Ukrainian Catholic University

Bachelor Thesis

Enhance User Experience in Air Alert App: Analysis and Prototyping

Author:
Olena Sniatynska

Supervisor:
Kateryna Kamianets

A thesis submitted in fulfillment of the requirements for the degree of Bachelor of Science

in the

Department of Computer Sciences and Information Technologies
Faculty of Applied Sciences

Lviv 2025

"*It is the time you have wasted for your rose that makes your rose so important.*"

Antoine de Saint-Exupéry, The Little Prince

UKRAINIAN CATHOLIC UNIVERSITY

Faculty of Applied Sciences

Bachelor of Science

Thesis Title

by John Smith

Abstract

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too…

Acknowledgements

The acknowledgments and the people to thank go here, don't forget to include your project advisor…

Contents

List of Figures

List of Tables

For/Dedicated to/To my...

Chapter 1

Introduction

1.1 Motivation

Their role is simple yet vital: to warn civilians of incoming threats. In Ukraine, these systems have become a part of daily life, often sounding dozens of times a day across different regions. Mobile alert applications extend the reach of sirens, delivering critical warnings even when traditional alarms are inaudible, and they have become a central element of Ukraine's emergency communication infrastructure. However, as the war has prolonged, new challenges have emerged.

The effectiveness of an alert system depends not only on the accuracy of the warning but also on the user's willingness to respond. A growing concern is the phenomenon known as alert fatigue. This desensitization can lead users to ignore or miss critical safety notifications. In some regions, users may receive over ten alerts per day, regardless of their immediate risk level, which contributes to psychological overload and disengagement. If not addressed, these issues could significantly reduce the effectiveness of air raid alert systems and increase risks for civilians.

While it remains essential that air raid alerts cannot be silenced or omitted—given the life-critical nature of the information—the form and context in which alerts are delivered must evolve. Failure to adapt to users' changing needs has led to several recurring limitations, including:

1. Alert Fatigue: Repeated, non-differentiated alerts cause users to become desensitized to alerts.

2. Lack of Personalization: Which results in unnecessary disruption and user frustration.

3. Overwhelming Frequency: In high-risk areas, excessive daily notifications overwhelm users, making distinguishing between more and less critical warnings difficult.

4. Usability Flaws: Many apps lack clear layout prioritization of information or support for cognitively overloaded users.

This thesis focuses on the user experience (UX) of air raid alert mobile applications and explores strategies for improvement to maintain their effectiveness during prolonged conflict. It addresses a critical gap: the need to preserve the urgency and reliability of alerts while mitigating alert fatigue and improving user psychological engagement through enhanced information delivery and interface design.

In life-critical systems, every second matters. Even small improvements in UX that help users respond more quickly and confidently can save lives. Therefore, this thesis aims to ensure that air raid alert applications remain not only technically functional but also emotionally sustainable—serving as supportive tools in times of crisis rather than adding to the burden of an already stressed population.

1.2 Contributions

1.3 Structure Of The Thesis

Chapter 2

Related Work

2.1 Publications

This chapter will consist of the literature review of works on related topics. We will also dive into the research of existing alert apps, which will cover the existing work done in this area.

2.1.1 Public response to government alerts saves lives during Russian invasion of Ukraine

This study [2] analyses how government messages in Ukraine helped people pay more attention to alerts and stay safe during the Russian invasion. It shows that people who responded to alerts were less likely to be harmed. However, over time, some people stopped reacting to the warnings, which led to preventable deaths. This is important for my thesis because it highlights alarm fatigue — the phenomenon when people start ignoring alerts because of their frequency. The research suggests that making alerts better suited to how people perceive danger can improve their effectiveness.

- Effective alert messaging played a crucial role in reducing civilian deaths during the war, with the estimation of 35-45% of potential casualties being avoided [page 3].
- Lowered responsiveness over time resulted in civilian deaths, showing the importance of maintaining user engagement with alerts.
- *"Linking the mobility response to a source of information on civilian harm, we find that the overall mobility in response to the alerts significantly reduced the number of civilian casualty events, but diminished responsiveness also led to a large number of plausibly avoidable civilian deaths. In particular, our bounding exercises suggest that 35 to 45% of potential civilian casualties were avoided through the messaging system, although between 8 and 15% of observed civilian casualties could have additionally been avoided if postalert responsiveness had remained the same over time. These figures suggest that government messaging can be a powerful tool to minimize harm during war, but public engagement with these alerts is essential."* [page 3].
- Government messaging serves as a powerful tool in crisis communication, but public engagement is essential for maximizing its effectiveness.

2.1.2 Interaction Design for Web Emergency Management Information Systems

This paper [1] addresses the interaction design of emergency management systems, specifically for web-based platforms (WEMIS). It is relevance to my thesis due to its detailed analysis of how interaction design can support situational awareness and usability in context of emergency. The work provides frameworks: integration of the DERMIS model and the PIE model, that are directly applicable to the design of more usable, context-aware alert systems.

- The article explains activity awareness, the ability of teams to understand not only what is happening, but what others are doing. In the context of this papert it is more related to the role-based functionality,but this is also applicable for users monitoring multiple regions or relatives there.
- Interaction principles using PIE model. The authors suggest that well-designed emergency systems should help users clearly see what's happening (observability), understand what will happen next (predictability). They also express the importance of system transperancy about its actions, so users feel in control and informed. These qualities are especially important in high-frequent alert environments to prevent alert fatigue and maintain user trust.
- Paper divides emergency response into pre-incident, during-incident, and post-incident phases, and matches interaction needs to each. This structure can guide the design of air raid apps to deliver context-relevant alerts, such as distinguishing MiG threats from ballistics.

2.1.3 Universal Design of ICT for Emergency Management from Stakeholders' Perspective

This paper[3] provides a review focused on the integration of Universal Design (UD) principles into emergency management technologies. Which is directly relevant to my goal of enhancing the usability and accessibility of alert apps. It is written that the emergency ICT systems should be usable under stress and by individuals with diverse needs, which aligns with my focus on improving engagement through better UX design.

- Current emergency apps lack inclusivity: Many ICT systems in the emergency domain fail to account for users with disabilities, cognitive limitations, or situational impairments.
- User diversity must be prioritized: Effective emergency management tools should be designed to serve a wide range of users.
- Implication for alerting apps: Alerting systems must include features like customisable notification format, distinctive alert cues, and context-sensitive interface design to be usable under high levels of stress and satisfy varied user needs.

2.2 Applications

2.2.1 ЄТривога (eAlert)

ЄТривога is a volunteer-developed mobile application designed to provide comprehensive air raid alerts across Ukraine (see Fig. 2.1). It supports sound and vibration-based alerts for threats such as missile attacks, UAVs, shelling, and explosions. The app enables multi-region tracking, making it suitable for users monitoring threats affecting family members in different locations.

Key Features

1. Multi-region and subregion subscription
2. Notification severity and sound customization
3. Cause of alert visibility
4. Informational updates about explosion events and planned blasts

User Feedback Summary
Users value the customization of vibration patterns and the ability to track multiple regions. However, concerns are raised regarding inconsistent alert accuracy, especially in critical regions (Zaporizhzhia). A frequent complaint is that app contains excessive advertising during use, which is distractive when trying to view the alert information.

User Flow – Configuring Alert and Receiving a Notification:

1. Open the app and navigate to the *Home* tab.
2. Select *Add Region* option, then search and subscribe to one region.
3. Under *Notification Settings*, for Air raid alert type adjust alert severity and vibration.
4. Wait for a real-time alert from selected regions. The app plays a sound and vibration immediately upon threat detection.
5. Tap the alert to view the threat details; the sound stops upon user interaction.

2.2.2 Air Alert

Air Alert is the official app supported by Ministry of Digital Transformation of Ukraine(see Fig. 2.2). It supports critical notifications that override silent modes and ensures immediate delivery of alerts without requiring user registration.

Key Features

1. Critical alerts with maximum volume
2. District and community-level targeting
3. Automatic push alerts on both start and end of an air raid
4. No personal data collection

User Feedback Summary
The app is valued for simplicity and reliability but criticized for its rigid audio settings. Users request alert-type specific sounds and improved muting options for less critical notifications.

User Flow – Configuring Alerts for Multiple Regions and Receiving a Notification:

1. Open the app and navigate to the *Home* tab.
2. Select a city, district, or territorial community from the dropdown menu.
3. Grant permission for *(Critical) Notifications.*
4. Wait for the alert system to push a critical alert.
5. Wait for a real-time alert from selected regions. A loud siren plays instantly, even in silent mode
6. Tapping the notification opens the app with alert details; the sound stops upon user interaction.

2.2.3 UNEBO – Air Alarms

UNEBO offers a data-rich environment for monitoring national alert coverage(see Fig. 2.3). Beyond basic alerts, the app provides statistics, military border visualization, and infrastructure maps.

Key Features

1. National air raid map with clickable regions
2. Alert history and statistics by region
3. News aggregation and crisis mapping
4. Alert cause transparency

User Feedback Summary
Users commend its wide feature set and visual data clarity, but express concern over limitations in auditory alert customization (e.g., only functioning when the phone is not in silent mode).

User Flow – Configuring Alert and Receiving a Notification

1. Open the app and navigate to the *Settings*.
2. Choose from the region list (only regional-level selection is available).
3. Enable push notifications.
4. No options to customize severity or sound.
5. Receive alert as a notification with short sound (only if phone is in normal mode)
6. Tapping the notification opens the app with alert details; the sound stops upon user interaction.

2.2.4 Air Alarm Ukraine

Air Alarm Ukraine combines emergency alerting with civil support information such as shelter locations, emergency contact numbers, and donation links(see Fig. 2.4). It emphasizes clarity and flexibility for multi-location monitoring.

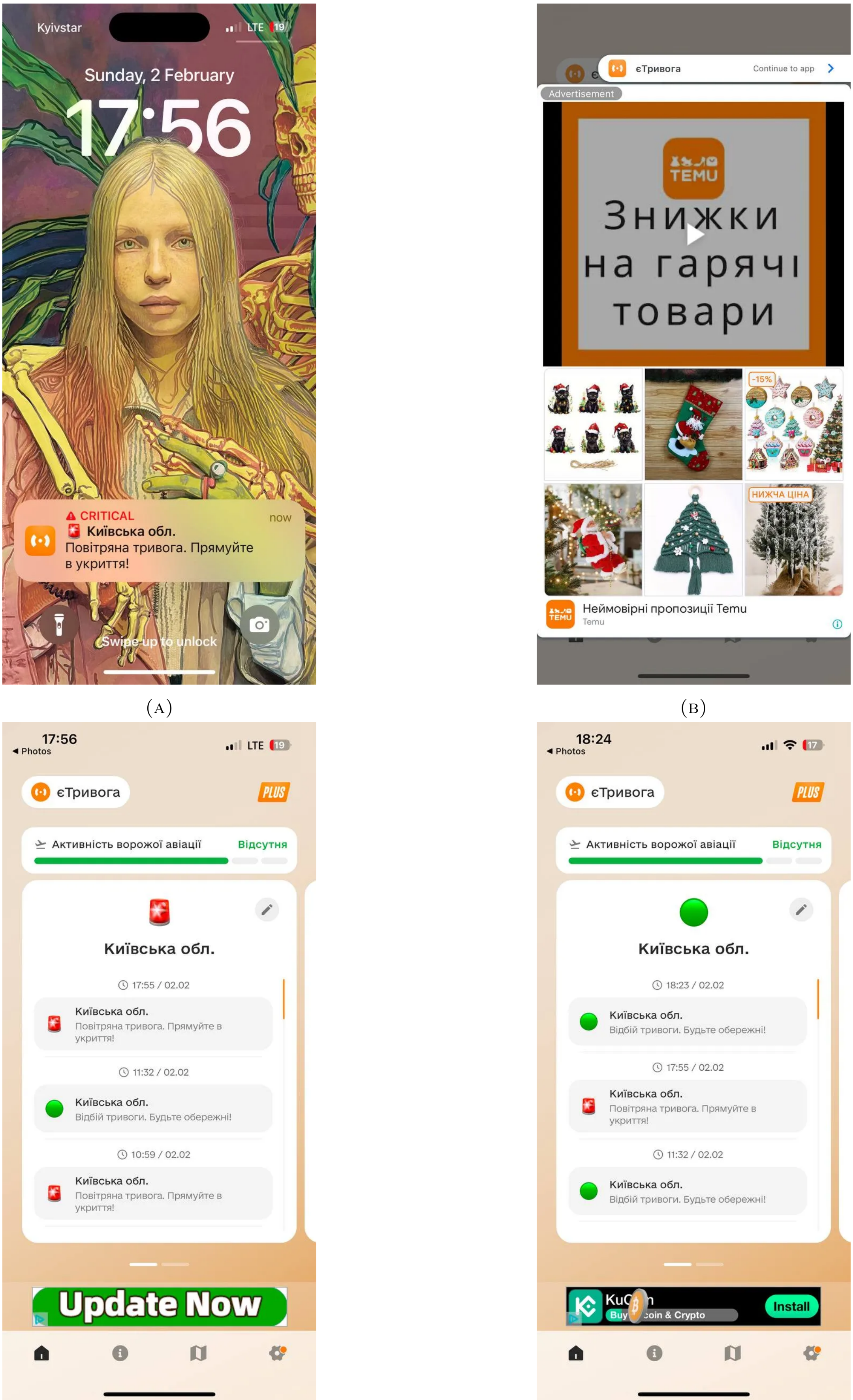
Key Features

1. District and community-level tracking
2. Configurable alert sound severity
3. Shelter info integration
4. Direct donation and support options

User Feedback Summary
Users highlight its simplicity and effectiveness in tracking multiple locations. However, they report challenges with alert volume control and request differentiated sounds for alarm types. Widget support is also frequently requested.

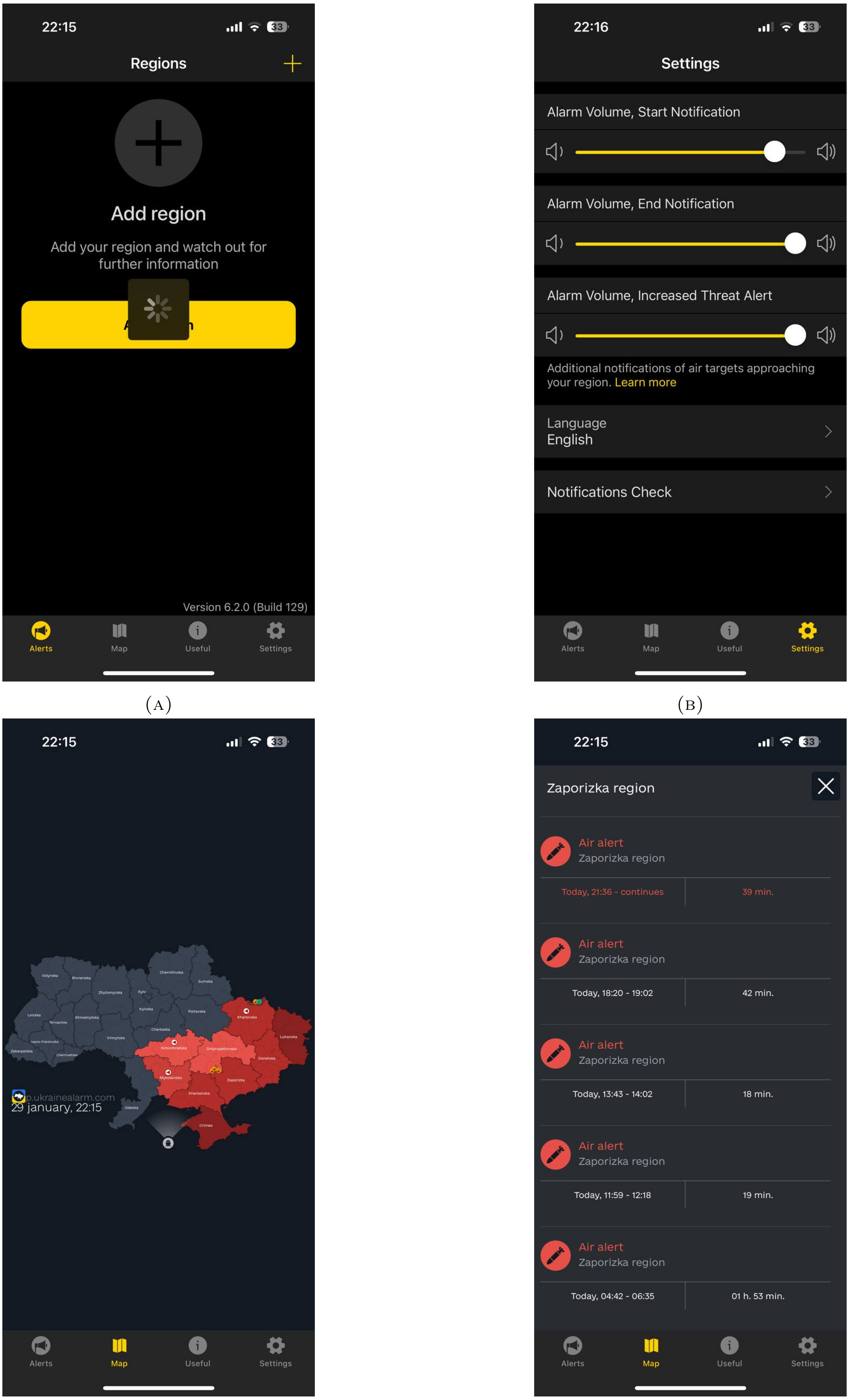
User Flow – Configuring Alert and Receiving a Notification:

1. Open the app and navigate to the *Home* tab.
2. Select *Choose your region* option subscribe to up to eight different regions or communities.
3. Configure alert volume and optionally change sound tone.
4. During a threat, receive a visual notification first, followed by a delayed sound (typically 4–5 seconds later).
5. Tapping the notification opens the app with alert details; the sound stops upon user interaction.



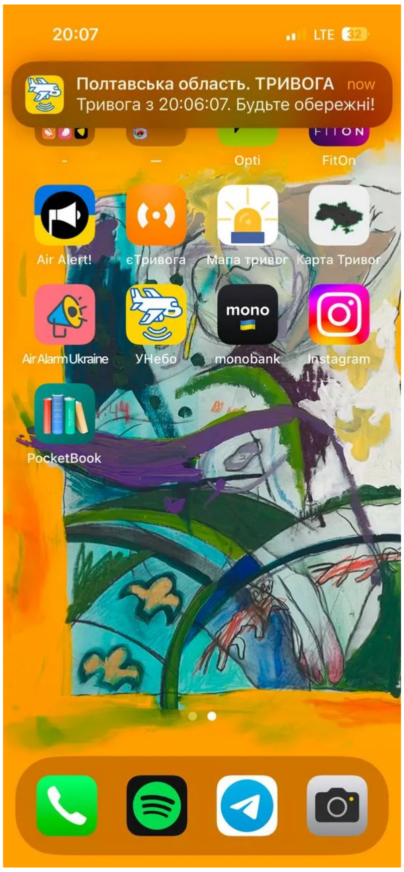
(A) (B) (C) (D)

FIGURE 2.1

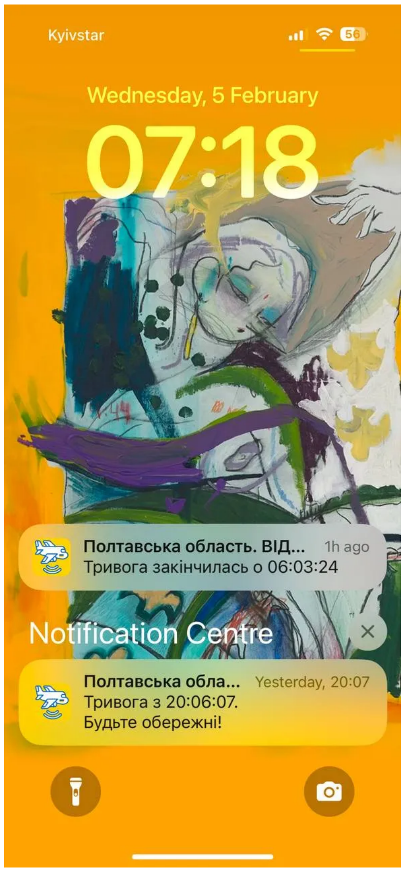


(a) (b) (c) (d)

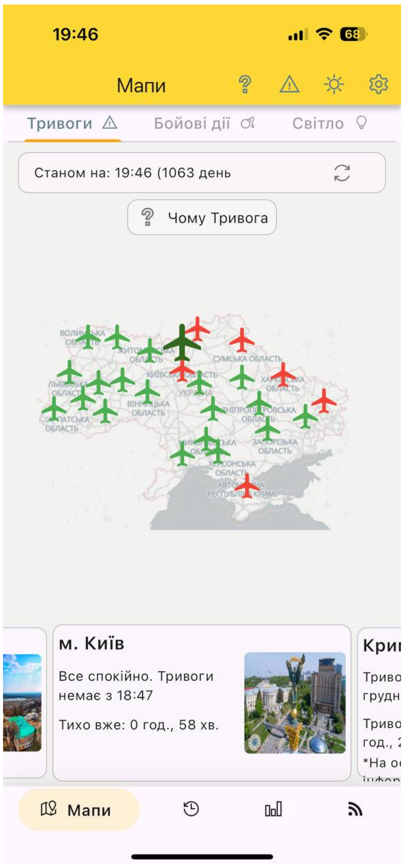
Figure 2.2



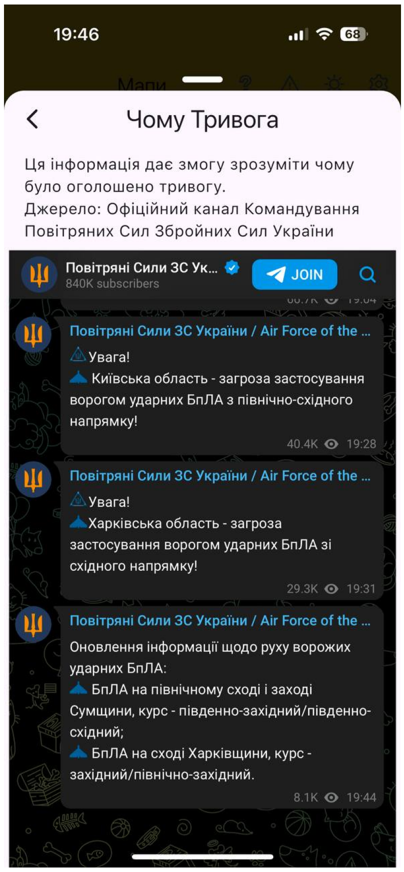
(A)



(B)

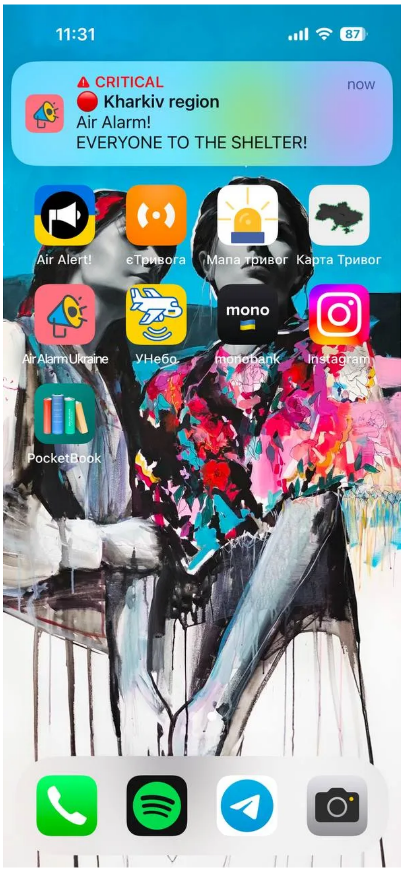


(C)

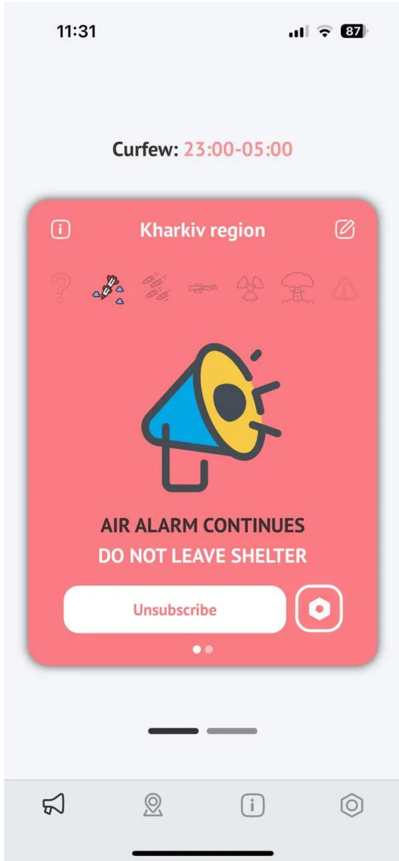


(D)

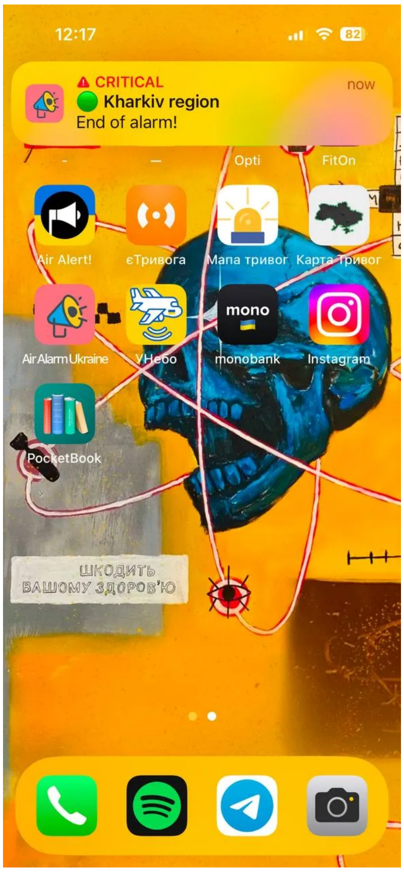
FIGURE 2.3



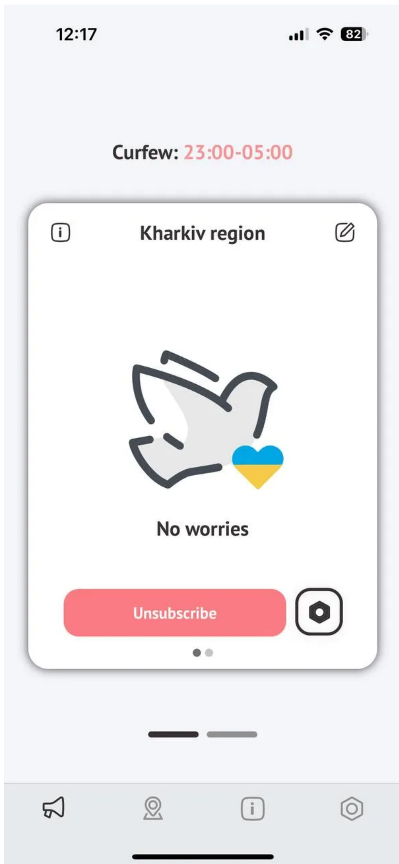
(A)



(B)



(C)



(D)

Figure 2.4

Chapter 3

Theoretical Background

3.1 Design Thinking

Design Thinking is a human-centered, iterative problem-solving methodology [4] that emphasizes empathy, creativity, collaboration, and experimentation. Unlike traditional analytical approaches, it blends intuitive thinking with structured processes to address complex, ill-defined problems. Its growing relevance across industries such as business, education, and healthcare has been supported by its adaptability and user-centric focus.
The process model typically consists of five stages, a cyclical, not linear process:

1. Clarify: In this phase, the focus is on comprehending user needs deeply and defining the main problem with clarity.

2. Ideate: In the ideate phase, we generate a wide range of ideas. The goal is to have many options that could potentially address the user problem identified.

3. Develop: In development, ideas are converted into physical prototypes for the first round of testing. Prototypes help reveal how users perceive solution and testing helps find lacking concepts.

4. Implement: Implementation brings the tested solution to final state while continuing to refine it through user feedback. It is where the product is completed.

3.2 DERMIS Framework

Murray Turoff introduced the Dynamic Emergency Response Management Information System (DERMIS) framework [9] as a way to design information systems that can adapt and respond effectively during emergencies. DERMIS's core idea is that emergency response is inherently unpredictable, and systems need to be flexible, user-centered, and capable of supporting real-time coordination. Rather than relying on bureaucracy procedures DERMIS promotes a design that adjusts dynamically with the crises evolvement.

The key principle behind this framework is that emergency systems must support more than just information delivery — they must also help users interpret and act on that information under pressure. This includes providing timely and accurate data, enabling seamless communication between agencies, and supporting role adaptability as situations change.

Core Design Principles of DERMIS

The DERMIS framework is grounded in several critical principles designed to enhance decision-making, user experience, and operational reliability in time of crisis:

1. **System Training and Simulation:** The system should be usable in both crisis and non-crisis contexts to enable continuous familiarity without the need for separate training environments.

2. **Information Focus:** The system must prevent information overload by prioritizing relevant and actionable content for different user roles.

3. **Crisis Memory:** A persistent log of system activity and crisis events supports after-action review and organizational learning.

4. **Exceptions as Norms:** Emergency systems must be capable of handling unforeseen scenarios and deviations from standard operating procedures.

5. **Flexibility and Adaptability:** The architecture should allow dynamic reassignment of roles, responsibilities, and processes as crises evolve.

6. **Free Exchange of Information:** Open, bidirectional communication across organizational boundaries is essential for multi-agency coordination.

7. **Information Validity and Timeliness:** Data must be up-to-date and trustworthy, especially when life-critical decisions depend on it.

8. **Role Transferability:** Users should be able to assume new roles or delegate responsibilities rapidly when necessary.

9. **Coordination:** Tools for coordinating decentralized teams and units must be built into the system design.

For the purposes of this work, two design principles are especially relevant:

- Information Focus (Principle 2)
- Information Validity and Timeliness (Principle 7)

These principles directly address the core challenges of mobile alert systems, where users must quickly receive, understand, and act upon highly urgent messages under potentially stressful conditions.

Information Focus is essential in avoiding cognitive overload caused by excessive or poorly organized content—a common usability issue in current air alert applications. This principle supports efforts to simplify and structure content delivery in way that maintain clarity.

Information Validity and Timeliness, on the other hand, ensures that alerts are both accurate and received at the right moment—factors that directly impact public safety and trust.

3.3 Minimizing Cognitive Load

3.3.1 Cognitive Load Theory

Cognitive Load Theory (CLT), introduced by Sweller [8], presumes that human work – has a restricted capacity to process information. When this capacity is overridden, task performance and learning may be affected. CLT identifies three types of cognitive load [6]:

1. Intrinsic Load: The inherent complexity of the information or task.

2. Extraneous Load: The way information or tasks are presented, which can be modified to reduce unnecessary load.

3. Germane Load: The mental effort required to process, construct, and automate schemas.

This is supplemented by Wickens' work on multiple resource theory[10], highlighting the distribution of attention between sensory modalities. Single-modality reliant interfaces (e.g., visual-only notification) can overload users and debilitate decision-making under stress. Properly balanced multimodal notification (e.g., sound and haptic), if well calibrated, can improve performance by allocating cognitive load.
In the context of air alert applications, users are often under stress and need to process critical information within limited time. Thus, minimizing extraneous cognitive load is important to ensure that the users can properly interpret alerts and take the appropriate actions.

3.3.2 Principles for Reducing Cognitive Load in UX Design

Effective UX design can minimize extraneous cognitive load by adhering to a set of significant principles:

1. Hick's Law states that the more options a person faces, the longer it takes them to make a decision. By reducing unnecessary choices and focusing only on relevant alternatives, we can streamline the decision-making process and help users act faster and with greater confidence. [5],[6], [**https://shorturl.at/Fr3n4**]

2. Implement Visual Hierarchy: Structuring content based on size, color, and spacing directs users' attention to critical elements, enabling faster information processing.[5]

3. Eliminate Irrelevant Content (Coherence Principle): Reducing unnecessary visual elements and focusing on essential information helps users process content more efficiently, minimizing extraneous cognitive load.

4. Use Consistent Patterns: The use of consistent interface elements minimizes extraneous cognitive load by allowing users to anticipate system behavior, which also contributes to navigation effectiveness. Mendel and Pak (2015) discovered, through a study, that users with consistent interfaces browsed considerably fewer pages when looking for information than users with inconsistent interfaces, demonstrating better performance as a result of fewer cognitive demands.

5. Provide Immediate Feedback: Immediate feedback on task performance allows learners to rectify errors right away, reducing uncertainty and cognitive load. Evidence in medical education showed that measurement of cognitive load after procedures and real-time feedback by instructors helped in the identification of learning barriers, facilitating customized training and better skill acquisition.

6. Chunking: Means organizing related information into reasonable bits to optimize the effectiveness of processing and retrieval abilities. This concept relies on principle from cognitive psychology (Miller's Law), which dictate that the working memory of humans is approximately 7$\pm$2 items simultaneously. Research indicates that chunking is a cost-saving strategy that enhances the effectiveness of symbolic sequence learning.[5], [6]

7. Employ Progressive Disclosure: This approach involves the sequential disclosure of information, only showing the absolute minimum at any one time. This strategy minimizes the risk of user overload and enables individuals to concentrate on the task in hand.[5]

8. Recognition Over Recall: Creating interfaces that facilitate recognition over recall minimizes cognitive effort. By using visual cues and common elements, users are able to recognize choices without having to engage memory to a high degree.[5]

3.4 Survey design

The process involved in survey planning and execution consists of a number of steps like research objective development, questionnaire creation, sampling, data collection, and validation of data.[7],[**https://jkms.org/pdf/10.3346/jkms.2023.38.e403?**]

- The first and most important step in survey design is the clear definition of the research purpose. The research purpose guides all other choices, such as questions to ask and how to answer them. A clear definition also ensures content validity, or questions actually measure the topic under study.

- Survey questions have to be well written to be unambiguous and meaningful. Good questions do not use confusing terminology, double meanings, or leading suggestions. They use clear, uncomplicated language that is less likely to cause misunderstandings and facilitates a fluent cognitive process for the respondent. Questions also need to be grounded in prior research or established theories when available, and that underpins construct validity—the premise that the survey measures what it's intended to measure.

- The selection of an effective response format is informed by measurement theory that takes into account the use of reliable and valid scales in order to well measure the desired constructs. Theory-driven knowledge regarding scale sensitivity works to advise judgments concerning scale length, balance, and complexity in an attempt to get exact measurement while maintaining the ease of understanding for the respondent.

- The theoretical foundation of sampling comes from statistical inference and probability theory, which aim to ensure that the sample accurately represents the larger population and reduces bias. Probability sampling is generally preferred because it allows researchers to make general conclusions about the population. In contrast, non-probability sampling should be clearly justified, as it has certain limitations. Sampling methods should always match the research goals and the planned data analysis.

- Pre-testing of a questionnaire is an essential step based on theoretical principles that helps in verifying whether the questions are clear, consistent, and relevant before using the survey on a larger scale. Pretesting helps in identifying problems that can affect accuracy or the reliability of findings. It also helps researchers to make corrections to improve the quality of the questionnaire and verify that it measures as it is intended to measure.

3.5 Testing-Interview

[https://www.researchgate.net/publication/379899849_PROTOTYPE_TESTING_MULTIC
[https://blog.uxtweak.com/prototype-testing-questions/] [https://medium.com/eightshapes-llc

Prototype test interview practice relies upon usability research and evaluation theory, namely the paradigm of iterative, user-centered design. The purpose of such interviews is to generate rich qualitative insight into user attitudes, behavior, and usability issues, using prototypes as tangible artifacts to enable reflection and interaction.

Test interviews with prototypes are a methodologically dense adjunct to task-based usability testing and behavioral observation. While usability metrics like task success rate, error rate, or time-on-task might reflect surface-level interaction problems, interviews access the cognitive and affective response of users, enabling researchers to understand the "why" behind user behavior and preference.

Interviews are required to unpack users' mental models, interpretability problems, and use assumptions peculiar to the context. This is within the constructivist tradition of qualitative research, in which meaning is built collaboratively through dialogue, and user perceptions are elicited through guided questioning.

Effective prototype testing interviews are theory-driven and structured according to several guiding principles:

1. Clarity and neutrality: The questions must not be biased, framing-effect-free, or contain leading phrasings. They must permit free expression, free from suggestive words that might prime specific answers.

2. Sequential logic: Interviews begin with warm-up or rapport-building questions and proceed towards specific usability or design-related questions. This approach makes use of the cognitive convenience of narrative recall before demanding critical judgment.

3. Contextual grounding: Questions are anchored to specific user tasks or prototype interactions, making them situational rather than abstract. This focus increases ecological validity and enables user reflection.

4. Cognitive load minimization: Interview guides are designed not to overload the respondent, cognitive load theory asserts. They split complex questions into trivial ones and use vocabulary congruent with the user's level of literacy and knowledge of the domain.

To give methodological integrity, interviews must be designed carefully so that they will be useful for internal and external validity. This involves:

- Consistency of administration – administering the same script or protocol to all participants.

- Thematic saturation – conducting repeated interviews until no additional usability insights emerge.

- Triangulation – integrating interview data with observational notes, screen shots, or surveys in order to confirm findings.

Chapter 4

Proposed Solution

4.1 Problem Formulation

The war in Ukraine has made air raid alert applications a compulsory element of civilian life. These digital platforms are designed to give advance warning of impending aerial bombardments to enable individuals to seek immediate shelter. While the underlying objective of such apps is technical in nature — ensuring maximum coverage and speed of alertirir—their sustainability over time relies on more than their ability to push alerts. Increasingly, the success of these systems depends on users' perception, interpretation, and response to the alerts over time.

This thesis examines how UX design can be applied strategically to reduce alert fatigue and make air raid warnings more responsive and reliable in general. It seeks to discover the current interaction patterns and pain points of the users, particularly under the condition of prolonged exposure to high-stress levels.
The most important research questions guiding this study are:

- How do users interact with air alert apps during the duration of protracted conflict?
- What are the most significant usability pain points regarding air alert apps?
- What principles can be used to reduce users' cognitive overload?
- How can personalization techniques be used to improve response?
- What UX design strategies can mitigate alert fatigue?

Some assumptions are made in order to conduct this study.

- Users already know about mobile-based air alert applications.
- Users have regular exposure to alerts.
- Users make the decisions based on the air alert apps
- Users are using mobile phones for receiving alerts.

For the sake of staying on track, the following are out of the scope of this thesis:

- Development or exploration of hardware-based alert systems.
- Geopolitical or military interpretation of frequency or targeting of aerial bombardments.
- Clinical-level psychological impact of trauma, PTSD, or chronic stress.
- Broadcast media such as TV or radio outside of the mobile app domain.

4.2 Design Thinking

4.2.1 Clarify

In the Clarification phase of the Design Thinking process, I focused on structuring and defining the underlying design problems in terms of real user needs, behaviors, and contextual limitations. To aid in this purpose, I used following approaches:

- Hypothesis Mapping. In persona-problem-cause-motivation-hypothesis format, a number of key user pain points were uncovered. For instance, city users frequently mute warnings not out of lack of concern, but rather because they get too many non-relevant warnings. Sensitive users feel more anxious because there is no tiered severity communication within the alert system. These hypotheses enabled us to redefine the design issue from "ineffective warnings" to "warning overload and threat differentiation ambiguity."

- Market Environment Review. Although in-depth competitor analysis is addressed in Related Works, the market scan for this phase was aimed at general UX shortfalls for tools overall. The majority of apps were not customizable based on different types of users, lacked visualization of severity gradation, or had no recovery steps provided after the alert. Section 2.2

- Customer Journey Mapping. Observational learnings were integrated across scenarios. These maps helped reveal emotional states and unmet information needs at each step of the user experience. Above all else, journey data highlighted that users often lacked.

- Online Survey: In this study, a survey questionnaire was designed to collect quantitative data on user satisfaction, preferences, and needs on existing air alert applications. It was intended to establish common problems, determine trends among different age groups, and assess opinions concerning specific app functionalities. Google Forms was chosen as it can easily and quickly be configured and gives a simple way for users to submit responses. It also gives automatic summarization of the collected data. The objective was to get a minimum of 50 responses in an effort to give meaningful results. The survey intended to gather both user experience and behavior habits towards the use of air raid alert apps. In user research 50 or more respondents is generally sufficient sample size to reveal general behavioral trends and patterns. According to statistical theory, assuming the confidence level is set at 95%, then 72 responses provide a margin of error of approximately ±11.5% [**https://shorturl.at/6tjx8**]

Calculate sampling error(SE) using the formula:

$$SE = z \times \sqrt{\frac{p(1-p)}{n}}$$

where:

- $z = 1.96$ (for a 95% confidence level),
- $p = 0.5$ (maximum variability),
- $n = 72$ (sample size).

$$SE = 1.96 \times \sqrt{\frac{0.5(1-0.5)}{72}} = 1.96 \times \sqrt{\frac{0.25}{72}}$$

$$SE = 1.96 \times \sqrt{0.00347222} = 1.96 \times 0.0589$$

Thus the error margin:

$$SE \approx 0.1154$$

These approaches allowed me to triangulate user findings on behavioral, functional, and emotional levels.

One potential shortcoming of the survey is bias due to difficulty in obtaining a full representative sample. Differences in access to technology and willingness to respond may cause a skewing in the age groups and geographic regions covered in the responses. To counter this, survey responses were analyzed considering variations in threat perception by region.

4.2.2 Ideate

Upon finishing the Clarification phase, I began the Ideation phase with the primary focus of generating an extensive and varied list of candidate solutions to fix the primary user problems of the prior phase. This was one step towards crossing over from insight to opportunity as well as the development of the basis for following prototyping. The ideation process was devised to foster divergent thinking under the constraints of keeping user requirements, constraints, and usability in the real world as the priority. It consisted of the following techniques:

- Cross-Domain Inspiration. To avoid designing within the confines of existing air raid alert apps only, I adopted ideas from fields such as health, mobility, accessibility, gaming, and social media. Such an approach helped incorporate features of behavior-based warnings, social check-ins for safety, and integrating wearables.

- Reverse Brainstorming. In this approach, I deliberately set the conditions in which ideas under proposal can fail. In this exercise, key usability and accessibility hazards arose, including the potential to exclude deaf users and the danger of over-filtering notifications.

- SCAMPER Method. Using the SCAMPER system (Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, Reverse), I analyzed the interface, content provision, and feedback elements of the alert system methodically. This enabled me to explore new pairs and alternatives—e.g., replacing auditory with visual notifications, or reversing the app's intent for earthquake response.

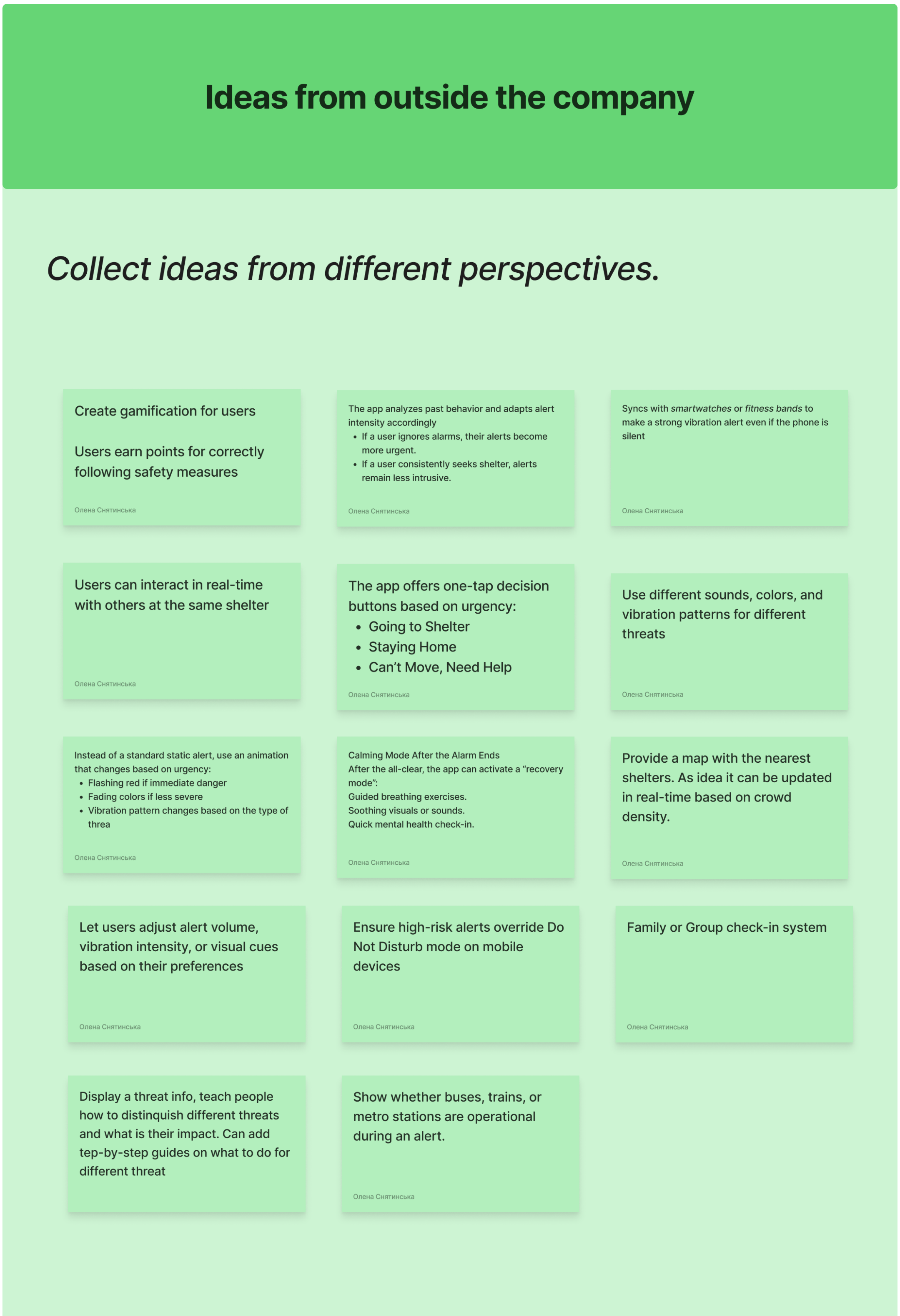


FIGURE 4.1: Enter Caption

FIGURE 4.2: Enter Caption

Figure 4.3: Enter Caption

4.2.3 Develop

After the directions were identified during the Ideation phase, the Develop phase focused on converting the ideas into realistic and testable features. The phase was a shift from generating many ideas to choosing and developing the most suitable ones through testing and feedback.

Feature definition

As a first step, I organized all the ideas generated into a comprehensive list of possible features. These varied from essential safety functionality to supportive functionality.

FIGURE 4.4: Enter Caption

Prioritisation

To assist in determining which features would contribute most to user experience and system usefulness, I employed the Kano model, a method of feature prioritisation. The model places features into three categories:

- Basic features are expected by users; their absence causes dissatisfaction.
- Performance features increase user satisfaction when performed well.

- Excitement features are unexpected but can greatly improve satisfaction when included.

Using this model, I could define the core features that would be essential to the app, and those that are more emotional or motivational.

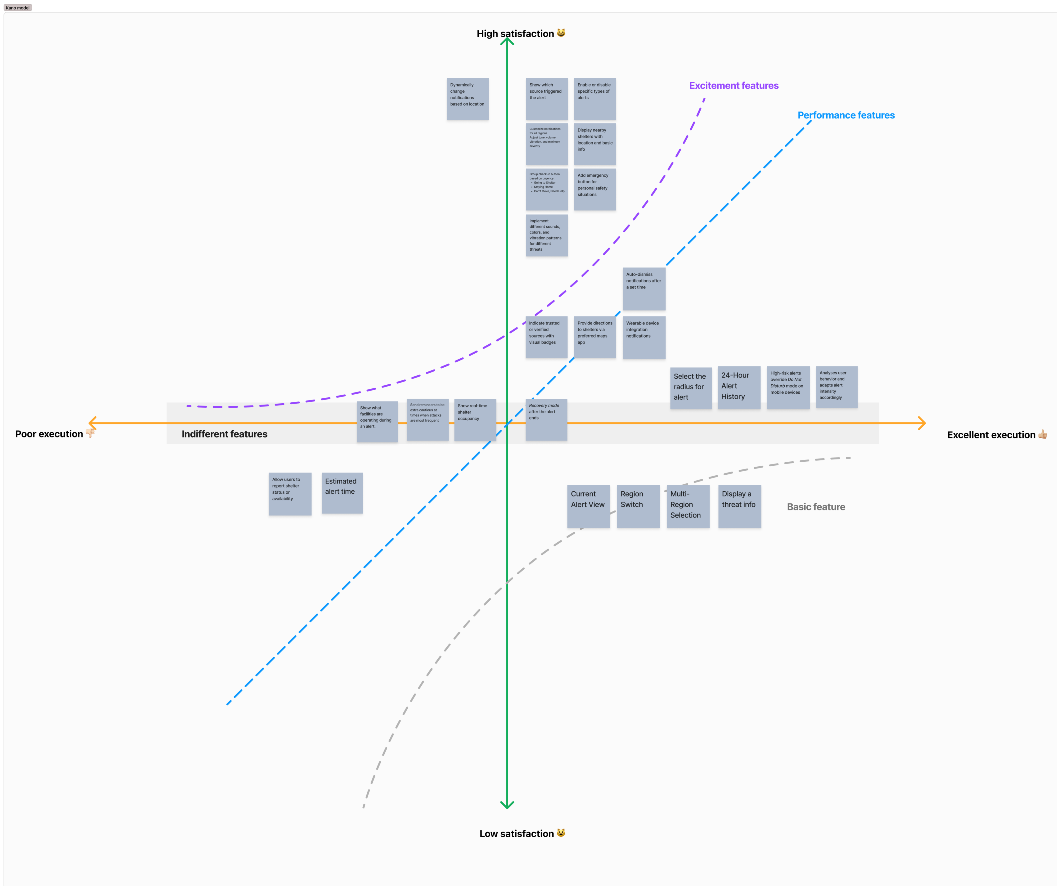


FIGURE 4.5: Enter Caption

After prioritising the feature set, the task was to structure the functional requirements by creating user stories and epics. This method makes sure that the final app addresses a specific user goal directly.

By defining each functionality, it was then possible to convert abstract concepts into actionable goals with clear, structured acceptance criteria.

User Stories and Acceptance Criteria

Epic: Administrative Area selection

Select the Administrative area

User Story: As a user, I want to select my administrative area so that I can receive alerts relevant to my selected location.

Acceptance Criteria:

1 The user should select a administrative area to receive alert notifications.

  a User can select up to 10 administrative areas (administrative area, district or community).

2 The user can select a administrative area from a predefined list of administrative areas in Ukraine.
    a User can select multiple administrative areas at once.
3 The selected administrative area is saved and used for alerts.
    a If not changed, the user should receive alert notifications for all selected administrative areas.

Epic: Manual Alerts

Recieve the alert notification

User Story: As a user, I want to receive alerts by type, so that I will be informed about the possible threat.

Acceptance Criteria:

1 User should recieve the alert for setted administrative area, when the threat is detected for this administrative area.
2 Each alert should be sent to the user via push-notification (if not changed by user in phone settings otherwise)
3 Each notification alert should include
    a threat type
    b area affected
4 Each notification should be sent with the alert sound
5 When the user selects the notification
    a alert sound stops
    b user is redirected to the alert app to the alert view page for the administrative area.

Access the alert view page - alert mode

User Story: As a user, I want to have the ability to view the alert, so that I can assess the level of threat.

Acceptance Criteria:

1 The alert view page includes the alert information:
    a threat type
        i air raid alert
        ii threat of shelling
        iii threat of street fighting
        iv chemical threat
        v radiation threat
    b area (for which alert was issued)
    c time started
    d recommended actions
    e option to access the shelter map
    f user connected to this administrative area, including
        i connected user's name

- ii connected user's status
- iii option to phone the connected user
- iv connected user's location

g information source (source that triggered the alert)

h other information about the threats in this administrative area, sourced from:

- i official telegram channels
- ii unofficial telegram channels

i alert settings option

2 Each alert type has distinct elements:

- a display colour
- b display icon
- c recommended action

Access the alert view page - non-alert mode

User Story: As a user, I want to have the ability to view the alert, so that I can assess the level of threat.

Acceptance Criteria:

1 The alert view page includes the information:

- a administrative area
- b last alert information (including the information that was displayed during the alert)
- c option to access the shelter map
- d breathing exercises
- e user connected to this administrative area, including
  - i connected user's name
  - ii connected user's status
  - iii option to phone the connected user
  - iv connected user's location
- f information source (source that triggered the alert)
- g other information about the threats in this administrative area, sourced from:
  - i official telegram channels
  - ii unofficial telegram channels
- h alert settings option

2 Each alert type has distinct elements.

Access the alert per administrative area page – alert mode

User Story: As a user, I want to have the ability to view alerts on different administrative areas, so that I can stay informed about the threat in other administrative areas.

Acceptance Criteria:

1 The alert per administrative area page includes:

a alert map of Ukraine with:
  i affected administrative areas (with announced alerts)
  ii direction of missile movement
b general alert view blocks, selected by the user, each block contains:
  i affected administrative area
  ii threat type
  iii user connected to this administrative area
  iv number of missiles targeted for this administrative area
c option to add new administrative area
  i when user selects this option - the user should be redirected to the select the administrative area functionality
d option to change user's status
e general settings option

Access the alert per administrative area page – non-alert mode

User Story: As a user, I want to have the ability to view alerts on different administrative areas, so that I can stay informed about the threat in other administrative areas.

Acceptance Criteria:

1 The alert per administrative area page includes:
  a alert map of Ukraine with:
    i affected administrative areas (with announced alerts)
  b general alert view blocks, selected by the user, each block contains:
    i administrative area
    ii user connected to this administrative area
  c option to add new administrative area
    i when user selects this option - the user should be redirected to the select the administrative area functionality
  d option to change user's status
  e general settings option

Epic: Location Based Alerts

View Alert per administrative area page location-based

User Story: As a user, I want to view list of location-based administrative areas so that I can view only areas I need at this moment.

Acceptance Criteria:

1 When the location is allowed.

2 The user can view alert details.

3 The user can specify the location radius, based on this radius the system should send alert notification
  a if the user's radius area includes any administrative area, it is added to the block list

4 If the user is not located in the area for more than 3 days, the corresponding area is removed from the list

5 User has the ability to add and delete an area manually (view Select the administrative area item)

6 Alerts will be automatically disabled if the user crosses the Ukrainian border.

7 If the connected user has the location on

  a the administrative area for this user should change depending on their location

  b the connected user administrative area should be removed from the list instantly (when user changed location)

View alert history

User Story: As a user, I want to view a history of past alert so that I can review previous threat and consequences.

Acceptance Criteria:

1 The user can view past alert in the non-alert view

2 Alert includes details:

  a threat type

  b affected area

  c time started

  d time ended

  e recommended actions

Epic: Settings

General Settings

User Story: As a user, I want to access a General Settings page, so that I can manage core app preferences.

Acceptance Criteria:

1 User has the ability to access the General settings page

2 When accessing the page user can view following modifications:

  a Switch off all notifications

  b Switch off all alert notifications (user will still receive the connected users status updates)

  c Silence after option - will silence the alert sound after the specified time period

  d Allow location option

    i The app requests location permission from the user.

    ii User alerts are based on GPS data if location is enabled (view Location based Alerts epic).

    iii If location is disabled, alerts for the user are based on the selected administrative area.

Alert Notifications Settings

User Story: As a user, I want to choose which types of alerts I receive so that I only get notifications relevant to me.

Acceptance Criteria:

1 The user can change notification settings for the specific administrative area

2 The user can switch the notifications for specific alert types on or off

  a Only enabled alert types should trigger notifications.

  b The default setting is to enable all alert types.

3 The user can choose different sounds for each alert type.

  a Upload your own sound

  b Default Alert sound

  c Alert Announcement

4 The user can adjust the volume level for each alert type.

5 The user can preview sound options before selecting.

6 The user can switch vibration on/off

Other settings

User Story: -

Acceptance Criteria:

1 User has the ability to add user to specific administrative area, with information

  a connected user name

  b connected user phone number

2 User should have the ability to delete the administrative area

  a when deleting the approval option should appear

  b if user selects the option to delete the administrative area - it should be removed from administrative area list and notifications for this administrative area should be disabled.

Epic: Status

Status providing

User Story: As a user I want to provide my status, so that my connected users have the information on my safety.

Acceptance Criteria:

1 When accessing the alert list user can see the option to leave their status.

2 Using this option user can leave their status, including

  a Shelter: I am safe

  b On the way to the shelter

  c Not going to shelter, at home

  d Need help

  e On the road / on the street

3 When the option is selected and saved, the user should receive the notification, symbolising that their status was changed and sent to their connected users.

4 When selected, status can be changed.
5 Status will return to empty one day after it was set, if no other interaction with status change functionality was made.

Status receiving

User Story: As a user I want to receive my connected user's status, so I can understand whether they are safe and need help.

Acceptance Criteria:

1 When a user's connected user is changing or setting status, the user should receive the notification message.
2 The notification message should include:
   a status
   b connected user's name
   c connected user's picture (if added)
3 When clicking on the notification, the user will be redirected to the Alert View page, where the connected user is located or added manually.
4 The status should also be changed on the Alert View page for this connected user.

Epic: Shelter Map

Access the shelter map

User Story: As a user, I want to be able to view Shelter map, so that I can be informed about safe spaces.

Acceptance Criteria:

1 When accessing the Alert View page, the user can see the option to go to the shelter map page.
2 On the Shelter map page, the user can view the map with the elements:
   a user's pin location (if location is allowed)
   b shelters pin locations
   c block with the location address, estimated time to the shelter on foot and option to view this location in system maps.
3 When clicking on the shelter pin location, the block with the location address is highlighted when clicking on the shelter pin location.

High-Fidelity Prototype

Following definition of the feature set, I designed a high-fidelity prototype including key flows. I tested the prototype with seven users.

Protoryope Testing

In scope of this thesis the app was demonstrated to the target group to test its usability and functionality. The testing was done in a controlled environment, where we could observe user behavior and offer technical help if needed. This allowed for more detailed feedback, although it required more time and organization compared to remote testing.

Metrics

Quantitative usability measures will be collected in order to give an objective measure, including: [**file:///Users/home/Downloads/applsci-14-01792.pdf**]

1. First Attempt Success Rate (%). This metric measures the percentage of tasks that are completed successfully on the first try, with no errors or assistance. In emergency situations such as air alerts, users need to respond quickly and correctly without needing several attempts.

2. Navigation Efficiency (%). Navigation efficiency involves comparing steps taken by users with the minimum necessary to complete a task. In an emergency, users must navigate to the essential actions in as few interactions as possible.

3. Were the Tasks Difficult to Complete rate? This metric captures the rate (1 to 10) at which the users reported tasks being difficult to complete during the prototype testing. Subjective perceptions about task difficulty directly affect user trust and intention to use the app during real emergencies.

4. Error Rate per Testing (%). This measure calculates the number of errors divided by the number of tasks performed. Minimizing user errors guarantees life-saving information is processed correctly.

Prototype Fidelity

The prototype is high-fidelity, so the participants can actually fully model the user's experience. This level was used so the participants could best intuitively and realistically sense usability and the impact of the design.

Prototype Test Limitations

- Participant Selection: Participant selection would be a potential limitation as the pre-specified specifications might not encompass the entire set of variations in user experience. To this effect, participants are hired which are variant from each other in terms of range and composition to prevent selection bias.

- The Hawthorne effect (observer effect) may also affect the behavior of participants while testing. To minimize this, participants will be informed that they are being tested on the prototype and not their performance. Their attention will be directed at obtaining unbiased feedback and results, and participants will be encouraged to express criticisms.

4.2.4 Implementation

Implementation stage brought all stages together in a fully completed prototype. The initial design was altered depending on the results of the survey, case studies, testing of prototypes, and feedback from users to fix recognized usability issues and better cater to user requirements.

Chapter 5

Experiments and Results

5.1 Survey

5.1.1 Demographic Distribution

A total of 72 participants completed the survey. The survey population consisted mainly of young adults:

- 46% belonged to the 26–39 age range,
- 39% belonged to the 18–25 age range,
- 14% belonged to the 40–59 age range.

The three regions mentioned most were Lvivska (55%), Kyivska (48%), and Vinnytska (41%). Multiple regions were often selected, as participants indicated all locations they had lived in during the war. This wide geographic spread ensures a representative distribution of users across both relatively safe and high-risk areas.

Alert Fatigue and User Reaction Patterns

Participants were asked: *"Do you think you are reacting to air raid warnings less often than during the initial months of the war?"* A clear majority (84%) responded that they feel a decreasing sensitivity over time, while only 11% reported no change in responsiveness. This finding validates the hypothesis that repeated exposure to high-frequency warnings leads to a normalization effect and reduces behavioral urgency. This alert fatigue may critically impact the effectiveness of alert systems, as many users may no longer perceive each warning as actionable.

App Usage

Survey results show the following breakdown:

- 45.8% (33 of 72) currently use air alert applications,
- 43.1% (31 respondents) used them in the past but no longer do,
- 11.1% (8 respondents) have never used any such apps.

This suggests high awareness and trial but also significant dropout, possibly due to issues of trust, perceived usefulness, or experience quality. The most commonly mentioned apps were:

- "Повітряна тривога" and "AirAlert" (most widely used),

- *Air Raid Alert Map of Ukraine*, which was previously popular but has since lost usage,
- *Kyiv Digital (Київ Цифровий)*, the third most used overall.

When asked how important alert apps are on a 1–7 scale, the most common rating was "1" (not important), selected by 25% of participants. The mid-range value "4" was also common (18.1%), while high-importance ratings were relatively rare. This implies that while alert apps are widely recognized, they are often abandoned due to low perceived value, redundancy with other alert sources (e.g., Telegram), or inadequate user experience.

Situation-Based Questions

Participants were asked how they typically respond to air raid alerts in various real-life contexts. Across scenarios, a dominant trend of passive or filtered engagement was observed:

- **In public transport:** Most participants continued their activity or checked Telegram (official and unofficial) for updates.
- **At work:** Responses were divided between continuing work (24), mimicking others' behavior (21), and consulting formal sources (19), indicating the influence of workplace norms.
- **At night:** The most common behavior was monitoring official channels (32), followed by continuing current activities (31) and checking unofficial sources (29). Some moved to safer spots at home (19), and only 15 went to designated shelters.
- **In familiar outdoor areas:** 44 continued their activity, while 29 checked official sources and 23 relied on situational awareness.
- **In unfamiliar outdoor areas:** The pattern remained consistent—42 continued their activity, 32 checked official channels, and 24 relied on context.

These responses reveal a dual trend:

1. Reduced urgency to act, even in potentially risky settings.
2. Strong reliance on information filtering—using digital channels to assess threat relevance.

This behavior suggests cognitive adaptation to prolonged threat exposure. Users are shifting from automatic alert compliance to a more deliberate, filtered response. While this may reduce panic, it can introduce delays in high-risk situations. From a design standpoint, merely issuing alerts is insufficient—alerts must be credible, contextual, and informative enough to justify interruption.

Desired App Functionalities and Customisation Preferences

Survey participants expressed a strong preference for flexible, context-aware alert features.

Preferred Notification Types

- 63% preferred a standard sound signal,
- 47% preferred text messages,
- 45% preferred vibration alerts,
- 29% preferred visual signals,
- 26% preferred spoken or voice alerts.

This indicates a preference for **multi-modal alerts**, with vibration and audio for immediacy and text messages for clarity and interpretability.

Notification Parameter Priorities

Participants emphasized the importance of:

- Vibration settings and volume control,
- Alert sound type (alarm, melody, or voice),
- Control over alert duration.

These preferences reflect a demand for personalization that allows users to tailor how and when they receive alerts.

Alert Filtering and Scheduling

- 82% support differentiated alerts by threat type.
- 66% want the option to switch alerts on or off by threat category.
- 46% wish to receive alerts for multiple regions, while 54% prefer local-only alerts — which I believe is suggesting a desire to avoid alert notification overload.
- 77% support quiet hours, with many preferring to mute non-critical alerts only.

Key insight: Users want air raid alerts to be **smart, relevant, and non-intrusive**. They prefer systems that:

- Provide specialized alert types,
- Adapt to user schedules and locations,
- Deliver actionable, context-rich information—not just alarms.

5.2 Prototype Testing results

There were seven participants in the prototype testing. Six participants sessions are recorder, and one has the meeting notes. The tests used a scenario-based approach, where individuals were invited to react to real-life air alert scenarios such as:

- Woken up at night by a siren
- Is traveling to a new city, user receives an alarm and don't know where to go

- User is in other city from the relative and wants to check the relative situation
- Alert started and user needs help
- User is tired of alarms and want to change the sound and volume of the alarm
- User is traveling and don't want to go to settings and switch notifications every time.

5.2.1 Pain Points Identified

Several pain points emerged consistently across the participants:

- Button for shelter maps was not always distinct enough. Users sometimes hesitated, unsure if element was actionable.
- Several users did not understand term "3 rockets" and were unsure if it referred to the number, type, or direction of missiles.
- Threat information on alert screen was too general.
- Participants had difficulty finding sound settings because they were split between general and region-specific sections without clear guidance.
- Help request feature was seen as limited — remote contacts may not be able to assist, but the functionality idea itself was welcomed.

5.2.2 Additional Observations

- Across all participants, alarm sound personalization functionality was ranked as the top priority (8.6 average rate). It was expressed, that this functionality is basic & vital for the application, but is lacking sometimes. It also was mentioned that it is useful for the more crowded spaces (like work or school), so the sound of alert will not interrupt the work, when already in safe space.
- Dynamic GPS-based alerts was ranked as the second top priority (8.4 average rate), participants mostly expressed usefulness of this fucntionality and highlithed as a good point to lower probavility of recieving the alarm for not located area.
- Status sending was least functional (7 average rate) and received the highest number of usability-related comments during testing. Some participants expressed problems with its reliability, considering that the primary purpose of an alert app is to bring warning information. Some users said that, in case of emergencies, they would prefer to use either in-built phone features or a specific emergency app other than relying on the status sending feature alone.

5.3 Final Prototype

Functionality	Participant 1 (testing3)	Participant 2 (testing4.1)	Participant 3 (testing5.1)	Participant 4 (testing1)	Participant 5 (testing2.1)	Participant 6 (testing6)	Participant 7
Shelter map	10	6	7	8–10	2-3	8.5	10
Linked persons monitoring	10	10	9	6-7	8-9	4–9	3
Send status	10	7	7	2-3	5-6	7-10	5-9 (depending on presence of relatives in same region)
Customizable alarm sound for different regions	10	7	High	9-10	7-8 (expressed that it is the basic functionality)	9–10	9
Dynamic GPS-based alert switching	9	6	9	9	9-10	9-10	7

FIGURE 5.1: Enter Caption

Metrics	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7	Average
First Attempt Success Rate (%).	4/7 ≈ 57%	5/7 ≈ 71%	6/7 ≈ 86%	5/7 ≈ 71%	6/7 ≈ 86%	6/7 ≈ 86%	6/7 ≈ 86%	≈ 77.6%
Were the Tasks Difficult to Complete? Rate	1	2	1	4	2	2	2	2
Error Rate per Task	2/7 (was confused by settings & shelter map) ≈ 29%	2/7 (was confused by settings differentiation) ≈ 29%	1/7 (settings) ≈ 14%	2/7 (was confused on how to silence alert & settings) ≈ 29%	1/7 (settings) ≈ 14%	1/7 (settings) ≈ 14%	1/7 (settings) ≈ 14%	≈ 20.4 %

FIGURE 5.2: Enter Caption

Chapter 6

Conclusions

Appendix A

Appendix

Bibliography

[1] Teresa Onorati Alessio Malizia Paloma Díaz Ignacio Aedo. In: *Interaction Design Principles for Web Emergency Management Information Systems*. Retrieved from . International Journal of Information Systems for Crisis Response and Management, 2011. URL: https://www.researchgate.net/publication/220295327_Interaction_Design_Principles_for_Web_Emergency_Management_Information_Systems.

[2] D. Van Dijcke, A. L. Wright, and M. Polyak. "Public response to government alerts saves lives during Russian invasion of Ukraine". In: *Proceedings of the National Academy of Sciences (PNAS)* (2023). Retrieved from . URL: link.

[3] Terje Gjøsæter, Jaziar Radianti, and Weiqin Chen. "Universal Design of ICT for Emergency Management from Stakeholders' Perspective: A Systematic Literature Review". In: *Information Systems Frontiers* (). Retrieved from . DOI: 10.1007/s10796-020-10084-7. URL: https://link.springer.com/article/10.1007/s10796-020-10084-7.

[4] Rajendra K. Gupta. *Principles and Practice of Design Thinking*. Retrieved from ResearchGate. 2025. DOI: 10.13140/RG.2.2.11453.78566. URL: https://www.researchgate.net/publication/389647531.

[5] William Lidwell, Kritina Holden, and Jill Butler. *Universal Principles of Design: 125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach through Design*. Retrieved from Google Books. Rockport Publishers, 2010. ISBN: 978-1592535873.

[6] Shruti Mishra, Abhishek Guleria, and Vaibhavi Parikh. "Reducing Cognitive Load in UI Design". In: *International Journal for Research in Applied Science and Engineering Technology (IJRASET)* (2025). Retrieved from . ISSN: 2321-9653. DOI: 10.22214/ijraset.2025.67917. URL: https://www.ijraset.com/research-paper/reducing-cognitive-load-in-ui-design.

[7] Nidhi Prasad, Vikash Kumar, and Sanjay Kumar. "Survey research–concept and development". In: *Journal of Indira Gandhi Institute of Medical Sciences* (2024). Retrieved from ResearchGate. DOI: 10.4103/jigims.jigims_10_24. URL: https://www.researchgate.net/publication/382728667.

[8] John Sweller. "Cognitive Load During Problem Solving: Effects on Learning". In: *Cognitive Science* 12.2 (1988). Retrieved from , pp. 257–285. DOI: 10.1207/s15516709cog1202_4. URL: https://onlinelibrary.wiley.com/doi/10.1207/s15516709cog1202_4.

[9] Murray Turoff et al. "The Design of a Dynamic Emergency Response Management Information System (DERMIS)". In: *Journal of Information Technology Theory and Application (JITTA)* (2004). Retrieved from . URL: https://www.researchgate.net/publication/308162811_The_design_of_a_dynamic_emergency_response_management_information_system.

[10] Christopher D. Wickens. “Multiple Resources and Mental Workload”. In: *Human Factors* 50.3 (2008). Retrieved from , pp. 449–455. DOI: 10.1518/001872008X288394. URL: https://doi.org/10.1518/001872008X288394.