User centered design of an emergency support solution for horseback riders

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Abstract

As horseback riding has become increasingly popular, and is such a dangerous sport, there is a need for an emergency support solution for horseback riders that can help them get the assistance they require in time. In order to design such a solution, firstly, the design aspects that should be considered for implementation were identified through a user research performed on expert horseback riders. The user research proved that there is a need for such a solution and highlighted the importance of involving potential users in the design process of an emergency support solution. From the feedback that was obtained, it was decided that the system should be composed of an assistance assessment and request stand-alone smart-wristband, a management mobile application, and a clip-on GPS tracker. Then, a user flow diagram to illustrate the interaction flow that the system should follow to meet the principles of universal design was created. Through the user flow diagram, the importance of considering the universal design principles and the human factors when designing safe interactions was revealed. Finally, digital and interactive prototypes for the smart-wristband and the mobile application were developed. The prototypes were developed through two iterations. The design of the first iteration focused on meeting the user requirements identified as part of the first research question, whereas the second focused on meeting the principles of universal design. Both iterations were evaluated through user tests on expert horseback riders. The feedback obtained from the evaluation of the first iteration was used to improve the design and create the second iteration prototypes. The feedback obtained through both iterations was positive and showed that the designed solution was highly suitable for the intended task, practical and easy to use. Through the user centered design approach undertaken for the design and evaluation of the prototypes of this thesis, a distinctive point of view and results were developed.

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Chapter 1

Introduction

1.1 Background and Problem Statement

In the last decades, equestrian sports have become increasingly popular among children and adults around the entire world. In Norway, the number of horseback riders has doubled in the past 20 years, and in the United States, 30 million people ride horses every year [1][29]. Horseback riding is a sport that can be executed both alone and in company, and is usually performed as a recreational activity, exercise or competitive sport.

In comparison to other sports, horseback riding requires the athlete to work alongside an animal. This facet of the sport adds an additional risk factor. Equestrian sports require not only that riders master the fundamentals of the sport, but also that they have knowledge about the care, control and behavior of the animal itself. Consequently, due to the unpredictability of the horses, and the rider's head being positioned on average approximately 3 meters above the ground, moving unrestrained at speeds of up to 65 km/h, horseback riding is considered an extreme sport [42][24]. According to scientific papers such as [6], due to the high rate of hospital admissions that it leads to, horseback riding is considered more dangerous than motorcycle riding, skiing, football and rugby [32]. An estimated number of 50,000 patients are sent into the emergency room yearly because of horseback riding injuries in the United States [11]. The most common injuries occur due to a fall from the horse, with the most frequently affected body regions being the head and upper extremities [27]. Additionally, when it comes to equestrian fatalities, neurological trauma was reported as the most frequent cause, with head injuries accounting for nearly 60% of the deaths [9][27].

When an accident occurs, riders can often find themselves in emergency situations such as being injured, incapacitated or unconscious. According to the National Trauma Databank, between the years of 2003 and 2012, 45.2% of sports related traumatic brain injuries among adults were related to horseback riding [32]. A neuro critical care specialist at University Hospitals Case Medical Center, stated that while concussions in other sports usually lead to long-term effects of repeated head injuries, for equestrian injuries, one brain injury could mean permanent damage and severe repercussions [32].

Therefore, because horseback riding has become increasingly popular, and is such a dangerous sport, there might be a need for an emergency support solution for horseback riders that can help riders get the assistance they require in a timely fashion.

1.2 Scenario

There are numerous emergency situations which riders can find themselves in. For instance, when a person falls off their horse, they may get their foot stuck in the stirrup, suffer a concussion or get stepped on by the horse, all of which could result in highly dangerous scenarios. If a rider in an emergency situation is with another person, that person may be able to trigger a response from the patient, ask for help, perform Cardiopulmonary Resuscitation (CPR), or treat physical injuries if needed. However, if the rider is alone, the scenario can become challenging due to their inability of treating themselves or asking for help. When riders find themselves in such emergency situations, getting the appropriate help in a fast manner could be lifesaving. Therefore, in order to aid horseback riders who are in such emergency scenarios, a technological solution that identifies emergency situations, confirms the rider's condition, and requests external help in case of necessity was proposed.

1.3 Limitations

As mentioned in section 1.2, the initial idea was to develop an Information and Communication Technology (ICT)-based solution that performed the following three main functionalities: identification of emergency situations, identification of riders' support needs, and acquisition of help if required. Based on research undertaken as part of a project report [46], it was discovered that there are a number of already existing technologies that can identify a rider in a situation of emergency, and several other technologies that could potentially send a request for help in case of need. However, a lack of research on the identification and confirmation of riders' support needs was identified. For that reason, and due to the amount of time available for this thesis, it was decided to limit the scope by focusing on the interaction between such an ICT-based solution and horseback riders to obtain new knowledge. In order to create the interaction, the aims and objectives explained in the next section were established.

1.4 Aims and Objectives

During the development of this thesis, it is hoped to achieve the following **aims**:

- **To investigate the importance of involving potential users in the design process:** Understanding the perspectives of potential users could provide valuable information.

- **To be aware of the importance of universal design principles to perform safe interactions between a designed solution and the horseback riders in emergency situations:** When in situations of emergency, the rider might be in distress or unwell, thus, performing safe interactions will be critical.
- **To consider the relevance of a user centered design approach to create an interface through which assistance can be requested and provided to horseback riders in potential emergency situations:** A suitable interface should take into consideration the intended user, action and environment so that the solution's purpose is attained in the most productive manner.

In order to achieve the aforementioned project aims, actions will be taken. Thus, the following **objectives** are defined:

- **To collect a number of aspects that should be considered for the design of the interaction flow and prototype:** Data will be gathered through questionnaires and semi-structured interviews with experienced horseback riders for requirements specification.
- **To produce a user flow diagram to determine the interactions and technologies required to accomplish the principles of universal design:** The system should identify the user needs in situations of emergency, and decide with that information the protocol to follow to aid the horseback rider.
- **To develop the design of a clickable and interactive prototype for an ICT-based tool that aids horseback riders in potential emergency situations:** The prototype will be created in an iterative process with focus on the intended users by involving potential users in each iteration.

1.5 Research Questions

According to the objectives formulated above, the following research questions will be addressed:
RQ 1: What design aspects should be considered when implementing an ICT-based tool that aids horseback riders in potential emergency situations?
RQ 2: What interaction flow should a system that aids horseback riders in situations of potential emergency follow to meet the principles of universal design?
RQ 3: How could the needs of horseback riders in potential emergency situations be fulfilled with an ICT-based tool following the User Centered Design approach?

1.6 Report Structure

This thesis is divided into six chapters. The current chapter is the *Introduction*, which explained the basis of the research topics and ethical considerations. Next, the *Theory* chapter will introduce relevant state-of-the art research about design aspects and methods to consider, and forms of interaction. Thereafter, the *Methodology and Tools* chapter will describe the methods and tools that were utilized during the development of this thesis, together with how they were used. After that, the *Solution and Results* chapter will present each of the individual parts of the conceptual design and the prototype created during this project, along with the outcomes obtained through the user research and evaluation. Thereafter, the *Discussion* chapter will interpret the results in regards to the research questions and reflect on the work process. Lastly, the concluding thoughts will be gathered in *Conclusion and Future Work* together with possible changes that could be performed in future iterations of the solution.

1.7 Ethical and Privacy Considerations

The project will focus on designing an ICT-based solution to help horseback riders in situations of potential emergency. This could impose ethical issues as in order to accurately test the created interactions, the prototype would have to be tested by horseback riders during emergency situations. As mentioned earlier in this chapter, such situations include falling off a horse, suffering a concussion or getting stepped on by a horse, all of which would be dangerous to replicate. Thus, for the user tests of this project, the prototype will not be tested under emergency situations, and the tests will be conducted safely and professionally towards participants.

In order to answer the first research question, a user research that identified the user requirements will be performed. As mentioned earlier, the data resulting from the user research will be collected through both questionnaires and semi-structured interviews. Nevertheless, before any data is collected, an application will have to be sent to the Norwegian center for research data, NSD, which stands for norsk senter for forskningsdata in Norwegian. Although the participants of both the questionnaires and interviews will be kept anonymous, it necessary to request the NSD approval because the interviews will be audio recorded. According to the official website of NSD [33], a voice on an audio recording is also considered personal information. Thus, the NSD application will be sent in for approval together with the proposed questionnaire questions, interview questions and the consent form that will be showed to each interview participant before recording. Once the approval for data collection is granted, the research will begin.

Chapter 2

State-of-the-art and Theoretical Background

2.1 Design Aspects to Consider

When implementing an ICT-based tool, there are numerous design aspects that should be considered, such as usability [21]. Nevertheless, according to a systematic literature review, [40], most already existing ICT tools and platforms for emergency management do not take into consideration Universal Design nor accessibility. Universal Design is defined as the design of an environment that meets the needs of all people who wish to use it regardless of their age, size, ability or disability [17]. Awareness about how Universal Design can benefit all users is as crucial as it is rarely found [40]. Good efforts towards accessible tools and platforms exist, but mostly on the conceptual or prototype level [40].

In May 2020, a master's thesis [7] on the evaluation of four universally designed earthquake-related emergency management websites discovered that none of the examined websites were accessible and usable to all test users [7]. An article written by Romano et al. about designing effective and efficient mobile emergency notification applications, revealed a number of consequences derived from not taking usability into account in the design phase of researched mobile devices [44]. These consequences included users being required to fill out complex forms with abundant and useless information during emergency situations. The message content was also mainly based on text, which in situations of emergency can potentially mislead the user and make the task completion slower [44]. Another paper written on similar matters highlighted that the most imperative factors in the design of emergency systems are speed, reliability, weight, affordability, task and environment adaptability [48]. Regarding the interface of the technologies, the most important characteristics are learnability, immersiveness, and ability to afford a high sense of spatial presence [48].

In 2013, Baharuddin et al. wrote a review [2] about usability dimensions for mobile applications. There are a number of already existing usability guidelines particularly for desktop and web-based applications, but not for mobile applications. Thus, this review addressed this issue by proposing dimensions to consider when designing and evaluating mobile applications. The dimensions considered four factors: user, environment, technology and task/activity. The user dimensions were demographics, perception and emotional context. The environment dimensions were the physical or social conditions. Finally, the technology dimensions were device type and interface, while the task dimensions were realism of openness/closeness of task description [2].

As mentioned earlier, it is crucial for web designers and web developers to be aware of the Universal Design principles. Additionally, there is a set of accessibility and usability guidelines, called the Web Content Accessibility Guidelines (WCAG), that have gained relevance and have consistently been used in order to consider users with different abilities [7]. WCAG (version 2.1) contains a wide range of recommendations for making web content more accessible for people with disabilities and cognitive limitations [58]. In 2019, Radianti et al. wrote an article, [41], about the inaccessibility of a selection of universally designed information sharing tools for disaster risk reduction. Three out of five of the selected tools failed at 3 of the 4 main principles of WCAG 2.1. The most common detected issues included missing labels, resizing issues, lack of instructions and compatibility issues. As measures to minimize these issues, it was determined that special focus should be put on four aspects, these are: providing labels for web elements in order to support screen reader users, providing and improving resizing functions, providing instructions and help, and improving compatibility with current and future user agents, including assistive technologies [41].

Another design aspect to consider in the implementation of emergency ICT-based tools is the field of Human-Computer Interactions (HCI). HCI is a multidisciplinary field of study that focuses on the design of interactions between users and technological devices [19]. In 2008, Weber et al. wrote a paper, [18], discussing preliminary thoughts, challenges and implications of designing context-aware HCI for emergency management. The following five challenges of HCI for incident management were identified: reduction of complexity of user interfaces, priority of primary task, heterogeneity of the involved actors, heterogeneity of ICT user interfaces, and information security and data privacy [18]. The paper also established the importance of context-awareness by adapting to the user, the platform and the environment to meet distinct requirements for HCI [18].

Finally, given that users play a big role in the usage of emergency systems, human functioning should also be considered in the design of said systems. In 2015, Borell and Stroh wrote a paper, [8], that suggested three possible strategies to consider in the design of ICT-based emergency management support systems. The first strategy was to choose an appropriate degree of ICT-based processing, which suggests to neither present too much raw data nor to have too processed and condensed information [8]. The second and third strategies were to offer user-controlled degree of processing and to offer adjustable filters, which would allow users to choose the type of information to process and present [8].

There is a consensus in all researched papers on the fact that the effective use of ICT-based emergency management support tools require human factors to be considered in both the design and operational phases of such systems [8]. Otherwise, performance could be severely compromised. Emergency systems have a high potential impact. Nevertheless, there is still a long way to go in the implementation of universally designed warning systems that function well for all kinds of users [40].

2.2 Existing User Flow Diagrams

User flow diagrams are commonly used to visualize and map the flow of an application or system [51]. With the use of such diagrams, the possible interactions at each interface of a system can be presented. Prawira et al. created three different user flow diagrams in the development of an emergency management prototype system [37]. With this system, reporting of an emergency could be done in three different ways: through a button inside an application (such as a mobile application), through the power button on a device (such as on a mobile phone), and through voice commands [37]. Figure 2.1, figure 2.2 and figure 2.3 illustrate the three user flow diagrams which Prawira et al. made use of to successfully distinguish and explain the three aforementioned ways of reporting an emergency.

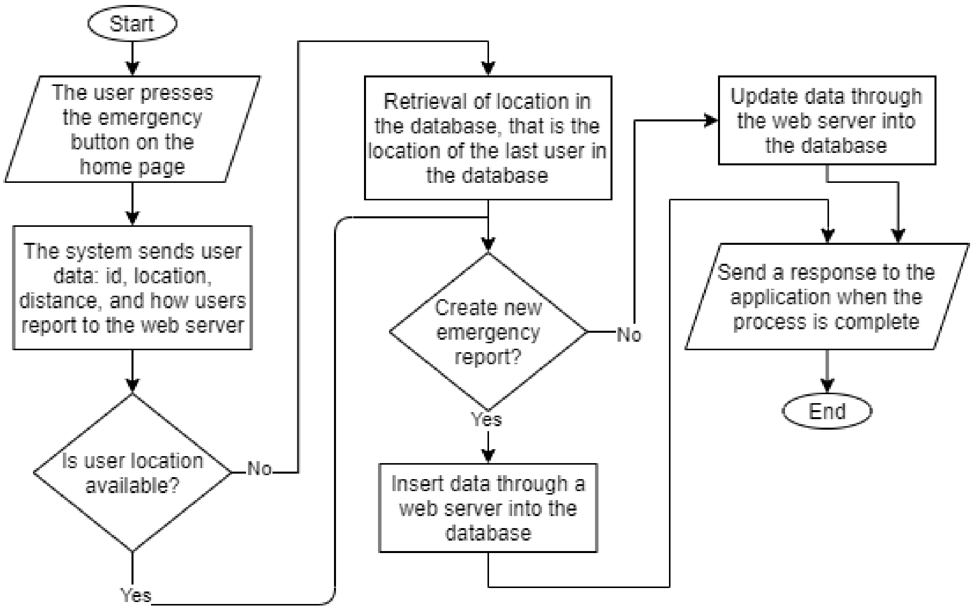


Figure 2.1: User Flow Diagram using the button inside an application, inspired by [37]

The *Start* and *End* objects indicate where the beginning and finish of the flow are. The rectangular objects indicate actions, the rhombic objects indicate decisions, and the arrows indicate the direction of the flow. As stated by Prawira et al., the results from the performance testing showed that by using the button inside the application, the system needed an average time of 6.96 seconds to report an emergency and request the needed help, while using the button on a device and using the voice command caused a delay of 21.08 seconds and 20.33 seconds respectively [37]. Using the button on a device and using voice commands have the advantage for the user being able to request help while the device is locked. However, using a device's button has the disadvantage of additional 10 seconds to cancel the reporting in case of a mistake. Additionally, the success of reporting using voice commands depends on the clear pronunciation of words [37].

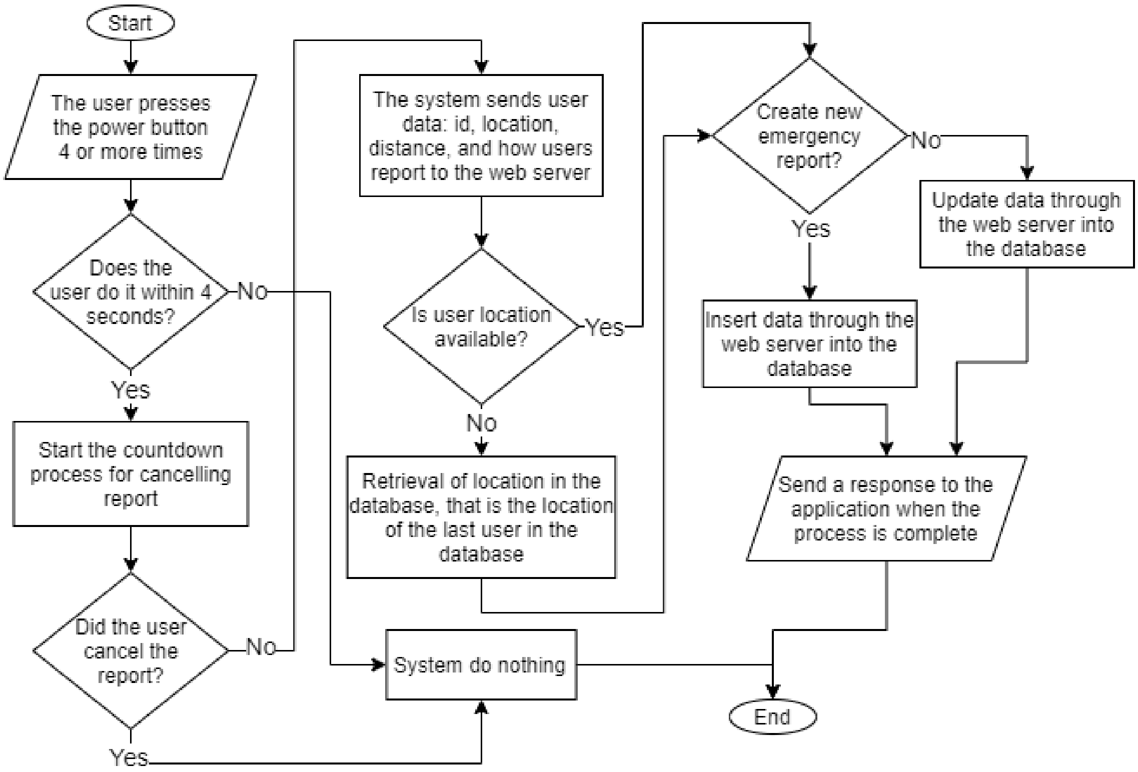


Figure 2.2: User Flow Diagram using the button of a device, inspired by [37]

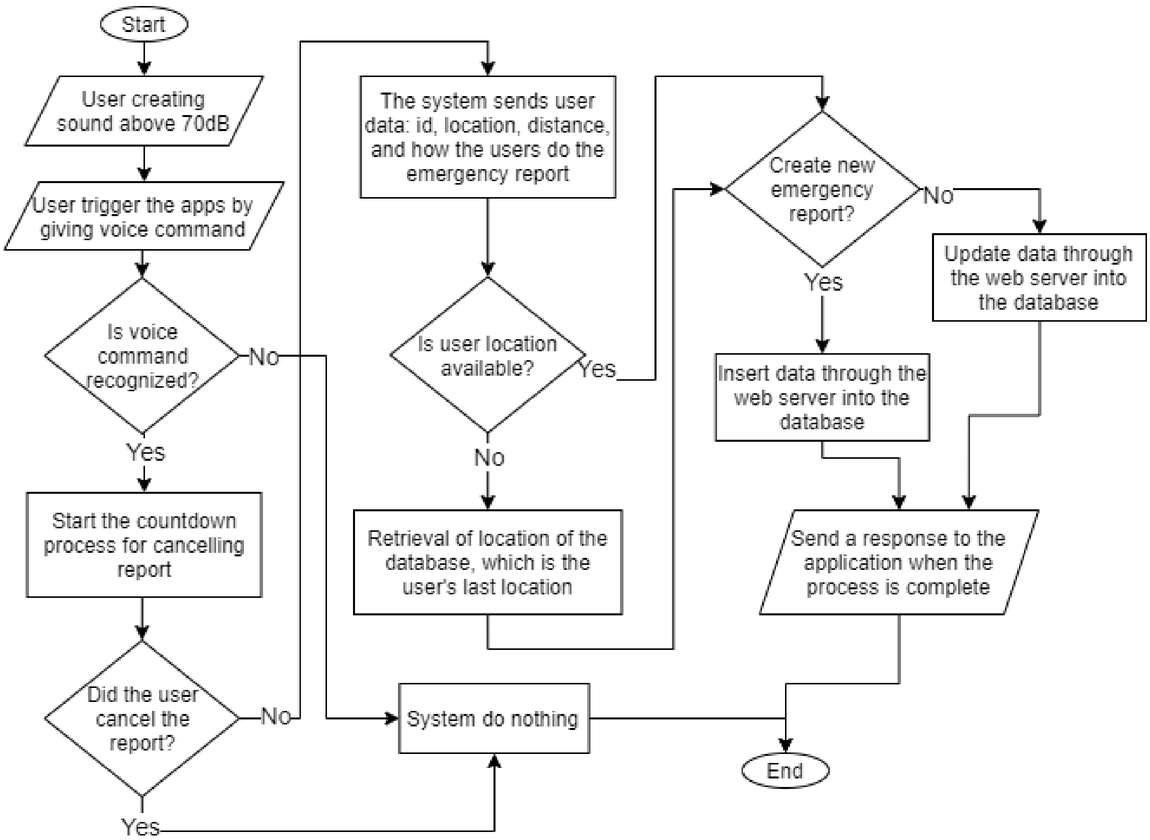


Figure 2.3: User Flow Diagram using voice commands, inspired by [37]

Another paper that benefited from the use of user flow diagrams is an article written by

Khan et al. about the development of an accident detection and rescue system [26]. The user flow diagram can be seen in figure 2.4. The small black circles indicate where the activity flow starts and ends. As seen in the user flow diagram, there are a number of different ways in which the flow of the system may end [26].

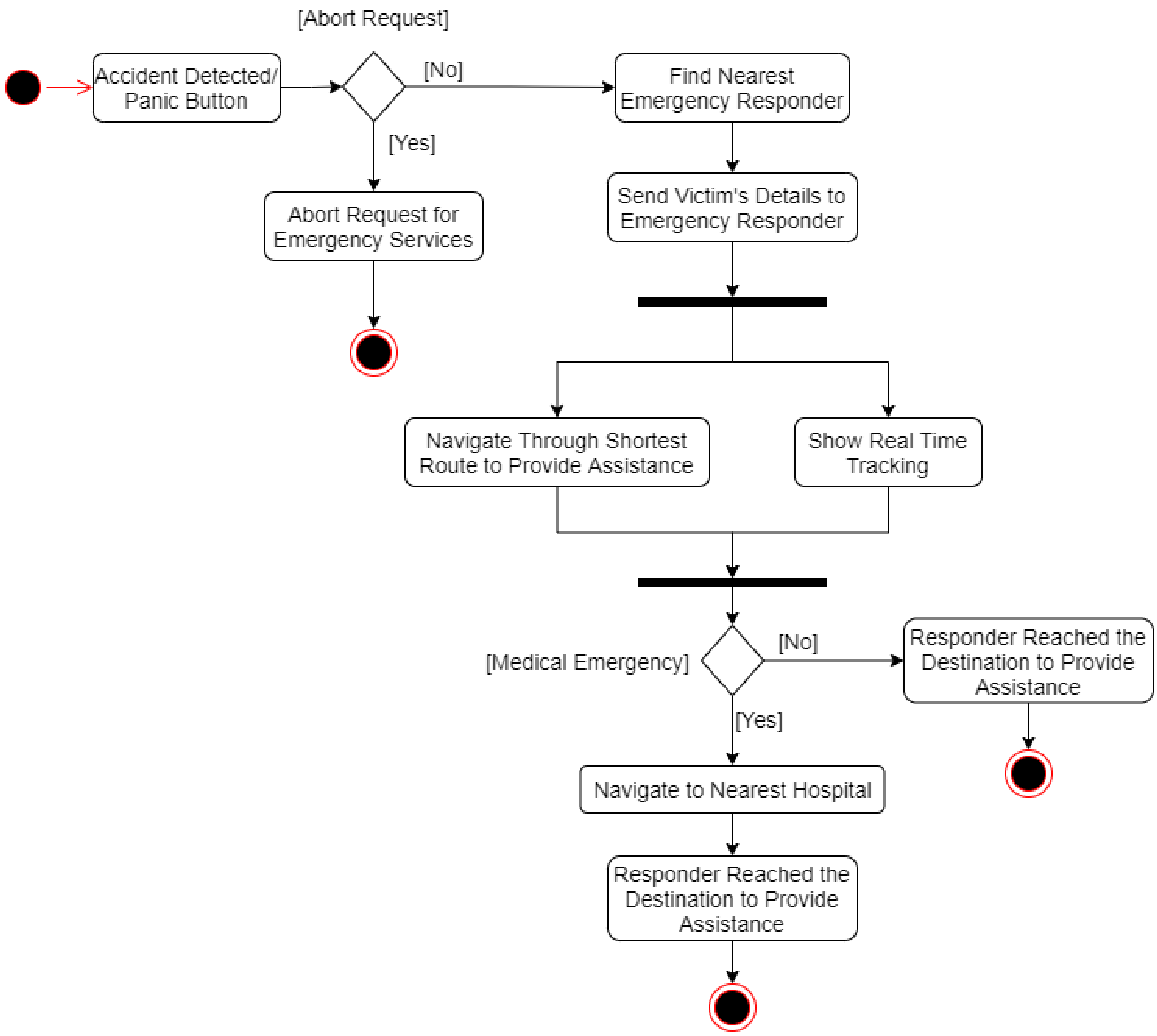


Figure 2.4: User Flow Diagram, inspired by [26]

2.3 Design Methods

Both practitioners and academic communities have advocated the fact that new emergency systems and approaches are long overdue [57]. The methods that are followed to design such emergency systems have a direct impact on their performance and are therefore important. In 2007, Bartel Van de Walle and Murray Turoff performed a literature review as part of an article about the emerging trends and technologies of emergency response information systems. This literature review unveiled the relevance of user-centered systemic approaches and emphasised the need of user requirements for the design of future emergency systems [57].

A prototype of a mobile application that allows users to make emergency calls using an

iconographic touch interface was created by Paredes et al. in 2013 [35]. The interface evaluation process of said prototype included 3 iterative phases: generic user evaluation, users with special needs evaluation, and operational evaluation [35]. During each of these phases, a number of generic requirements, user requirements and functional requirements were gathered respectively. Over 100 beta testers participated in these quantitative evaluation phases through which preliminary information for the refinement of the application was also collected. The validity of the presented approach was proven and was seen as very promising by all users. Later, qualitative information was collected through interviews with health professionals, emergency and security services, civil protection and deaf people to create the final prototype [35].
Similarly, in 2018, Suyoto et al. wrote an article [43] about the design of the Healthy Phone, which is a mobile medical emergency call application that can help people with hearing impairments in situations of emergency. The process of doing so was comprised of the following phases: planning the User Centered Design (UCD) process [25], understanding the context of use, specifying the user requirements, producing design solutions, and evaluating the design [43]. The results indicated that the process of designing a mobile application was successful with high user requirement fulfilment [43].
In 2017, Stepanova et al. wrote a paper [48] about gathering and applying guidelines for the development of robotic technology to be used during Urban Search and Rescue (USAR) operations, which allows exploring environments that are inaccessible or unsafe for a human team. The guidelines were derived from a literature review and a qualitative study which focused on usage scenarios and specific requirements for communication, control and user experience [48].
In May of 2020, Radianti et al. wrote a paper [39] about the process towards situational disability-aware universally designed information support systems for enhanced situational awareness. This paper's preferred design process included the identification of the demons of situational awareness (SA demons) in order to help understand what could happen to people in stressful situations. These SA demons included: attentional tunnelling, requisite memory trap, data overload issue, misplaced salience, complexity creep, errant mental model, out-of-the-loop syndrome, workload, fatigue and other stressors [39]. The situational disabilities of touch, vision, hearing, cognition, speech, movement and dexterity, which limit a person's abilities, were also identified [39]. The principles of Universal Design, together with the WCAG 2.1, were then used to provide invaluable input about the requirements and to mitigate the effects of the aforementioned SA demons and situational disabilities [39].
Based on recommendations from relevant literature and the writers' own experience with development projects, a number of best practices for efficient development of inclusive ICT were determined in a researched article. Some of these included [23]:

- Having a user needs analysis brainstorming session conducted by experts to collect user requirements.

- Prefer paper prototypes over web mockups and grid building tools due to efficiency and cost issues.

- Prepare multiple designs in a co-design phase.
- Let experts wipe out the most obvious usability and accessibility flaws before involving user groups.
- Design and test the user interface first, then complement it by the functionality of the underlying system.
- Make user trials as hands-on/realistic as possible.

Chapter 3

Methodology and Tools

This thesis follows the Design Science Research Methodology (DSRM) for information systems [36]. Additionally, it was decided to use the User Centered Design (UCD) process in order to involve users and focus on their needs during different phases of the design process [20]. Hereafter, this chapter will explain the DSRM process along with its stages, and mention the UCD in the stages it was applied to.

The DSRM process is composed of 6 stages. As seen in figure 3.1, the first stage is the *Problem identification and motivation*, which was explained in the introduction of this report, chapter 1. The second stage addresses the *Objectives of a solution*. The state-of-the-art (chapter 2), the current methodology chapter (chapter 3), the user needs assessment (chapter 4), and the requirements specification in chapter 5 explain the work within this stage. As part of this stage, a requirements analysis was performed in a user centered manner, following the selected UCD approach. The third stage is the *Design and Development*, which comprises the use cases, flow interaction and conceptual design in chapter 5. These show the interactions between an ICT-based tool and horseback riders. The fourth and fifth stages are the *Demonstration* and the *Evaluation*, which are presented in chapter 6. In this chapter, a high-fidelity prototype and the evaluation test results of an ICT-based tool are presented. These were developed in a user centered manner and as part of an iterative process guided by the principals of universal design. The prototype realizes a digital and clickable model of the tool, but is not fully functional. The information gathered through the requirements analysis in the second stage was also used to develop the design and prototypes in stage 3 and 4. The sixth and last stage is the *Communication*, which includes the documentation of the entire research process, in this case represented by this thesis report. The following sections will explain the methods and tools used in the aforementioned stages.

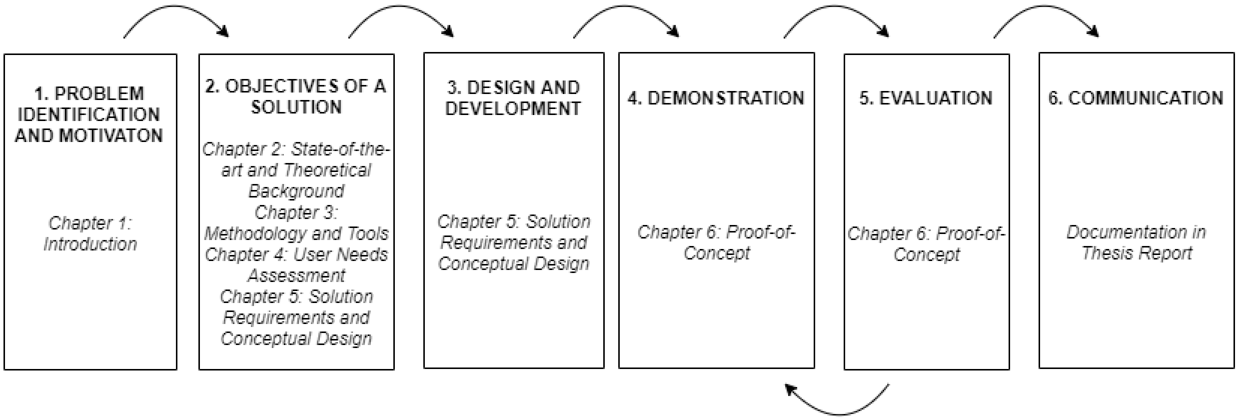


Figure 3.1: The DSRM that was adopted, inspired by [36]

As mentioned earlier, the design methodology chosen for the development of this project is the User Centered Design (UCD). Through UCD, the perspectives of the end users were considered in all steps of the problem-solving process. This way, knowledge of the end users directly influenced the solution design. These are the UCD activities undertaken in the development process of the project[25]:

1. Understanding and specifying the context of use.
2. Specifying the user requirements.
3. Producing design solutions.
4. Evaluating the design.

These activities were iterated where necessary.

3.1 Problem Identification and Motivation

As mentioned earlier, the Introduction (chapter 1) covers the results of this stage. The problem was firstly identified when the author of this thesis thought of researching existing technologies that could aid a horseback rider in emergency situations. More specifically, technologies that could aid an unconscious horseback rider, which is a highly dangerous situation that riders could find themselves in. Therefore, a systematic literature review was performed [45]. This review, which identified technologies that could recognize of loss of consciousness in adults, concluded that there are no technologies that can identify loss of consciousness without any external human involvement. When this discovery was made, the author of this thesis recognized that when a person is unconscious or in a situation of danger, ensuring the well being of that person should be prioritized, rather than diagnosing the rider. Thus, an emergency support solution for horseback riders that can help riders get the assistance they require in a timely fashion was thought of instead.

Additionally, the feedback obtained from the user research of this thesis showed that the problem is real and reoccurring. The fact that most horseback riders ride alone, are involved in severe accidents often, and tend to depend on a communication device that can easily get damaged to request assistance, proves that an emergency assistance solution for horseback riders is certainly needed.

3.2 Objectives of a Solution

During this stage, a few tools and methods were used for the literature review and the user research that were conducted.

3.2.1 Literature Research

The literature research presented in chapter 2, followed a protocol in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement guidelines. Firstly, the Population, Intervention, Comparison, and Outcome (PICO) framework was used to determine different aspects of the three research questions and to identify potential keywords of each aspect. Thereafter, the keywords were used to create search queries, which were later used on the search platform EBSCOhost to perform a search on several databases simultaneously. The number of obtained papers was equal to 382. After a process of screening and eligibility, the obtained papers and papers from the reference lists of such papers were reviewed. Finally, a total of 15 papers were selected for the final analysis of the state-of-the-art of this thesis.

3.2.2 User Research

The user research, which was performed in a user centered manner, was composed of two parts: (1) questionnaires and (2) semi-structured interviews. The two subsections in this section will describe these two parts in more detail.

Questionnaires

The first part of the user research of this thesis was composed of a questionnaire made up of 11 open- and closed-ended questions. The main purpose of the questionnaire was to gather quantitative data, with a few questions gathering qualitative answers as well. The questions involved topics such as whether horseback riders ride alone and the kind of communication devices that are commonly used by horseback riders and where they are stored. The obtained data helped gather support needs horseback riders might have in situations of potential emergency in order to identify requirements for the solution.

The online tool *SurveyXact*, which is a tool for creating questionnaire-based surveys [50] was used to create the questionnaire and store the results. The questionnaire was distributed through email and answered by 35 participants in order to collect data and opinions. The questionnaire questions can be found in appendix A. The prerequisites to be able to partake in the questionnaire were firstly for the participants to be experienced horseback riders, and secondly to have experienced at least one accident involving a horse before. The participants were selected from Facebook groups of horseback riders that frequent at local stables in the area of Kristiansand in Norway.

Semi-structured Interviews

The second part of the user research was composed of semi-structured interviews made up of 5 main topic questions as well as additional related questions that were asked if relevant. The main purpose of the interviews was to gather qualitative data. The questions involved topics such as previous horseback riding accidents that respondents might have been involved in, the kind of help they were in need of, and whether help was actually received. The obtained data helped gather support needs horseback riders might have in situations of potential emergency in order to identify requirements for the solution.

The interviews were undertaken with 7 participants. Due to the current situation with the COVID-19 pandemic, the necessary precautions were taken. Firstly, a number of participants were messaged through Facebook requesting for them to partake in the interviews. If accepted, a consent form containing information such as the nature of the questions, purpose, and how the data would be stored was sent to them through email. Once signed, the consent forms were then sent back through email. The signed consent forms of all 7 participants can be found in appendix B. Thereafter, the interviews were performed through phone and video calls while being audio recorded from the interviewer's end of the call. The prerequisites to be able to partake in the interviews were the same as for the questionnaires: the participants needed to be experienced horseback riders and to have experienced at least one accident involving a horse before. The participants were selected from those who had already answered the aforementioned questionnaires. Although a few interview questions were similar to those from the questionnaire, the participants were asked to elaborate their answers and to describe their accidents in detail. The following list shows the common questions that were asked together with the main topics that these related to:

1. **Whether there was an accident**
    - Have you ever been involved in a horseback riding accident? It could be an accident in which you, someone else or the horse was injured. It could also be any situation in which you needed help while horseback riding.
    - If yes, do you mind me asking a few questions about it?
2. **About the accident and the rider's state**
    - What kind of accident was it?
    - Did it involve a fall from the horse?
    - How were you feeling at that moment?
    - Were you physically injured or in need of help?

- Were you conscious the entire time?
- Were you able to stand on your feet after the accident?

3. **About the rider's resources**
   - Were you alone or in company?
   - Did you have your phone or any other communication/assistance device with you (such as smartwatch)?

4. **About the required help and the support tool**
   - What kind of help would you say you were most in need of?
   - What help did you end up getting/not getting?
   - Do you think you could have benefited from an electronic solution such as a smart-wristband?
   - If yes, what would you like the solution to communicate like?
   - Where do you think it should be positioned (horse, body, where...)?

5. **Further comments**
   - Do you have any more comments to add?

3.3 Design and Development

After the user research was performed and the user requirements were identified, the interaction flow that the system should follow was determined in order to answer the second research question. The software tool *Draw.io*, [13] for making diagrams and charts, was used to create the use case diagrams, the user flow diagrams and the swimlane activity diagram.

3.4 Demonstration

Finally, to answer the third research question of this thesis, high-fidelity digital prototypes of an ICT-based tool were developed. These were created in a user centered manner and as part of an iterative process guided by the principals of universal design. It was decided that the prototype would be a digital and clickable model of the tool, however would not be fully functional.
The software tool *Proto.io* [38] for creating digital and clickable prototypes was used to create both the first and second iteration of the system's prototypes. The second iteration of the prototype was designed with the use of the feedback received during the evaluation of the first iteration.
Design processes are often presented as iterative in order to continually improve a product [14]. By making a design process iterative, a series of steps are repeated, adjusting and improving the product with each cycle. In the case of this project, the UCD process

activities number three and four were iterated as seen in figure 3.2. Firstly, all UCD activities were fulfilled once, then, the results from the design evaluation (activity four) were used to adjust the prototype and produce a new design solution (activity three). Finally, the new design was evaluated once again. Thus, the design and evaluation were iterated twice.

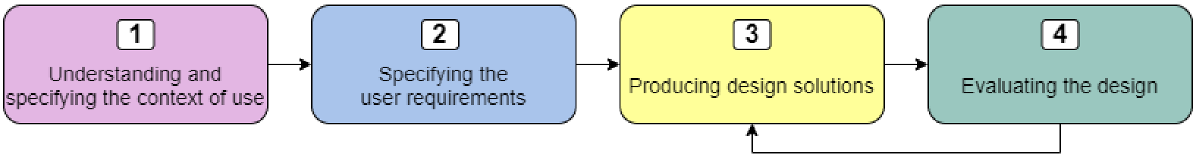


Figure 3.2: The iterative design process that was adopted

3.5 Evaluation

The prototypes were evaluated via the video conferencing tool *Zoom* [59]. This was done through audio and video calls while showing the prototypes to the participants through screen sharing, and allowing them to test the prototypes themselves through screen control sharing. The data collected during the evaluation of both iterations was stored with the use of the scandinavian online tool *SurveyXact* for online surveys [50].
In order to maximize usability, the evaluation of the design was executed by focusing on the seven principles of Universal Design. The seven principles are as follows [16]:

1. Equitable Use.
2. Flexibility in Use.
3. Simple and Intuitive Use.
4. Perceptible Information.
5. Tolerance for Error.
6. Low Physical Effort.
7. Size and Space for Approach and Use.

These principles attempt for the design to be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability.

3.6 Communication

Finally, the communication stage is represented by this thesis report, which was written with the use of the collaborative cloud-based LaTeX editor Overleaf [34].

Chapter 4

User Needs Assessment

The following sections will present the results that were obtained from the user research. The user research was divided into two parts. First, the questionnaire results will be shown together with the key findings, and then, the interview results will be explained.

4.1 Questionnaire Results

As mentioned in the previous chapter, the questionnaire was composed of 11 questions and answered by 35 experienced horseback riders. The results from the questionnaires will be presented in the following figures.
The first question of the questionnaire was "Do you usually horseback ride alone or in company?". As seen in figure 4.1, 57% of the participants horseback ride mostly alone, while 40% of them horseback ride around half of the time alone and the other half in company. Only one person out of the 35 participants answered that they mostly horseback ride in company.

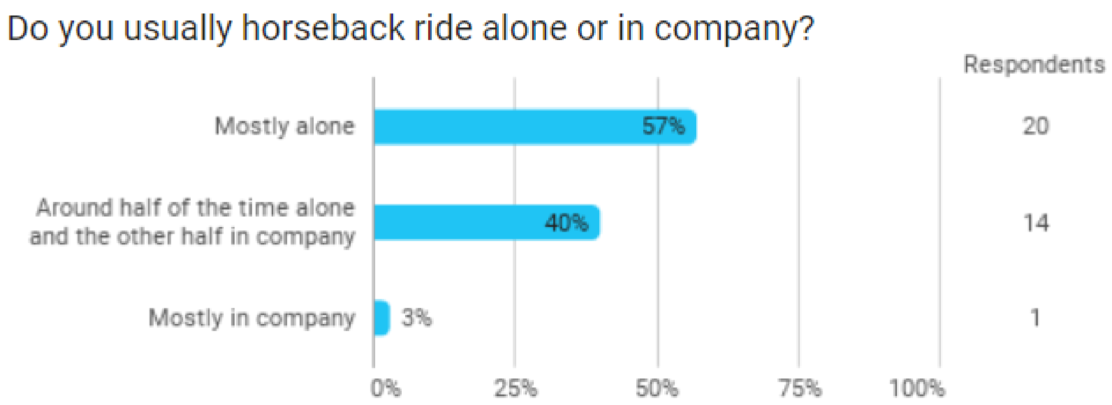


Figure 4.1: User research questionnaire, question 1

The second question of the questionnaire was "Do you usually take your phone or another communication/aiding device with you while you ride?". In this question, participants could select multiple answers. As shown in figure 4.2, 91% of the participants bring their mobile phone with them, 11% of them bring a smartwatch, 9% bring a fitness tracker, and 6% do not bring any communication/aiding devices with them when they ride.

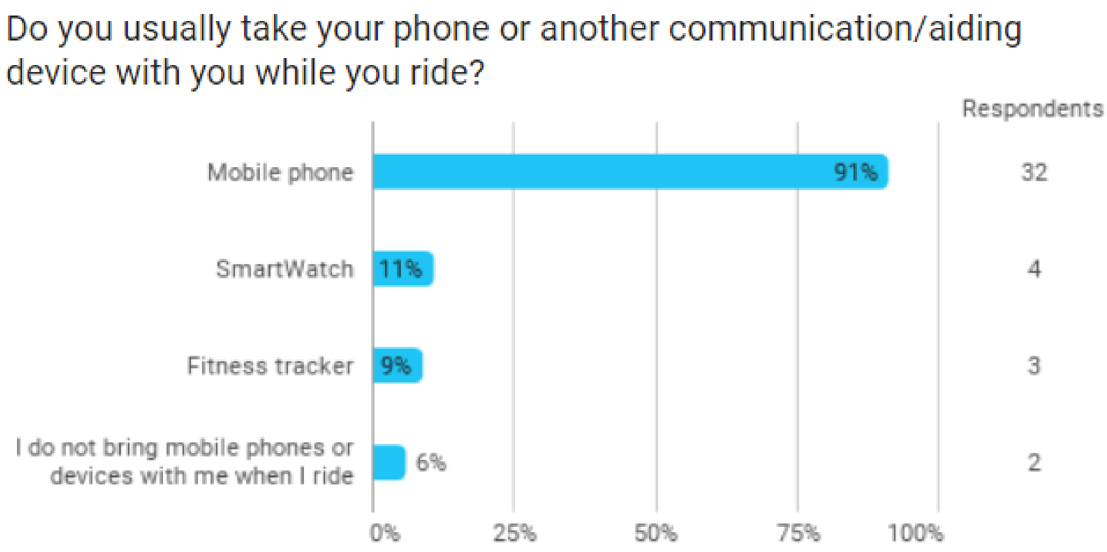


Figure 4.2: User research questionnaire, question 2

The third question of the questionnaire was a Likert scale question with the following 3 statements: "I use my mobile phone mainly for communication purposes", "I use my phone mainly for entertainment purposes", and "I use my phone mainly for functional purposes". Only those who had answered that they bring a mobile phone with them when they ride in question number 2 could see this question, which was 32 of the participants. The results of this question, which can be seen in figure 4.3 and figure 4.4 showed that most people use their mobile phones for communication and functional purposes when horseback riding, while some also use them for entertainment purposes.

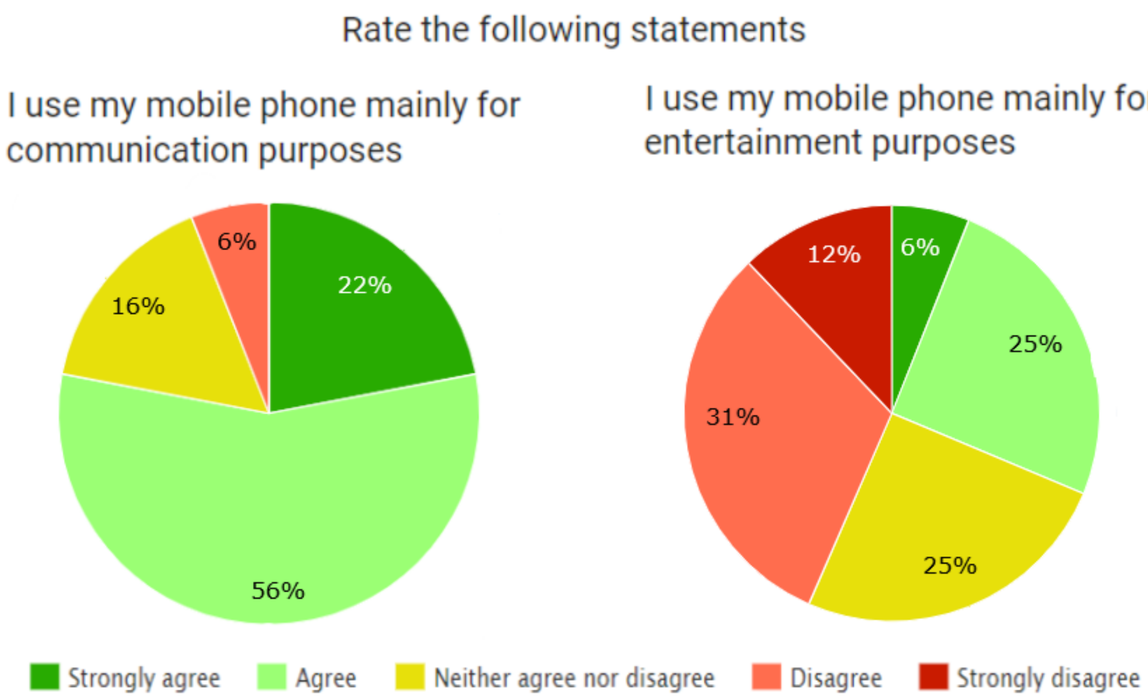


Figure 4.3: User research questionnaire, question 3 part 1 and 2

The fourth question of the questionnaire was "Where do you usually keep the phone/device(s)

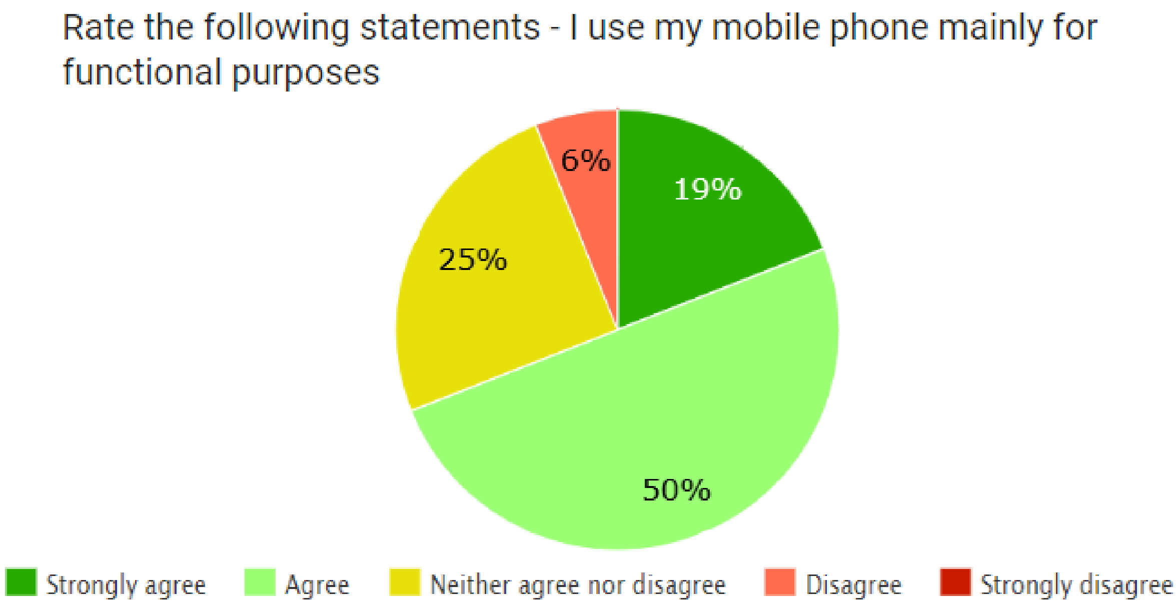


Figure 4.4: User research questionnaire, question 3 part 3

stored while you ride?". In contrast to question 3, those who had answered that they bring a mobile phone or another device with them when they ride in question number 2 could see this question, which was 33 of the participants. The results of this question, which can be seen in figure 4.5, showed that out of the 32 that bring their phones with them, 64% keep it in the pocket of their sweater/hoodie/t-shirt, 18% keep it in the pocket of their riding pants, and 15% keep it in their underwear (such as in the bra or tucked in the waistband of their riding pants/underwear). Additional answers that none of the participants selected and that are not included in the bar chart include: "in a fanny pack/separate bag that I take with me" and "in other places".

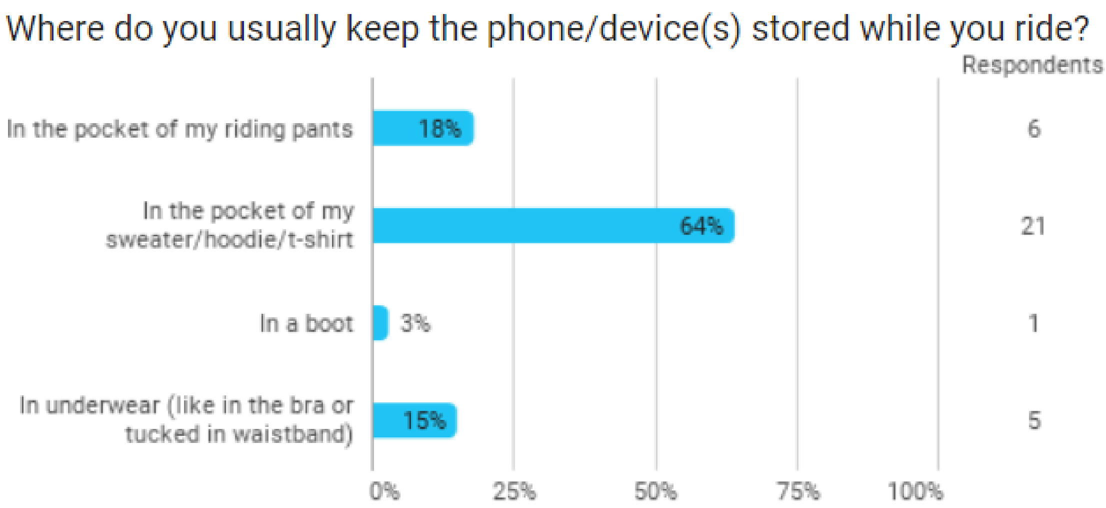


Figure 4.5: User research questionnaire, question 4

The fifth question of the questionnaire was another Likert scale question with the following 4 statements: "My phone/device(s) can easily get damaged in an accident when stored where I usually store it/them", "My phone/device(s) can easily fall out of the place where I keep it/them", "I can easily access my phone/device(s) from where I store it" and "In case of emergency, I would like to access my phone to get help". As with question 4, those who had answered that they bring a mobile phone or another device with them when they ride in question number 2 could see this question. The results of this question, which can be seen in figure 4.6 and figure 4.7 showed that most participants believe that their mobile phone can easily get damaged in an accident when stored where they usually store it, it cannot easily fall out of the place where it is usually kept, it can easily be accessed from where it is usually kept and that they would access their mobile phone to get help in case of an emergency.

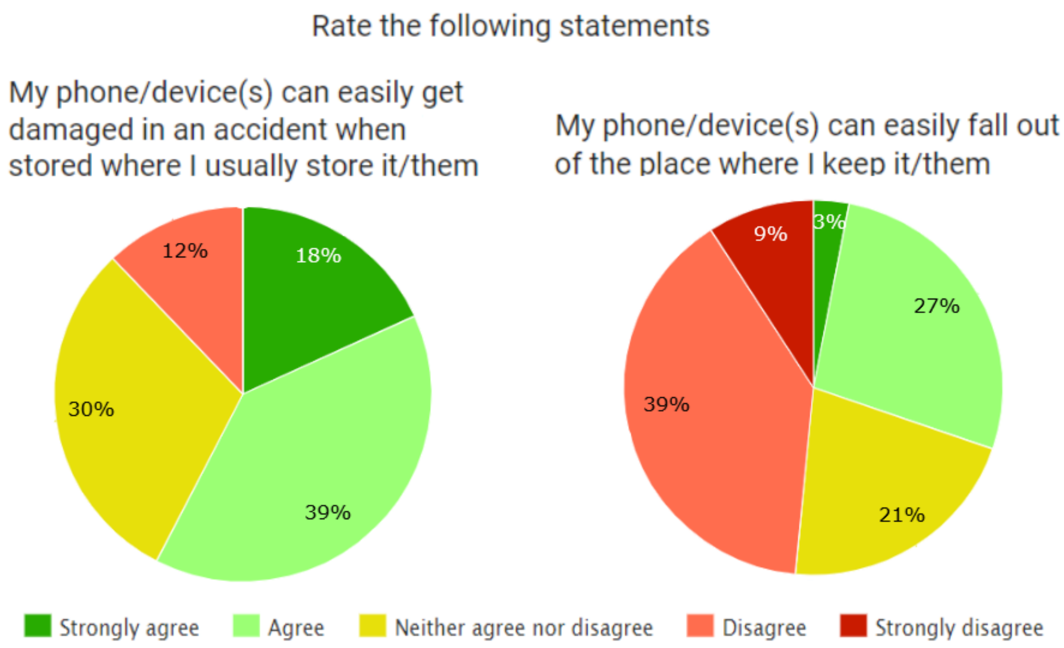


Figure 4.6: User research questionnaire, question 5 part 1 and 2

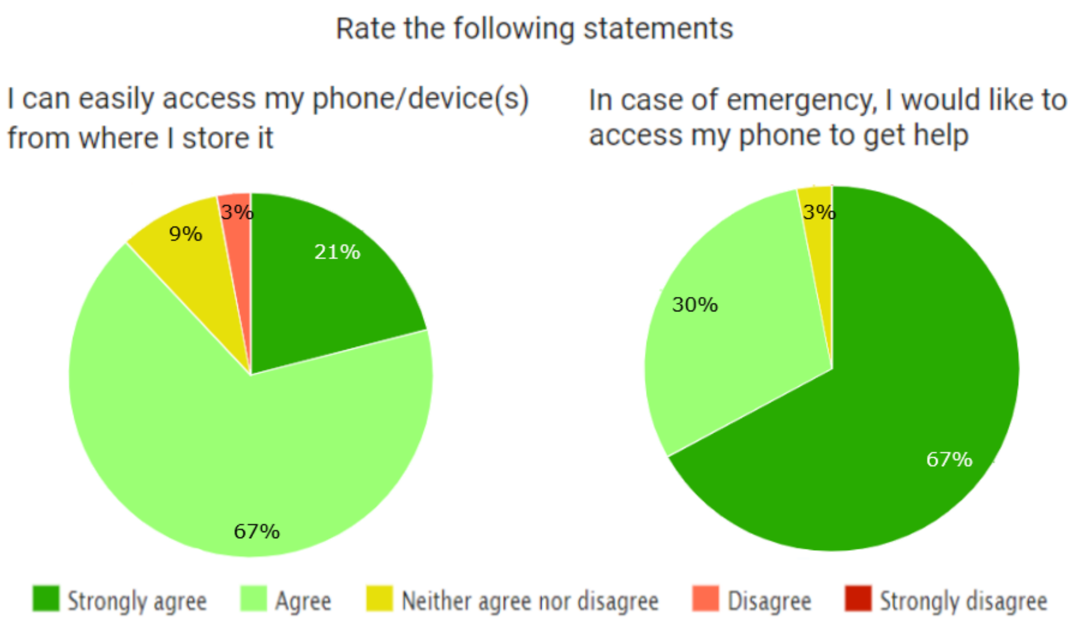


Figure 4.7: User research questionnaire, question 5 part 3 and 4

The sixth question of the questionnaire was "Have you ever had a horseback riding accident? It could be an accident in which you, someone else or the horse was injured. It could also be any situation in which you needed help while horseback riding". As seen in figure 4.8, 30 out of the 35 participants, i.e. 86% of them, have been involved in a horseback riding accident before, whereas 14% of them have not. After this question, those 5 participants that answered that they had not been involved in a horseback riding accident were then directed to the finish page where they were thanked for their participation. The remaining 30 participants were shown follow-up questions regarding the accident they had been involved in. If they had been involved in several accidents, the participants were encouraged to respond the to questions with their most severe accident in mind.

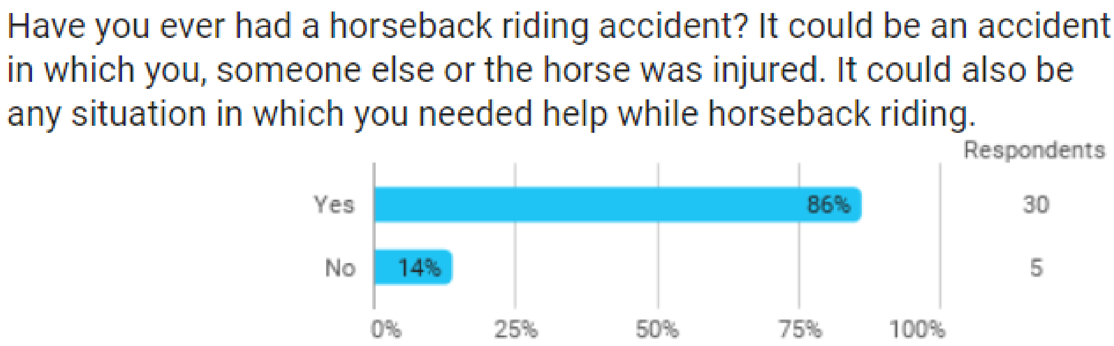


Figure 4.8: User research questionnaire, question 6

The seventh question of the questionnaire was "What was your physical state right after the accident?". In this question, participants could select multiple answers. As seen in figure 4.9, 30% were unharmed, 23% were physically injured in the head, 17% were physically injured in extremities, 17% were physically injured in another form and 13% were unconscious. Additionally, 3 participants answered with the option "other", in which they could specify other forms of injuries. These participants answered: "The horse was injured", "My arm got hit pretty badly", and "One time I had a mild concussion and another time a cut on my lip that needed four stitches".

The eighth question of the questionnaire was "How were you feeling after the accident?". This question had an open-text field for participants to write their answers in. The different types of answers and their frequency can be seen in figure 4.10. The most common answers include: hurt, dizzy/confused and scared.

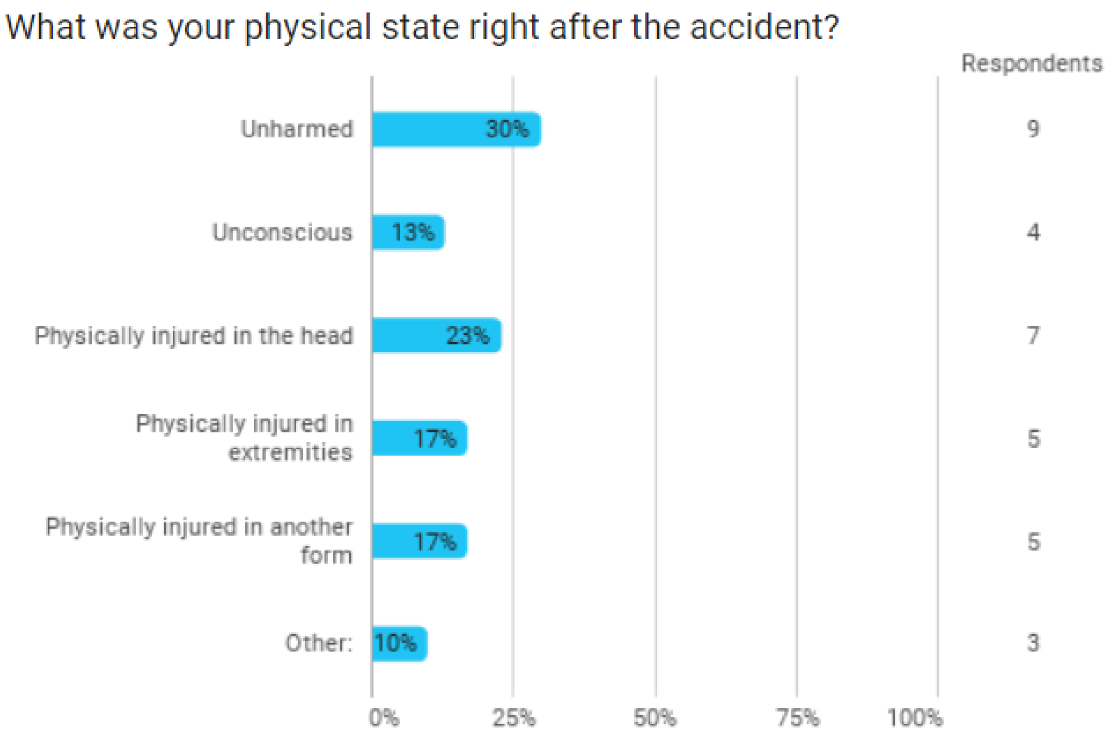


Figure 4.9: User research questionnaire, question 7

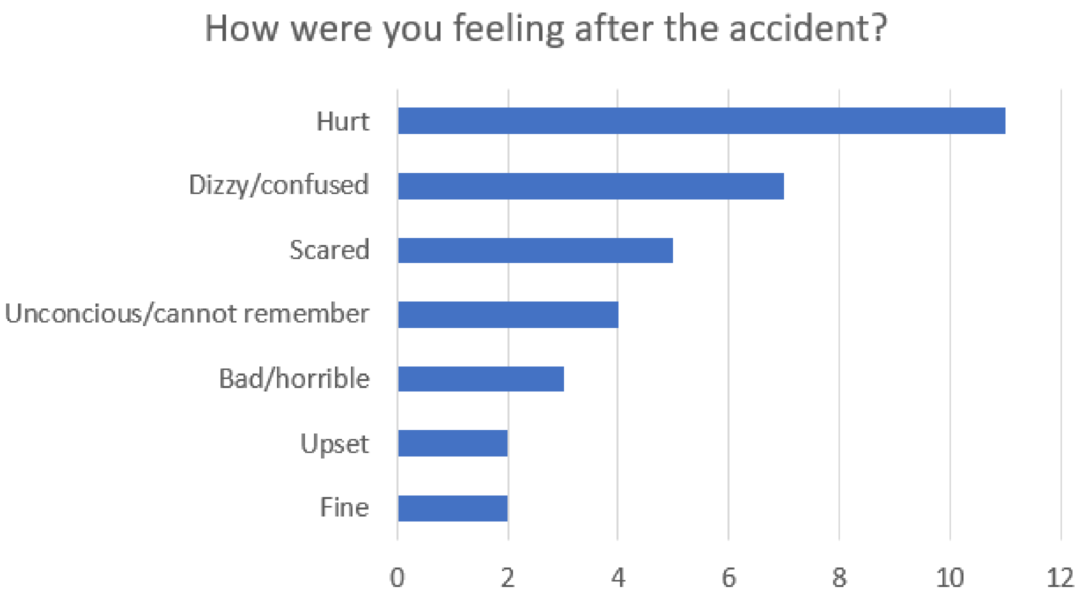


Figure 4.10: User research questionnaire, question 8

The ninth question of the questionnaire was "How did you request or try to request for help after the accident?". As seen in figure 4.11, out of the 30 participants who answered in question 6 that they had been involved in a horseback riding accident, 25 of them have requested for help after the accident. 40% of them requested the help personally, 37% of them were together with someone else who requested the help, and 7% of them requested the help in another way. None of the participants selected the response "help was needed but not requested due to inability to do so".

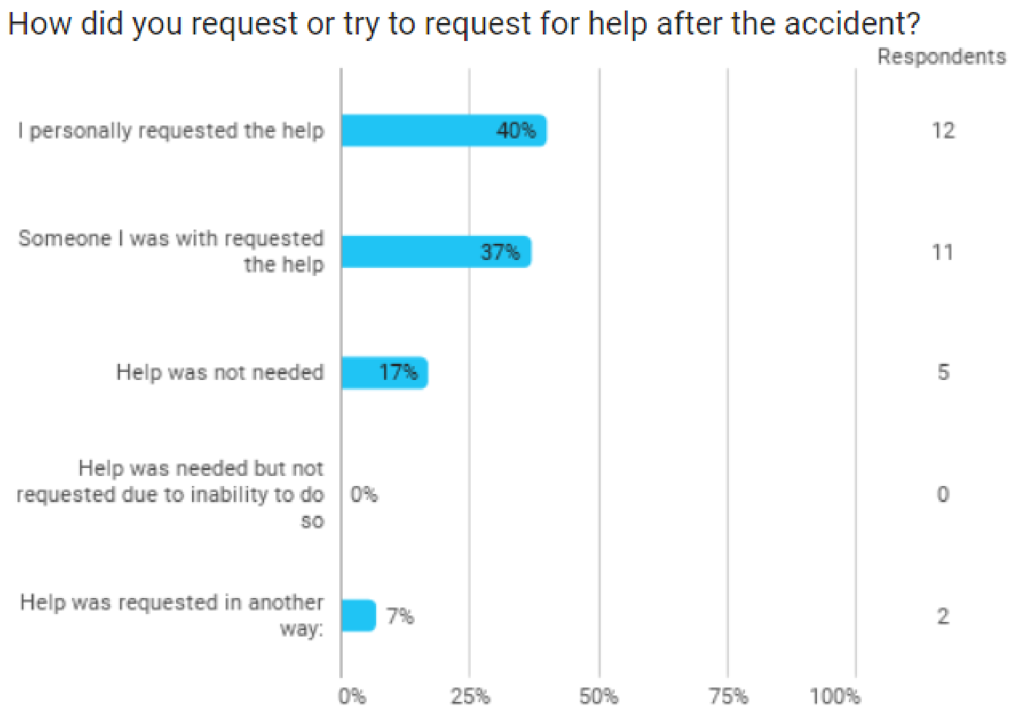


Figure 4.11: User research questionnaire, question 9

The tenth question of the questionnaire was "What kind of assistance were you provided with after the accident?". This question had an open-text field for participants to write their answers in, and could only be seen by those who answered that they had requested help in question 9. The different types of answers and their frequency can be seen in figure 4.12. The most common answers include: hospital/ambulance, none and parent/friends. Out of those 25 participants who had requested assistance, 11 went to the hospital or requested an ambulance, 3 went to the doctor's office, and 1 called the emergency veterinarian.

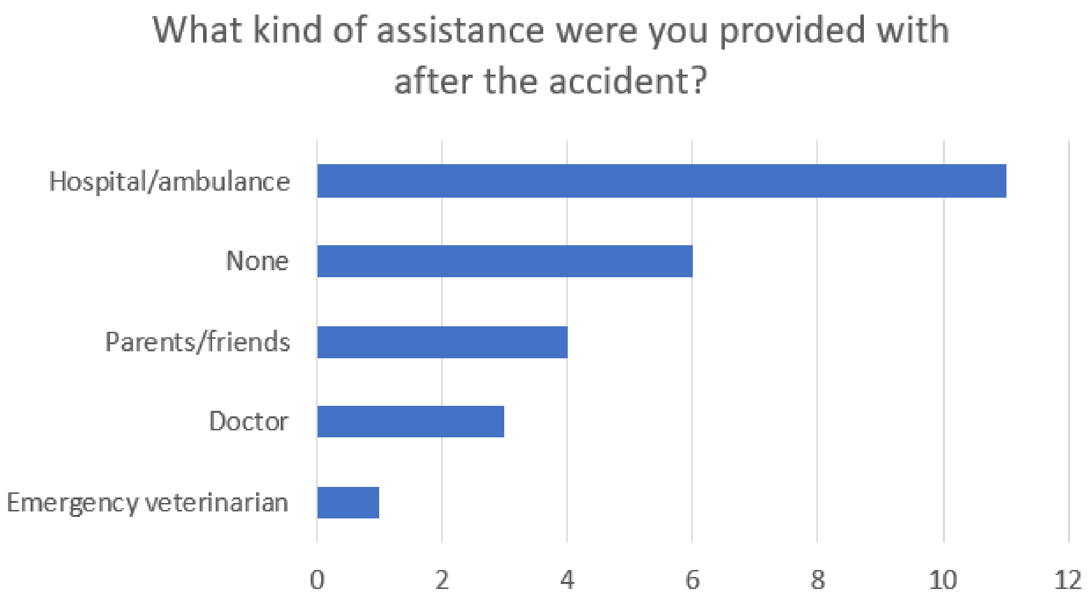


Figure 4.12: User research questionnaire, question 10

The eleventh and last question of the questionnaire was "How long (in minutes) did you have to wait before the assistance arrived?". The answers of this question were stored and the average waiting time was calculated. As seen in figure 4.13, horseback riders waited an average of 22.4 minutes until the requested assistance arrived.

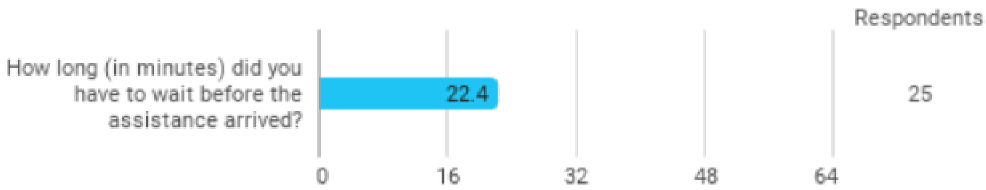


Figure 4.13: User research questionnaire, question 11

4.1.1 Questionnaire Key Learnings

Reasons for Development

From the data that was gathered through the questionnaires of the user research, a number of reasons for the development of an emergency support solution for horseback riders were identified.
Firstly, the fact that most horseback riders ride alone implies that in case of emergency, the rider might struggle to obtain help. When a rider rides on their own, it means that there is no other person who could request assistance if needed. Thus, requesting for help is left to the rider in the emergency situation who might be incapacitated to do so or even unconscious.
Secondly, nearly all horseback riders bring their mobile phones with them, however, most of them believe that their phones can easily get damaged in an accident. In case of an accident, if the rider's mobile phone is damaged, it is possible that the mobile phone can no longer be used to request assistance. Thus, relying on a device that can easily get damaged in an accident, might not be a safe option.
Thirdly, 30 out of the 35 participants that answered the questionnaires had been involved in a horseback riding accident before, 25 out of those 30 had to request help in such accidents, and 11 out of those 25 were brought to the hospital or requested an ambulance. The significant amount of riders that have been involved in accidents and that had to request for help indicates that accidents in which assistance is required are common among horseback riders. Given that these are frequently reoccurring events, it showed that there is a need for an emergency support solution for horseback riders and is therefore, another reason for development.
Fourthly, only 9 out of the 30 participants that were involved in accidents were not injured during their accidents, and even if horseback riders are not severely injured after an accident, according to the questionnaire, most of them felt dizzy, in pain and scared. It is not easy for an emergency support solution to remedy these feelings, however, if the riders had the reassurance that they had a system with them from which could request help if needed, this could provide some comfort.

Other Key Learnings

It was learned from the questionnaire results that horseback riders waited an average of 22.4 minutes before the requested assistance arrived. When severely injured or in a situation of emergency, waiting for 22.4 minutes can become a long time and potentially have a negative effect on the state of health of a rider. Therefore, it was decided that the main goal of the support system should be to make the assistance request process as fast as possible and to decrease waiting time.

On the one hand, it was learned that nearly all horseback riders bring their phones with them. Thus, because so many horseback riders see them as their main tool of communication, mobile phones could become the direct competitors of the emergency support solution proposed in this thesis. If it is expected that horseback riders stop bringing their mobile phones with them, the support solution should provide advantages that the mobile phones do not to horseback riders in situations of emergency. This means that the emergency support solution should ideally be as reliable, usable and effective as mobile phones are, while providing features suitable to horseback riders that mobile phones do not provide. Otherwise, experienced horseback riders may continue to rely on their mobile phones when horseback riding.

On the other hand, it was also learned that a lot of horseback riders use their phones for communication, entertainment and functional purposes while horseback riding. This could indicate a reason why horseback riders may still prefer to rely on their mobile phones while horseback riding, given that some use many of their mobile phones' additional features while riding.

4.2 Interview Results

The 7 interviewees that participated in the interviews were guaranteed anonymity in this thesis project, therefore, their identity will be kept anonymous. In the next paragraphs, the interview results will be summarized and divided by the topics mentioned in chapter 3.

1. Whether there was an accident

According to the results obtained, all horseback riders had been involved in at least one major accident, and most horseback riders had experienced multiple of them. None of the participants objected to answering questions about their accidents.

2. About the accident and the rider's state

The most common kind of accidents that the horseback riders had experienced were falls. Such falls were often the outcome of horses fighting each other, or horses getting scared of noises or movements such as those caused by traffic. A number of those falls led to their horse running away, their horse falling over them or their horse stepping on them.

A few riders had also experienced car accidents in which the horses were hit at low speed by cars and thereafter jumped on top of the cars. Car accidents while horseback riding were often caused by horses getting scared and running into traffic. Another rider also experienced getting stuck in a swamp with their horse.
The most common kind of injuries that were mentioned by the horseback riders are concussions, which often led to unconsciousness for periods of time ranging from 20 seconds to a few minutes. Other common injuries include broken bones, bruises, panic attacks and disorientation. Because most of them were severely injured, the majority of the riders had to request for help, with only a few of them being able to horseback ride back to the stable.

3. About the rider's resources

According to the results from the interviews, a few more accidents had occurred alone than in company. According to one of the interview participants:

> "Horseback riding both alone and in company has its downsides. Some accidents only occur when riding together with other riders and their horses, mostly due to the interactions among horses. When a horse gets scared, agitated or is feeling playful, that will affect the mood of the other horses, which can sometimes cause physical reactions or even conflicts between them. However, riding on one's own can be dangerous and can make requesting assistance hard in situations of emergency, especially if injured. Therefore, evaluating which is safest can sometimes be challenging."

4. About the required help and the support tool

A number of interviewees mentioned that requesting for help was at times challenging due to the lack of service in certain areas such as forests. For that reason, in order to request assistance after accidents, several riders had to either walk out of the forest to find mobile connectivity or walk to the nearest road to stop a car. This often caused assistance to be delayed. The kind of assistance that the riders were in need of included medical assistance (by doctor, ambulance or hospital), fire department assistance, help finding their horse and help getting home.
According to the interview participants, a common act among riders is to always think of the horse's well being first, and then the rider's. This mentality has often lead riders to worry about the whereabouts of the horse, and the assistance that the horse might be needing first, and postpone the assistance that the riders themselves might be in need of. When requesting assistance, the interviewees had different preferences for who to contact in situations of emergency. A few horseback riders would prefer to contact their parents while others would prefer to contact other riders belonging to the same stable. Additionally, some would rather contact an ambulance directly in case of a severe accident, whereas others would still rather contact a parent first.

All the interview participants agreed in that they could benefit from an electronic support solution for horseback riders, especially if this system provided the possibility of not having to depend on their phones in an emergency. This was a common opinion among riders due to several reasons: accessing a mobile phone is not always easy if it is safely stored, due to the cold in winter, mobile phones do not always function as expected, and their battery tends to run out, and during summer there are fewer options for storage as generally less clothing is worn.

Most participants suggested for the solution to be a wristband. Given that riders already wear gloves, the riders believed that a wristband would not create an added discomfort. However, a rider suggested for the solution to be an attachable that could be clipped on gear or clothing (such as boots or riding trousers), and another rider suggested for the system to be worn inside a small fanny pack around the stomach. In order to request assistance, a number of interviewees mentioned that the system should allow riders to contact predetermined contacts when manually triggered. Another suggestion was to be able to pair several wristbands belonging to people that are a part of the same stable if they all make use of the same system. This was suggested as a method for riders to help other riders that belong to the same horseback riding community. A few participants suggested that the support solution could produce loud noises while requesting assistance to attempt to wake up a potentially unconscious rider, and to warn people in the surroundings that the rider is in need of help. It was also suggested that the system could send the rider's location to their predetermined contacts when requesting assistance.

5. Further comments

As further comments, several participants mentioned the importance of keeping track of the horse's location in case it runs away after a fall. Most riders had often lost horses after accidents and claimed it was highly common. A participant once helped a close friend look for a horse that had gone missing for 3 days. To remedy this, a participant suggested to include a horse tracking system by clipping a small Global Positioning System (GPS) tracker on the horse's saddle. Two other participants also suggested for the solution to be waterproof due to that they had experienced accidents that involved water and heavy rain.

Chapter 5

Solution Requirements and Conceptual Design

This chapter will present the requirements specification and proposed solution. The solution requirements will be described first, and then, the use cases, flow interaction and conceptual design will be specified.

5.1 Requirements Specification

5.1.1 Requirements Rationale

All interview participants agreed in that falls are the most common kind of accidents that they have experienced. According to their interview answers, sometimes riders are able to request the assistance themselves. Therefore, a number of interviewees mentioned that the system should allow riders to request assistance when manually triggered. When asked about their state after the accidents, several of them mentioned that they had experienced concussions and unconsciousness which prevented them from requesting help after the fall. Therefore, it was decided that the emergency support solution should, apart from being able to request assistance when triggered manually by the rider, also automatically request assistance after a fall is detected.

The results from the fourth question showed that when requesting assistance, the interviewees had different preferences for who to contact in situations of emergency. Thus, it was decided that in order to allow each user to request assistance from the person that they personally wish to request assistance from, users should be allowed to establish a list of predetermined contacts to choose from. Given that some interviewees also mentioned that they would rather contact a parent instead of the emergency services even in severe accidents, it was decided that the rider should have the option of either choosing a contact from a predetermined contacts list or the emergency telephone number in an emergency. A number of interviewees also suggested that the system could send the rider's location to their predetermined contacts when requesting assistance. For that reason, it was decided that the system should keep track of the user's position at all times and be able to send it to the predetermined contacts when in a situation of emergency.

Another finding was that horseback riders often ride in forests and areas with no service. In fact, some interview participants had sometimes issues requesting assistance due to there being no service in their location. Thus, it was understood that in the same way that mobile phones can make emergency calls in areas of no network signal, the support solution should be able to perform emergency calls even in areas with no service.

Additionally, a number of valuable suggestions were made by the interview participants when asked about how they thought the emergency support solution should communicate. Given that so many horseback riders had experienced unconsciousness, it was decided that the system should produce alarm sounds while requesting assistance. This was decided as an attempt to trigger a response from a potentially unconscious rider after a fall is detected, and to warn people in the surroundings that the rider is in need of help. At this stage it was decided that the system should include two mechanisms: an assistance assessment mechanism and an assistance request mechanism. During the assistance assessment mechanism, the system should ask the rider whether assistance is required and from who, and during the assistance request mechanism, the system should make use of communication mediums to request assistance from the selected contact.

When asked about any further comments, several participants mentioned how highly common it is for horses to run away after a fall. Therefore, as a suggestion made by an few interview participants, it was decided that the mobile application's functionality should include horse tracking. This way riders would be aware of the horse's location and would be able to get the directions to that location.

Finally, insights about the type of device that could host the emergency support solution were considered. It was learned that horseback riders often go for walks out in the nature and that some riders had been involved in accidents that resulted in them getting wet. Thus, the system should be waterproof. Additionally, riders desired for the system to be small, comfortable and made out of strong materials that could endure rough falls from a horse. Therefore, it was decided that the device should be a small, robust and comfortable stand-alone wristband. It was decided on a wristband as the main device because of how accessible it would be in an emergency situation. Additionally, having the emergency support solution on the riders wrists seemed visible and comfortable to the interviewees, which is why most agreed that a wristband would be a good idea.

5.1.2 Requirements

From the user research that was performed, 15 requirements were identified. Out of those 15, 9 of them were functional requirements, while the remaining 6 were non-functional requirements. A summary of the requirements can be found in table 5.1. The full description of each requirement will be explained in the next subsections. The requirements will be presented by using the Volere Requirements Specification Template [55].

Nr	Type	Description
1	Functional requirement	The system shall contain an assistance assessment mechanism.
2	Functional requirement	The system shall contain an assistance request mechanism.
3	Functional requirement	The system shall track the horse's position at all times.
4	Functional requirement	The system shall track the user's position at all times.
5	Functional requirement	The system shall provide the user a way to establish predetermined contacts.
6	Functional requirement	The system shall produce alarm sounds if the user does not provide feedback after the assistance assessment mechanism is activated.
7	Functional requirement	The system shall be able to call/send text messages to the predetermined contacts and emergency services with the user's coordinates and an SOS message.
8	Functional requirement	The system shall activate its assistance assessment mechanism when holding in the two emergency buttons located on opposite sides of the wristband.
9	Functional requirement	The system shall activate its assistance assessment mechanism when a fall is detected by the system.
10	Reliability and availability requirement	The system shall be able to contact the emergency services even in locations with no service.
11	Speed and latency requirement	When the assistance assessment mechanism is activated, the system shall contact the emergency services in a fast manner if the user provides no feedback to the system.
12	Precision or accuracy requirement	The system shall produce loud, continuous alarm sounds if the user does not provide feedback after the assistance assessment mechanism is activated.
13	Expected physical environment requirement	The system shall be waterproof.
14	Appearance requirement	The system shall be integrated into a small device.
15	Appearance requirement	The system shall be integrated into a device which can be easily attached to the rider, horse or gear.

Table 5.1: User requirements

User Requirement 1

The first requirement that was identified is *the system shall contain an assistance assessment mechanism*. This is a functional requirement for the system to include a mechanism that asks the user whether assistance is needed and if yes, from who. The requirement will be achieved if the system successfully gathers feedback from the user about whether assistance is required and about whether the emergency services or a predetermined contact should be contacted. The Volere Requirements Specification Template for this requirement can be seen in figure 5.1.

Requirement #: 1 **Requirement Type:** 9 a **Event/BUC/PUC #:** 1

Description: The system shall contain an assistance assessment mechanism.

Rationale: To be able to ask the user whether assistance is needed and from who.

Originator: Anonymous interview subjects.

Fit Criterion: The system successfully asks whether the user is in need of assistance, and if so, whether it should contact the emergency services or a predetermined contact.

Customer Satisfaction: 5 **Customer Dissatisfaction:** 5

Dependencies: 2, 7, 9, 12 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.1: User requirement 1

User Requirement 2

The second requirement that was identified is *the system shall contain an assistance request mechanism*. This is a functional requirement for the system to include a mechanism that requests for help when the user is in need of it. The requirement will be achieved if the system successfully uses the information gathered through the assistance assessment mechanism (requirement 1) to contact the selected person through a medium of communication. The Volere Requirements Specification Template for this requirement can be seen in figure 5.2.

Requirement #: 2 **Requirement Type:** 9 a **Event/BUC/PUC #:** 1

Description: The system shall contain an assistance request mechanism.

Rationale: To be able to request for help when the user is in need of it.

Originator: Anonymous interview subjects.

Fit Criterion: The system successfully uses the information gathered through the assistance enquiry mechanism to contact predetermined contacts and/or emergency services.

Customer Satisfaction: 5 **Customer Dissatisfaction:** 5

Dependencies: 4, 7, 11, 12 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.2: User requirement 2

User Requirement 3

The third requirement that was identified is *the system shall track the horse's position at all times*. This is a functional requirement for the system to provide information about the horse's location at any given moment. The requirement will be achieved if the system successfully displays the horse's coordinates to the user and updates them at least every 5 seconds. The Volere Requirements Specification Template for this requirement can be seen in figure 5.3.

Requirement #: 3 **Requirement Type:** 9 a **Event/BUC/PUC #:** 1

Description: The system shall track the horse's position at all times.

Rationale: So that the user, or others, know where the horse is if for example it runs away after a fall.

Originator: Anonymous interview subjects.

Fit Criterion: The system holds the horse's coordinates and updates them at least every 5 seconds.

Customer Satisfaction: 4 **Customer Dissatisfaction:** 2

Dependencies: NA **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.3: User requirement 3

User Requirement 4

The fourth requirement that was identified is *the system shall track the user's position at all times*. This is a functional requirement for the system to hold information about the user's location so that it can be sent during the assistance request mechanism. The requirement will be achieved if the system successfully stores the user's coordinates to the user and updates them at least every 5 seconds. The Volere Requirements Specification Template for this requirement can be seen in figure 5.4.

Requirement #: 4 **Requirement Type:** 9 a **Event/BUC/PUC #:** 1

Description: The system shall track the user's position at all times.

Rationale: So that the system is able to send the user's current position during the assistance request mechanism.

Originator: Anonymous interview subjects.

Fit Criterion: The system holds the user's coordinates and updates them at least every 5 seconds.

Customer Satisfaction: 5 **Customer Dissatisfaction:** 5

Dependencies: 2, 8, 11, 12 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.4: User requirement 4

User Requirement 5

The fifth requirement that was identified is *the system shall provide the user a way to establish predetermined contacts*. This is a functional requirement for the system so that the user is able to establish a few contact possibilities that the user will be able to choose from in an emergency. The requirement will be achieved if the system successfully displays an interface which allows the user to choose a maximum of 5 contacts and stores them as predetermined contacts. The Volere Requirements Specification Template for this requirement can be seen in figure 5.5.

Requirement #: 5 **Requirement Type:** 9 a **Event/BUC/PUC #:** 1

Description: The system shall provide the user a way to establish predetermined contacts.

Rationale: So that the user is able to establish who they would like to notify in case of emergency.

Originator: Anonymous questionnaire subjects.

Fit Criterion: The system displays an interface which allows the user to choose a maximum of 5 contacts and stores them as predetermined contacts.

Customer Satisfaction: 4 **Customer Dissatisfaction:** 3

Dependencies: 1, 7 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.5: User requirement 5

User Requirement 6

The sixth requirement that was identified is *the system shall produce alarm sounds if the user does not provide feedback after the assistance assessment mechanism is activated.* This is a functional requirement for the system to attempt to trigger a response from a user that could potentially be unconscious. The requirement will be achieved if the system successfully produces alarm sounds while the assistance assessment mechanism is activated, which is while the system asks the user whether assistance is required and if yes, from who. The Volere Requirements Specification Template for this requirement can be seen in figure 5.6.

Requirement #: 6 **Requirement Type:** 9 a **Event/BUC/PUC #:** 1

Description: The system shall produce alarm sounds if the user does not provide feedback after the assistance assessment mechanism is activated.

Rationale: To try to wake up a user that could potentially be unconscious.

Originator: Anonymous interview subjects.

Fit Criterion: The system successfully produces alarm sounds if the user does not provide feedback while the assistance assessment mechanism is activated.

Customer Satisfaction: 4 **Customer Dissatisfaction:** 2

Dependencies: 1 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.6: User requirement 6

User Requirement 7

The seventh requirement that was identified is *the system shall be able to call/send text messages to the predetermined contacts and emergency services with the user's coordinates and an SOS message*. This is a functional requirement for the system to request help through two communication mediums and by sending essential information to locate the user in case of emergency. The requirement will be achieved if the system successfully calls/sends text messages to the chosen subject, which may be a predetermined contact or the emergency services, and sends the user coordinates together with an SOS message. The Volere Requirements Specification Template for this requirement can be seen in figure 5.7.

Requirement #: 7 **Requirement Type:** 9 a **Event/BUC/PUC #:** 1

Description: The system shall be able to call/send text messages to the predetermined contacts and emergency services with the user's coordinates and an SOS message.

Rationale: So that the system is able to request for assistance in numerous ways and by providing essential information to locate the user in case of emergency.

Originator: Anonymous interview subjects.

Fit Criterion: The system successfully calls/sends text messages to the chosen subject (predetermined contacts and/or emergency services) with the user's coordinates and an SOS message.

Customer Satisfaction: 5 **Customer Dissatisfaction:** 5

Dependencies: 1, 2, 4, 5, 8 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.7: User requirement 7

User Requirement 8

The eighth requirement that was identified is *the system shall activate its assistance assessment mechanism when holding in the two emergency buttons located on opposite sides of the wristband.* This is a functional requirement for the user to be able to manually trigger the system. The requirement will be achieved if the system successfully activates the assistance assessment phase on the 4th second holding the two emergency buttons in. The Volere Requirements Specification Template for this requirement can be seen in figure 5.8.

Requirement #: 8 **Requirement Type:** 9 a **Event/BUC/PUC #:** 1

Description: The system shall activate its assistance assessment mechanism when holding in the two emergency buttons located on opposite sides of the wristband.

Rationale: So that the system can be manually triggered by the user.

Originator: Anonymous questionnaire subjects.

Fit Criterion: The system successfully activates the assistance assessment mechanism on the 4th second of holding the two emergency buttons in.

Customer Satisfaction: 4 **Customer Dissatisfaction:** 3

Dependencies: 1 **Conflicts:** NA

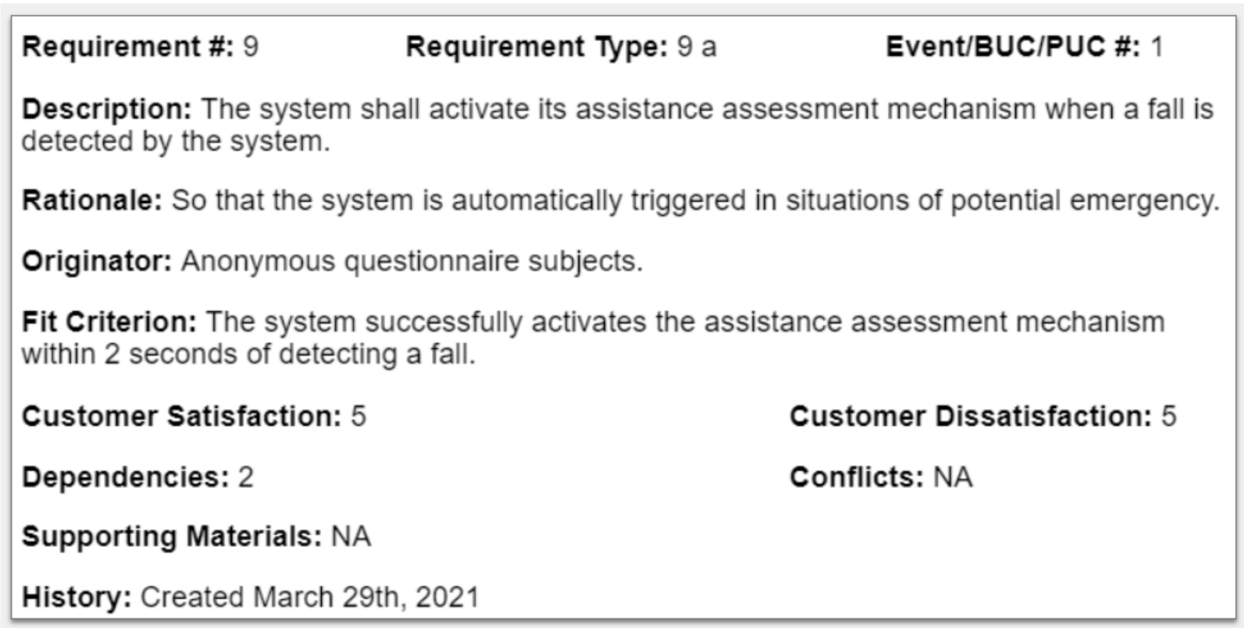
Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.8: User requirement 8

User Requirement 9

The ninth requirement that was identified is *the system shall activate its assistance assessment mechanism when a fall is detected by the system*. This is a functional requirement for the system to be automatically triggered in case of a fall. The requirement will be achieved if the system successfully activates the assistance request mechanism within 2 seconds of detecting a fall. The Volere Requirements Specification Template for this requirement can be seen in figure 5.9.



Requirement #: 9 **Requirement Type:** 9 a **Event/BUC/PUC #:** 1

Description: The system shall activate its assistance assessment mechanism when a fall is detected by the system.

Rationale: So that the system is automatically triggered in situations of potential emergency.

Originator: Anonymous questionnaire subjects.

Fit Criterion: The system successfully activates the assistance assessment mechanism within 2 seconds of detecting a fall.

Customer Satisfaction: 5 **Customer Dissatisfaction:** 5

Dependencies: 2 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.9: User requirement 9

User Requirement 10

Requirement #: 10 **Requirement Type:** 12 d **Event/BUC/PUC #:** 1

Description: The system shall be able to contact the emergency services even in locations with no service.

Rationale: So that the system is able to request assistance even in areas with no service like deep in forests or mountains.

Originator: Anonymous interview subjects.

Fit Criterion: The system successfully connects to the strongest network that it can find to allow for emergency calls/text messages to go through even where there is no service.

Customer Satisfaction: 5 **Customer Dissatisfaction:** 4

Dependencies: 7 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.10: User requirement 10

The tenth requirement that was identified is *the system shall be able to contact the emergency services even in locations with no service.* This is a performance requirement, more specifically, a reliability and availability requirement, for the system to be able to request assistance even in areas with no service like deep in forests or mountains. The requirement will be achieved if the system is able to successfully establish a connection with the strongest network that it can find so that emergency calls/text messages can get through even where there is no service. The Volere Requirements Specification Template for this requirement can be seen in figure 5.10.

User Requirement 11

The eleventh requirement that was identified is *when the assistance assessment mechanism is activated, the system shall contact the emergency services in a fast manner if the user provides no feedback to the system.* This is a performance requirement, more specifically, a speed and latency requirement, for the system to immediately request assistance in situations where the user is potentially incapacitated, such as unconscious. The requirement will be achieved if the system is able to successfully contact the emergency services after 30 seconds if the user provides no feedback to the system. The Volere Requirements Specification Template for this requirement can be seen in figure 5.11.

Requirement #: 11 **Requirement Type:** 12 a **Event/BUC/PUC #:** 1

Description: When the assistance assessment mechanism is activated, the system shall contact the emergency services in a fast manner if the user provides no feedback to the system.

Rationale: So that the system immediately requests assistance in situations where the user is potentially incapacitated.

Originator: Sandra Ackermann Gutierrez, Development Engineer.

Fit Criterion: The system shall contact the emergency services after 30 seconds if the user provides no feedback to the system.

Customer Satisfaction: 5 **Customer Dissatisfaction:** 5

Dependencies: 2, 7, 8 **Conflicts:** NA

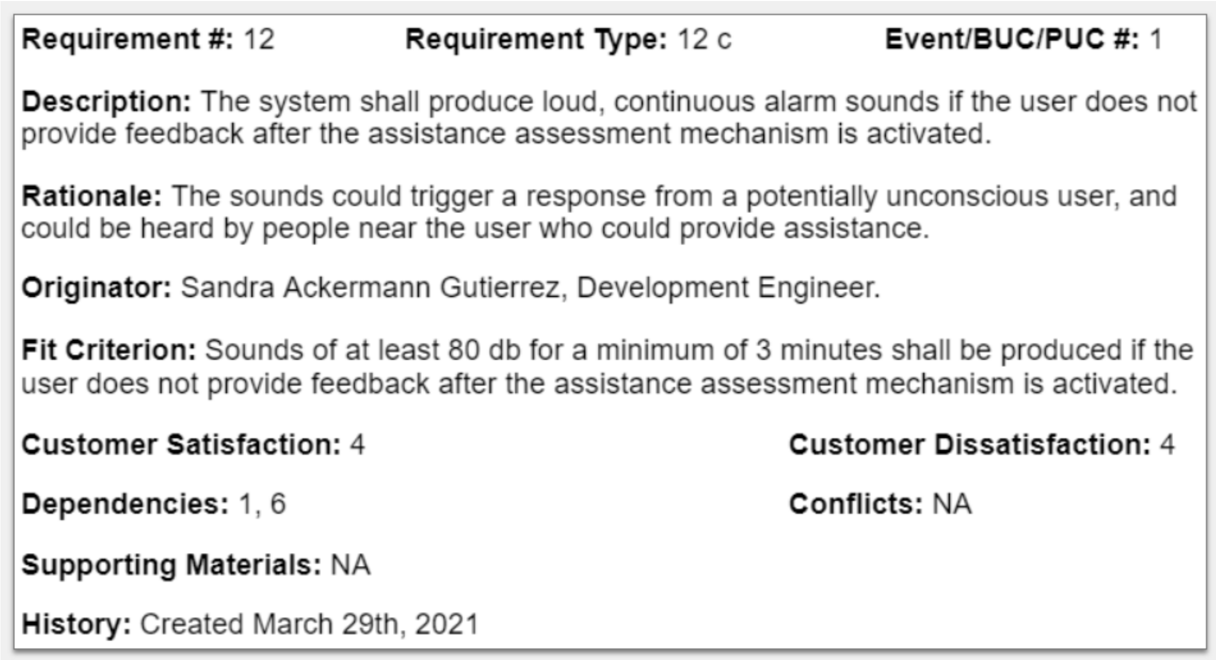
Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.11: User requirement 11

User Requirement 12

The twelfth requirement that was identified is *the system shall produce loud, continuous alarm sounds if the user does not provide feedback after the assistance assessment mechanism is activated.* This is a performance requirement, more specifically, a precision or accuracy requirement, for system to produce sounds that could trigger a response from a potentially unconscious user, and that could be heard by people near the user who could provide assistance. The requirement will be achieved if the system is able to successfully produce sounds of at least 80 db for a minimum of 3 minutes, given that the user does not provide feedback after the assistance assessment mechanism is activated. The Volere Requirements Specification Template for this requirement can be seen in figure 5.12.



Requirement #: 12 **Requirement Type:** 12 c **Event/BUC/PUC #:** 1

Description: The system shall produce loud, continuous alarm sounds if the user does not provide feedback after the assistance assessment mechanism is activated.

Rationale: The sounds could trigger a response from a potentially unconscious user, and could be heard by people near the user who could provide assistance.

Originator: Sandra Ackermann Gutierrez, Development Engineer.

Fit Criterion: Sounds of at least 80 db for a minimum of 3 minutes shall be produced if the user does not provide feedback after the assistance assessment mechanism is activated.

Customer Satisfaction: 4 **Customer Dissatisfaction:** 4

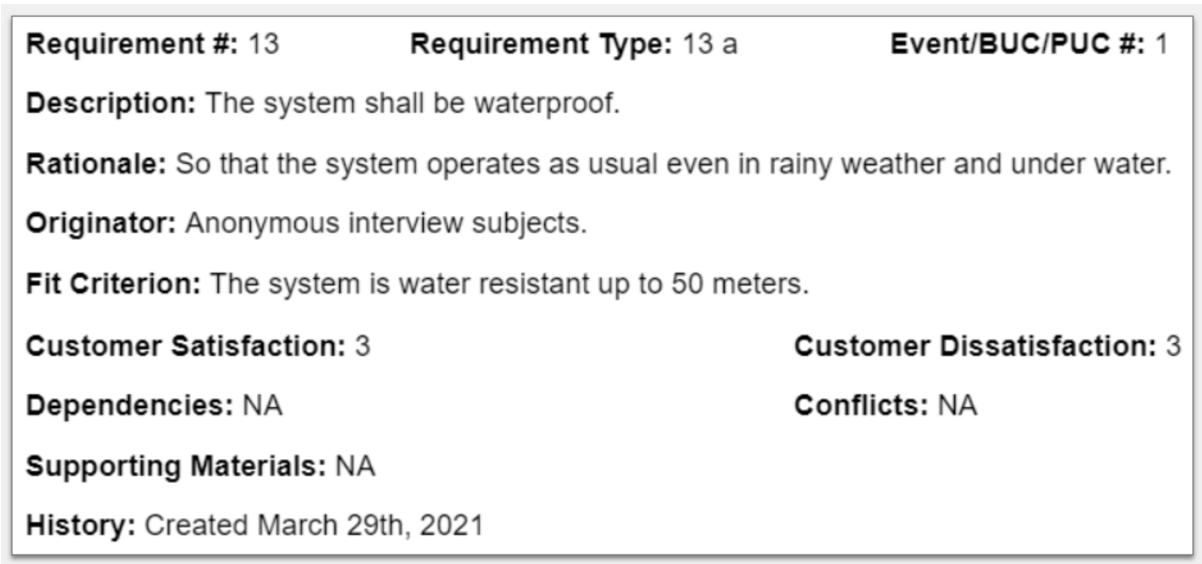
Dependencies: 1, 6 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.12: User requirement 12

User Requirement 13



Requirement #: 13 **Requirement Type:** 13 a **Event/BUC/PUC #:** 1

Description: The system shall be waterproof.

Rationale: So that the system operates as usual even in rainy weather and under water.

Originator: Anonymous interview subjects.

Fit Criterion: The system is water resistant up to 50 meters.

Customer Satisfaction: 3 **Customer Dissatisfaction:** 3

Dependencies: NA **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.13: User requirement 13

The thirteenth requirement that was identified is *the system shall be waterproof*. This is a operational and environmental requirement, more specifically, an expected physical environment requirement, for the system to guarantee to operate as expected even in rainy weather and under water. The requirement will be achieved if the system is water resistant up to 50 meters. The Volere Requirements Specification Template for this requirement can be seen in figure 5.13.

User Requirement 14

The fourteenth requirement that was identified is *The system shall be integrated into a small device*. This is a look and feel requirement and environmental requirement, more specifically, an appearance requirement, for the system to be easy to carry when horseback riding. The requirement will be achieved if the system is integrated into a device smaller in size than a mobile phone. The Volere Requirements Specification Template for this requirement can be seen in figure 5.14.

Requirement #: 14 **Requirement Type:** 10 a **Event/BUC/PUC #:** 1

Description: The system shall be integrated into a small device.

Rationale: So that the system is easy to carry when horseback riding.

Originator: Anonymous questionnaires subjects.

Fit Criterion: The device shall be smaller in size than a mobile phone.

Customer Satisfaction: 5 **Customer Dissatisfaction:** 5

Dependencies: 15 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.14: User requirement 14

User Requirement 15

Requirement #: 15 **Requirement Type:** 10 a **Event/BUC/PUC #:** 1

Description: The system shall be integrated into a device which can be easily attached to the rider, horse or gear.

Rationale: So that the system can be easily carried and not lost.

Originator: Anonymous interview subjects.

Fit Criterion: The device is attached and lost less than 1% of the time.

Customer Satisfaction: 4 **Customer Dissatisfaction:** 5

Dependencies: 14 **Conflicts:** NA

Supporting Materials: NA

History: Created March 29th, 2021

Figure 5.15: User requirement 15

The fifteenth requirement that was identified is *the system shall be integrated into a device which can be easily attached to the rider, horse or gear*. This is a look and feel requirement, more specifically, an appearance requirement, for the system to be easily carried and not lost. The requirement will be achieved if the system is integrated into a device that can be attached and lost less than 1% of the time that is tested. The Volere Requirements Specification Template for this requirement can be seen in figure 5.15.

5.2 Use Cases

Given the results gathered during the user research, it was decided that the system would be made up of an assistance assessment and request stand-alone smart-wristband, a management mobile application and a clip-on GPS tracker. The wristband was designed for the rider to request assistance in emergency situations, the mobile application was to manage predetermined contacts and other settings, and the clip-on GPS tracker could be attached to the horse's gear (such as on the horse's saddle) so that the rider can track the horse's position if it runs away. The knowledge gathered through the questionnaires and interviews was then used to establish the functionality of the smart-wristband and mobile application. The functionalities of the wristband and mobile application are shown in the Unified Modeling Language (UML) [53] version 2 use cases in figure 5.16 and 5.17 respectively.

Figure 5.16 shows the use case of the smart-wristband. Requesting assistance through the wristband can be achieved in two ways: through a fall detection mechanism and by manually pressing the two emergency buttons located on opposite sides of the wristband for 4 seconds. Once the wristband is active, the user can then either confirm or deny the assistance need. If the need of assistance is confirmed, the user will then be able to choose who to request it from. If the need of assistance is denied, the wristband will return to an idle state.

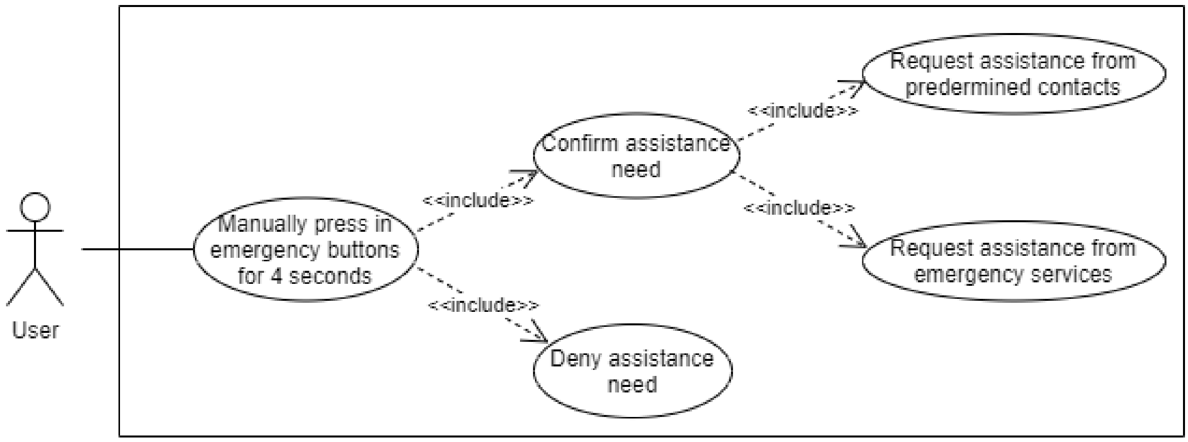


Figure 5.16: Use case of wristband

Figure 5.17 shows the use case of the mobile application. Once the rider has signed up and logged into the mobile application, the user will then be able to pair the application with the smart-wristband, see the predetermined contacts, see the horse's location and see their own profile. From the predetermined contacts list the user is able to create, edit and delete contacts saved in that list. From the profile page the user is able to edit their personal information which is sent to contacts in emergency cases.

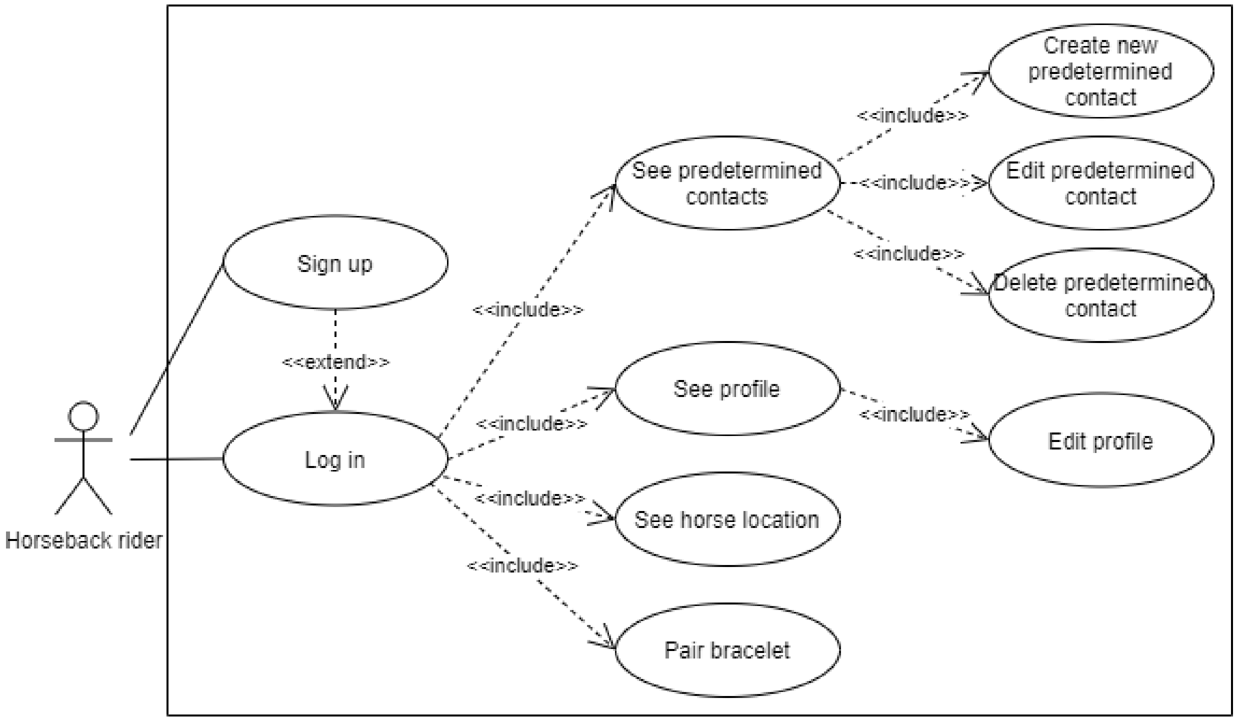


Figure 5.17: Use case of mobile application

5.3 User Flow Diagram

To determine the interaction flow that the system should follow and answer the second research question of this thesis, the user flow diagram of the designed wristband shown in figure 5.18 was created. As mentioned in chapter 2, the rounded rectangles mark the start and end of the user flow, the rectangles indicate actions, the rhombuses indicate decisions, and the arrows indicate the direction of the flow. The colors green, yellow and red indicate the state that the wristband is in. Green means that the wristband is in idle phase, yellow that the wristband is in assistance assessment phase and red that the wristband is in assistance request phase. The states of the wristband and the flow among them can be seen in figure 5.19.

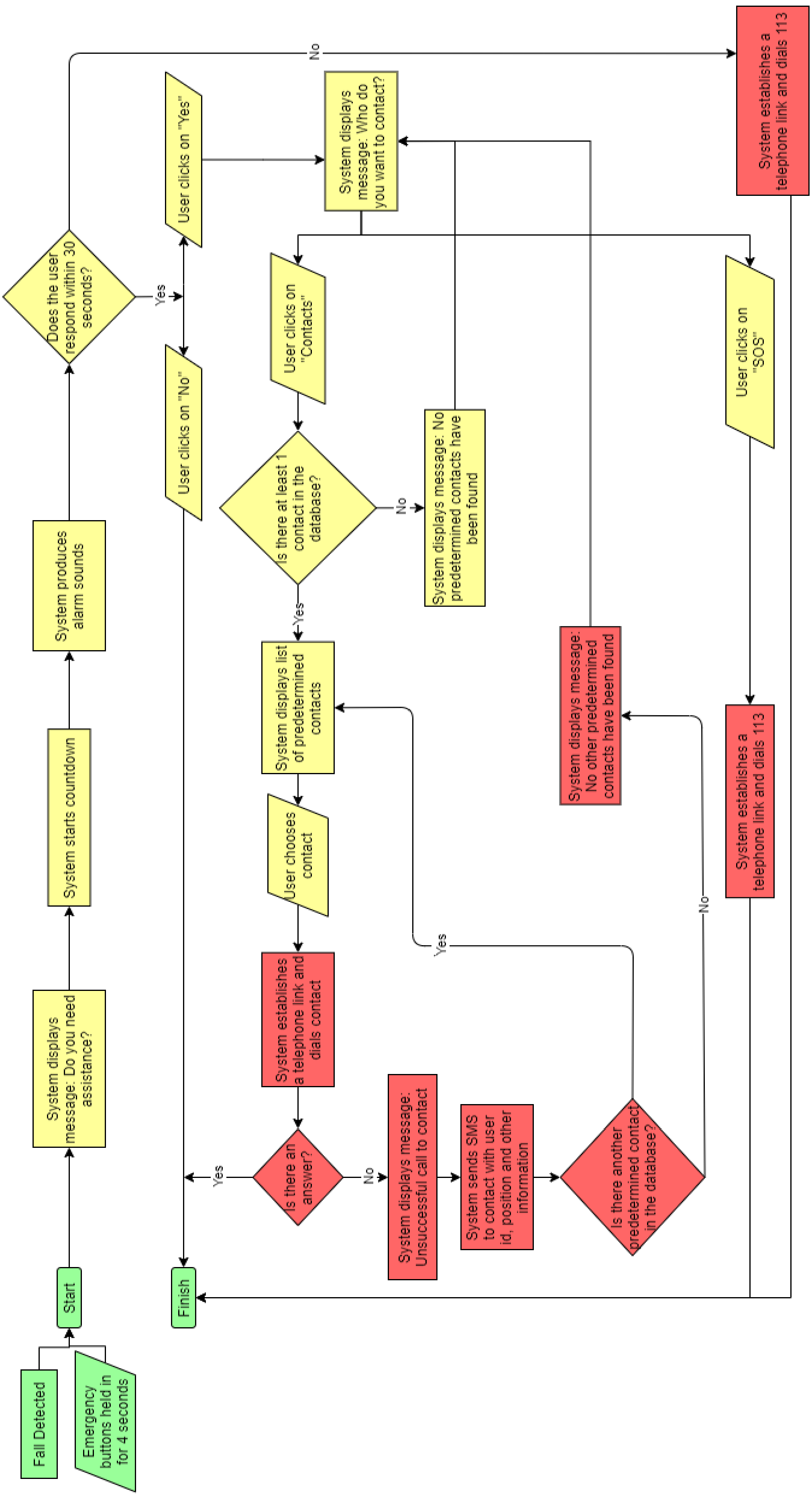


Figure 5.18: User flow diagram

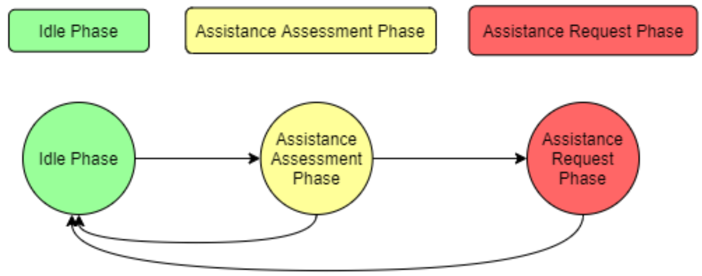


Figure 5.19: User flow diagram states

The wristband's default state is the idle phase. Thus, once the wristband is powered on, it will be in the idle phase. As seen in figure 5.18, the wristband can be triggered by a fall or the manual activation of the wristband, which will kick start the process flow for the emergency. As long as either of those two triggers occur, the wristband will switch from the idle phase to the assistance assessment phase.

Once the assistance assessment phase is activated, the wristband will display the message *Do you need assistance?* and a countdown starting from 30 seconds will begin. It will also start to emit alarm sounds at this stage. If the user does not provide an answer by the time the countdown reaches 0, then the wristband will switch from the assistance assessment phase to the assistance request phase and call 113, which is the emergency telephone number in Norway. After the call is made, the wristband will return to the idle phase.

If the user does provide an answer, however, there are two possible outcomes. The first is that the user responds *No*, in which case the wristband will return to the idle phase. The second is that the user responds *Yes*, in which case the system will display the message *Who do you want to contact?*. The user will then be shown two options, either *Contacts* or *SOS*.

On the one hand, if *SOS* is selected, the wristband will switch from the assistance assessment phase to the assistance request phase and call 113. After the call, the wristband will return to the idle phase once again. On the other hand, if *Contacts* is selected, then the system will check for saved predetermined contacts in its database and display a list of them. Once the user chooses one of the displayed contacts, then the wristband will switch from assistance assessment phase to the assistance request phase and dial the selected contact's telephone number. If the call is answered, then the wristband will return to the idle phase. If no answer is provided, then the system will automatically send a text message notifying the selected contact that the user is in need of assistance, together with the user's id and position. Next, if additional predetermined contacts are found in the database, then the user will be able to try to contact those. Otherwise, the system will switch from the assistance request phase to the assistance assessment phase and display the message *Who do you want to contact?* once again, in case the user desires to contact the emergency telephone number given that no other predetermined contacts were found.

5.4 Conceptual Design

As mentioned earlier, it was decided that the system would be made up of an assistance assessment and request stand-alone wristband, a management mobile application and a clip-on GPS tracker. The wristband was designed for the rider to request assistance in emergency situations, the mobile application was to manage predetermined contacts and other settings, and the clip-on GPS tracker could be attached to the horse's gear (such as on the horse's saddle) so that the rider could track the horse's position if it runs away.

The swimlane activity diagram that delineates the actions between the user, the wristband and the mobile application can be seen in figure 5.20. In order for a horseback rider to start using the system, the user must start by creating an account on the mobile application. Once the user account is created, the user can proceed to log into the mobile application.

Once the user is logged into the mobile application, the main menu will be displayed. From the main menu, the user will be able to create a set of predetermined contacts that will be stored in the mobile application's database. From that same menu, the user will also be able to pair the wristband to the account created on the mobile application. To do so, the user must search for the wristband from the mobile application which will establish a connection via Bluetooth Low Energy (BLE). The user will then confirm the connection from the wristband, thus completing the pairing process. By pairing the wristband and the mobile application, the predetermined contacts that were established on the mobile application are synchronized across both devices. The smart-wristband will then be ready to be used.

The smart-wristband's program will set the wristband's state to *Idle Phase* by default when started. When in idle phase, the assistance assessment phase can be triggered either if the user manually presses the two physical buttons located on each side of the wristband for 4 seconds, or if the wristband detects a fall. In order for the smart-wristband to be able to detect a fall off the horse, a horseback riding fall detection algorithm could be implemented. In 2017, Magnusson wrote a thesis in which an equestrian fall detection algorithm that used smartphone sensor data was implemented and tested [30]. The thesis proved that such falls can be accurately detected with the use of the algorithm. The sensors used for the algorithm were an accelerometer, gyroscope, magnetometer, linear acceleration sensor and gravity sensor. These sensors can be found in most smartphones, and thus, the smart-wristband would need to have these integrated into the hardware for the algorithm to work. The assistance assessment phase and assistance request phase can be exited by manually pressing the same two physical buttons of the wristband for 4 seconds. This could be used if the horseback rider no longer desires to request assistance, in which case the action will be logged as a denial of need of help, and the wristband will transition back to the idle phase.

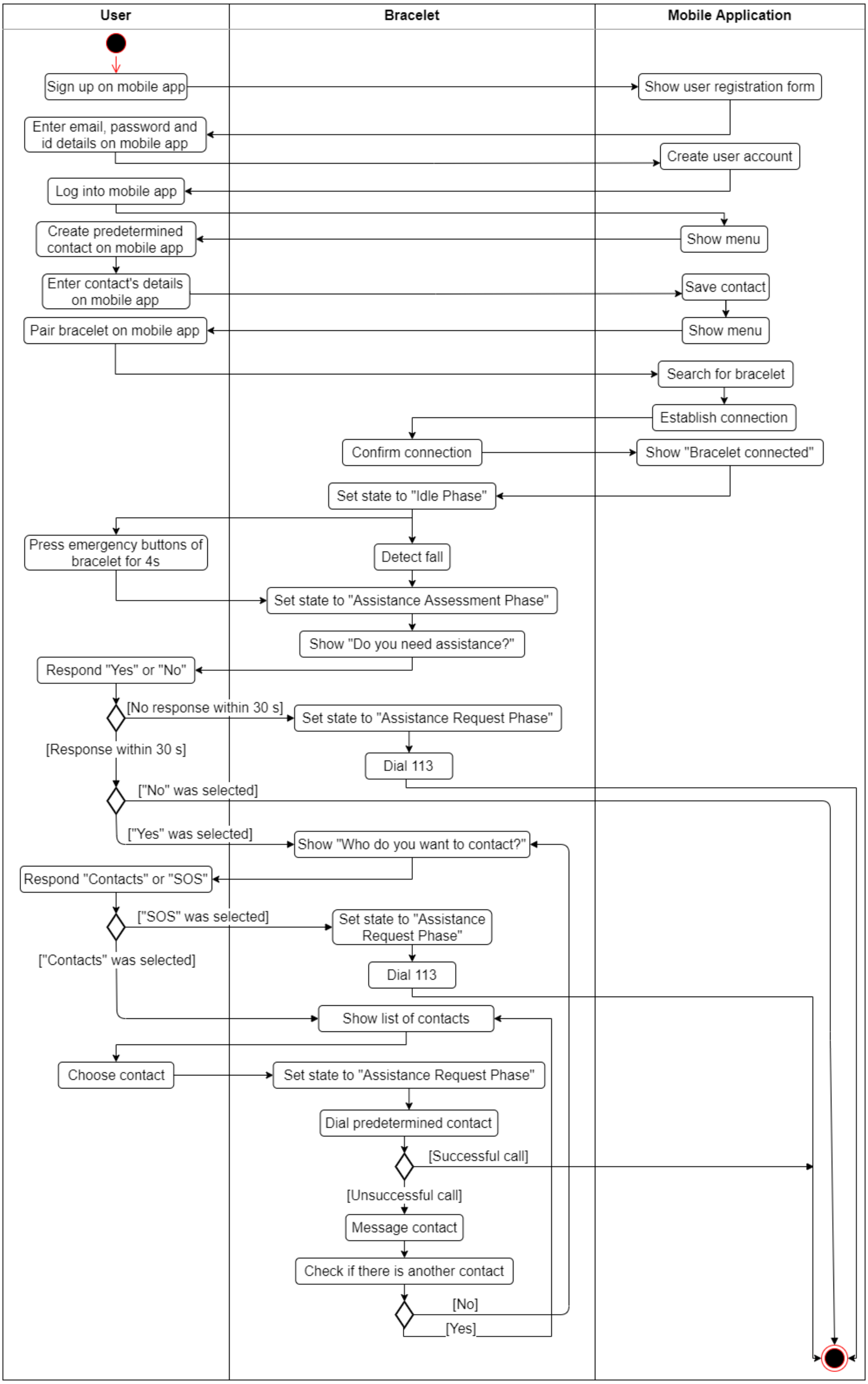


Figure 5.20: Swimlane activity diagram

Once a potential emergency situation is identified, the wristband will proceed to the assistance assessment phase. During this phase, the wristband will make an assessment of the situation by asking the user whether assistance is required and if affirmative, who would the user like to contact. During this process, a countdown is started and loud alarm sounds are played, for which reason the smart-wristband should integrate a speaker as an output device. If during the assistance assessment phase is it determined that the user is in need of help, either because the rider did not provide an answer or because the rider confirmed the need for assistance, then the wristband will transition to the assistance request phase. During the assistance request phase, the wristband will establish a communication through a telephone call with either the emergency services or a contact selected by the rider. For that reason, apart from a speaker, the wristband will need an integrated microphone as well as an input device. The communication will be established through a cellular network communication module integrated in the wristband. Cellular network communication is widely used in Internet of Things (IoT) wearables and includes numerous advantages [3]. If the selected contact does not answer the telephone call, then the wristband will automatically send an assistance request text message to the selected contact together with the user's ID and position. The user position will be retrieved from a GPS integrated into the wristband.

The operating system that will be used for the wristband is Android. All devices running the Android operating system version 4.1 and up include a supplemental service called ELS [22]. ELS makes location from Android devices available to emergency services when an emergency call or text message is placed. Thus, when an emergency call, such as a call to 113, is placed from the smart-wristband in a country that supports ELS, like Norway, the location of the device will be sent to the appropriate emergency infrastructure, either over SMS or HTTPS [22]. This service will also automatically connect the wristband to the nearest strongest network that it can find to allow for emergency calls to go through even in areas where the mobile carrier has no service. This fulfills requirement number ten which was *The system shall be able to contact the emergency services even in location with no service.*

Finally, the last component of the system is the GPS tracker to keep track of the horse's position and send the information to the mobile application. A GPS tracker provides a long range and could determine the position of the horse more accurately outdoors in comparison to a Bluetooth tracker [52], which is why a GPS tracker was preferred. There are numerous existing GPS trackers in the market for pets and livestock such as Minifinder [31] and Digitanimal [12]. A GPS tracker will also be integrated in the wristband in order for the system to keep track of the user position at all times from the mobile application.

Chapter 6

Proof-of-Concept

This chapter will present the designed first and second iteration prototypes for both the smart-wristband and mobile application, together with the evaluation process and results of them all.

6.1 Prototypes

To answer the third research question of this thesis, the prototypes of the mobile application and the wristband were designed in an iterative manner. Firstly, the first iteration of the prototypes was designed and evaluated. Then, with the feedback received during the evaluation, the second iteration of the prototypes was designed and evaluated once again. The first iteration of the prototypes aimed at meeting the user requirements explained in section 5.1, whereas the second iteration focused on the meeting the principles of universal design.

After researching and brainstorming for names, it was decided that the system's name would be *RiderAssist* given that it is a system that aims to provide assistance to horseback riders. The logo that was designed for the system and used across the mobile application and the wristband can be seen in figure 6.1. The logo is composed of a horse and a heart because the logo's purpose is for the user to associate it with horses and healthcare. Finally, the color green was picked as the logo's, and therefore the system's, primary color because it represents wellness.

Figure 6.1: RiderAssist logo

As mentioned in chapter 3, the online prototyping tool Proto.io was used to create the prototypes. Proto.io allows users to pick the type of device and model that the prototypes will be designed for. For the mobile application prototype, an iPhone 11 was picked because of how widely used iPhones are in Norway and because the number 11 is one of the newest models. Therefore, it was determined that the iPhone 11 could possibly be used by a lot of people in Norway. RiderAssist's wristband is a stand-alone bracelet. No online prototyping tools that offered the possibility of creating prototypes of stand-alone wristbands were found. Therefore, when creating the prototype for the smart-wristband, an Apple Watch was picked as the device on Proto.io. The shape and size of the Apple Watch correspond to the user requirements 14 and 15, which were *The system shall be integrated into a small device* and *The system shall be integrated into a device which can be easily attached to the rider, horse or gear*. There are nonetheless two hardware features of the designed system that are different from an Apple Watch. The first being that Apple Watches are water resistant but not waterproof [5], whereas RiderAssist shall be waterproof as stated by requirement number 13, *The system shall be waterproof*. The second being that the Apple Watch has two buttons on the same side of the device [4], whereas RiderAssist shall have one located on each side of the device.

6.1.1 First Iteration

The first iteration of the prototypes aimed at meeting the user requirements that were established. Firstly, the mobile application's design will be explained and thereafter, the smart-wristband's.

Mobile Application

When the RiderAssist's mobile application is opened for the first time, the *Login page* will be displayed. This page can be seen in figure 6.2. This page will require the user to input their email address and password in order to log in. If the user does not have a RiderAssist account, a new one can be created by clicking on the *Sign up* button located in the bottom of the *Login page*. By clicking on this button, the user will be redirected to the *Sign up* page that is shown in figure 6.3. The *Sign up* page requires the user to accept the terms and conditions of RiderAssist and input their full name, date of birth, email address and password in order to create a new account. Once signed up, the user will be redirected to the *Login page*, where the user will need to use the same email address and password that was used to sign up, in order to log into the mobile application. Once logged in, the main *Menu page* which can be seen in figure 6.4, will be displayed. The main menu contains the menu options *Predetermined contacts*, *Horse location* and *Bracelet* in addition to a *Profile* button on the top right corner of the page. The profile icon button can be found in a number of different pages so that the user can access it from any of those pages. From the *Profile page*, seen in figure 6.9, the user will be able to edit their personal information and log out of RiderAssist.

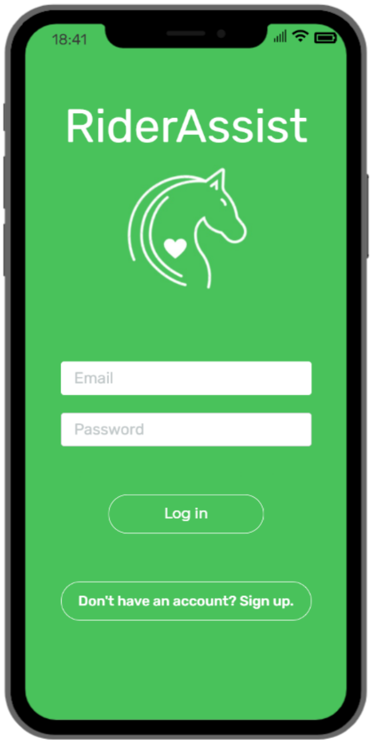


Figure 6.2: First iteration: Mobile application's login page

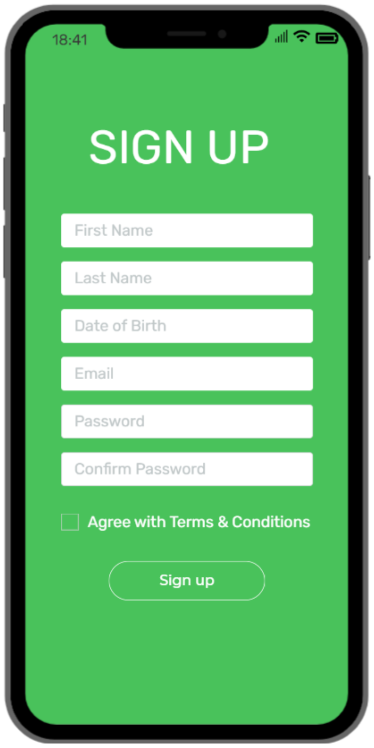


Figure 6.3: First iteration: Mobile application's sign up page

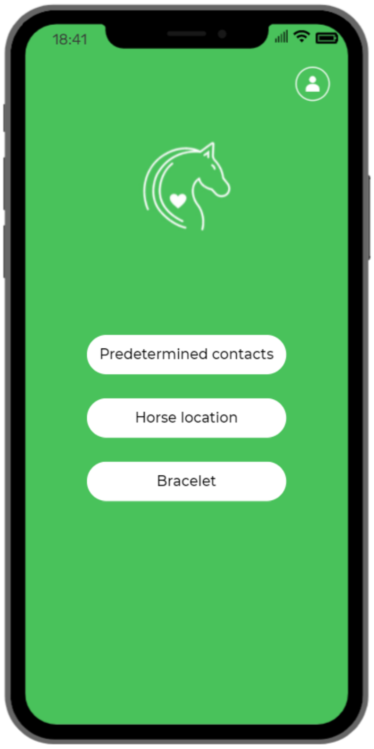


Figure 6.4: First iteration: Mobile application's menu page

When *Predetermined contacts* is selected on the *Menu page*, the user will be shown the *Contacts page* seen in figure 6.5. From this list, the user can select any of the already existing predetermined contacts to see each contact's details. The contact details of *Mom* are seen in figure 6.6. From each contact's page, the user can edit the contact details or delete the contact entirely by clicking on *Save contact* and *Delete contact* respectively. When either of these two buttons are pressed, the user is automatically redirected back to the *Contacts page*.

By clicking on *Create new contact* on the *Contacts page*, the user will be shown the *New contact page* which can be seen in figure 6.7. On this page, the user can input the new predetermined contact's name and telephone number in order for the contact to be added to the *Contacts page*. This feature meets requirement number five, which was *The system shall provide the user a way to establish predetermined contacts*. By clicking on the *Create contact* button in figure 6.7, the user is automatically redirected to the *Contacts page*. The three aforementioned interfaces, along with upcoming ones, include a *Back* button located on the top left corner which will allow the user to return to the previously visited page.

Figure 6.5: First iteration: Mobile application's contacts page

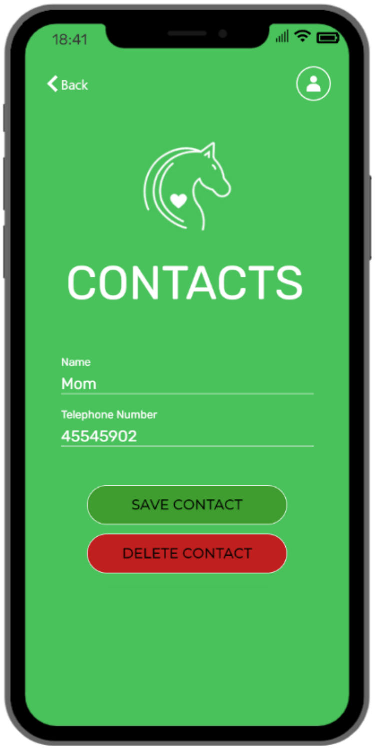


Figure 6.6: First iteration: Mobile application's mom contact page

Figure 6.7: First iteration: Mobile application's new contact page

When *Horse location* is selected on the *Menu page*, the user will be shown the page seen in figure 6.8. On this page, the user will be able to see the horse's and their position on the map, along with the distance between them. This is possible due to the horse GPS tracker and the GPS tracker of the wristband. This feature meets requirement number three, which was *The system shall track the horse's position at all times*, and requirement number four, which was *The system shall track the user's position at all times*. The user's position is also used to send assistance request text messages to predetermined contacts from the smart-wristband. When *Bracelet* is selected on the *Menu page*, the user will be shown the page seen in figure 6.10. On this page, the user will be able to search for the wristband by clicking on the *Search bracelet* button. Thereafter, figure 6.11 will be shown, followed by figure 6.12 and figure 6.13 in order to show the pairing process between the RiderAssist account and the wristband. When the button *Ok* is pressed the user will be redirected to the *Menu page* and the wristband will be successfully paired.

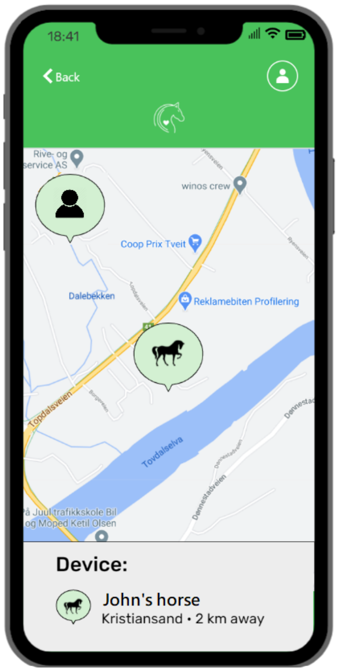


Figure 6.8: First iteration: Mobile application's horse location page

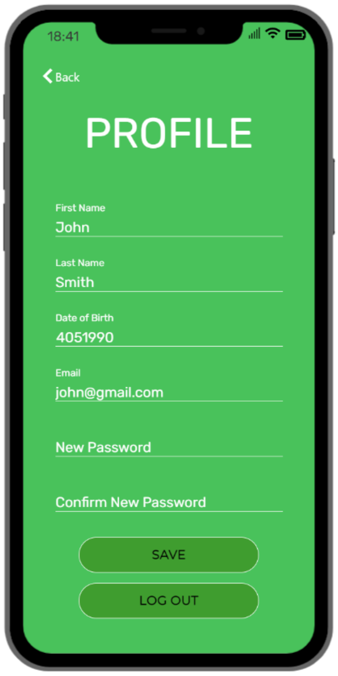


Figure 6.9: First iteration: Mobile application's profile page

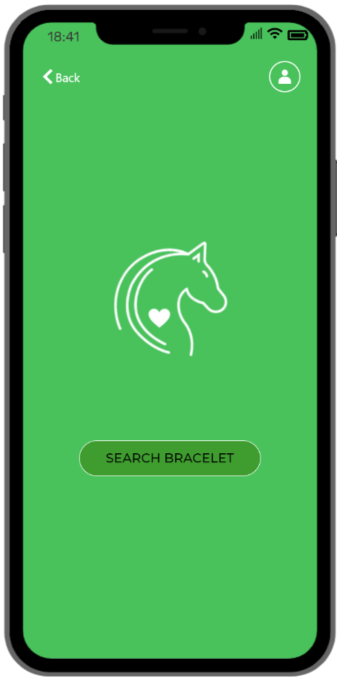


Figure 6.10: First iteration: Mobile application's wristband page part I

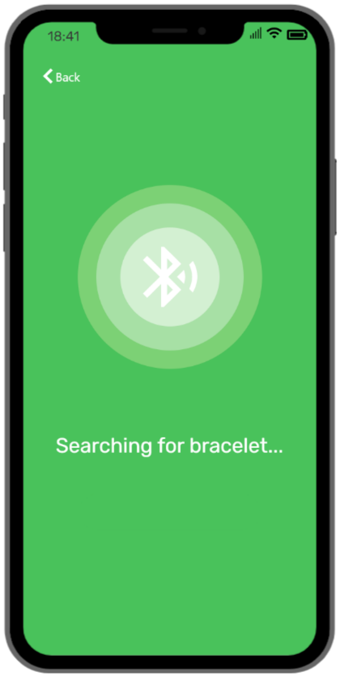


Figure 6.11: First iteration: Mobile application's wristband page part II

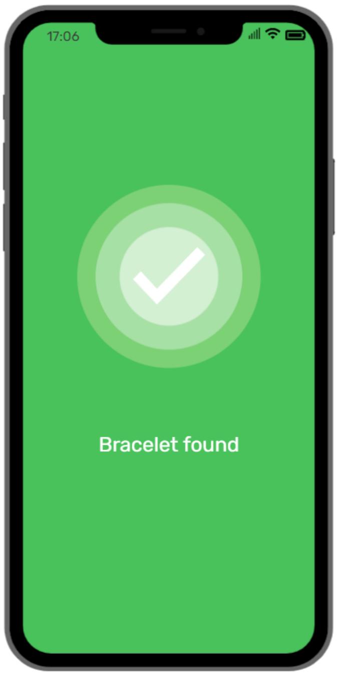


Figure 6.12: First iteration: Mobile application's wristband page part III

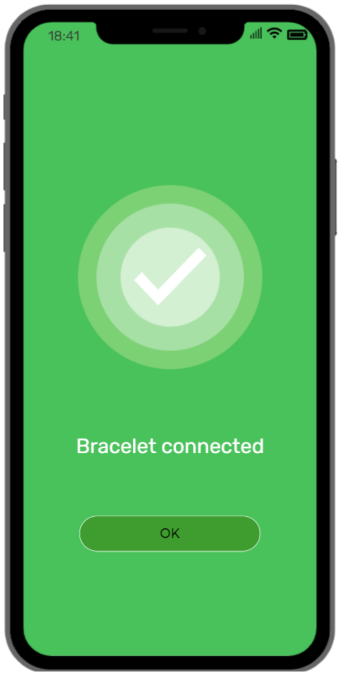


Figure 6.13: First iteration: Mobile application's wristband page part IV

Wristband

The default page of the wristband is the *Home page* which can be seen in figure 6.14. This page displays the time and date so that it can be used as a watch when in the idle phase. However, when a fall is detected or the rider presses the two emergency buttons that will be located on each side of the wristband, the wristband will activate its assistance assessment mechanism. These features fulfill requirement 8 and 9, which were *The system shall activate its assistance assessment mechanism when holding in the two emergency buttons located on opposite sides of the wristband* and *The system shall activate its assistance assessment mechanism when a fall is detected by the system.*

Figure 6.14: First iteration: Smart-wristband's home page

Figure 6.15: First iteration: Smart-wristband's countdown part I

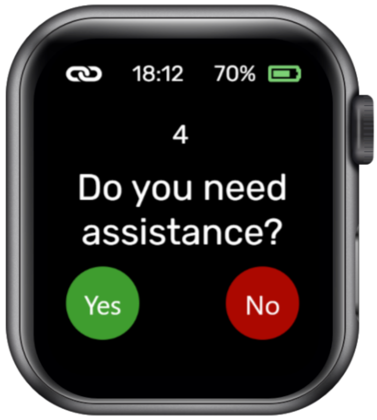


Figure 6.16: First iteration: Smart-wristband's countdown part II

The assistance assessment mechanism is represented by figures 6.15-6.22 and fulfills requirement number 1 which was *The system shall contain an assistance assessment mechanism.* From figures 6.15-6.20, the wristband displays a countdown along with the message *Do you need assistance?* and two buttons. It was decided that the rider would have 30 seconds to answer to this question before the emergency services were contacted through a telephone call as seen in figure 6.47. Thus, fulfilling requirement 11, which was *When the assistance assessment mechanism is activated, the system shall contact the emergency services in a fast manner if the user provides no feedback to the system.* However, for testing purposes it was decided to start the countdown from 5 instead of from 30 on the prototype so that test users would not need to wait for 30 seconds before seeing what occurs thereafter.

For as long as the assistance assessment mechanism is activated, the wristband should produce alarm sounds. Therefore, while the screens in figures 6.15-6.22 are displayed, the prototype was programmed to create loud alarm noises as well. This fulfills requirement 6 and 12, which were *The system shall produce alarm sounds if the user does not provide feedback after the assistance assessment mechanism is activated* and *The system shall produce loud, continuous alarm sounds if the user does not provide feedback after* *the assistance assessment mechanism is activated.*

Figure 6.17: First iteration: Smart-wristband's countdown part III

Figure 6.18: First iteration: Smart-wristband's countdown part IV

Figure 6.19: First iteration: Smart-wristband's countdown part V

Figure 6.20: First iteration: Smart-wristband's countdown part VI

Figure 6.21: First iteration: Smart-wristband's assistance assessment page

Figure 6.22: First iteration: Smart-wristband's contacts page

If the rider pressed *No* when asked *Do you need assistance?*, the wristband would return to the idle phase and display the *Home page*. If the rider pressed *Yes* however, the wristband would display figure 6.21, in which the user is asked who they would like to contact. The user is given two button options: *Predetermined contacts* and *Emergency services*. If the rider pressed *Emergency services*, the wristband would transition from the assistance assessment mechanism to the assistance request mechanism and dial the emergency services as seen in figure 6.24. This meets requirement number 2, which was *The system shall contain an assistance request mechanism*. If the rider pressed *Predetermined contacts*, the wristband would transition from the assistance assessment mechanism to the assistance request mechanism and display the contacts list as seen in figure 6.22. From that list, the rider will be able to choose which contact to call. This feature fulfills requirement 7, which was *The system shall be able to call/send text messages to the predetermined contacts and emergency services with the user's coordinates and an SOS message*. For example, if the rider decided to request assistance from their dad, the wristband would proceed to display figure 6.23. Any of the calls can be muted and unmuted by pressing on the mute/unmute symbol on the left side, and cancelled by pressing on the hang up icon in red on the right side.

Figure 6.23: First iteration: Smart-wristband's dad contact page

Figure 6.24: First iteration: Smart-wristband's emergency services page

6.1.2 Second Iteration

The second iteration's aim was to meet the principles of universal design and to improve the prototypes of the first iteration, based on the feedback received from the test users. Firstly, the mobile application's changes will be addressed and thereafter, the smart-wristband's.

Mobile Application

A number of changes were made during the design of the second iteration of the mobile application. In regards to the appearance of the mobile application, a few changes were made to make the possible actions clearer and more understandable. For example, the green color that was used as background on all pages of the first iteration, it is now only used on the top bar, buttons and details instead. Additionally, the top bar of each page contains a title page so that the users know at all times where they are. Furthermore, all pages of the second iteration have a bigger font on all forms of text, and the text on all buttons is now displayed in white or green instead of black as suggested by the user test results.
On figures 6.25, 6.26 and 6.27, the mobile application's *Login page*, *Sign up page* and *Menu page* can be seen respectively. As suggested by the user test participants on the evaluation of the first prototype, the *Login page* now includes a *Forgot your password?*

button for users that might be unable to remember their password. Another change that was made from the participants' suggestions, was making the *Terms & Conditions* on the *Sign up page* a clickable link and increasing the size of the checkbox before it. A third change that was made on the *Sign up page* is adding the format in which the date of birth should be inputted. This was highly requested by several test users. On the *Menu page*, the buttons are more separated than on the first iteration, and they include an icon. These changes were made to prevent mistakes when choosing a menu option.

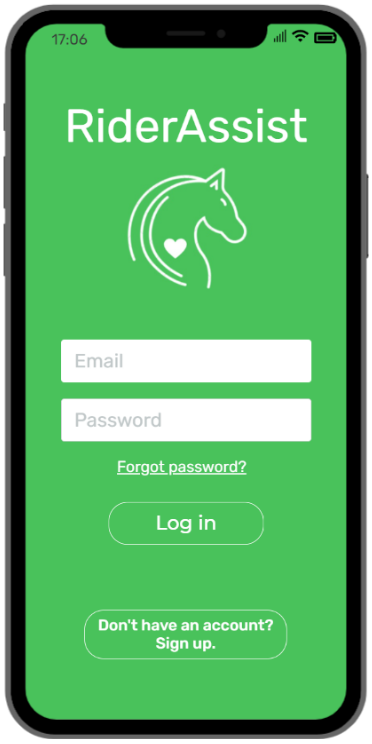


Figure 6.25: Second iteration: Mobile application's login page

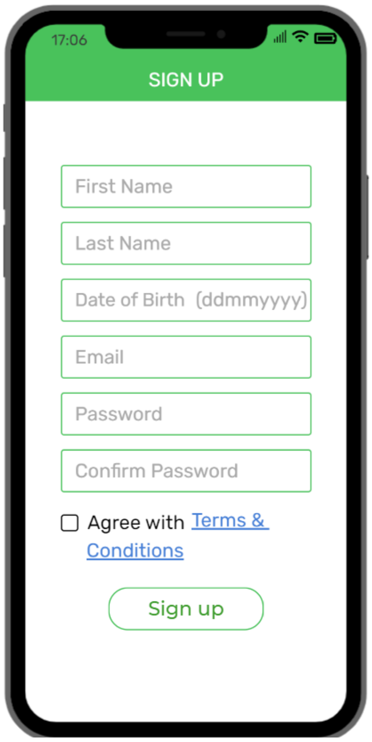


Figure 6.26: second iteration: Mobile application's sign up page

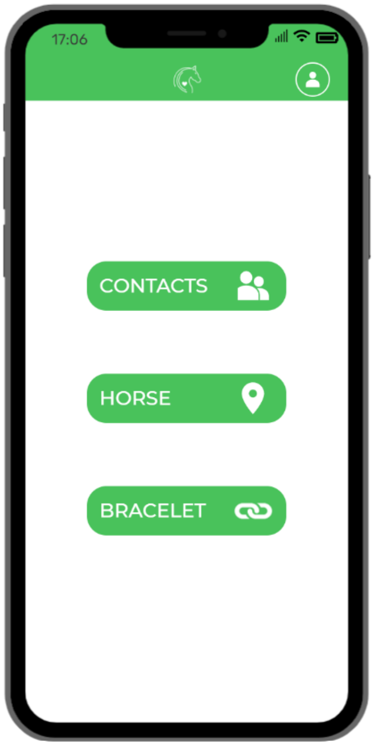


Figure 6.27: Second iteration: Mobile application's menu page

On figures 6.28, 6.29 and 6.30, the mobile application's new *Profile page*, *Contacts page* and *New contact page* can be seen respectively. Changes made to these three pages include: the *Log out* button on the *Profile page* is no longer green as all other buttons but red instead, the contact options in the *Profile page* are now more separated to prevent mistakes, and the *New contact page* now has a page title, which it did not before.

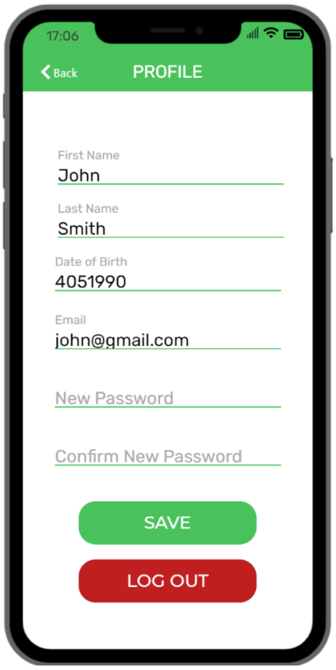


Figure 6.28: Second iteration: Mobile application's profile page

Figure 6.29: Second iteration: Mobile application's contacts page

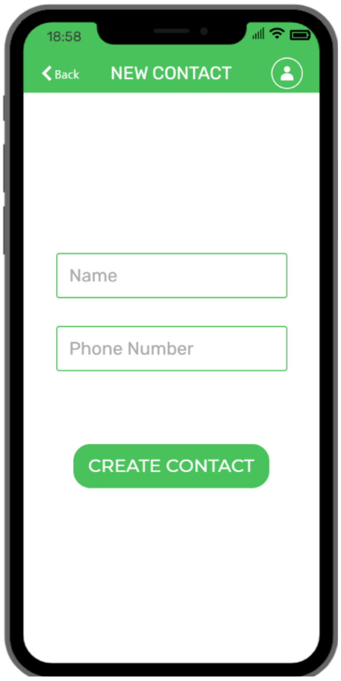


Figure 6.30: Second iteration: Mobile application's new contact page

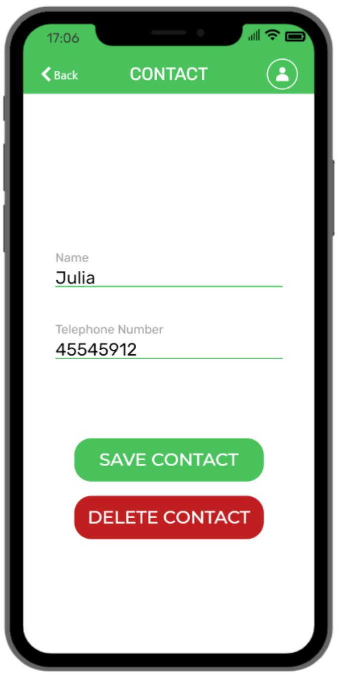


Figure 6.31: Second iteration: Mobile application's Julia page

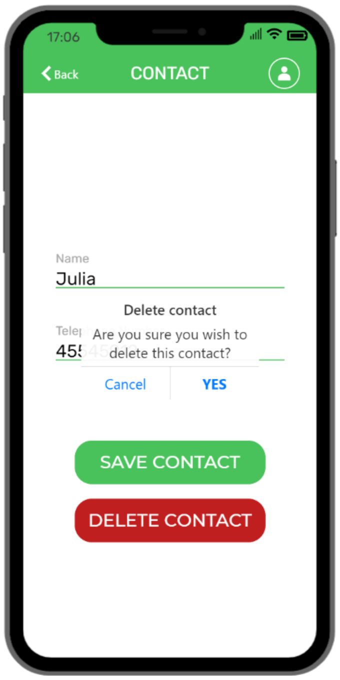


Figure 6.32: Second iteration: Mobile application's Julia page with message

Figure 6.33: Second iteration: Mobile application's wristband page part I

On figures 6.31 and 6.33, the mobile application's new *Contact page* for the contact Julia, and the *Bracelet page* can be seen respectively. The *Save contact* and *Delete contact* buttons on figure 6.31 are now more separated to prevent the user from accidentally deleting the contact. Additionally, as suggested by the evaluation results, another functionality change was implemented to prevent the user from accidentally deleting a contact. When the user clicks on *Delete Contact*, the user will now be prompted with a message asking whether the contact should permanently be deleted. In the first iteration prototype, the contact was directly deleted instead. As shown in figure 6.32, the user will then be given the options to accept the message, which deletes the contact, or cancel, which sends the user to the contact's page. The *Search bracelet* button on the *Bracelet page* was made significantly bigger.

Figures 6.34, 6.35 and 6.36, illustrate the mobile application's pairing process. No additional changes were made to these pages except for the general appearance changes mentioned in the start of this subsection.

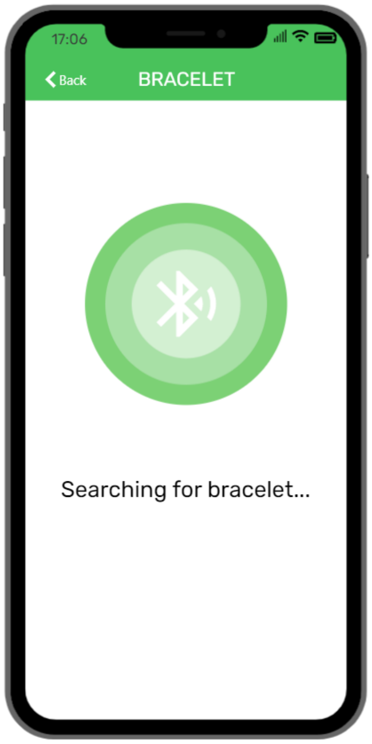


Figure 6.34: Second iteration: Mobile application's wristband page part II

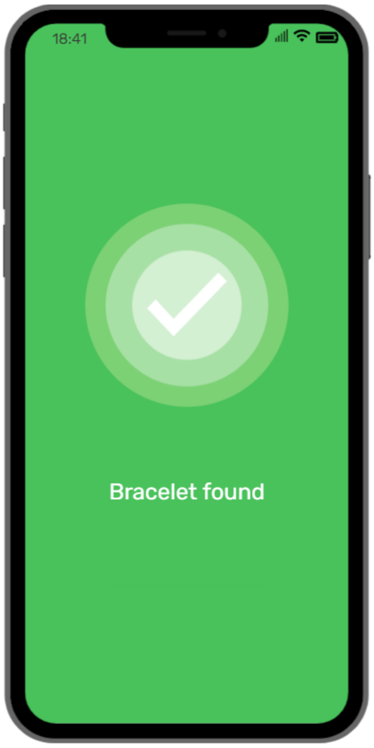


Figure 6.35: Second iteration: Mobile application's wristband page part III

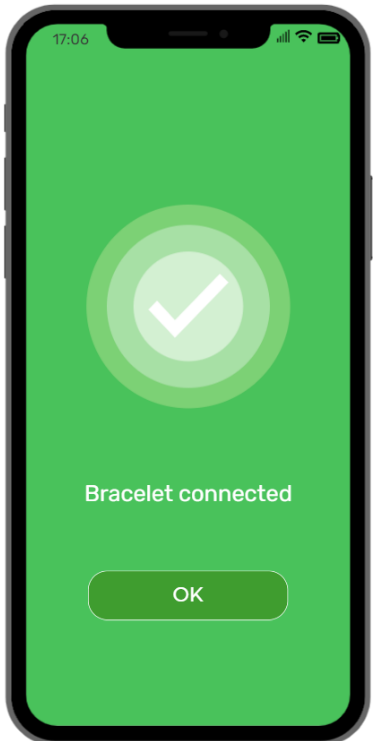


Figure 6.36: Second iteration: Mobile application's wristband page part IV

Figure 6.37 shows the mobile application's *Horse page*. No appearance changes were made to this page. However, the new functionality of receiving assistance request notifications from other RiderAssist users was implemented. It was decided to implement this functionality because it was suggested during the user research interviews and during the user tests. Additionally, it was discovered during the user research questionnaires that the average time horseback riders wait for assistance is 22.5 minutes, which can be a long time to wait for help. Thus, as an attempt to reduce the waiting time, assistance request notifications are sent to other RiderAssist users in case they are located closer to the rider in need of help than that rider's predetermined contacts. To simulate this functionality during the tests, a notification was shown to the test users while in the *Horse page* as seen in figure 6.38. The notification can be canceled in which case the user can keep using the application as usual, or accepted, in which case the user will be redirected to the *Assistance request page* shown in figure 6.39. On this page, the test users could see the location in the map of the horseback rider in need of assistance, and get the directions to that location.

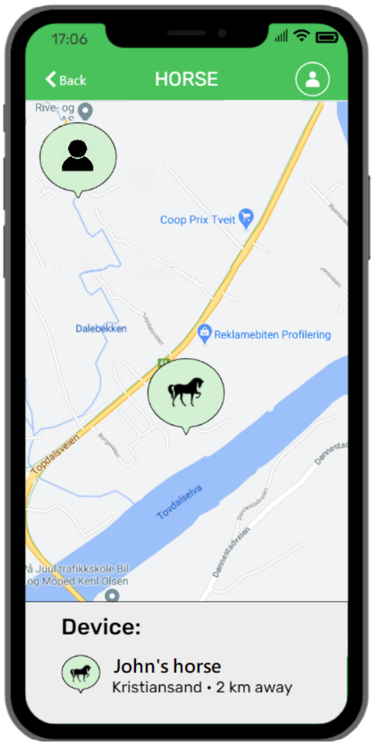


Figure 6.37: Second iteration: Mobile application's horse location page

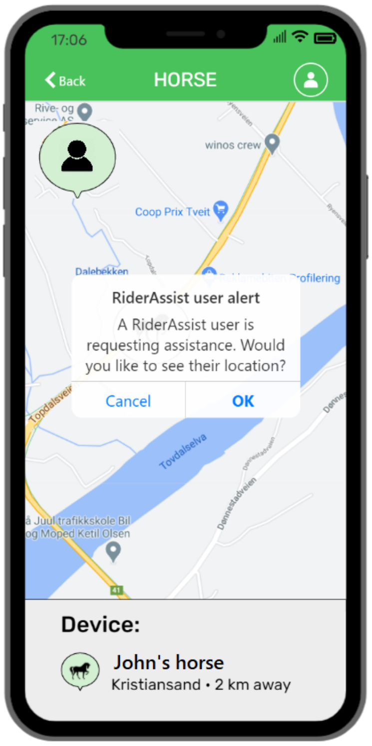


Figure 6.38: Second iteration: Mobile application's horse location page with notification alert

Figure 6.39: Second iteration: Mobile application's assistance request page

Wristband

Only a few changes were made during the design of the second iteration of the smart-wristband. On figure 6.40 the wristband's *Home Page*, which no changes were applied to, can be seen. Figures 6.41-6.46 show the pages in which the rider is asked whether assistance is needed along with a countdown. The first changes that were made to these pages are to increase of size of the *Yes* and *No* buttons. Given that the wristband will be small in size, it was decided that the buttons should be bigger than they were in the first iteration. Furthermore, as suggested by the test users, it was decided that the assistance assessment mechanism could be activated through voice commands apart from by detecting a fall and by hand. Another suggestion made by the test participants was for the smart-wristband to vibrate alongside making alarm sounds while the assistance assessment mechanism is activated.

Figure 6.40: Second iteration: Smart-wristband's home page

Figure 6.41: Second iteration: Smart-wristband's countdown part I

Figure 6.42: Second iteration: Smart-wristband's countdown part II

Figure 6.43: Second iteration: Smart-wristband's countdown part III

Figure 6.44: Second iteration: Smart-wristband's countdown part IV

Figure 6.45: Second iteration: Smart-wristband's countdown part V

Figure 6.47 and 6.50 show the interface design for when a telephone call to the emergency services and the contact dad are placed respectively. On these telephone call interfaces, the mute/unmute button was removed. This was suggested by one of the test users during the first iteration of user tests because it seemed unnecessary to them and because it could even be misused. If an emergency telephone call is taking place, muting the call is probably not desired by the user and it could even be used accidentally. On figure 6.48, the system asks the user who they would like to contact. On this page, the text "Predetermined Contacts" and "Emergency services" was changed to "Contacts" and "SOS" respectively. This change was performed as suggested by a test user to increase clarity and performance when in an emergency. Additionally, the size and shape of buttons were changed to match those of the buttons in the other interfaces. Finally, figure 6.49 shows the *Contacts page*. No changes were applied to this page.

Figure 6.46: Second iteration: Smart-wristband's countdown part VI

Figure 6.47: Second iteration: Smart-wristband's emergency services page

Figure 6.48: Second iteration: Smart-wristband's assistance assessment page

Figure 6.49: Second iteration: Smart-wristband's contacts page

Figure 6.50: Second iteration: Smart-wristband's dad contact page

Principles of Universal Design

As mentioned earlier in this section, the second iteration focused on making sure that the 7 principles of universal design were achieved. The following paragraphs will describe examples of how each principle can be achieved on both the wristband and the mobile application.

Principle 1: Equitable Use

This principle is achieved through the wristband when it produces sounds and vibrations during the assistance assessment phase. This is done in order to alert those incapable of looking at the wristband. Making use of colors that have high contrast on the mobile application and wristband helps users with weak vision. Additionally, e-ink can be used on the wristband for users standing in the sunlight.

Principle 2: Flexibility in Use

Examples of this principle include: allowing the user to decide who they wish to contact in an emergency, and allowing the user to choose the desired method of assistance assessment activation (voice command or manually).

Principle 3: Simple and Intuitive Use

This principle is achieved by offering few but concise possible actions on the wristband, this makes the actions easy to interpret for people. Also, displaying titles on the different screens of the mobile application allows the user to know where it is at all times. Displaying feedback on the mobile application when pairing the wristband to the mobile application with messages such as "Searching for wristband", "Wristband found" and "Wristband connected".

Principle 4: Perceptible Information

Using a map to indicate the horse's location on the mobile application helps communicate information effectively. Furthermore, using a clear and understandable font style that is big in size promotes readability on the smart-wristband.

Principle 5: Tolerance for Error

This principle is achieved when the mobile application displays a message asking the user whether a contact should permanently be deleted after clicking on *Delete contact*. It is additionally achieved by displaying a countdown on the wristband warning the user of the time left before automatically contacting the emergency services.

Principle 6: Low Physical Effort

This principle is firstly achieved by grouping together the mobile application menu options in the center of the screen. This makes the buttons more accessible and requires less effort if used with one hand. Secondly, the wristband only requires riders in a potential emergency to perform 2 to 3 clicks to request assistance.

Principle 7: Size and Space for Approach and Use

To make action targets on the wristband easy to tap and large enough, big round buttons, approximately of the size of a thumb's fingertip, are placed on each side of the wristband's interface. On the mobile application, the primary action buttons are placed within easy reach with adequate space between buttons. Additionally, the mobile application displays virtual keyboards that only cover part of the screen to avoid the user blocking their own interactions.

6.2 Evaluation

The first and second iteration of the prototypes were evaluated through user tests. The feedback obtained from the first iteration was used to improve the second iteration's prototypes. Due to time constraints, the feedback obtained from the second iteration was not used to create a third iteration, but instead, it was considered as improvements that could be made if future iterations were to be made.

The procedure of the evaluation of both the first and second iterations followed the same main steps. These steps were: welcoming the participants, explaining the goal and procedure of the test, allowing the users to carry out the test tasks and answer the test questions, and thanking the participants for their collaboration. The tests were performed individually on 5 experienced horseback riders and lasted around 30 minutes. The participants of the user tests were picked from the participants of the user research interviews. It was decided to use the same participants, test tasks, and test questions, to evaluate both iterations in order to check whether the feedback had improved. The user tests were composed of 14 test tasks, 7 test questions and a System Usability Scale (SUS) [54]. The SUS is a reliable tool for measuring usability that was created by John Booke in 1986. It consists of a 10 item questionnaire which users have to answer to with a Likert scale [54]. The following list shows the test tasks. The test tasks for the smart-wristband were separated into two parts so that the users could test two different scenarios.

Test tasks for the mobile application:

1. Sign up to RiderAssist by creating a new account.
2. Log into RiderAssist.
3. Create a new predetermined contact with name "Julia" and phone number "12345678".
4. See the contact details of "Mom" and change the contact's phone number.
5. Delete the predetermined contact "Julia".
6. Pair your bracelet to your user account.
7. See your horse's location.
8. Accept the user alert notification.
9. Log out of RiderAssist.

Test tasks for the smart-wristband:

- **Scenario 1:**

1. Wait for the countdown to pass without choosing an answer (after the timeout the emergency services are automatically contacted).
2. Hang up after the call.

- **Scenario 2:**

1. Confirm the need of assistance.
2. Request assistance from the predetermined contact "Dad".
3. Hang up after the call.

The test questions and the SUS will be shown in the following subsections together with the user results.

6.2.1 First Iteration

The evaluation of the first iteration was performed to test whether the mobile application and smart-wristband met the user requirements. The usability test plan dashboard of this iteration can be seen in figure 6.51.

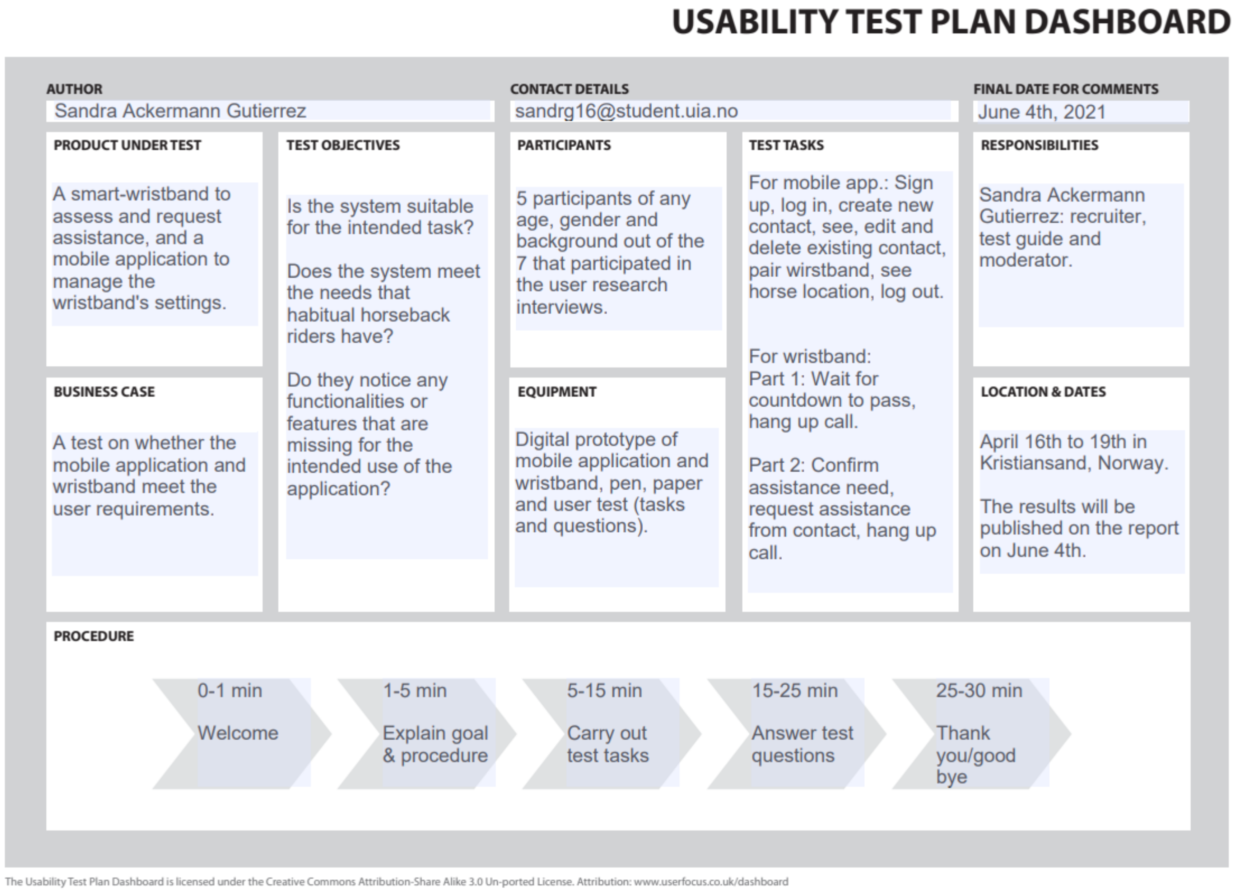


Figure 6.51: Usability test plan dashboard of first iteration

Tables 6.1 and 6.2 show the results obtained on the test questions of the first iteration of the prototypes. Question 1 and 2, which were *1. How suitable for the intended task did you find the prototypes?* and *2. Say three words that you would use to describe the* *system*, were asked to obtain insight about the likeability of the system and the participants' opinions about the system. The feedback obtained in these two questions was positive, with all participants agreeing in that the system was practical, easy to use and suitable, among other things. Question 3 to 7 were asked to gather information about the functionality and design features that the user would want to change on both the mobile application and smart-wristband. As seen in tables 6.1 and 6.2, a few suggestions were made. The suggestions in green are those that were applied to the second iteration, whereas those in red were not.

	Participant 1	**Participant 2**	**Participant 3**
1. How suitable for the intended task did you find the prototypes?	I found it suitable, easy to use and straightforward in its functionality.	Good.	I think it is very appropriate.
2. Say three words that you would use to describe the system	Easy, functional, necessary.	Good, practical, helpful.	Pretty, useful, practical.
3. Is there anything of the mobile application's design and appearance that you would change?	I would include a link to signify the terms and agreements.	I Would add a start-up guide.	I would add details about the format of the date of birth.
4. Is there anything of the mobile application's functional features that you would change?	No.	Just the start-up guide.	I would add a "are you sure you wish to delete contact?" before deleting it.
5. Is there anything of the bracelet's design and appearance that you would change?	No.	No.	No.
6. Is there anything of the bracelet's functional features that you would change?	I would include a way to check the horse's location through the bracelet in case I fell and the horse ran away.	I would add an SOS button and voice control.	To prevent false alarms maybe it should vibrate when asking "Do you need assistance?".
7. Do you have any other comments to add?	I think this kind of technology is very important for riders, it's good to have a quick way to get help.	No, good idea.	Looking forward to the new version!

Table 6.1: User test results of first 3 participants, first iteration

All suggestions were considered individually by taking into account how long it would take to design them due to time constraints, and how much value they would add to the system if implemented. On the evaluation of the first iteration, three change suggestions were not applied. The first handled about adding a start-up guide. Although creating a start-up guide can be relevant for ICT-based solutions, creating one for the mobile application and the smart-wristband would have been time consuming. If the system were to be produced however, a start-up guide could be included in the user instructions. The other three change suggestions handled about merging two of the mobile application's and the wristband's functionalities into each other. Thus, the two suggestions were: to add the necessary functionalities to be able to request assistance from the mobile application and to be able to see the horse's location from the smart-wristband. Since these two functionalities are already possible from one of the system's devices, it was decided to leave the possibility of being able to do both from the same device for future iterations.

	Participant 4	**Participant 5**
1. How suitable for the intended task did you find the prototypes?	Very suitable. It is simple to use which you need in an emergency situation. It has all the functions you need to request assistance.	I find it very appropriate. Seems to fulfill its purpose covering all possibilities of events and lacking few functionalities.
2. Say three words that you would use to describe the system	Simple, streamlined, quick.	Practical, easy to use, valuable.
3. Is there anything of the mobile application's design and appearance that you would change?	For entering the date when creating an account, I was unsure of which format to use to put in my date of birth.	If I would have to be picky I would say: the date of birth format is not clear, the tick on the agreements is not clear, the text on the dark green buttons could be white.
4. Is there anything of the mobile application's functional features that you would change?	Maybe the mobile version should also have a feature that allows the user to request assistance.	I would add a "Forgot your password?" option when logging into the app.
5. Is there anything of the bracelet's design and appearance that you would change?	I would change the text on the buttons predetermined contacts and emergency services. I would change them to 'contacts' and '113.'	No.
6. Is there anything of the bracelet's functional features that you would change?	No.	I would remove the mute button when calling someone. I find it unnecessary and maybe harmful.
7. Do you have any other comments to add?	N/A.	Should the mobile app maybe also get notifications when other RiderAssist users need help?

Table 6.2: User test results of last 2 participants, first iteration

After the participants had answered the test questions, they completed a SUS in order to evaluate the prototypes. The test participants answered each of the 10 items in the SUS by choosing one of the 5 response options [47]. The results obtained on the SUS of the first iteration can be seen in table 6.3. The following list shows the response format of the SUS. Each number on table 6.3 represents the according response option.

Strongly disagree: 1
Disagree: 2
Neither agree nor disagree: 3
Agree: 4
Strongly agree: 5

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

Table 6.3: SUS results, first iteration

The scoring process of the SUS is as follows [47]:

- For odd-numbered items: subtract one from the numerical user response.
- For even-numbered items: subtract the numerical user response from 5.
- This scales all values from 0 to 4 (with four being the most positive response).
- Calculate the summation of the converted responses for each user.
- Multiply the value obtained for each user by 2.5. This converts the range of possible values from 0 to 100.

By following the steps mentioned above, the final scores of the SUS shown in table 6.4 were obtained. A SUS score over 68 is considered above average, whereas a score under 68 is considered below average [47]. The average of the final SUS scores that were obtained was 91.5/100.

Participant 1	100/100
Participant 2	77.5/100
Participant 3	90/100
Participant 4	95/100
Participant 5	95/100
Average	91.5/100

Table 6.4: SUS final scores, first iteration

6.2.2 Second Iteration

The evaluation of the second iteration was performed to test whether the prototypes met the principles of universal design. The usability test plan dashboard of this iteration can be seen in figure 6.52.

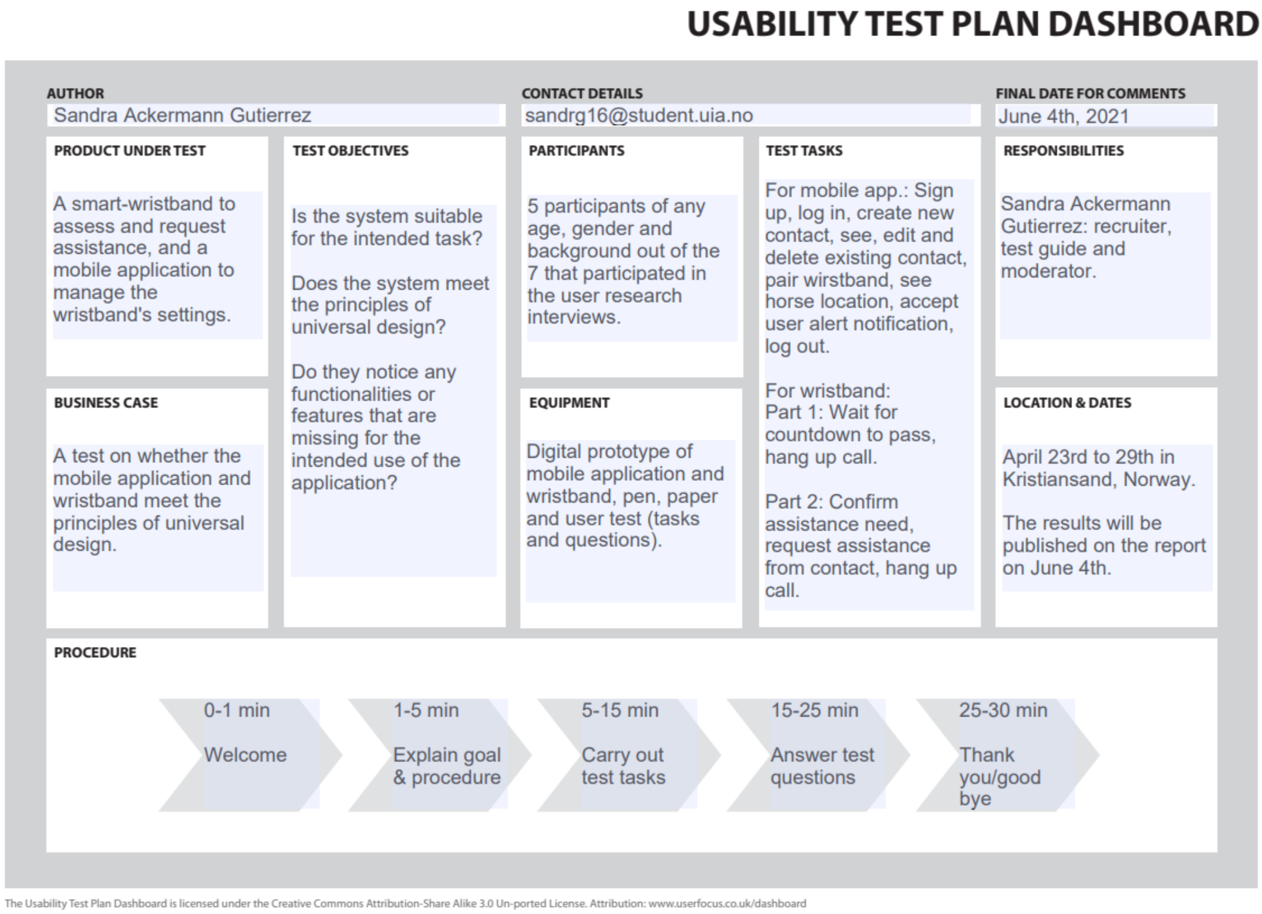


Figure 6.52: Usability test plan dashboard of second iteration

Tables 6.5 and 6.6 show the results obtained on the test questions of the second iteration of the prototypes. The feedback obtained in question 1 and 2 was positive in this iteration as well, with all participants agreeing in that the system is easy, quick and practical among other things. As seen by the results from question 3 to 7, only a few suggestions were made on this round of testing, with most feedback being positive. Since a third iteration was not conducted, the feedback in green is positive with no changes being suggested, whereas the three in red are further changes that were suggested and that will be included in future work. These suggestions were: for the mobile application to automatically log the user in after signing up (without having to input the log in details), to have a *Log out* button always visible in the top bar of the mobile application, and to be able to see the horse's location from the wristband.

	Participant 1	**Participant 2**	**Participant 3**
1. How suitable for the intended task did you find the prototypes?	I thought it was very suitable and easy to use.	It now seems even more suitable, very good!	Very efficient and practical for requesting help.
2. Say three words that you would use to describe the system	Quick, easy and safe.	Easy to use, practical, useful.	Quick, clear, efficient.
3. Is there anything of the mobile application's design and appearance that you would change?	No everything looks great!	I slightly struggled finding the log out, but then I remembered it would be in the profile. I perhaps suggest to always have it at the top.	No, I like the design and its simplicity.
4. Is there anything of the mobile application's functional features that you would change?	When you create an account have the app automatically sign you in.	No.	N/A.
5. Is there anything of the bracelet's design and appearance that you would change?	No, it looks great.	No.	I like the simple design, you are not likely to get confused when going through the processes.
6. Is there anything of the bracelet's functional features that you would change?	N/A.	No.	I would like to see my horse's location on the bracelet in case the horse runs away.
7. Do you have any other comments to add?	No, great ideas!	Not really!	The updated buttons (contacts and SOS) simplify the process. They are easier to use now!

Table 6.5: User test results of first 3 participants, second iteration

	Participant 4	**Participant 5**
1. How suitable for the intended task did you find the prototypes?	Perfectly suitable.	Very suitable. The prototypes provided an effective service and would be very useful.
2. Say three words that you would use to describe the system	Easy to use, accessible, efficient.	Concise, effective, practical.
3. Is there anything of the mobile application's design and appearance that you would change?	Not really, I like it.	No, I think it is a very clear appearance and design and it is not over complicated.
4. Is there anything of the mobile application's functional features that you would change?	Not really.	No, all the functions are important and do an effective job.
5. Is there anything of the bracelet's design and appearance that you would change?	Not really.	No, the design and layout is very clear and is very easy to operate.
6. Is there anything of the bracelet's functional features that you would change?	Not really.	No, the features are clear and are aesthetically pleasing.
7. Do you have any other comments to add?	I hope you make it happen!	Excellent idea and very well designed and clearly a lot of thought has been put in.

Table 6.6: User test results of last 2 participants, second iteration

After the participants had answered the test questions, they completed the SUS to evaluate the second iteration prototypes. As in the first iteration evaluation, the test participants answered each of the 10 items in the SUS by choosing one of the 5 response options which represent the numerical values shown in the following list [47]. The results obtained on the SUS of the second iteration can be seen in table 6.7.

Strongly disagree: 1
Disagree: 2
Neither agree nor disagree: 3
Agree: 4
Strongly agree: 5

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

Table 6.7: SUS results, second iteration

By following the same steps as mentioned in the first iteration evaluation, the final scores of the SUS shown in table 6.8 were obtained. The average of the final SUS scores that were obtained was 100/100.

Participant 1	100/100
Participant 2	100/100
Participant 3	100/100
Participant 4	100/100
Participant 5	100/100
Average	100/100

Table 6.8: SUS final scores, second iteration

Chapter 7

Discussion

This chapter will discuss the designed solution, the obtained results and the process of development of this project. These findings will be used to answer the research questions mentioned in the introduction of this thesis. Finally, the limitations encountered during the progression of this thesis will be explained.

7.1 Discussion of User Research Results

The user research provided a great deal of valuable information. To begin with, from the results obtained through the questionnaires, it was discovered that there are a number of reasons supporting the relevance of the development of an emergency support solution for horseback riders, and therefore, a need for such a system. The first reason that was unveiled is that most horseback riders ride alone. If most horseback riders ride alone, then most riders are likely to struggle to request assistance if severely injured. Thus, having an emergency assistance solution would facilitate doing so. Most horseback riders stated that they bring their mobile phones with them when riding, which means that they rely on their phones to communicate with others in cases of need. However, most of them also stated that they believe their phones can get easily damaged in an accident. Thus, by relying on a solution that is designed to sustain horseback riding accidents may prove to be a better approach than smart-phones which may get easily damaged. According to the questionnaire results, most horseback riders had been involved in a severe horseback riding accident before. Most of those horseback riders that had been involved in accidents, ended up requesting assistance, and most of those who requested assistance were brought to the hospital or were assisted by an ambulance. This shows not only that horseback riding accidents are common, but that severe horseback riding accidents in which emergency assistance is required are frequent as well. All things considered, the fact that most horseback riders ride alone, are involved in severe accidents often, and tend to depend on a communication device that can easily get damaged to request assistance, proves that an emergency assistance solution for horseback riders is certainly needed.

Thus, when it was understood that there was a need for a solution such as the one being proposed in this thesis, research began on the design aspects that should be considered in order to implement this solution. These aspects answered the first research question of this thesis, which was *What design aspects should be considered when implementing an ICT-based tool that aids horseback riders in potential emergency situations?*.

From the questionnaire results it was learned that horseback riders waited an average of 22.4 minutes for assistance to arrive when in need of help. If a rider were to be in a critical state, waiting for 22 minutes could have a negative impact on their health or even decrease the likelihood of recovery of the rider. This aspect was greatly considered in the design of the solution, making decreasing the waiting time while providing an appropriate assessment, the main aims of the support system.

Another important aspect that was considered is that nearly all horseback riders bring their mobile phones with them, and nearly all of them would be interested in a stand-alone support solution so that they did not have to depend on their phones to request assistance while horseback riding. This signified a few key points. Firstly, that the support solution should be able to request the assistance without depending on the mobile phone being in close proximity so that riders would not need to bring their phones with them. Secondly, that because so many horseback riders see mobile phones as their main tool of communication even while riding, phones could be considered the direct competitors of the emergency support solution proposed in this thesis. If it is desired that horseback riders stop bringing their mobile phones with them, the support solution should provide advantages to horseback riders in situations of emergency that the mobile phones do not. This means that the emergency support solution should ideally be as reliable, usable and effective as mobile phones are, while providing features suitable to horseback riders that mobile phones do not provide. Otherwise, experienced horseback riders may continue to rely on their mobile phones when horseback riding. On a different note, the questionnaire results also showed that a considerable amount of horseback riders use their phones for communication, entertainment and functional purposes while horseback riding. This could indicate a reason why horseback riders may still prefer to rely on their mobile phones to request assistance, given that mobile phones include countless entertainment and functional features.

From the user research interview results, 15 design aspects to consider were gathered and translated into user requirements. Out of those 15 requirements, 9 of them were functional requirements while the remaining 6 were non-functional requirements. An aspect that was considered when establishing the user requirements was that while falls are the most common kind of horseback riding accidents, and disorientation, pain and concussions are common injuries, each accident can be considerably different. There are many variables to consider when assessing horseback riding accidents. These include the location of the accident, whether the rider is alone or in company, whether the rider is able to ride back to the stable, whether the horse has ran away and whether there is mobile phone connectivity to name a few. Therefore, considering as many aspects as possible, the 15 requirements mentioned in section 5.1 were identified in order to assess and attempt to help the rider in different possible circumstances. This is the reason why the system contains an assistance assessment mechanism and an assistance request mechanism, so that the system gathers data to assess the rider's needs in that instance, and requests help from the appropriate person rapidly. This way, the kind of help that the rider obtained could be customized to the rider's needs in that specific emergency situation.

The aforementioned aspects were considered for the first and second iteration of the solution design, which can be considered the initial phases of the design of the solution. In order to make the assistance solution even more appropriate for its purpose and optimize its design, even more aspects could be considered in future iterations. It is however, important to note the importance of involving the user in each stage of the process. Utilizing a user centered design unveiled the relevance of said aspects and their purpose. The author of this thesis is in fact a frequent horseback rider, and even this author discovered aspects never considered before. For example, it was learned from the user research questionnaires that a common act among riders in Norway is to always think of the horse's well being first, and then the rider's. This mentality often leads riders to worry about the whereabouts of the horse, and the assistance that the horse might be needing first, and postpone the assistance that the riders themselves might be in need of. The unawareness of this mentality could come from the fact that this author had mostly horseback ridden in an equestrian school in Spain, where it was mostly ridden in arenas. Thus when accidents occurred, the horse was unable to run away far from the rider, unlike in Norway, where horseback riding is often performed outdoors and outside arenas. The author of this thesis did not participate as a respondent in the user research questionnaires or interviews. However, this shows not only that involving target users in the design process of a solution contributes to unique viewpoints from experts, but also that involving several target users is highly important to obtain the perspectives of users from different backgrounds.

7.2 Discussion of Interaction Flow

Once the design aspects that should be taken into consideration were identified, the interaction flow that the proposed solution should follow was established. Through both the user flow diagram and the prototypes, numerous features which could meet the principles of universal design were proposed. The full list of these features can be seen in sub-sub-section 6.1.2. This provided an answer to the second research question of this thesis, which was *What interaction flow should a system that aids horseback riders in situations of potential emergency follow to meet the principles of universal design?*.

In section 5.3, the user flow diagram that represents the interaction flow can be seen. The different colors indicate the 3 different states that the system can be in. These are the idle phase, the assistance assessment phase and the assistance request phase. The interaction flow moves in a circular motion starting in the idle phase. When a potential emergency is identified either by manually triggering the wristband or through a detected fall, the system will enter the assistance assessment phase. Once the emergency situation is assessed, the system will determine whether to return to the idle phase or to request assistance. If assistance must be requested, then the system will enter the assistance request phase and act as a communication medium. Once help is requested, the interaction flow is redirected to the start, to the idle phase, ready to assist the rider once again when needed. The interaction flow was set to move in a circular motion to create a loop and so that the system would reset automatically, guaranteeing availability of assistance at all times even if help had been requested earlier.

Apart from being able to trigger the assistance assessment mechanism through manual commands and fall detection so that the principles of universal design are met, a third trigger is mentioned in this thesis. This trigger is through voice commands, which would allow the rider to trigger the assistance assessment mechanism on the wristband by merely saying a command out loud. A voice command has not been proposed yet, but it should be clear, concise and not easily mistaken with other words. A trigger that was considered and not proposed due to unsuitability was to trigger the assistance assessment phase after drastic changes in the vital signs of the rider. After contemplating the idea, this was disregarded due to that vital signs monitoring systems can jeopardize measurements during exercise due to unstable skin-electrode contact. Measuring the vital signs of the rider in other ways was soon disregarded too. This is because doing so would require the device in which the system is integrated into to be sizeable and intricate, which is the opposite of what experienced horseback riders desired as shown by the user research. Additionally, during horseback riding, it is natural for the rider to have a high pulse rate and respiratory rate, thus alterations in vital signs might not necessarily be equivalent to an emergency situation.

It was decided that when requesting assistance from either a predetermined contact or emergency services, the system should always try to perform a telephone call first. Sending a text message instead of making a telephone call, was firstly considered. However, due to the potential urgency of the matter, it was decided to establish a telephone call given that information can be exchanged at a higher speed through this medium. If no answer was provided, before allowing the user to call someone else, the system sends a text message to the contact notifying that the rider is in need of help, together with their location. This was established as part of the interaction flow so that predetermined contacts would be able to see what the telephone call referred to even after the call was made. Thus, if a predetermined contact was in a meeting while receiving a telephone call, that contact might be unable to or not willing to answer. However, if the contact were to receive a text message after the call regarding the rider's need of assistance, that contact might make an exception or be more inclined to assist the rider immediately. Additionally, the more communication mediums are used, the higher possibilities there might be of reaching the predetermined contacts and obtaining help.

The aforementioned flow was created as the initial flow proposal of the solution design. In order to make improvements in the interaction flow, further research on the relatives of experienced horseback riders or emergency service workers could be executed. These subjects could give insights to their preferred methods of contact regarding a rider that

is in a potential emergency situation.
As mentioned in chapter 2, awareness about how Universal Design can benefit all users is crucial but rarely found [40]. In fact, no state-of-the-art literature was found regarding the use of universal design on horseback riding support solutions. Therefore, the literature that was investigated in chapter 2 regarded support solutions for other types of emergencies. As seen in the chosen literature, good efforts towards accessible tools that make use of universal design exist but mostly on the conceptual or prototype level [40]. According to Baharuddin et al, there are four usability dimensions to consider when designing mobile applications. These are: user, environment, technology and task/activity [2]. Due to time constraints, the solution that was designed in this thesis project was only developed as a prototype. However, it was made sure that the usability dimensions were considered when designing the solution's interactions in order to meet the requirements for universal design. This was executed by considering the user's demographics, perception and emotional context, the environment's physical and social conditions, the technological interface and device type, and the tasks' description. Additionally, a few papers that were investigated for the literature review mentioned the importance of considering human functioning when designing ICT-based emergency management support systems. In order to do so, as suggested by Borell and Stroh in [8], a strategy was adopted for the solution design of this thesis report. The strategy was to choose an appropriate degree of ICT-based processing, which suggests to neither present too much raw data nor to have too processed and condensed information. Furthermore, there is a consensus in all researched papers on the fact that the effective use of ICT-based emergency management support tools require human factors to be considered in the design of such systems. Thus, it was especially focused on the following universal design principles: that the interaction flow was intuitive, required low physical effort, and was tolerant to error.

7.3 Discussion of Prototypes and Evaluation

In chapter 6, the first and second iteration of the solution's prototypes and evaluation phases are presented. These provided an answer to the third research question of this thesis, which was *How could the needs of horseback riders in potential emergency situations be fulfilled with an ICT-based tool following the User Centered Design approach?*.
The first and second iteration of the prototypes were evaluated through user tests. The feedback obtained from the first iteration was used to improve the second iteration's prototypes. Due to time constraints, only two iterations were performed. The tests were performed individually on 5 experienced horseback riders and were composed of test tasks, test questions and a System Usability Scale (SUS). It was decided to use the same participants, test tasks, test questions and an SUS, to evaluate both iterations in order to check whether the feedback had improved.
The evaluation results of the solution's first and second iteration showed that the participants found the overall solution highly suitable for the intended task, practical, and

easy to use. Then, the participants were asked what features of the appearance and functionality of both the mobile application and smart-wristband they would change. In regards to what could be improved, a total of 14 different suggestions were made during the evaluation of the first iteration, whereas a total of 3 different suggestions were made during the second iteration. The fact that there were less suggestions during the second iteration of the prototypes suggests that participants were more content with the newest version. Also, the fact that a very low number of suggestions were made during the second iteration suggests that the prototypes meet most of the horseback riders' requirements. Out of the 14 suggestions that were made in the evaluation of the first iteration, all suggestions were applied except for 3. Thus, although not big, a number of changes were applied to the prototypes of the second iteration.

The last part of the user tests was composed of an SUS. The average SUS score of the first iteration was 91.5 out of 100, while the average SUS score of the second iteration was 100 out of 100. From the first score, it is visible that horseback riders are highly content with the solution. The increase in SUS score from the first to the second iteration confirms that there is an improvement in the horseback riders' perception of the system. The fact that the SUS score that the second iteration received is the maximum score (100 out of 100), that does not mean that the system is optimized or perfect. It just means that the set of expert horseback riders that participated in the tests are satisfied with how the solution meets their requirements.

In 2020, a project report [46] written by the same author as this thesis identified a few papers about existing technologies that can aid a horseback rider in situations of emergency. The first paper was a master thesis written on the detection of equestrian falls [30]. The author of this paper, Magnusson, aimed at creating a mobile application that could identify falls from a horse with the use of smartphone sensors. However, due to the limited available time, Magnusson only had time to develop and test the fall detection algorithm and not the mobile application itself. The algorithm proved to perform well, however, the final solution was incomplete. Magnusson's solution is somewhat similar to the one designed in this thesis except for one big difference. Magnusson's idea was for the algorithm to be part of a mobile application, which would then depend on a smartphone device to detect falls. Through the user research that was performed however, it was discovered that horseback riders believe their phones can get easily damaged in a horseback riding accident. Also, it was discovered that horseback riders would prefer for the solution to not depend on a mobile phone to request assistance, so that there is no need to take the mobile phone with them while riding. Taking the user research into consideration, the conceptual design proposed in this thesis would be more suitable for the task than that proposed in Magnusson's work. Thus, by involving potential users in different stages of the design process, crucial information was identified in order to make the designed solution different from others.

The remaining papers were all patents and reports about wearable emergency support solutions such as smart-helmets, t-shirts and vests [10][49][56]. It was suggested that these devices could be used in sport activities in which an injury could occur. The devices embedded sensors to detect anomalies in the rider's vital signs. Although these solution ideas might perform very well, according to the results of the user research, riders prefer a solution integrated into a small and easily accessible device. Smart t-shirts and smart vests are not particularly small devices, and accessing smart-helmets in an emergency situation to request assistance could be complex and inaccessible. Thus, there are a few insightful reports about existing support solutions that could be used for horseback riders. However, none of these reports mentioned having performed a user research or having involved potential users in any stage of the solution design process. Thus, through the the user centered design approach undertaken for the design of the prototypes of this thesis, a distinctive point of view and results were developed.

7.4 Limitations

There are a number of limitations that were encountered during the progress of this thesis project. The next subsections will discuss a few process limitations and ICT limitations that were identified.

7.4.1 Process Limitations

The first limitation that was identified was the time constraint of 5 months, which lasted from January 4th to June 4th of 2021. The total amount of time that was available determined a great deal of aspects, starting with the amount of time that was available for each stage of this project, such as for the requirements assessment, solution design and evaluation. This again, determined aspects smaller in size such as the amount of subjects that could participate in the user research, the amount of iterations that could be executed, and the amount of tests that could be accomplished to name a few. Thus, time management and having a concise idea of what could and could not be accomplished in time became imperative.

The UCD process executed during this project is far from being a perfect process. The knowledge, time and resources needed to perform an optimal UCD process are greater than the ones available to the author of this project, and thus, there is a learning curve that must be mentioned. Therefore, the approach undertaken during this project is only a simplified version.

Another limitation that was realized from the start of the project was the infeasibility of the recreation of a near-to-reality test scenario. The project focused on the creation of interactions between an ICT-based solution and horseback riders in situations of potential emergency. Therefore, the prototypes should ideally have been tested by horseback riders during real emergency situations. However, situations such as falls off a horse, concussions, or getting stepped on by a horse for example, could be highly dangerous and unsafe to replicate. Thus, the user tests of this project were not replicated perfectly in order to conduct them safely and professionally towards participants.

Additionally, another limitation has been caused by the COVID-19 pandemic. Due to the

COVID-19 related contact restrictions, the user research questionnaires and interviews, as well as the user tests had to be performed online instead of in a direct person-to-person way. The questionnaires were created and distributed online, the interviews were performed through audio recorded phone calls, and the user tests were showed and tested through the Zoom video conferencing tool with screen control sharing. This proved to be challenging, however, it was easily overcome with the technology and tools available today. Additionally, it proved to be great experience that can be considered for the execution of future interviews online.

7.4.2 ICT Limitations

As mentioned in section 5.4, it was decided that the system would be made up of a stand-alone wristband for assistance assessment and request, a management mobile application, and a clip-on GPS tracker. The wristband was designed for the rider to request assistance in emergency situations, the mobile application was to manage predetermined contacts and other settings, and the clip-on GPS tracker could be attached to the horse's gear (such as on the horse's saddle) so that the rider could track the horse's position if it runs away. These ICT features include a few limitations.

The current solution is designed so that the wristband is able to make telephone calls and send text messages by itself without depending on a smartphone. This was decided due to expert horseback riders' preferences to not depend on their mobile phones to request assistance, as shown by the user research. However, if the smart-wristband is to perform telephone calls and send text messages, then a wristband with inbuilt telephony functionality, a plan with a cell phone provider, a Subscriber Identity Module (SIM) card and a telephone number will be required.

Additionally, the current solution is designed so that the wristband and the mobile phone are paired via Bluetooth. Because of that, in order to set up and update the predetermined contacts list, the wristband and mobile application have to be physically close to each other, which is a limitation. An approach to solve this limitation would be for the wristband to have access to the Internet and to enable IoT cloud connectivity. With the use of cloud computing, storage and analysis of data can be done quickly and in real-time [15]. Thus, by using cloud computing, the mobile application could push the contacts list and user information to a cloud service, from which the wristband could access them. In this manner, as long as the wristband has access to the Internet, the information on the wristband can be updated without the need of having the mobile application physically close to it. Nevertheless, cloud computing technology would come at a cost. In this thesis, it has not been discussed the kind of battery that the wristband would integrate. Regardless of the battery life the wristband would have, the battery consumption would increase if the wristband made use of 3G or 4G Internet connection [28], which would create another potential limitation.

Chapter 8

Conclusion and Future Work

8.1 Conclusion

In conclusion, the emergency support solution for horseback riders that was designed is composed of an assistance assessment and request stand-alone smart-wristband, a management mobile application, and a clip-on GPS tracker. To create the user centered design of the solution, three research questions were answered.

The first research question was answered by gathering a number of aspects that should be considered for the design of the interaction flow and prototypes. The user research showed that there is a need for a support solution due to the riders' vulnerability while riding. When asked what they thought of the idea, the feedback received from the interview participants was exceedingly positive. The user research also revealed the importance of involving potential users in the design process. Among other things, answering the first research question revealed that while falls are the most common kind of horseback riding accident, and disorientation, pain and concussions are common injuries, each accident can be considerably different. It was shown that there are many variables to consider while developing this solution to provide adequate efficacy in the various circumstances.

To answer the second research question, a user flow diagram to determine the interactions and technologies required to accomplish the principles of universal design was produced. The solution's interaction flow moved in a circular motion. It was decided that the assistance assessment phase would be triggered through manual commands, voice commands and fall detection. During the assistance assessment phase, the rider was asked whether assistance should be requested and from whom. When the assistance request phase was activated, the wristband contacted a predetermined contact or the emergency services. A telephone call was made. If unanswered, a text message was sent. The importance of considering the universal design principles when designing safe interactions was revealed. The effective design of ICT-based emergency support solutions require consideration of the universal design principles and human factors.

The third research question was answered by developing the user centered design of interactive prototypes that aid riders in emergencies. The prototypes were composed of a smart-wristband and a mobile application, which were designed for two iterations. The results showed that the design was highly suitable for the intended task, practical and easy to use. From the obtained feedback, it was concluded that users were more content with the second iteration compared to the first, and that the prototypes met the identified requirements. There are a few reports about existing support solutions that could be used for riders. When compared to other solutions, although they perform well, they do not meet the requirements and expectations that expert riders have expressed through the user research. This is because none of the existing solution reports mentioned performing user research or involving potential users in the design process. Thus, through the user centered design approach undertaken for the design and evaluation of the prototypes of this thesis, a distinctive point of view and results were developed.

8.2 Future Work

This thesis report explained the prototypes that were developed given the time that was available. If time permits, the next iterations would focus on the following improvements. During the evaluation of the first iteration of the prototypes, a few change suggestions were not applied to the second iteration prototypes. These suggestions include creating a guide for both the mobile application and wristband, implementing the functionality of being able to see the horse's location from the wristband, and implementing the functionality of assistance request on the mobile application. By combining a few of the wristband's and the mobile application's functionalities, the possibility of only making use of one device might be considered. Thus, if the mobile application and the wristband contain most of the same functionalities, then riders might be inclined to only make use of one of them. Given the results from the user research that was performed, riders might prefer to depend on the smart-wristband rather than on the mobile application during emergency situations. However, this is a decision that would have to be made in future iterations if as mentioned, the functionalities of the mobile application and wristband are combined.

Additionally, during the evaluation of the second iteration of the prototypes, a few change suggestions that could be considered in future iterations were made. These include automatically logging the user into the mobile application after sign up, and placing the log out button in a constantly visible place. As mentioned, these are all suggestions from expert horseback riders. Thus, these are not mandatory, and it will be up to the designers to decide whether these suggestions will be acted on or not.

Furthermore, the author of this thesis thought of two additional possible changes. The first being a notification inbox. The idea is for the rider to receive assistance requests from other RiderAssist users. Thus, a place where incoming notifications will be kept and stored should be provided. The second is to provide the user with the option of choosing a contact from the ones stored in their device, apart from being able to manually enter the details of a new predetermined contact. This would aid the user in choosing new predetermined contacts from a mobile phone.

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Appendices

Appendix A

Questionnaire

Hi, my name is Sandra and I am conducting a questionnaire to gather information for my master's thesis. The purpose of this questionnaire is to understand what support needs horseback riders have in situations of potential emergency by asking about previous emergency situations that you as a rider might have been involved in, and how you think an electronic solution might help. This questionnaire contains questions about previous horseback riding accidents you have had, what kind of help you needed in that situation and other details about how you usually ride (alone / with others, bring your phone or not…).

Filling out this questionnaire is voluntary and will take about 10 minutes. Your answers from the questionnaire will be registered electronically and will be completely anonymous when used on the final report. If you choose to participate in the project by filling out this questionnaire, please click on **Next** to give consent.

Do you usually horseback ride alone or in company?

- ☐ Mostly alone
- ☐ Around half of the time alone and the other half in company
- ☐ Mostly in company

Do you usually take your phone or another communication/aiding device with you while you ride?

- ☐ Mobile phone
- ☐ SmartWatch
- ☐ Fitness tracker
- ☐ Other device (please specify):__________
- ☐ I do not bring mobile phones or devices with me when I ride

Rate the following statements

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I use my mobile phone mainly for communication purposes	☐	☐	☐	☐	☐
I use my mobile phone mainly for entertainment purposes	☐	☐	☐	☐	☐
I use my mobile phone mainly for functional purposes	☐	☐	☐	☐	☐

Where do you usually keep the phone/device(s) stored while you ride?

- ☐ In the pocket of my riding pants
- ☐ In the pocket of my sweater/hoodie/t-shirt
- ☐ In a fanny pack/separate bag that I take with me
- ☐ In a boot
- ☐ In underwear (like in the bra or tucked in waistband)
- ☐ In other places (please specify)__________

Rate the following statements

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree

My phone/device(s) can easily get damaged in an accident when stored where I usually store it/them	☐	☐	☐	☐	☐
My phone/device(s) can easily fall out of the place where I keep it/them	☐	☐	☐	☐	☐
I can easily access my phone/device(s) from where I store it	☐	☐	☐	☐	☐
In case of emergency, I would like to access my phone to get help	☐	☐	☐	☐	☐

Have you ever had a horseback riding accident? It could be an accident in which you, someone else or the horse was injured. It could also be any situation in which you needed help while horseback riding.

☐ Yes
☐ No
☐ I do not know, or I would rather not say

What was your physical state right after the accident?

☐ Unharmed
☐ Unconscious
☐ Physically injured in the head
☐ Physically injured in extremities
☐ Physically injured in another form
☐ Other:__________

How were you feeling after the accident?

____

How did you request or try to request for help after the accident?

☐ I personally requested the help
☐ Someone I was with requested the help
☐ Help was not needed
☐ Help was needed but not requested due to inability to do so
☐ Help was requested in another way:__________

What kind of assistance were you provided with after the accident?

How long (in minutes) did you have to wait before the assistance arrived?

____

Thank you for participating in this survey! When pressing "Finish", your data will be stored.

Appendix B

Interview Consent Forms

Vil du delta i forskningsprosjektet

«Nødstøtteverktøy for ryttere»?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å forstå hva hesteryttere trenger av en IKT-basert løsning i krisesituasjoner. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Formålet med prosjektet er å forstå hva hesteryttere kan trenge av en IKT-basert løsning i krisesituasjoner ved å spørre om tidligere krisesituasjoner som disse ryttere har vært i. Vi vil også spørre om andre detaljer som om ryttere pleier å ta telefonen med seg og om de pleier å ri alene for å forstå mer om situasjonene de kan befinne seg i.

Dette forskningsprosjektet er en masteroppgave. Intervjuet vil svare på følgende forskningsspørsmålet: Hvilke designaspekter bør vurderes når et IKT-basert verktøy som hjelper hesteryttere i potensielle nødsituasjoner skal implementeres?

Hvem er ansvarlig for forskningsprosjektet?

Martin Wulf Gerdes (veileder) ved Universitet i Agder (UiA) er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?

Du ble spurt om å delta fordi du rir hest og du har opplevd en hesteulykke tidligere. Rundt 4-5 personer vil bli spurt om å delta i intervjuet.

Hva innebærer det for deg å delta?

Hvis du velger å delta i prosjektet ved å svare på intervjuspørsmål vil ta deg ca. 15-20 minutter. Intervjuet inneholder spørsmål om tidligere hesteulykker du har hatt, hva slags hjelp du trengte i den situasjonen og andre detaljer om hvordan du pleier å ri (alene/med andre, tar med telefonen eller ikke…). Dine svar fra intervjuet blir registrert ved lydopptak.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger

Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

- Sandra Ackermann Gutierrez (student), Martin Wulf Gerdes (veileder), Santiago Martinez (bi-veileder) og SurveyXact (databehandler) vil ha tilgang til personopplysningene dine.
- For å sikre at ingen uvedkommende får tilgang til personopplysningene, vil navnet og kontaktopplysningene dine bli erstattet med en kode som lagres på egen navneliste adskilt fra øvrige data.
- Deltakerne vil ikke kunne gjenkjennes på rapporten og bare anonyme opplysninger vil publiseres.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?

Opplysningene anonymiseres når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er 31. Mai 2021.

Dine rettigheter
Så lenge du kan identifiseres i datamaterialet, har du rett til:
- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?
Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra *Universitet i Agder (UiA)* har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?
Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:
- *Santiago Martinez (916 17 967),* Martin Wulf Gerdes (90798973) ved *UiA* eller Sandra Ackermann Gutierrez (40545907).
- Vårt personvernombud ved UiA: *Ina Danielsen, ina.danielsen@uia.no*

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:
- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen

Martin Wulf Gerdes (Veileder)

Santiago Martinez (Veileder)

Sandra Ackermann Gutierrez (Student)

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet "Nødstøtteverktøy for ryttere", og har fått anledning til å stille spørsmål. Jeg samtykker til å delta i *intervju.*

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

09.03.2021

(Signert av prosjektdeltaker, dato)

Vil du delta i forskningsprosjektet

«Nødstøtteverktøy for ryttere»?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å forstå hva hesteryttere trenger av en IKT-basert løsning i krisesituasjoner. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål
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Dette forskningsprosjektet er en masteroppgave. Intervjuet vil svare på følgende forskningsspørsmålet: Hvilke designaspekter bør vurderes når et IKT-basert verktøy som hjelper hesteryttere i potensielle nødsituasjoner skal implementeres?

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Hva innebærer det for deg å delta?
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Sandra Ackermann Gutierrez (Student)

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Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

-- 11.03.21
(Signert av prosjektdeltaker, dato)

Vil du delta i forskningsprosjektet

«Nødstøtteverktøy for ryttere»?

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Helene T Vøllestad
10.03.21

(Signert av prosjektdeltaker, dato)

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