealed that use of personal data must be clearly communicated for users to feel comfortable using the application. For example, the application should allow users to specify how their location data can be used and whether they want to remain anonymous when sharing information. Additionally, concerns were raised regarding potential misuse by authorities, such as mass surveillance. Consequently, it is crucial for authorities to establish transparent policies outlining their objectives with the system and the type of data they collect.

7

Discussion

This chapter provides a discussion around various aspects of the thesis: why a change of scope was made, the main findings and how they relate to the research question, the overall process and methods used, the limitations that existed and affected the project, ethical considerations surrounding the topic and results, and lastly, future work.

7.1 Change of Scope

At the start of the research, the scope was intentionally broad and exploratory, as outlined in more detail in chapter 5.1. Changing the scope made it narrower, focusing on an area previously unexplored in any prior research involving the Swedish Police Authority. Insights gained from early interviews with UX designers and police officers highlighted a significant need for improved communication between civilians and police in emergency situations. This led to a shift in focus toward designing an application that facilitates easier information sharing from civilians to police. Consequently, the research questions were revised to better align with this new focus.

A major takeaway from this change of scope is the importance of flexibility in research. Being open to adjusting the research scope based on emerging insights proved crucial to ensure that the study remained relevant and impactful. This flexibility was particularly important in this thesis, as limited access to information about the Swedish Police Authority and their needs existed before security clearance was granted.

Another important lesson learned is the importance of early and continuous engagement with stakeholders. Given the multitude of parties involved in the research area, representation from various stakeholders was ensured. Through an iterative approach with a scope and methods that evolved based on newly obtained insights, the aim was to ensure that the final results reflected the perspectives and needs of all affected parties. This collaborative and iterative process not only enriched the research but also fostered a sense of ownership and relevance among stakeholders, ultimately enhancing the study's impact and applicability.

7.2 Results

What design recommendations can be proposed for a mobile application aimed at enhancing civilians' ability to share and process vital information during emergency situations?

The study resulted in a semi-functional prototype and eleven design recommendations that contextualise the prototype. The requirements list laid the foundation for developing the prototype and, consequently, the design recommendations.

The interviews revealed an ongoing pilot project at the Swedish Police Authority aimed at enabling citizens to share photos from their phones in real-time during emergency calls with RLC operators. Until recently, this functionality was unavailable. This unavailability could slow down police response efforts because officers had to gather this information themselves on the spot. The new media-sharing system sometimes operates in conjunction with an older system for retrieving users' GPS positions. Both systems function similarly: RLC operators send a web link to the user's phone, allowing the user to upload their media and position.

The new media-sharing functionality has generally received positive feedback from police officers and RLC operators during testing. However, interviews also indicated room for improvements to facilitate real-time information sharing for citizens and streamline police response efforts. The current process of retrieving media and position could still pose limitations because these two systems operate separately rather than as a unified unit. From a user perspective, this separation does not provide an optimal user experience. Additionally, receiving links during a stressful situation may hinder the timely sharing of critical information. Consequently, the current process could potentially delay receiving media and positions from citizens, thereby impeding police response efforts. In emergency situations where every second counts, this could be crucial.

Interviews with police officers and RLC operators also indicated that integrating the current tip-off form available on the authority's website into a mobile application could increase the likelihood of citizens reporting incidents, thus helping to prevent and combat crime. Additionally, while crowdsourcing for public safety had not been considered by the Swedish Police Authority, RLC operators expressed that requesting information from the public could prove useful for larger emergency situations involving numerous people.

These three major functionalities — real-time media sharing, reporting of tip-offs, and crowdsourcing — served as the basis for designing a mobile citizen emergency app. To better understand the factors to consider in its design and how to prioritise them, it was necessary to establish a requirements list by gathering key data from UX, police, and RLC interviews, as well as relevant literature. The literature review provided a solid foundation for understanding overarching requirements, while the interviews reinforced topics from the literature and provided insight into more specific requirements relevant to the Swedish Police Authority, such as the aforementioned real-time media sharing, reporting of tip-offs, and crowdsourcing.

Nass et al. [3] point out that during large-scale emergencies, common issues include communication lines at the command centre becoming overwhelmed, which prevents people from getting help or conveying vital information about the event. Additionally, there are often significant delays in accurately identifying the exact location of the incident, potentially worsening the overall impact of the situation. This aligns with the RLC operators' observations that during some emergency situations, they receive numerous phone calls, making it harder to gather vital information since they have to spend time talking to each caller. Additionally, if emergency operators need photos or the caller's location, it could further delay providing assistance. The media-sharing and GPS positioning functionality was designed to expedite the process of receiving assistance while still enabling the provision of useful information for response measures, such as media and exact location data. Since no links need to be sent out by the emergency operators, citizens can easily share their location data and media directly through the app.

The RLC operators saw potential in using crowdsourcing during emergencies, but they also noted that its use should be clearly motivated; otherwise, it could do more harm than good. Authorities should have a clear idea of what type of information they want to request and provide accurate details from the start so that citizens can respond appropriately and provide precise information. They emphasised the importance of providing accurate details about the situation from the outset to ensure no innocent people are targeted. They also suggested that crowdsourcing should be used only for large-scale emergencies, such as shootings, since managing it would require significant resources. This aligns with Ernst's claims [19], who emphasised that organisations must recognise both the opportunities and the potential problems that crowdsourcing can bring, particularly regarding the quality of crowdsourced information. According to Estellés-Arolas [20], collaboration between law enforcement and the public could prove beneficial in fighting crime and is suggested as a potential area for improvement.

The proposed recommendations include both general and specific suggestions, some of which were also reinforced from the evaluation. For instance, DR#1, DR#2, DR#3, are design recommendations tailored specifically for the Swedish Police Authority. DR#11 was largely based on findings from interviews with police officers, RLC operators, civilians, and literature. Tan et al. [5] state that it is important to build trust with users to prevent them from uninstalling or not using the application. Part of building trust with users involves showing regard for user privacy and security by being transparent about how their data is gathered and used, such as in the case of geolocation.

While some design recommendations address accessibility and usability factors, it is important to note that not all such factors are covered. Therefore, these recommendations should ideally complement the WCAG and the usability guidelines for disaster applications as proposed by Tan et al [5].

The prototype was developed to demonstrate how the design recommendations can be applied in a practical manner. It is important to note that this prototype is just *one* example of how these recommendations can be applied. Additionally, the prototype

developed in this project is not a fully realised design or high-fidelity prototype. It was created within a limited time frame and tested with only a small number of users. Consequently, the design is an ongoing process, allowing for further refinement and exploration of more user needs. Future implementations of a prototype can use these design recommendations, ideally alongside other guidelines, and can be adapted to fit specific contexts and requirements.

7.2.1 Generalisability

The prototype in this project is primarily designed to enhance direct emergency communication between citizens and emergency operators by focusing on making the process of sharing media and location data more user-friendly. This aims to expedite assistance for citizens and provide police officers with better information to work with. The prototype is also aimed at enhancing communication of emergency information to citizens, thereby increasing their awareness of local events and informing them how to stay safe. Consequently, the prototype can be used to communicate all kinds of emergencies such as crimes, explosions, or fires.

However, since the prototype is designed for a government agency and for emergency matters directed towards the general public, the collaboration between the police and other first responders, such as fire and medical services, is crucial for a coordinated and effective response. It remains unclear to what extent the prototype can be adapted for other entities or organisations in more specialised contexts. For example, the prototype could be adjusted to address healthcare matters, such as sharing locations of health resources, collecting public data on health trends or disease outbreaks, and providing real-time updates during health crises.

It is also unclear whether the design recommendations are effective for creating emergency mobile applications that enhance citizen information sharing and streamline police responses. While some recommendations were created with the Swedish Police Authority in mind, they are also general enough to be explored in other contexts. Including flexible recommendations was important to ensure applicability to various purposes, as overly specific guidelines might not be universally suitable. For example, DR#4-DR#11 can be considered general, while DR1#-DR#3 can be considered specific.

The design recommendations have only been assessed based on the prototype created in this project. Therefore, further research is needed to evaluate and refine these recommendations in the context of other projects. To fully understand their applicability and potential for generalisation, the design recommendations must be evaluated in relation to other contexts and prototypes.

7.3 Process

This section provides a detailed discussion, critique, and defence of the various steps and decisions taken throughout the research process. It aims to offer a transparent view of how the study was conducted, including participant selection and prototype

development, while addressing potential limitations and justifications for the choices made.

7.3.1 Participants in Interviews and Evaluation

The research included four distinct participant groups: UX designers at the Swedish Police Authority, police officers, RLC operators, and civilians. The first three groups were selected for their specialised expertise and relevance to the study, while civilians represented the intended user group of the application. Although the number of participants in the first three groups was relatively small, this was justified by their specific and homogeneous nature — participants within each group shared similar job descriptions and areas of expertise, ensuring the data collected was rich and highly relevant to the study's objectives.

In contrast, the civilian group would benefit from a larger sample size due to its inherent diversity. Unlike the previous groups, civilians exhibited greater variability in backgrounds and perspectives, which is crucial given their role as primary users of the proposed application. However, the limited number of civilian participants may not fully represent the diverse spectrum of potential users. Chapter 5.9.1 presents the demographic distribution, revealing notable flaws such as limited age and technological proficiency diversity among test subjects. This study's restricted civilian participation could restrict the findings' applicability to the broader population. Future research should aim to include a more extensive and diverse civilian participant base to enhance result representativeness and applicability.

The age distribution among civilian participants, detailed in table 5.11b showed a notable imbalance. Out of 11 participants, the majority were aged 18 to 24, with no representation in the categories of 17 or younger, 35 to 44, or 65 and older. This uneven distribution limits result generalisability, as it fails to adequately represent perspectives and experiences across a broader age spectrum. Notably, older adults may possess varying technological proficiencies and interaction preferences that are not captured in this study. This lack of age diversity could introduce bias into the results, potentially overlooking usability challenges or design preferences that are pertinent to older users. Ensuring a more balanced age distribution in future studies would yield a comprehensive understanding of how the application can be used and perceived across diverse age groups.

Participants' self-perceived technological proficiency, rated on a scale of 1 to 5, varied among the sample. The distribution detailed in table 5.11c suggests varying levels of familiarity with technology among participants. Those with higher ratings may navigate digital interfaces more confidently, while those with lower ratings may encounter challenges or require additional support. Understanding these varying levels of technological proficiency is crucial for designing user-friendly apps that cater to diverse user needs and abilities. Recognising these subjective ratings is crucial, reflecting participants' assessments of their own skills and introducing variability that may impact data reliability. This study relies on self-perceived ratings to provide insights into participant confidence levels, contributing to a comprehensive understanding of their technological capabilities.

7.3.2 Civilian Participants' Attitudes on Privacy

Participants in the study generally supported the app, viewing it as beneficial for enhancing safety and communication with law enforcement. However, many participants' prevalent 'nothing to hide' mentality regarding privacy was notable and unexpected. While this perspective suggests a perception of enhanced security, it raises significant ethical concerns. As researchers, we find this attitude problematic because it downplays the importance of privacy rights. The notion that individuals need not worry if they have nothing to hide oversimplifies the complexities of privacy in the digital age and ignores the broader implications of unchecked data collection and surveillance, including potential misuse by authorities or threats to personal autonomy.

It is essential for app designers, policymakers, and society at large to adopt a nuanced approach that effectively balances public safety with respect for privacy. Upholding privacy rights should not be compromised solely in pursuit of perceived security benefits. Given the app's potential to enhance public safety, addressing these privacy concerns becomes even more critical. Future developments and implementations must prioritise ethical considerations to ensure that technological advancements uphold fundamental rights and freedoms without unjustified intrusion into personal privacy.

7.3.3 Prototype

In developing the final prototype, the focus was on implementing three primary functionalities: reporting of tip-offs, sharing location and media during emergency calls, and crowdsourcing. Emphasis was placed on refining these functionalities to ensure they were polished and intuitive for testing, while other typical features of a fully realised product were omitted. One notable exclusion was the absence of a settings page, which typically offers options for configuring notification settings and managing areas of interest for updates. The decision to exclude a settings page was justified as it did not directly contribute to testing the new functionalities. The primary goal was to refine and validate core features essential for emergency communication. Including a settings page would have added complexity without providing significant insights into the effectiveness or usability of the primary functionalities. Moreover, it would have required additional time that was not feasible within the project's constraints. Therefore, it was deprioritised to maintain a clear focus on the most critical aspects of the application.

7.3.4 Example Choices in Prototype and Interviews

The examples used in the prototype may appear somewhat extreme, particularly the scenario involving an explosion. This choice was deliberate to illustrate the potential utility of crowdsourcing in emergency situations, as discussed with RLC operators during interviews. They emphasized that for less severe cases, crowdsourcing would not be utilized to avoid unnecessarily alerting civilians in real-time. Instead, it would be reserved for more critical situations where timely information could potentially

save lives.

During civilian interviews, various scenarios were explored to gauge perceptions and reactions to the application's features. Participants considered broader societal implications, including ethical considerations regarding its use in politically sensitive contexts and its role in potentially fostering an informant society. While emotionally charged due to their connection to crime and safety, these scenarios are essential for comprehending the intricate dynamics surrounding the application's deployment. They highlight the necessity of addressing ethical concerns and developing a nuanced understanding of how such technology intersects with individual rights, societal values, and political environments. Therefore, despite their sensitive nature, these examples are pivotal for guiding the development and deployment of the application.

7.4 Limitations

This section addresses the various limitations encountered during the research process. The constraints and challenges related to security vetting, time, and the handling of sensitive data, and how these factors impacted the scope and execution of the study are discussed.

7.4.1 Security Vetting and Data Handling Procedures

Before being allowed to gather data and conduct interviews with personnel at the Swedish Police Authority, passing a security vetting was required. For the purposes of this thesis, the relevant security level was 3, which is the lowest in Sweden. This security vetting is a comprehensive assessment that includes interviews, document verification, and criminal record checks; as a result, it took around 8 weeks to be granted security clearance.

Once security clearance was granted and access to the IT-department office at the police station was obtained, a range of courses had to be taken to gain access to various software. This is mandatory for everyone who performs any kind of work within the police authority to ensure the proper handling of information and to control what can be shared publicly. All digital data gathered and analysed had to be stored on computers provided by the Swedish Police Authority and used exclusively with approved software. For example, before any collected data could be included in this report, it had to be approved by the assigned advisor at the Swedish Police Authority. While this did not significantly hinder the work, as new data could be continuously sent for approval, it did limit the ability to share the data with the supervisor for feedback.

7.4.2 Time Constraints

The process of being granted security clearance significantly limited the time available for data gathering within the Swedish Police Authority. During the waiting period for approval, interviews could not be conducted with employees, delaying the start of the research process. To utilise this time productively, focus was placed on theoretical

work, including conducting a literature review of previous studies relevant to the project. Additionally, interviews planned with UX designers and police officers were organised in advance, ultimately saving time once security clearance was granted.

The time constraints necessitated quicker decision-making and reduced the time available for considering the study's direction. However, due to the planning done before the active phase of the study began, these decisions were more manageable. Any time needed for reflection was reserved for data analysis and the development of interviews, prototypes, and other research activities.

7.4.3 Sensitive Data Handling

As researchers conducting a master's thesis, there are limitations regarding the handling of sensitive data. Due to legal and ethical considerations, access to personally identifiable information or other sensitive data was not permitted. As a result, the research was constrained to anonymised or aggregated data sets, potentially limiting the depth of analysis and insights that could be derived.

When creating the interview questions for the evaluation, this limitation was considered from the start. While many valuable insights were still gathered, the absence of personal experiences from civilians may have resulted in a lack of certain thoughts and opinions. Although this limitation ensured compliance with privacy regulations and ethical guidelines, it may have constrained the scope of the study and hindered the ability to fully comprehend certain aspects of the communication dynamics between civilians and the police.

7.5 Ethical Considerations

The development and implementation of an application aimed at enhancing emergency communication necessitate a thorough examination of ethical considerations. This section explores the potential ethical challenges associated with the application, focusing on the misuse by civilians, the risk of authority misuse, and the critical aspects of data security and privacy. Addressing these ethical concerns is essential to ensure the application serves its intended purpose without causing harm or violating fundamental rights. By proactively identifying and mitigating these risks, the goal is to create a robust framework that upholds ethical standards and fosters trust among all stakeholders.

7.5.1 Civilian Misuse

One of the primary ethical concerns regarding the application is the potential for misuse by civilians. While the goal of the application is to facilitate better emergency communication, there are several ways in which it could be misused, potentially undermining its effectiveness and causing disturbance or even harm.

A significant risk involves the violation of privacy and integrity of others. This misuse could include sharing sensitive or private information without consent, potentially

leading to distress or harm for the individuals involved. There are different ways this can happen, both intentionally and unintentionally. For instance, while recording a crime can be useful for evidence and aiding investigations, it might be distressing to the victim. In situations where obtaining consent is challenging, the immediate provision of real-time information to the police could be beneficial but also ethically complex. This poses an ethical dilemma for bystanders, raising the question of whether it is appropriate to place the responsibility of making such decisions on civilians. Some thoughts and opinions of civilians on this matter were gathered and presented in chapter 5.9.2.

Another risk is intentional misuse in the form of disturbance, either by providing false information or spam. This risks leading to wasted resources, whether through unnecessary police actions or the need for more work to validate the truthfulness of reports. In the worst-case scenario, police resources might be diverted away from legitimate reports and urgent matters. Additionally, some well-intentioned but anxious or psychologically ill individuals might make unnecessary reports, further contributing to the problem. During interviews with RLC operators, discussed in chapter 5.5, concerns regarding misuse were raised, along with explanations of current instances of misuse in emergency calls.

Working around misuse can prove to be difficult. One reason is that when emergency calls or tip-offs are made, civilians have the right to remain anonymous. The possibility of anonymity is integral to ensuring that everyone can feel safe providing information. Consequently, it is difficult to verify users or implement mechanisms for flagging misuse. Educating civilians with clear guidelines and educational materials on the appropriate use of the application could potentially help mitigate unintentional misuse, though intentional misuse remains an issue. There could potentially be systems to verify the authenticity of the information provided, such as requiring multiple confirmations or supporting evidence. However, the challenge lies in ensuring reporting is as easy and accessible as possible, especially when the person making the report may have limited knowledge of the situation.

7.5.2 Authority Misuse

Another primary ethical concern is the misuse by authorities. Authorities may use the application to target individuals or groups based on discriminatory or unjust laws. This could lead to actions that are legally permissible but ethically questionable, such as targeting minority communities or political dissidents. Questions regarding this issue were asked in interviews with civilians, which can be seen in chapter 5.9.2.

A critical risk is the potential for the application to be used for mass surveillance. The ability to collect real-time data from civilians, including images and location data, could be exploited for extensive surveillance activities. This raises significant privacy concerns and the potential for abuse of power by authorities.

Tools like these may only be as ethical as the laws and authorities that enforce them. To address the risks of misuse by authorities, certain safeguards should be in place. Transparency is paramount; it is crucial that policies regarding data usage, access,

and purposes are clearly defined. Mechanisms for oversight and accountability to monitor how the application is used by authorities and to ensure compliance with ethical standards are also essential.

7.5.3 Data Security and Right to Privacy

Ensuring the safeguarding of sensitive information is paramount. Data must be protected against unauthorised access, necessitating robust security measures to minimise the risks of breaches and prevent unauthorised parties from accessing confidential data. This also raises ethical concerns regarding data retention periods and access permissions. Establishing transparent policies on data storage and retention is crucial, ensuring that information is retained only for necessary durations and accessible solely to authorised personnel.

Respecting individuals' right to privacy is a fundamental ethical consideration in developing any application that collects and processes personal data. For such applications, maintaining citizens' privacy is critical. This involves implementing stringent measures to prevent unauthorised access to personal information and minimising data collection to what is strictly necessary for the application's functionality. Furthermore, citizens must be fully informed about what data is collected, its intended use, and who has access to it. By prioritising privacy rights, a secure and trustworthy environment can be fostered, one that respects individual freedoms and promotes ethical technology use.

7.5.4 Perceived Safety

In addition to the technical and procedural aspects of security, the perceived safety of users interacting with the application is a crucial ethical consideration. While the application aims to enhance public safety and emergency response, it must also foster a sense of trust and confidence among its users. Perceived safety encompasses not only the actual security measures implemented but also the subjective feeling of security experienced by individuals when using the application.

It is essential to acknowledge that perceived safety can exist without actual results. Users may feel safer simply by knowing that an application is available for emergency situations, even if its effectiveness in real-world scenarios remains untested. This raises ethical questions about the responsibility of developers and policymakers in managing expectations and ensuring that perceived safety does not lead to complacency or a false sense of security among users.

There are risks associated with the application potentially making people feel more unsafe instead of safer. For example, if users perceive the application as unreliable or ineffective, it could erode trust in emergency response systems and deter individuals from seeking assistance when needed. Additionally, concerns about data privacy and the misuse of personal information may exacerbate existing anxieties about safety and security, leading to heightened perceptions of risk and vulnerability.

While the application aims to provide real-time updates about crime and emergencies,

the continuous stream of information may have unintended consequences. Constant exposure to alerts and notifications detailing criminal activities could contribute to heightened anxiety and fear among users, perpetuating a sense of insecurity and unease. In some cases, individuals may feel overwhelmed or distressed by the constant reminders of potential dangers in their surroundings. This raises ethical questions about the balance between providing valuable information for public safety and safeguarding the mental well-being of users. Sometimes, ignorance is bliss, and constant updates may contribute to a heightened state of worry rather than fostering a sense of security. Prioritising the perceived safety of users may be as important as the actual security the application provides.

7.6 Future Work

The research presented in this thesis centred on designing interactions for an application intended to enhance emergency communication. Before implementing an application like the prototype presented here, further investigation into usability testing and several other aspects is necessary.

One significant limitation of the research was the small number of participants in usability testing, which hindered the ability to generalise the findings. Future studies should aim to include a more diverse and extensive participant base to ensure broader applicability of the data. Additionally, future research could enhance the prototype testing by simulating the stress that users experience during emergencies. This approach would provide more realistic insights into the performance of the prototype in real-world scenarios.

Investigating the legal landscape surrounding mobile emergency apps is essential. This includes examining existing regulations governing data privacy, security, and law enforcement practices. Collaborating with legal experts can provide insights into navigating complex legal frameworks and ensuring compliance with relevant laws.

Establishing and maintaining trust between civilians and law enforcement agencies is fundamental for the success of emergency apps. Future work could explore strategies for building trust, such as community engagement initiatives, transparent communication practices, and accountability mechanisms for both users and authorities.

Understanding how perceptions of safety are influenced by the presence of emergency apps is also crucial. Further research could investigate the impact of this application's usage on individuals' perceived safety, including potential psychological effects and societal implications. This may involve conducting longitudinal studies to assess changes in perceptions over time and across different demographic groups.

8

Conclusion

This thesis aimed to investigate how emergency communication among civilians, emergency operators, and police officers can be facilitated, with a primary focus on the interaction between civilians and emergency operators. The project sought to answer the following research question:

What design recommendations can be proposed for a mobile application aimed at enhancing civilians' ability to share and process vital information during emergency situations?

Based on findings from a literature study and interviews with UX designers, police officers, and RLC operators, essential requirements were identified to serve as the foundation for the development of a semi-functional mobile app prototype specifically aimed at improving emergency communication. Consequently, a set of eleven design recommendations were created to contextualise the prototype.

The prototype resulted in three main functionalities for different situations: real-time media sharing and GPS positioning, crowdsourcing, and reporting of tip-offs. Additionally, a central component of the app is emergency alerts that inform citizens about incidents. Real-time media sharing and GPS positioning pertain to personal incidents and are only enabled during a call with an emergency operator. On the other hand, crowdsourcing is intended for critical cases where it may be relevant to request the public for information to facilitate response measures. Reporting of tip-offs is intended for non-emergent situations and, unlike crowdsourcing, is not linked to specific incidents.

To evaluate the prototype, usability testing and interviews were conducted with eleven civilian participants. While the usability testing provided insights into the prototype's practical usability, the interviews offered a more holistic perspective on the prototype from an ethical standpoint. In general, participants found the prototype easy to use and could see its potential in practice. However, concerns were also raised regarding potential misuse by both authorities and civilians and its impact on user privacy.

The study resulted in eleven design recommendations aimed at providing a foundation for the design of mobile applications focused on emergency communication, ensuring they are intuitive, user-friendly, and effective. To make the most of these recommendations, it is crucial to apply them in conjunction with other established principles or guidelines and maintain close collaboration with end-users to adapt the

app effectively. The design recommendations are as listed below:

1. Integrate real-time media sharing and automatic GPS positioning
2. Enable information sharing through crowdsourcing
3. Integrate tip-off functionality
4. Highlight crucial information
5. Minimise cognitive load
6. Account for accessibility
7. Communicate emergency updates
8. Provide appropriate feedback for actions
9. Use appropriate language
10. Provide contextualised content
11. Communicate transparency and ethical use

In conclusion, this thesis benefits both practitioners and researchers by providing a a set of design recommendations. However, to ensure the full applicability of these recommendations, further research is needed to evaluate and refine them in other projects.

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A

Interview Questions - UX Designers

Intervjufrågor

1. Introducerande
    a. Vad har du för arbetsroll och hur länge har du jobbat här?
2. När det kommer till att göra designarbeten där poliser i fält är användarna, har ni några specifika designprinciper/guidelines som följs? Vad innefattar de?
    a. Utöver dessa designprinciper, hur designar ni för just poliser? Vad är viktigt att tänka på?
3. Vilka typer av interaktioner strävar ni efter i användargränssnitt som används av poliser i fält? Det kan t.ex. gälla att informationsimatning ska se ut och ske på ett specifikt sätt.
    a. Kan du ge exempel på specifika interaktioner som ni designat som har varit ämnade för poliser som jobbar i fält där vissa situationer kan anses vara mer komplexa eller svårare att hantera än typiska situationer. Det kan gälla tidskritiska situationer där inmatning av information ska gå enkelt och snabbt , våldsamma situationer, poliser som kör motorcykel etc.
        i. Kan du förklara hur dessa interaktioner skiljer sig från de typiska interaktionerna som ni designar? Ge exempel på funktioner, strukturen, designen, informationshantering, navigation etc.
        ii. Kan du ge exempel på några svårigheter/utmaningar som dykt upp vid design av interaktioner som är ämnade för komplexa situationer i fältarbete samt förklara hur ni har löst dessa problem? Det kan gälla en specifik interaktion.
        iii. Kan du ge exempel på interaktioner för komplexa situationer som inte riktigt lösts eller visat bra resultat i tester?
    b. Vad har ni sett har varit bra och mindre bra med nuvarande interaktioner utifrån feedback ni fått?
4. Har ni experimenterat med nya typer av interaktioner för användargränssnitt (t.ex. röstinmatning eller annan form) inför framtida lösningar för poliser i fält?
    a. När det kommer till att designa användargränssnitt för polisen, finns det något specifikt ni strävar efter att införa/förbättra inför framtida lösningar?
5. Hur ser processen ut för att utveckla nya verktyg?
    a. Var/hur finner ni inspiration?
    b. Arbetar ni med spekulativ design?
6. Finns det något du vill tillägga som kan vara till hjälp i vårt arbete?

Interview questions (translated)

1. Introducing
    a. What is your job role and how long have you been working here?
2. When it comes to doing design work where police officers in the field are the users, do you have any specific design principles/guidelines that are followed? What do they include?
    a. Beyond these design principles, how do you design for police officers? What is important to take into consideration?
3. What types of interactions do you aim for in user interfaces used by police officers in the field? This could be, for example, that information input should look and happen in a certain way.
    a. Can you give examples of specific interactions that you have designed that have been intended for police officers working in the field where certain situations may be considered more complex or more difficult to handle than typical situations. This could be time-critical situations where information input should be easy and fast, violent situations, police officers driving motorbikes, etc.
        i. Can you explain how these interactions differ from the typical interactions you design? Give examples of features, structure, design, information handling, navigation, etc.
        ii. Can you give examples of any difficulties/challenges encountered in designing interactions intended for complex situations in fieldwork and explain how you have solved these problems? This could be for a specific interaction.
        iii. Can you give examples of interactions for complex situations that were not really solved or showed good results in tests?
    b. What have you found to be good and less good about current interactions based on feedback you have received?
4. Have you experimented with new types of user interface interactions (e.g. voice input or other form) for future solutions for police officers in the field?
    a. When it comes to designing user interfaces for the police, is there anything specific you aim to introduce/improve for future solutions?
5. What is the process for developing new tools?
    a. Where/how do you find inspiration?
    b. Do you work with speculative design?
6. Is there anything you would like to add that would be helpful in our work?

B

Interview Questions - Police Officers

Intervjufrågor

1. Introducerande
    a. Hur länge har du jobbat här?
    b. Vad har du för arbetsroll?
2. Hur ser arbetsprocessen ut vid ett nödfall (112) eller när någon ringer in och tipsar om något?
    a. Vilka olika steg är involverade i processen?
3. Finns det specifika svårigheter med hur ni hanterar storskaliga fall som involverar en stor densitet av människor?
4. Tror du att det hade underlättat ert arbete om civila hade kunnat skicka in information i form av bilder, ljudinspelning, videoinspelning samt position till RLC?
    a. I vilka situationer hade det underlättat om du fick denna typ av information direkt istället för att endast få beskrivningar?
    b. Ser du en användning för civila att kunna skicka in media vart de än befinner sig när det inte rör sig om nödfall och att behöva ringa in 112?
5. I en app för civila, vad tror du hade varit viktiga funktioner utöver tidigare nämnda media och positions-delning?
    a. Hur hade detta underlättat för civila användare som ska skicka in informationen samt operatörer och fältpolis som ska ta del av den?
6. Har du förslag på förbättringar kring digitala verktyg som du tror hade förbättrat ditt arbetsflöde?
    a. Vilka förslag är viktigast eller borde prioriteras?
    b. Kan du ge exempel på situationer där du tror att dessa ändringar hade underlättat ditt arbete?
7. Finns det något du vill tillägga som kan vara till hjälp i vårt arbete?

Interview questions (translated)

1. Introducing
    a. How long have you worked here?
    b. What is your job role?
2. What is the work process in case of an emergency (112) or when someone calls in with a tip-off?
    a. What are the different steps involved in the process??
3. Are there specific difficulties in how you deal with large-scale cases involving a high density of people?
4. Do you think it would have made your work easier if civilians could send information in the form of pictures, audio recording, video recording and position to the RLC?
    a. In what situations would it have helped if you received this type of information directly instead of only receiving descriptions?
    b. Do you see a use for civilians to be able to send in media wherever they are when it is not an emergency and having to call 112?
5. In an app for civilians, what do you think would be important features in addition to the aforementioned media and location sharing?
    a. How would this have made it easier for civilian users to send in the information and for operators and field police to access it?
6. Do you have any suggestions for improvements to digital tools that you think would improve your workflow?
    a. Which suggestions are most important or should be prioritised?
    b. Can you give examples of situations where you think these changes would have made your work easier?
7. Is there anything you would like to add that could be helpful in our work?

C

Interview Questions - RLC

Intervjufrågor

1. Introducerande
    a. Hur länge har du jobbat här?
    b. Vad har du för arbetsroll?
2. Hur ser arbetsprocessen ut på en typisk arbetsdag?
    a. Vilka typer av arbetsuppgifter utför du?
3. Tror du att det hade underlättat ert arbete och poliser som jobbar i yttre tjänst om civila hade kunnat skicka in information i form av bilder, ljudinspelning, videoinspelning samt position?
4. Har du arbetat med BOM?
    a. Hur tycker du att det fungerar i sitt nuvarande tillstånd?
    b. Vad är det som avgör om ni ska skicka ut en länk eller inte till personen som ringer in till 112?
    c. Tror du att det hade funnits fördelar om personer som ringer in till 112 kan skicka media direkt utan att få en länk av en RLC-operatör?
    d. Tror du att det hade funnits fördelar med att kunna skicka in media redan innan man ringer in till 112?
    e. I nuläget stödjer BOM endast bilder, vad tänker du om möjligheten att kunna skicka in ljud och videoinspelning samt position?
    f. Hur går processen till ifall någon som tidigare ringt in till 112 vill skicka in ny information?
    g. Hur tror du att användbarheten kan förbättras från användarens sida?
    h. Hur tror du att funktionaliteten kan utökas?
5. Hanterar ni storskaliga och småskaliga nödfall på olika sätt?
    a. Finns det några svårigheter med hur ni hanterar storskaliga nödfall?
        i. (BOM) Hur hade ni hanterat att behöva skicka ut länkar till många inkommande samtal vid ett storskaligt nödfall?
        ii. (BOM) Tror du att det finns en risk att det skulle komma in en överflödig mängd information om man hade kunnat skicka in media direkt utan en länk?
6. Tror du det finns potential i crowdsourcing för att samla information från medborgare?
    a. I vilka situationer tror du att det hade varit användbart?
    b. I vilka situationer tror du att det hade varit en nackdel?
    c. Vad tror du krävs för att crowdsourcing ska fungera i praktiken?
        i. kontroll över när det ska skickas ut
        ii. andra begränsningar? max antal, specifik grupp av personer osv.
7. Har du förslag på förbättringar kring digitala verktyg som du tror hade förbättrat ditt arbetsflöde?
    a. Vilka förslag är viktigast eller borde prioriteras?
    b. Kan du ge exempel på situationer där du tror att dessa ändringar hade underlättat ditt arbete?
8. Finns det något du vill tillägga som kan vara till hjälp i vårt arbete?

Interview questions (translated)

1. Introduction
    a. How long have you worked here?
    b. What is your job role?
2. What is the work process on a typical working day?
    a. What types of tasks do you perform?
3. Do you think that it would have made your work and that of police officers working in the field easier if civilians had been able to send in information in the form of pictures, audio recordings, video recordings and positions?
4. Have you worked with BOM?
    a. How do you think it works in its current state?
    b. What determines whether or not you should send out a link to the person who calls 112?
    c. Do you think there would be advantages if 112 callers could send media directly without receiving a link from an RLC operator?
    d. Do you think there would be advantages in being able to submit media even before calling 112?
    e. Currently BOM only supports images, what do you think about the possibility of being able to submit audio and video recordings as well as position?
    f. What is the process if someone who has previously called 112 wants to send in new information?
    g. How do you think usability can be improved from the user's point of view?
    h. How do you think the functionality could be extended?
5. Do you handle large-scale and small-scale emergencies differently?
    a. Are there any difficulties with how you handle large-scale emergencies?
        i. (BOM) How would you handle having to send out links to many incoming calls during a large-scale emergency?
        ii. (BOM) Do you think there is a risk that there would be a redundant amount of information if you could have sent the media in directly without a link?
6. Do you think there is potential in crowdsourcing to gather information from citizens?
    a. In which situations do you think it would be useful?
    b. In which situations do you think it would be a disadvantage?
    c. What do you think is needed for crowdsourcing to work in practice?
        i. control over when to send it out
        ii. other restrictions? max number, specific group of people etc.
7. Do you have any suggestions for improvements to digital tools that you think would improve your workflow?
    a. Which suggestions are most important or should be prioritised?
    b. Can you give examples of situations where you think these changes would have made your work easier?
8. Is there anything you would like to add that would help us in our work?

D

Interview Questions - Civilians (Swedish version)

Frågor

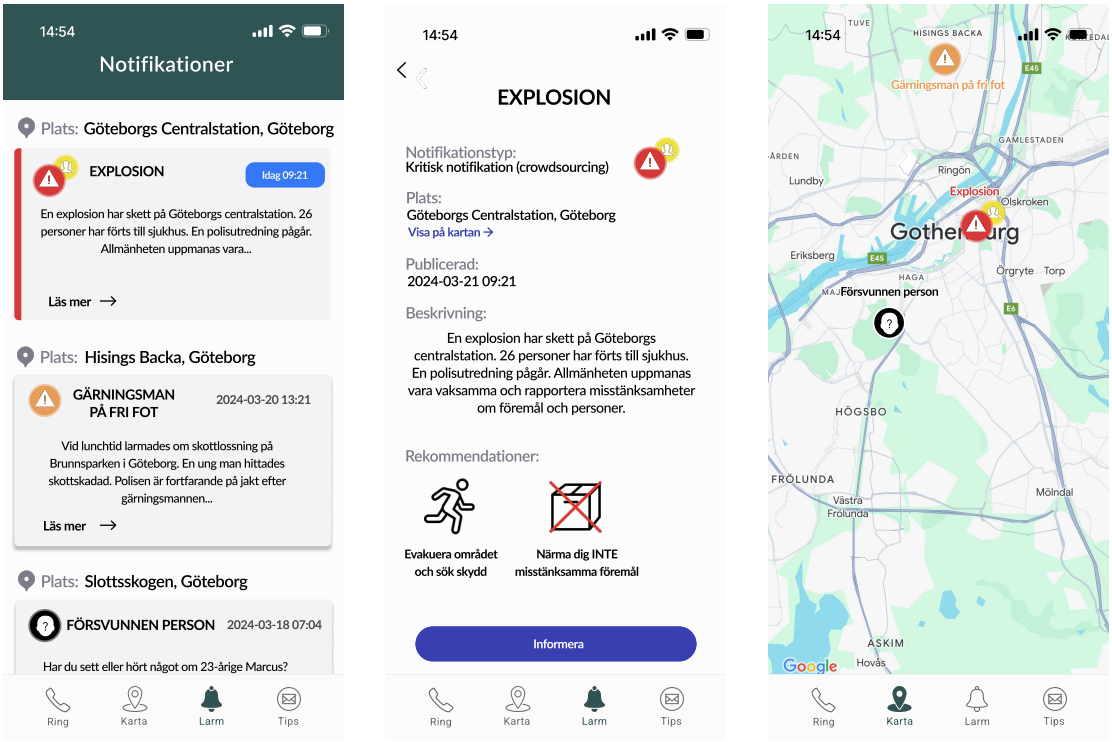
1. Vad har du för tankar kring om en sån här app skulle implementeras på riktigt?
    a. Ser du några potentiella fördelar med en applikation som denna?
    b. Ser du några potentiella risker?
    c. Vad anser du att man behöver ha i åtanke för att motverka potentiellt missbruk av en sådan här applikation om den skulle implementeras?
2. Tror du en sådan här app hade varit trygghetsgivande?
    a. Varför/varför inte?
    b. Tror du att det finns en risk att den ökar oro istället?
3. Tror du det finns en risk att en applikation som denna kan vara integritetskränkande?
    a. Hur och varför?
4. Skulle du själv kunna tänka dig att ha en sådan här applikation om det fanns tillgängligt?
    a. Har du några andra appar för nödsituationer idag? (ex. SOS alarm eller livräddarappen)
5. Vad är dina tankar kring en applikation som denna…
    a. … i ett demokratiskt samhälle?
    b. … i en auktoritär stat?

Scenarion

1. Du är ute på en promenad och får syn på ett okänt objekt du misstänker kan vara ett farligt objekt, men känner dig osäker.
    a. Vad skulle du göra…
        i. … om det hände idag?
        ii. … om denna app fanns tillgänglig?
    b. Hade du upplevt det enklare med en app som denna tillgänglig?
2. Tänk dig en incident där offret utsätts för stöld av sin handväska, hur ser du på att ett vittne skulle spela in händelsen?
    a. Tror du denna applikation uppmanar till att brott fotas eller spelas in för att samla material?
    b. Leder detta till ökat ansvar hos vittnen?
        i. Om så är fallet, anser du att det är rättvist att lägga detta ansvar på vittnen?
3. Föreställ dig att denna applikation har blivit fullt implementerad och tillgänglig för alla. Anser du att det är riskfyllt att ha verktyg som dessa redo att användas ifall landet skulle ta en politisk vändning?
    a. Är det etiskt att använda appen för att anmäla alla typer av brott?
    b. Vad tänker du kring denna teknologi i stater du anser ha oetiska lagar?
    c. Tror du att denna applikation kan leda till ett angivarsamhälle?

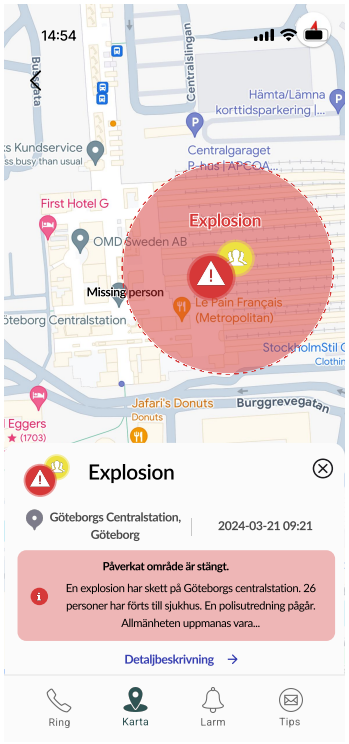
E

Prototype - Swedish version



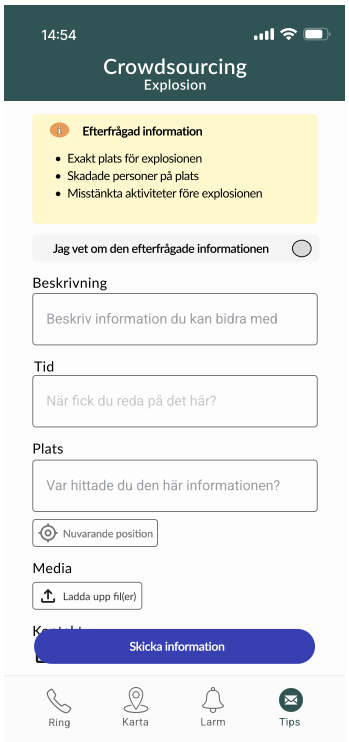
(a) Alerts (b) Alert detail view (c) Map

Figure E.1: Swedish version of the prototype's pages presented in the process chapter (continued on the next page).



(d) Map detail view

(e) Tip-off



(f) Provide information

(g) Call page

Figure E.1: (continued) Swedish version of the prototype's pages presented in the process chapter.

F

User Flows

This appendix contains larger versions of the user flow diagrams presented in chapter 5.7.2. These enlarged diagrams provide a clearer view of the user flows, making them easier to read and understand. The diagrams illustrate the processes of crowdsourcing and incident reporting within the mobile emergency application. These figures can be seen in the three following pages.

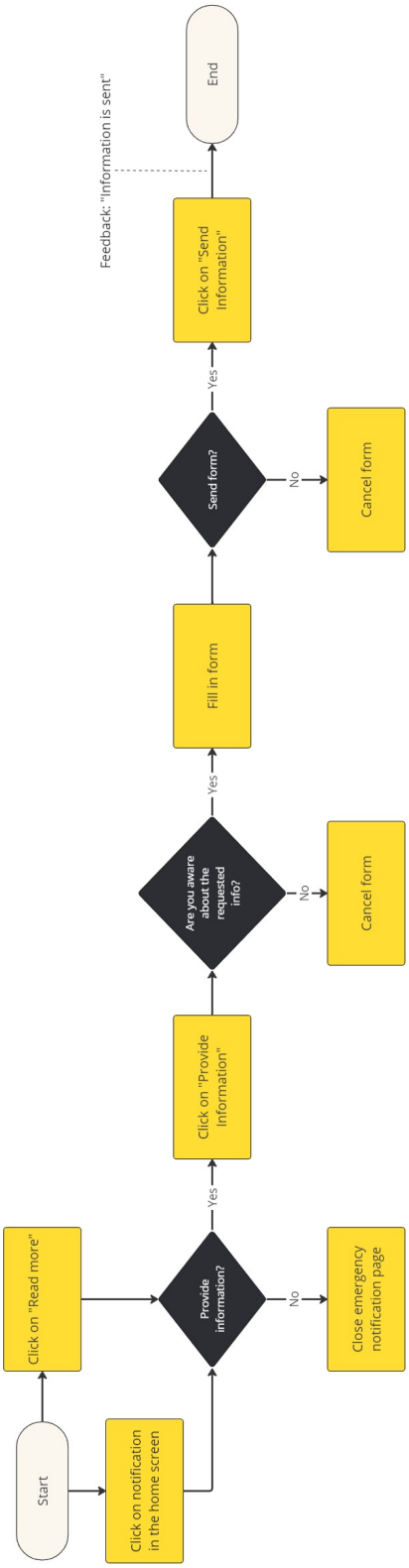


Figure F.1: Larger version of 5.4.

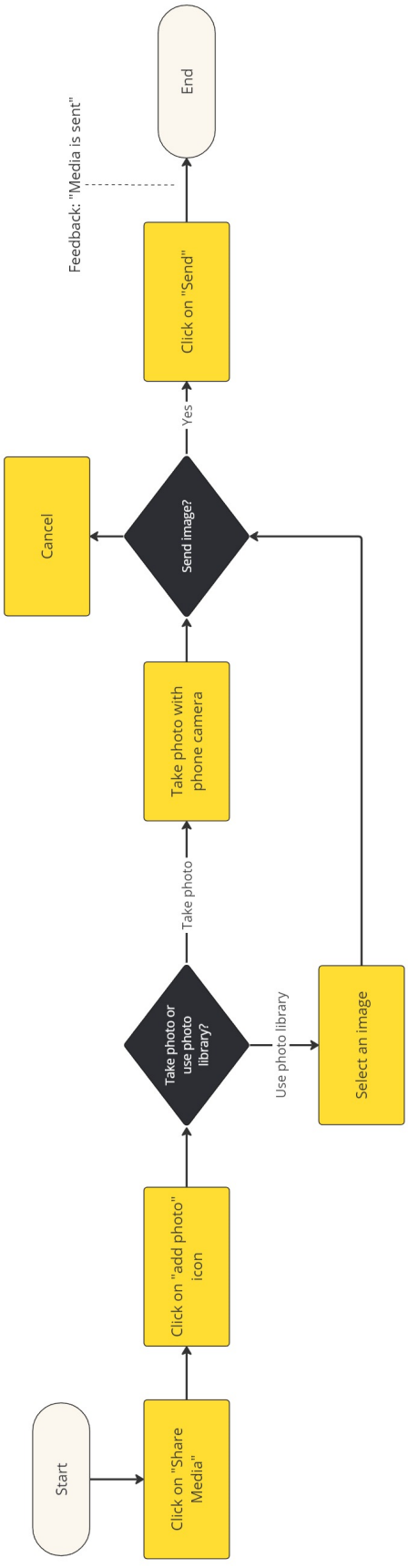


Figure F.2: Larger version of 5.5.

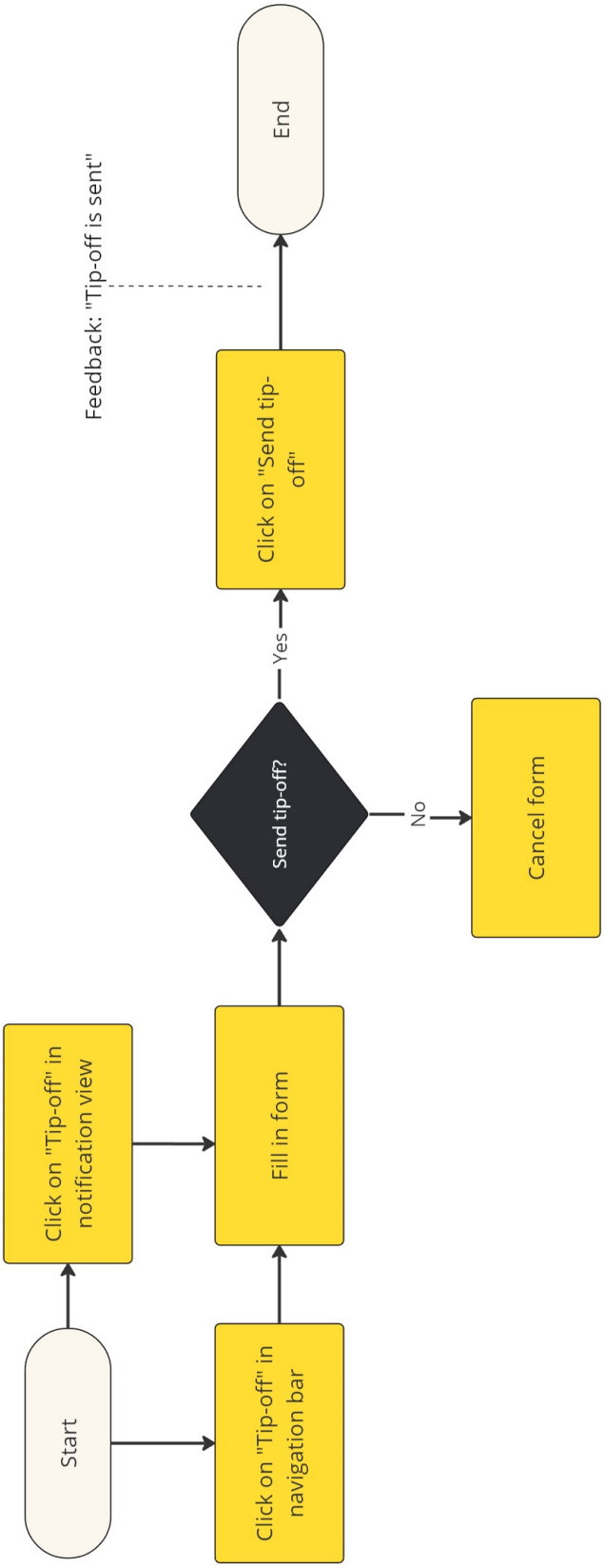


Figure F.3: Larger version of 5.6.