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Usability of mobile devices and applications for elderly users

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Laurea University of Applied Sciences **Abstract**
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Usability of mobile devices and applications – for elderly users

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The number of mobile devices has increased rapidly during the last years and it is nearing the point where almost everyone owns and uses one. Also, the number of elderly people, more precisely over the age of 65, has increased rapidly and will continue rising in the near future.

The goal of this thesis was to find out if the overall usability of mobile devices and their applications is designed well enough for elderly users and their needs. The aim was to discover the characteristic issues in the design of mobile device interfaces for elderly users and find possible solutions to improve them.

The thesis consists of a theoretical framework and a research part. The theoretical framework based on related extant literature reveals important factors in interface usability as well as elements that should be taken into consideration in an interface designing process. In addition, literature related to elderly people and the issues emerging with aging were examined. This thesis follows the case study technique. Interviews, observing users in action, field tests and project-related workshops were chosen as research methods.

Based on the results, it can be stated that many aging related factors affect usability of an interface and require special attention from the designers. Issues related to aging, such as vision, hearing, mental and physical abilities strongly affect the usability of a user interface. It was discovered that many elements of an interface, which are obvious for younger users, require more polishing and clarity when made for elderly users. In addition, the aspects of experience and, through that, the view of life, should be thoroughly thought through.

The subject is important as the need for mobile devices and applications is constantly increasing. Mobile devices and applications can also offer plenty of assistance for elderly users in their normal routines if designed properly. Several studies have been conducted in relation to elderly users and their mobile device usability. Nevertheless, as the subject is challenging and technology is continuously improving, the topic should be continuously revisited. Therefore, the present study contributes to this literature stream by addressing it from the viewpoint of current technology and the needs of elderly users. In order to create and maintain pleasant usability for the elderly, several studies and hard work is required.

Key words: elderly users, mobile devices, mobile applications, usability, aging

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1 Introduction

Mobile devices are a huge part of our lives these days in this hectic world. There is no way to deny that. Most of us are carrying one of these with them all the time. Wherever you go, you will find people using their cellphones, tablets or laptops for different purposes. Both work time and leisure are combined into these small devices full of different functions and applications to assist and entertain us during our weekly basics. Mobile application markets are full of different applications. You can find something pretty much for anything imaginable. The selection is enormous. Vast selection does unfortunately not guarantee quality in many cases as there are major differeces in usability between different applications and devices. A great idea can easily be ruined by bad execution and especially by badly designed usability. Most of us have various usability experiences of different mobile devices and applications. They often are good and even more often bad, as we tend to remember worse scenarios over the better ones.

After years of using and testing different user interfaces in applications, and having numerous different usability experiences with them, the spark of interest rose with the questions what makes a successful user experience, and which elements should be avoided in their design. This study focuses on elderly users, meaning people over the age of 65.

The subject is very current as mobile devices and the use of their applications are increasing fast at the moment. Nowadays, over a billion smartphones are shipped each year (Barker et al. 2013). Their quantity has been growing rapidly during the last few years, and it is still increasing, as the picture (fig. 1) below shows.

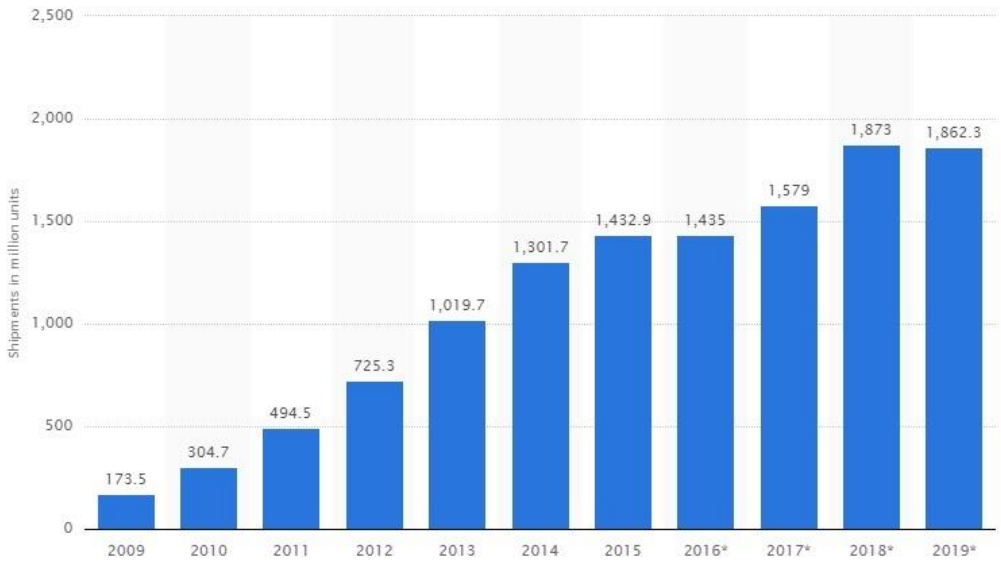

Figure 1: Shipments in million units (Statista 2016)

This thesis inspects the usability of mobile devices and their user interfaces especially for elder users; it familiarizes with how the usability can be improved and how it is evaluated. Questions reagarding what different users value are essential. The main focus is on elderly users, more precisely retired people over the age of 65, and their values, needs and requests for mobile device applications. The goal is to find out if the elderly users are taken into account well enough in general mobile application development.

The final idea for the theme of this thesis came from being part of a test group in a Laurea-project called CO'MON (Confident Motion). We had an opportunity to test a newly made prototype of a cellphone application called Companion. After testing the application for a while, more and more illogicalities and bugs came to our knowledge. This got me interested, and gave motivation to find out what it actually takes to make a logical, error-free and simple enough user interface for users from different categories. In this case, more specifically elderly users.

1.1 Objectives

The main objective was to find answers to the question "what are characteristic usability issues in a mobile application developed for an elderly person?" Finding answers to questions such as "what are the most critical usability issues for elderly users?" and "how can they be undestood and improved?" were crucial and getting knowledge about important factors that should be included in every design was also essential. Information was acquired by reading theoretic basics, conducting interviews, observating elderly test users in action and combining own knowledge from years of mobile device usage.

Another important objective is to create guidance for designing an application for elderly persons, which includes the most important and common usability issues that should be recognized during the design process. Requirements vary quite a bit from "regular software designing", and it is important to examine them closer to get a good, comprehensive overview. Hopefully it would guide similar projects in the future by giving "basic knowledge in one package".

1.2 Case descriptions

Two different cases were involved in this study. The first project was called Confident Motion (CO'MON), which was a bigger scale international EU-project that aimed to develop a mobile application for elderly people that would help their daily basises and offer security. The second case was obtaining general knowledge on how elderly people functioned with mobile de-

vices and their applications and getting information about the possible needs and wishes for future development. This was accomplished by user experience interviews.

1.2.1 Project Confident Motion (CO'MON)

As people age, they start to experience a normal decline in many abilities, such as perceptual, motor and cognitive abilities, which can limit their mobility and because of that, independence alike (Leung et al. 2009). Things that used to be obvious are not that obvious anymore. This is not a problem only for some of us, but for most of us at some point in our lives. It is a big part of being what we are, meaning humans. Even minor issues are capable of creating new challenges to normal routines. Challenges could, for example, relate to public transportation, locating correct places, or overall feeling of insecurity when traveling alone. Many elderly persons are afraid of falling down during movement, or being a victim of a crime. These kind of factors demotivate older people from moving, and in the worst scenario, passivate them. CO'MON –project was aimed to give an answer to these challenges. Its main focus was to assist elderly persons' independent traveling by giving them helpful information needed and at the same time increasing the feeling of security.

The application was made for elderly users with at least minor disabilities. Disabilities could have been issues with movement or for example memory. The idea behind the software design was to offer security for an elderly user during his or her daily operations, such as shopping or going to the library. This was accomplished by having a connection between two cellphones over the Companion application. Once the connection was established, the other user (called companion inside the application) was able to follow the movements of the elderly person (called traveler) by GPS-tracking, and also have a chat conversation between them.

The main idea of the Companion-cellphone applications was to enable GPS-tracking for the traveler during the journey. The journey itself could have been located anywhere, and its purpose could have been anything. Everything from basic shopping, walking a dog, or visiting a public library worked. As the software used Google maps, it was possible to be located anywhere around the planet as long as the connectivity and GPS-signals were strong enough.

The application enabled a possibility to follow the traveler via GPS-tracking. Companion, which in this case meant a person who was accompanying the traveler after an invitation, was able to see the traveler's movements in real time, and chat together. Before starting a journey, the traveler had to pinpoint a destiny for the journey. Bookmarked locations were also allowed for the more often visited places to make usability faster and more pleasant. Having bookmarks for personal favorites is often a very welcome feature, but it especially speeds things up when the user is not that familiar with the usage of an application overall. It was

also possible to set the destination as “just going out” without any specific goal. In this case the companion was able to follow movements of the traveler wherever the journey led.

The CO’MON (Confident Motion) project was coordinated by Copenhagen living lab (CLL) from Denmark. The main partners besides CLL and Laurea UAS (University of Applied Sciences) were Enthoven Associates from Belgium, Concept factory from Luxemburg and Xtel from Denmark. Laurea UAS was responsible for managing the tests in Finland and reporting all the user tests in different countries. The project started 1.3.2012 and ended 31.12.2014, and it was funded by European commission under the Ambient Assisted Living (AAL) Joint Programme. Finnish funding was by Tekes. Confident Motion project material was utilized for this information. (CO’MON project materials 2012-2014.)

1.2.2 User experience interviews

The second project for me was to obtain general knowledge from elderly users about their daily routines with mobile devices and applications. Being a part of the CO’MON project gave me ideas I wanted to study closer related to usability for elderly users.

I wanted to gather general knowledge about a proper user interface, and find out the possible generic issues in usability and design from a view of an elderly person. Also obtaining information about the type of applications they mostly used, and for what purpose, was important. Doing user experience interviews was a good way to obtain general knowledge, so I recruited four retired people, who were over the age of 65, and interviewed them. Related questions asked can be found in appendix 1.

2 Aging and mobile device usability for the elderly generation

This chapter is the theoretical framework for the thesis. It contains a vast amount of important information and general rules related to user interfaces and application designing. Also literature related to issues in aging are addressed. In this chapter guidelines made by different persons for user interface design will be examined and compared with each other. Other relevant aspects, such as elderly mobile device users, aging, tactile feedback and button sizes in mobile devices and applications are going to be inspected. Psychological norms that affect aging and through that interface designing and usability will also be investigated.

2.1 Elderly mobile device users

Elder generations might not be as interested or accustomed to newer technology as the younger are, but that does not mean they would not use or need it. There is plenty of poten-

tial support in mobile devices for older adults (over the age of 65), but they have been relatively slow to start using the mobile devices. Different mobile devices are able to support elder users in many ways: for example mobile phones can help older adults to stay connected, innovative memory aids can help them to remember important information and various portable game systems can even provide them with fun and stimulating mental exercise. (Leung et al. 2009.) Well-designed products can be, and already are, a great help for elderly people with some sort of disability. This will become even more important as usage of technology increases rapidly, and increasingly essential. Even if you did not want to, you might be forced to deal with new technology at least occasionally.

As the number of older users increase, many would think they presented a large-scale user group of such technology. This is not the case in mobile phone design though, and the design also is more focused to younger users. It has been reasoned that one reason could be "technophobia", meaning an anxiety associated with using advanced technologies. (Pattison & Stedmon 2006.) The whole design process should be thought separately especially if the product is targeted at elderly people. In this case, elements such as the size of the device, the buttons and more precisely the screen, matter a lot. At some locations, especially Singapore, tablets are purchased by older people much more than younger people. It has been thought that the reason for this is especially the bigger size of the products and the larger, clearer screens. (Barker et al. 2013.)

Figure 2 below shows the age distribution of mobile device users in different countries. As we can see, the age groups up from the age of 65, which are considered as elderly users, are rather sizeable in numbers. The amount of elderly users is high and it will only escalate in the future due to the increase in our lifespan, thanks to e.g. improved medical care. The so called "large age groups" are drawing closer to those ages as well. There is a massive potential market for older users, and whether the developers consider this enough is uncertain. Older users have their own needs and basically totally different heurestics compared to younger users.

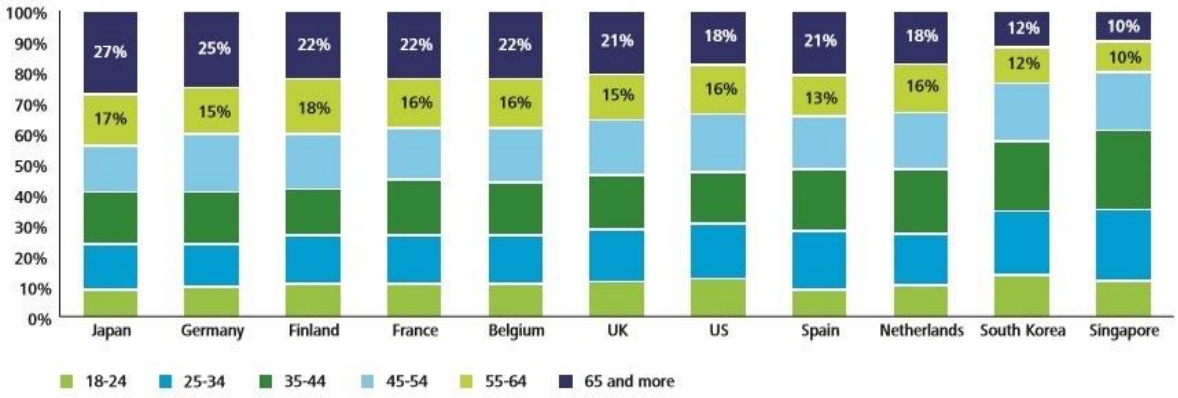

Figure 2: Age distribution of mobile device users (Barker et al. 2013)

The elderly generation also downloads applications to their mobile devices, as the figure below (fig. 3) presents. Even though the amount of downloads is not as high, it still is a notable volume. Depending on the country, the percentual amount of elderly people who downloaded at least one application to their mobile device was around 70-80% in the year 2013. In Finland the amount was 66%, which was a bit lower than other countries listed. Of course, there is a bigger difference when the amount of downloaded applications in total is examined. The young tend to download dozens of applications for different purposes, whereas elderly people might be happy with just a few necessary ones. It should also be taken into account, that the amount decreases as we move to even older age groups, such as 65+.

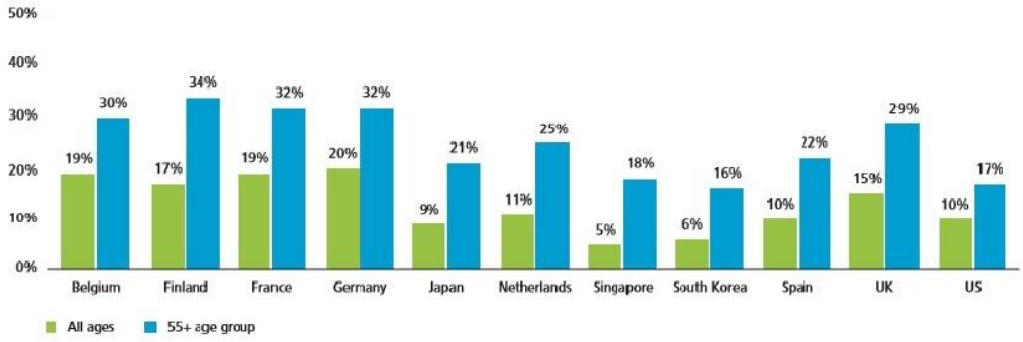

Figure 3: Percentual amount of people who NEVER downloaded application(s) to their cellphones (Barker et al. 2013)

It is also possible that the smart phone owners aged 55 and above may only occasionally connect to the internet with their phone, even though the phone would be made for that purpose. It used to be thought that the reason behind this was the difficulty in understanding the data plans expressed in mega- or gigabytes, or press articles about shocking bills. (Barker et al. 2013.) However, these issues should not be dominating anymore, as data packets sold for mobile devices often include unlimited, or otherwise high amount of data usage without the risk of getting billed extra.

As can be seen from figures 4 and 5 below, the number of older persons has increased a lot since the 1950s. Back in 1950, the total number of people aged over 60 was 205 million. 50 years later the number had increased to 606 million, which is about triple the amount. The growth rate of the number of older people will become significantly higher in the near future once the “baby boomer generation” starts reaching older ages in some parts of the world. (McNicoll 2002.) Back in 2015, there were 48 percent more people aged 60 years or over worldwide than there were in 2000. By 2050, the number of older people is indicated to have more than tripled since 2000. (United Nations 2015.) Figure 4 shows the development of the world population between years 1950 to 2050 in different age groups.

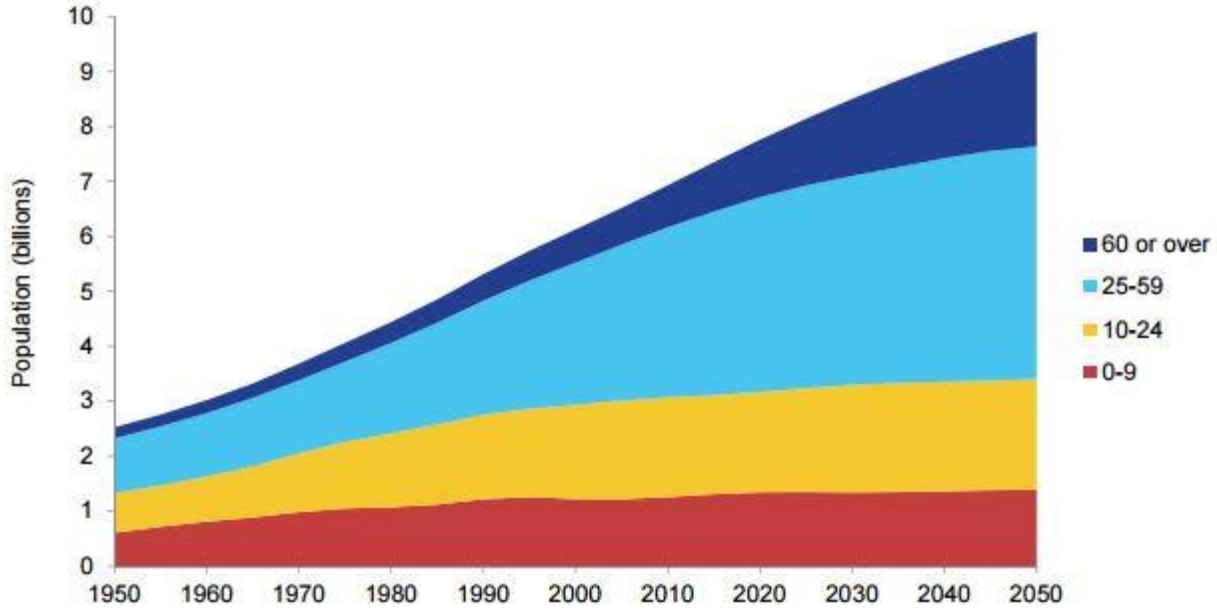

Figure 4: Global population by broad age group, 1950-2050 (United Nations 2015)

Image below (fig. 5) presents the chances in population age structure and increase in world population during years 2000-2050. It shows very well how the amount of people aged over 60 is increasing extremely rapidly.

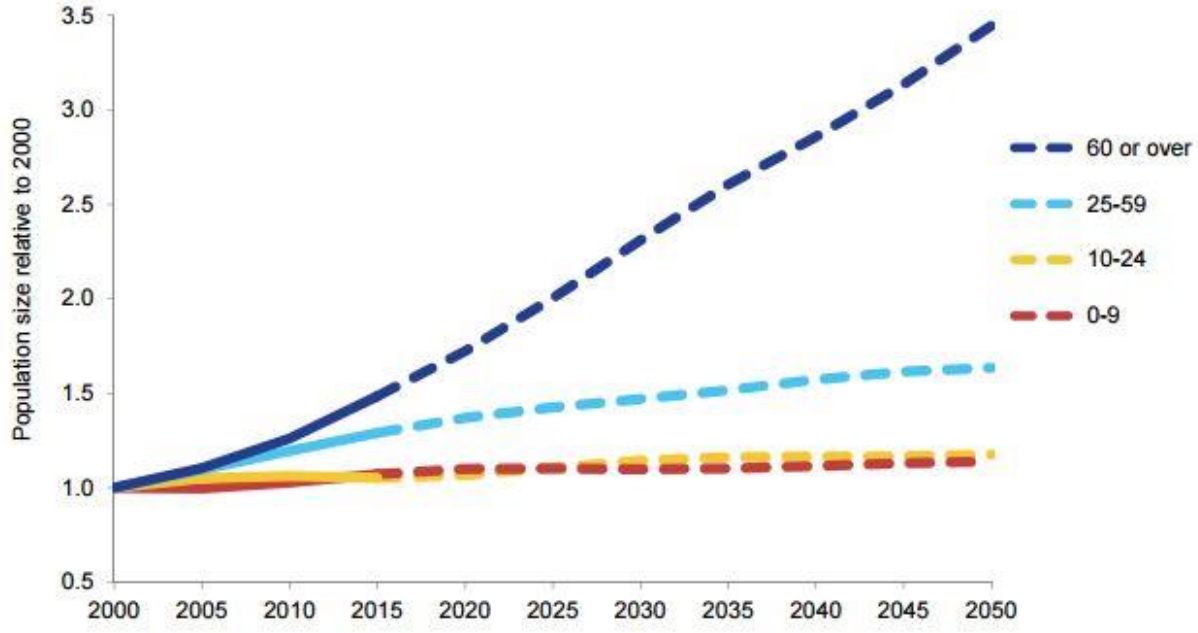

Figure 5: Increase in world population relative to 2000, by broad age group, 2000-2050 (United Nations 2015)

This chapter was brought up to show the raw facts about the increasing number of older people in the world. The growth rate is so high that it simply cannot be ignored. This also enlightens the potential market there is, and especially will be in the future, when it comes to older people and crafting solutions for their needs.

2.2 Definition of usability

“In order for design to be design and not art, it must serve human needs and goals” (Goodwin 2009, 4). According to Goodwin (2009) good design will help humans to accomplish something in an efficient, effective, safe, and enjoyable way. These are the elements all designers should aim their product to assist with.

ISO 9241 is a standard that is widely applied to usability. It includes plenty of information covering every aspect of usability including hardware, software, and usability processes. It can be used for designing a workstation, measuring reflections and colours on a display, or evaluating a graphical user interface for example. (Userfocus 2015.)

Jakob Nielsen (2012) writes about introduction to usability in an article “Usability 101: introduction to usability”. (Nielsen 2012). It answers to questions such as “how to define usability?” and “when and where to improve it?”. Nielsen states that usability is a quality attribute that defines how easy to use user interfaces are. He points out that usability is defined by

five quality components, which are *learnability, efficiency, memorability, errors,* and *satisfaction*. *Learnability* defines the easiness for users to accomplish basic tasks the first time using the design. *Efficiency* calculates how quickly users can perform tasks once they have learned the design. *Memorability* is about the time it takes for users to learn to use the design again when returning after a longer period of time not using it. *Errors* define the amount of errors users make, how severe they are, and how easily they recover from them. In the end *satisfaction* describes how pleasant it is to use the design.

Nielsen (2012) also points out that there are many other quality attributes out there. He especially mentions utility. It refers to the design's functionality and asks the question if it actually does what users need. Nielsen states that usability and utility are equally important: together they determine whether something is useful or not. Nielsen describes the differences of definitions a bit more closely: utility refers to whether the needed features are provided, usability is about how easy and pleasant the features are to use, and usefulness is usability and utility combined. Nielsen also ponders the reasons for why usability is so important. For example if a website is too difficulty to use, does not clearly tell what the company offers, users get lost while browsing the site, or if the information is too hard to read or find, users simply leave. As Nielsen states, there are no website manuals users would read or spend much time figuring out how the site is supposed to work. Moving to the next website is an obvious solution, as there most often are similar products or services available from other companies.

Improving usability is also addressed by Nielsen (2012). He states there are many methods for studying it, but the most common and useful one is user testing. User testing has 3 stages: getting hold of representative users, like customers, asking the users to perform representative tasks with the current design, and observing what the users do. It is important to notice where they succeed, and what are the difficulties they face while using the user interface. According to Nielsen (2012) the key point is to focus on testing the users and allowing them to solve their problems independently. Any help from outside could affect the results. Usually running a smaller scale testing is enough, meaning around 5 testing users.

Nielsen (2012) also talks about the proper time to work on usability. He mentions different steps to consider. At the beginning, before starting the new design, it is recommended to test the old design to identify the good parts that should be kept. It is also important to detect the bad parts to discord. It is also suggested to test competitors' designs. It can be an easy and cheap way to get valuable information and data from alternative interfaces similar to your own. Field studies, paper prototypes, multiple iterations as well as inspecting the design relatives to established usability guidelines are important. Once the final design has been de-

cided and implemented it should be tested again. And perhaps even again, to counter all the possible failures. (Nielsen 2012)

2.2.1 Psychology of usability in designing

Usability is a quality of a product; it can be a computer program, a mobile phone, or any other artifact. It also relies on research done in the field of cognitive psychology, as well as research related to human-computer interaction. (Sinkkonen 2006, 11.) The image below (fig. 6) shows a developing process of a user interface.

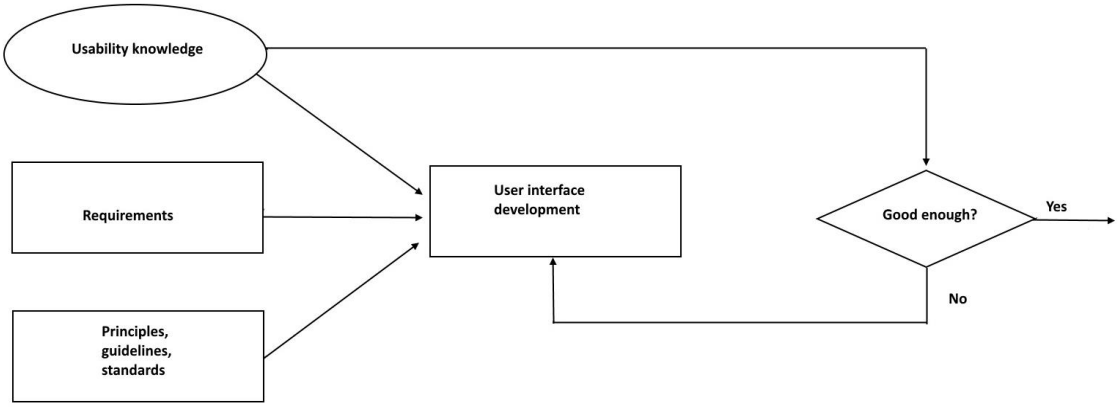

Figure 6: Developing a user interface, based on requirements as well as usability expertise, instructions and standards (Sinkkonen 2006, 11)

Sinkkonen describes some of the users' default attributes. It mentions physiological and psychological structures that we are born with, such as senses, memory structures and basic needs. Language, norms and habits are mentioned as relatively stable cultural attributes and conventions related to operating in technological environments, which can be strengthened if designers follow them. (Sinkkonen 2006.)

Some other factors that influence human behavior are unstable cultural elements, like fashion and subcultures, tasks, invidual limitations and abilities, physical environment and condition for the task and situation of use, meaning changes in illumination or time used per task. These attributes should be taken into consideration when designing a new product with a user interface. Users learn very different things compared to designers while performing their tasks. This is why a section for observing users in action should be included in every product development project. (Sinkkonen 2006, 21.) A very useful method for evaluating design is users trying out the product, or a prototype of it in practice. Asking them to perform different tasks one by one, and inspecting how they manage can be very rewarding. Other usable methods are for example focus groups, which can be helpful at the start of a project to get

quick information if the product idea is even viable, invidual interviews, and direct observation. (Goodwin 2009, 56-67.)

Conventions, meaning basic rules, habits, or agreements are crucial in development of a (mobile) product and are important to keep in mind during the designing process. Breaking conventions too much is risky and might cause bigger issues. New technologies do not always follow the principles and patterns used before. They keep evolving all the time, which of course is understandable. There often are too many incompatibilities between our old mental models, and the new system. For example, a line of text that looks like a hyperlink, but requires a double-click to activate can be confusing. Situations like this slow down our process of learning new technologies. And this gets highlighted way more when the user is an older person with less basic knowledge of the application. (Hannon 2008.) Completely redesigning a product because of conventional issues is probably not the best possible solution, unless the issue is too major to be avoided by any other way. Completely redesigning the user experience can just as well confuse the users who are used to the current version. In the worst screnario too radical changes lead to a loss of users.

Human actions play a big role when it comes to usability. There are plenty of different models for describing human actions. One of the most used ones, if not the most used, is Norman's model. It consists of seven stages, which are split into three groups. The first group is **defining a goal** which consists of forming a goal and the intent to act. The second group is **performing the action or function** including planning the action and performing the action. The third and last group is called **checking the effects, or evaluating the action using feedback**, and it includes observing feedback, interpreting feedback, and comparing feedback and goals. Figure 6 below shows Norman's action model.

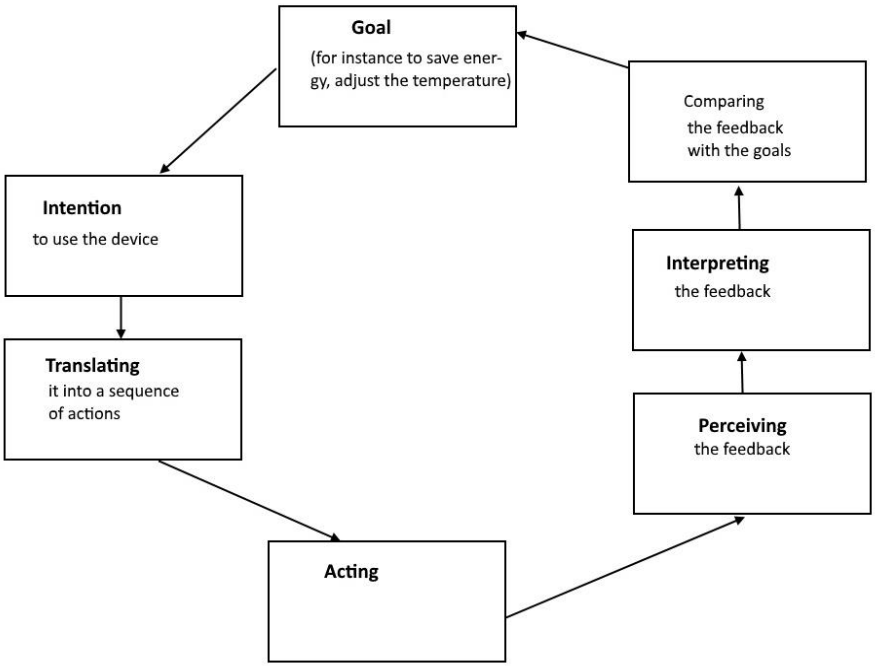

Figure 7: Norman's action model (Sinkkonen 2006, 44)

For a designer, it is also important to understand human perception. The most important things for a designer to understand about human perception are that users do not perceive all presented elements in the interface. It is also good to note that designers cannot see the interface like novice users. For designers, each part of the product has a meaning unlike novice users. Of course with more usage and knowledge about the product this can be improved. Once a person looks at a new product, the entire experience of the world affects how it is understood. This gives plenty of variation to interpretation of an application. Also recognizing familiar forms and elements is very precise if these forms have a meaning to the user. (Sinkkonen 2006, 56.) For several reasons, it is essential that people who are involved with the design also conduct all of the interviews. Designers are more effective at gathering needed and valuable data, and especially experienced designers are able to use it effectively to solve possible problems in design. (Goodwin 2009, 58.) This could also speed up the design process as there are less hands involved; received data comes directly to the person responsible for designing, and the needed changes to it can be made right away if needed. Goodwin (2009 572) says: ”Products should be like good waiters: unassuming and unobtrusive, but always anticipating need and learning preferences”.

As stated above, an entire experience of the world affects how an invidual person understands a new product. This is a major point where huge differences come in when younger and older users are compared. Their visions, experiences and knowledge of the world are most likely very different, which creates two totally distinct points of view. These points

should be kept in mind when planning a new user interface for an application. Even small things can make an application more appealing to users from different categories.

If we assume that people generally start at a similar point with same functions and abilities, once they become older they have gathered lots of different experiences, perceptions and mental models of the world. They may have suffered from different physical and mental issues as well. Pattison and Stedmon (2006) adds “from a similar starting point older users will have travelled and deviated further than other user groups and therefore be further away from design homogeneity.“ (Pattison & Stedmon 2006.)

Designers should also worry about how to present the information and how much of it there actually is. Finding balance between too much and too little information may be hard, but important. It is also vital to have a logical order for the stuff presented with a clear starting point. Other things like hierarchies, aesthetics, and visibility are also in an important role. A good interface should contain a visual appereance that supports all functionalities of the application. (Sinkkonen 2006, 95.) In a system or an application with a GUI (graphical user interface) symbols and icons are essential. Users will learn that certain icons, logos, or symbols mean possibility for certain action.

There are plenty of mistakes that often occur in an interface design. The most common and typical mistakes in interface designing are: Overall poor design with poor visual structure, not knowing when to stop working on it, unnecessary complexity, excess noise, bad balance between background and foreground, elements that are competing for the users attention, sloppy element definition, and gratuitous metaphors. Also polishing details of secondary importance, constructing unnecessary milieus and frivolous animations and 3D-effects occur often. (Sinkkonen 2006, 140.)

2.2.2 Functionality of memory and mental models

Understanding how our memory works is important when it comes to designing new interfaces. As we are only capable of remembering a certain amount of information, especially in short-term memory (sensory memory), it is essential to realize it when designing features. Our memory is comprised of three separate entities. Each one of these has its own, special function. (Sinkkonen 2006, 149.)

Sensory memory is the shortest memory we have. Information is only stored for a couple of milliseconds. For example, watching a movie shows the viewer a series of static images which are combined into a perception of a progressing movie. All this happen in the sensory memory. (Sinkkonen 2006, 149.)

Working memory is the part where information is stored for a short period of time. For example calculations and remembering phone numbers highly require working memory. As a downside, the contents of working memory will be destroyed once new things occupy a person's mind. Also any kind of disturbance or distraction can affect it. (Sinkkonen 2006, 149-150.)

Long-term memory, which is basically the base of all the memories we have. A big difference to sensory- and working memories is the fact that long-term memory is not emptied. Some theories even state that information never leaves long-term memory – it is just not always "available". This is not a proven fact, though. Life experience, knowledge and skills are all stored in long-term memory. (Sinkkonen 2006, 153.) Even though many wouldn't agree at first, forgetting is considered to be one of the most important attributes of memory. Without it, we would be living in a total information chaos. (Sinkkonen 2006, 156.)

Memorability is an important attribute also mentioned by Nielsen (2012). Applications should not be too complicated to remember and moving information from menu to menu should be minimal. This becomes even more important when an application is targeted at elderly users that might have some sort of restrictions. (Nielsen et al. 2012.) Elderly people maintain the ability to learn, but the process takes more time especially when it comes to complex material (Pattison & Stedmon 2006).

Once making decisions, the amount of options that can be properly processed is limited. This is because of the strain placed on the working memory. When it comes to complex decisions, the number of options available is directly reflected to the possible errors and the time spent on making a decision. If the consequences of a decision are not known, it gets even more complicated. All the options should be visible and easily noticed inside the product. This is especially important for novice users. Before a decision is made, the product should not react at all. (Sinkkonen 2006, 172.)

Problems can already easily be generated when using a new product without the knowledge of what to do exactly. This is a critical problem, which must be solved. It could be said that "any goal-oriented task that is not a routine procedure is a problem". Visible aspects of the interface are usually relied upon solving interface-related problems. Especially for novice users the general methods of problem solving can be quite limited. Because of this, old habits might be chosen first when a new problem occurs. Users often prefer an old, familiar way of doing things instead of a newer and more efficient method. (Sinkkonen 2006, 173-175.) It has been noticed that older users show a keen interest to learn and use advancing technologies, but unfortunately they often feel that they aren't fully equipped to do so (Page 2014).

Mental models mean our knowledge of something. These models can be used to explain why a product functions the way it does, for example. Users use existing schemata or their general knowledge of the product type to create mental models. These models may not be very accurate because people do forget details and it's also possible to confuse products with each other. Assuming things that are not true happens often as well. Accuracy depends a lot on how the user uses the product. When it is used successfully, models are improved to a level the user needs. People can also have several different mental models of the same product. (Sinkkonen 2006, 176-182.)

Learnability is one of the key points of usability. The ISO 9241-11 standard describes learnability through three parts; productivity (how many functions have been learned and what percentage of users have learned things), efficiency (how much time is used learning and relearning things), and pleasentness (how easy it is to learn the product). Training and practicing to use a product easily costs even more time and money than making the product easy to use by default. Difficult products generate negativity in users and they will start avoiding using them as much as possible. (Sinkkonen 2006, 193.)

During the designing process this should be taken into account. Too complex products most likely will not succeed on the market because of the negativity using them creates. For example some of the applications people are forced to use at my work create very negative feelings all around as the usability is slow and extremely unpleasant. People will rather use an easier version of similar product and save the extra education costs and other hassle it may cause. These days it is also very likely that there are similar products out there so there is less margin for failures.

Motivation in a design process is also an important thing to ponder. Motivation has been divided into three different sources. The first one is *situation specific motivation* (temporary fascination with external factors), the second *opertant motivation* (based on striving for an external prize), and the third one *content specific motivation* (based on interest in what is being learned, or its pontential uses). The last group, content specific motivation, should be carefully considered during product designing. This group contains great masses that are interested in the potential uses of the product. (Sinkkonen 2006, 197.) Issues such as anxiety, fear, computer literacy, beliefs, attitudes, acceptability and so on can be placed under the term motivational issues for the elderly people. Motivation is essential for learning and it can be stimulated by the use of technology. (Holzinger et al. 2007.)

2.2.3 Usability heurestics and important rules for a user interface design

Nielsen (1995) has investigated about 10 general principles for interaction design. “They are called “heurestics” because they are broad rules of thumb and not specific usability guidelines”, states Nielsen. These are the ten heurestics listed by Nielsen:

1. **Visibility of system status**, meaning the system should always keep users informed of what is going on by giving proper feedback within reasonable time.
2. **Match between system and the real world.** System messages should be clear. The system should “speak the user’s language” by using common words and phrases familiar to the user. Using system-oriented terms could cause big issues in understanding them.
3. **User control and freedom.** Users make mistakes while using the system, so there should be a “clearly marked emergeny exit” which is easy and fast to use without any unnecessary dialogues. Undoing and redoing should be supported.
4. **Consistency and standards.** This means that users should not have to wonder if the different words, situations or actions stand for the same thing.
5. **Error prevention.** A design that prevents a problem from occurring in the first place is naturally a better solution than even a good error message. “Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.”
6. **Recognition rather than recall.** Minimizing users’ memory load is important. This can be done by making objects, actions and options visible. Users should not have to remember information from one part of the dialogue to another. Instructions should also be visible.
7. **Flexibility and efficiency of use.** The point behind is to allow users to modify their frequent actions.
8. **Aesthetic and minimalist design.** No irrelevant information in dialogues. Keep everything as simple as possible.
9. **Help users recognize, diagnose, and recover from errors.** Error messages should be plain and understandable. No codes – instead the problem should be indicated precisely, and if possible a solution to a fix should be suggested.

The picture below (fig. 8) is an example of a bad way to present system error. The user will not get any helpful information out of this “blue screen”. System “stop” –message is presented as a string of codes which does not tell anything to a basic user.

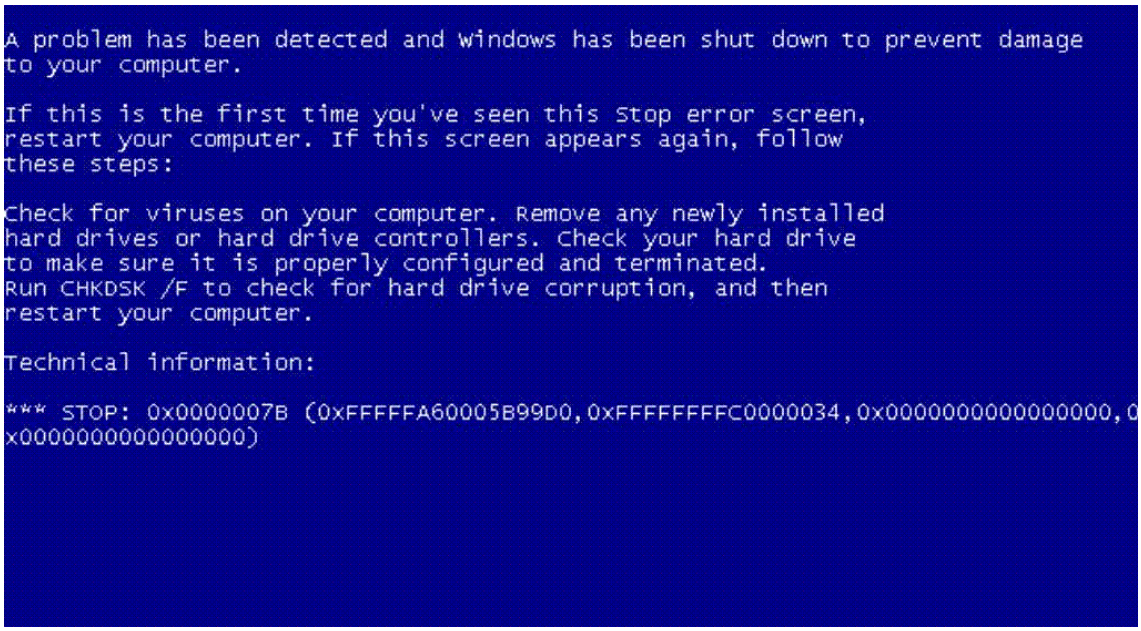

Figure 8: Windows XP "blue screen" (Fix Windows Xp Boot Blue Screen 2016)

10. **Help and documentation.** Sometimes it can be necessary to have some sort of help and documentation for usage. In this case it should be easily reachable. (Nielsen 1995)

Shneiderman (2010) has also been investigating interface designing and written rules about it called "The eight golden rules of interface design." Some of these points are quite related to Nielsen's heurestics, which highlights their importance even more. These eight rules are well-known in interface designing.

Ben Shneiderman's (2010) eight golden rules (fig. 9):

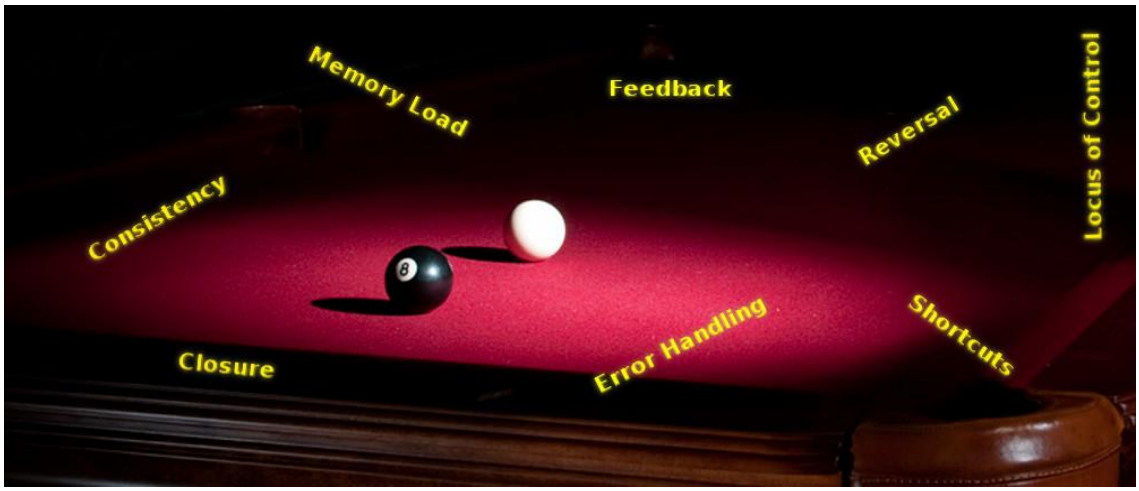

Figure 9: Shneiderman's eight golden rules (Obenndorfer 2013)

Shneiderman (2010) has explained his eight golden rules more closely:

1. **Strive for consistency** means that identical terminology should be used in prompts, menus and help screens. Also elements such as color layout and fonts should be consistent.
2. **Cater to universal usability** means that different types of users should be recognized. Novices, experts, younger and older people and even people with disabilities should be taken into consideration when planning the interface. Different features for different users are important; for example help tips for novices and shortcuts for more experienced users. Easy and simple solutions can make the application reachable for a new group of people.
3. **Informative feedback** should be offered, whichever action you take. Basically, the bigger the action, the better feedback should be received.
4. **Designing dialogs to yield closure** is important. Sequences of action should be organized into groups with a beginning, a middle, and an end. Feedback given after a sequence of actions is complete gives a user satisfaction and prepares for the next group of actions.
5. **All the possible errors should be prevented**. The system should be designed so that users cannot make serious errors. In case an error happens, the interface should detect it and offer a solution with instructions to recover from it.
6. **Permitting easy reversal of actions** means actions should be reversible. Being able to undo errors can encourage users to try unfamiliar options.
7. **Supporting internal locus of control** is important specifically in some cases. Especially experienced users desire the feeling of being in charge of the interface and all the

actions it does. Unnecessary surprises or new procedures that might slow down the process are often not welcome.

8. **Reducing short-term memory load** is relevant as we have a limited capacity on our short-term memory, which is the reason designers avoid interfaces where users must remember information from one screen and move it to another. A couple of examples are given, such as re-entering a phone number to a cellphone should not be needed, and the website address should remain visible. (Shneiderman & Plaisant 2010.)

There are many reasons for the importance of products that are user-friendly, easy to use and overall made in high quality. With them it is highly possible to gain benefits that improve business and competitiveness. There are plenty of other possible positive factors related. For example, application introduction can be run smoother. Training of the application usage can also be reduced, or in the best case, not needed at all. This can also reduce resources needed for educating resellers and delegates. This relates to the need of user support, which will also reduce. Getting to the point where a user interface is so simple to use that the amount of instructions and other documentation can be reduced is also one way to make profit, and naturally also make the usage more pleasant for the user. With good usability, applications are simpler with less unnecessary features. It is highly likely, that a product with good usability has a longer life cycle on the market. If the interface is built well, it is also cheaper to maintain in the future. Work processes for end users can also be enhanced by having a clear and simple basic structure for the interface. It is also likely that users make less mistakes when the interface is built clearly. In the end, users are happier as the user experience is positive, which can affect to possible boosts in sales. (Jokela 2010.) Keeping these points in mind while designing a new interface can be rewarding in the future.

Focusing on communication is extremely important. Things such as what is important, and what are the needs or wishes of the personas at various points of their tasks, and what input the system needs, are crucial. Other important principles that should be taken into consideration are visually communicating what elements of an interface do, using visual hierarchy to emphasize important information and controls, having a purpose for every element and a reason for every decision, repeating (same) elements for unity, and being decisive but using the smallest effective differences. (Goodwin 2009, 573.)

Good design also makes it as easy as possible to find important information and controls by drawing attention to them. Designers have a great responsibility to make this happen with some good solutions. Less important items do not need that much attention. (Goodwin 2009, 576.) It is possible to create a clear visual hierarchy by using contrast in visual properties. This basically means using different colors, shapes, sizes and positions. It is also worth mentioning that the stronger the contrast, the clearer the hierarchy. Contrast can be strength-

ened by toggling multiple properties but while doing this it is good to keep in mind that toggling every feature is easily an overkill. (Goodwin 2009, 577.) Representation of data should never visually mislead. In a good design correct and important information is presented immediately and at first glance. (Goodwin 2009, 580.)

Using icons to inform about objects and tools can be complicated in some cases. In first-time use icons usually are not the best possible solution, but they are very handy in file systems and lists for indicating object type and status. They are often good choices in productivity applications, since they reserve less space than text labels. Sometimes they can also be useful for communicating ideas to an international group of people who do not speak the same language. According to Leung et al. (2009), it seems likely that decline in perceptual and cognitive abilites, which accompanies normal aging has some effect on elderly users ability to interpret graphical icons.

Many things should be thought about when designing recognizeable icons. An important thing to remember is the order in which we recognize things; shapes are recognized quickest, followed by colors, and only much later by texture and other details in surface. Experimental data shows that simple, schematic icons with distinct shapes are way more recognizeable than highly detailed ones that might try to be too realistic. Basically the more visual information there is, the longer it takes to understand it. Icons with borders, or all with the same shape, take even more time to figure out. Icons are often rendered to smaller size, often as little as 16x16, which does not allow for much visual information. This just highlights the importance of simple design. (Goodwin 2009, 582-583.) The design of the icon greatly affects its usability, and also improves the usability of the target application (Leung et al. 2009). In conclusion, good design should nearly always minimize unnecessary memory, motor, mental, and visual work (Goodwin 2009, 573).

2.2.4 Guidelines for user interface design

Studying Nielsen's (1995; 2012), Norman's (cited in Sinkkonen 2006) and Shneiderman's (2010) usage guidelines closely gives a great overview, as they are often stated as a "backbone" for good usability in a device or an application. Later on, during inspection of functionalities of mobile devices and applications, these rules are there to assist and give correct direction.

2.3 Usability in mobile devices

When it comes to differences between usability of a mobile device compared to a non-mobile device, such as a desktop computer, many differences can be found. The most noticeable difference is the touch screen and its usage; no human interface devices (HIDs) as the keyboard or the mouse are required at all. This completely changes the user experience. Due to this, touchable buttons play a big role inside an interface. Tactile, vibration based feedback is a also a notable difference. If it is done properly, it can be a huge assist in certain situations. Mobile devices also most often include functions such as GPS-tracking, Bluetooth-connectivity etc. that open new possibilites for application designing.

2.3.1 Tactile feedback

Workers at Nokia Research Center had a research related to tactile feedback for a mobile touch screen button. This means the “vibration” feedback the user gets while making a decision and pressing a button to execute it. They committed three different experiments with different variations to learn the best possible solution.

The first experiment was implemented with the usage of piezo actuator enchanced touch screen device. It combined feedback of tactile and audio. Piezo actuator solution enabled various pulse shapes. The feedback was given both when the button was pressed and released. The second experiment was done by using vibration motor. It investigated “the subjective perceived pleasentness of different tactile feedbacks for a virtual button in a vibrotactile enhanced touch screen. Both devices looked identical. The third experiment was a mix of both earlier mentioned. Image below (fig. 10) shows the device used in testing.

Figure 10: Device used in testing (Koskinen et al. 2008)

As a conclusion, it was found in the study that a keypad with tactile feedback was more efficient and pleasant to use than one without it. Results also suggested that tactile feedback improves usability and that piezo feedback was slightly faster to use and its error rate was a bit lower. Piezo-style also received the highest score in the general preference from the users compared to vibra feedback. The results show that tactile feedback not only improves the usability of virtual buttons, but also the user performance and satisfaction. (Koskinen et al. 2008.)

Tactile feedback should be designed even better, and more precisely, when designing an application or user interface for elderly users. It should be extremely clear in every situation it is used in and add no confusion at all. It has been stated that, for example, poor vision can be supported by tactile feedback (Pattison & Stedmon 2006). For a less experienced user with possible minor or even major disabilities getting proper, clear feedback is important. It should also be considered if tactile feedback is necessary in every situation, or is it actually more clear for the users if there wasn't any at all.

2.3.2 Touch screen and touch screen button sizes

Designing proper touch screen button sizes inside the application is essential. It is an important task, and it has been found out that touch screen technologies does not only cause frustration between older users. Younger users also find difficulties with it, but adapts better to new technological changes. (Page 2014.) This kind of shows how important and challenging design issue this can be.

User interface controls must be big enough to capture fingertip actions. Larger targets should be used, with a size minimum of 8mm. All the interactive buttons and clickable text should be big enough (Kobayashi & Hiyama 2011, 96). Too small targets cause frustration and erroneous actions. While investigating different propositions for the optimal button size different variations were found. For example Apple recommends a minimum target size of 44 pixels wide 44 pixels tall whereas Microsoft suggests recommended touch target size of 9mm/34 pixels and a minimum size of 7mm/26 pixels. Microsoft also adds that minimum spacing between elements should be 2mm/8 pixels and the visual size of a UI control 60-100% of the touch target size. (Wroblewski 2010.)

Apple's recommendation was made for iPhone. It is important to point out that the sizes of the screen and the device itself increase all the time. Also the resolution keeps getting better and better as new devices are released. Then again, the differences won't change too dra-

matically forever, because there is a certain size limit for a mobile phone. It isn't that mobile anymore if you can't for example easily fit the device inside a normal pocket. Currently one of the biggest models available comes with a 5.7" screen. It isn't that realistic to get much bigger from that, if we're talking about mobile phone that is supposed to fit into a normal pocket. (Wroblewski 2010.)

Lastly, Nokia suggests that touchable interface elements should not be smaller than the smallest average finder pad. This means no smaller than 1 cm (0.4") in diameter or 1 cm x 1 cm square. Nokia also adds some more specific information, such as the size should be 7 x 7 mm with 1 mm gaps for index finger usage and 8 x 8 mm with 2 mm gaps for thumb usage. They also state that list type of components should have a minimum of 5 mm line spacing. (Wroblewski 2010.)

Gap between intended and actual touch locations should be addressed due to higher possibility that elderly users might miss the target areas. This is because of larger contact area of each finger. It was also noticed in an experiment that elderly people prefer dragging and pinching operations instead of tapping. (Kobayashi & Hiyama 2011.) This should be inspected more closely and though through in a design process.

The image presented below (fig. 11) shows an example how the same sized buttons differ depending on the screen size. It should be considered during the design process, if the same button size fits on all different mobile screens, or should it be tailored to different versions depending on device model and screen size.

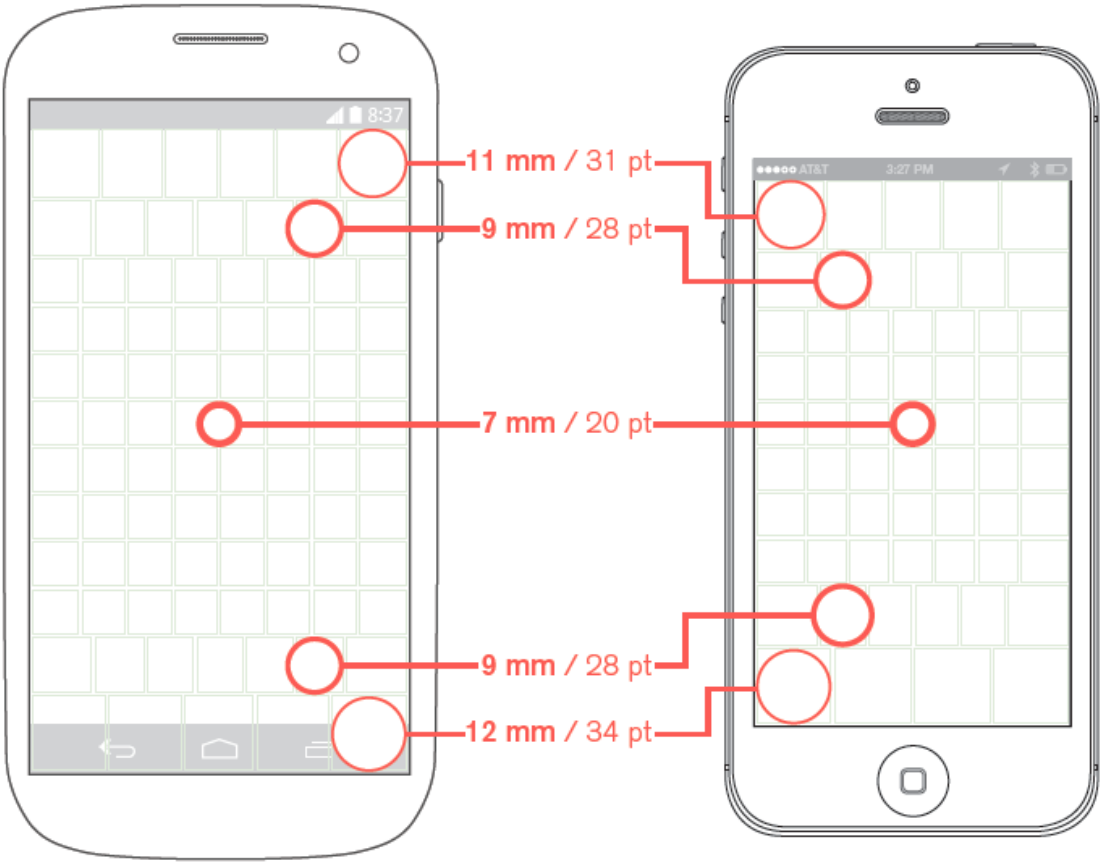

Figure 11: Comparison of button sizes on different screens (Hoober 2014)

2.4 Challenges in design for elderly users and aging related issues

Classical aging related issue is to see the difference between period, age cohort and individual aging. This is so called APC-issue, meaning Age, Period and Cohort. (Ilmarinen 2006, 61.) The core issue is that noticed effects necessarily aren't caused by aging, but could also be related at being a part of some certain generation, or be caused by currently ongoing phenomenon (Jyrkämä 2003, 99-100). Periodic effect mean those remarkable changes that has occured on a certain date to, for example, people at working life. For example improvement of information technology could be this kind of remarkable change. Effect of age cohort signifys about a cohort that has occured on some certain moment and whose life has been affected by the birth moment. Individual aging differences in aging mean differences in health, values, attitudes, physical, psychical and social performances. (Ilmarinen 2006, 61.) Explanation to this classic problem is according to Ilmarinen (2006) that individual differences in performance are more significant than differences between age groups. Also education, work experience and profession matters more than age. (Ilmarinen 2006, 62.)

Due to some possible limitations that aging unfortunately brings to all of us at some point in our lives, challenges in designing products for elderly users that are easy and pleasant enough

to use increases. As usage of mobile solutions increases rapidly, their need also grows in all age groups. There are many possible challenges that should somehow be solved during designing. Even though the technology design advances, older people still remain slower at adapting new technologies (Page 2014). As users age, their requirements keep changing. Designers should stay sensitive once modifying their user needs and keep in mind that eventually they might become the users themselves. (Pattison & Stedmon 2006.)

The main issues that aging usually brings are related to visual, audio, physical and mental states. Every one of these are somehow related to usage of an interface. It is stated by another study that amongst the cognitive factors that decline with age are memory functions and spatial abilities, which are required for accurate navigation. Motor behaviours change meaning it can take longer to make similar movements as younger people. Older people also tend to have reduced working memory capacity. (Page 2014.) It is good to keep in mind that the effected areas of decline caused by aging vary a lot between different persons due to reasons such as lifestyle, personal differences, amount of exercise, work and so on (Pattison & Stedmon 2006).

Designers should be capable to produce usability in an interface that is graphically clear to use with big enough icons, for example. Detail of visual information and information that could be counted as "useless" can be off putting for elderly people (Page 2014). Interface should also give clear audio feedback in case it's needed and used inside an application. Sound effects, that aren't clear enough or doesn't play with high enough volume, can be very hard to understand even for a younger user. Aging has been shown to have some sort of effects on the ability to interpret and respond to more complicated auditory information, and it also affects on capability of hearing higher frequencies (Pattison & Stedmon 2006). It should be thought through in case audio feedback is used, if text feedback should also be included, so users could read what's happening at the same time if hearing is an issue. Though hearing audio feedback can be an issue for anyone if the application is used at a noisy place.

When using mobile devices, physical limitations comes forward most often when dealing with touch-screen and trying to navigate with it. Some older people have issues with their hand and finger movement, and this obviously creates own challenges while using smaller mobile interfaces with tiny buttons. For example, aging can affect to hand and motor functions which can be noticed as a loss of strength, dexterity and range (Pattison & Stedmon 2006). Pressing tiny buttons can be very inaccurate and cause high amount of errors and frustration. Mental state can also affect usability in different forms. For example, if memory has been weakened, it's very hard to remember previous actions or information that was given earlier. Also learning new can be a lot harder than it used to be, which slows down the process of learning new applications. These points highlights importance of well-made memorability in-

side applications, and overall easy and simple usability that is fast and painless to learn, even for a novice user. It has been stated that complicated multi-functional devices are often more challenging for older users in comparison to younger ones (Page 2014). It was also found in another study that benefits of linear navigation and clear wording (for example “undo” vs “cancel”) are very important in a design for elderly users (Grindrod et al. 2014).

3 Research progression and methodical solutions

There are several forms of social science research and case study is one of them. Others include, for example, experiments, surveys, and histories. If the main research questions are “how?” or “why?”, a researcher has little or no control over behavioral events, or the focus of study is a contemporary phenomenon, then case study research is the preferred method. (Yin 2014, 2.)

This thesis followed a case study technique. It was built around two different sections. First one was the data gathered during CO’MON-project which was related to mobile application named Companion. Second section was the user experience interviews and data collected from them about mobile device and application usage of elderly people.

Case study process is a linear, but iterative process. It follows different steps which are partly combined with each other. There are total of six different steps to look at closer, and base the case study to. Figure 12 below shows all the steps and how they’re related to each other. Information was produced to each of these steps and reflected to own study. The plan was to study Yins Case Study Research –book and compare own studies to Yins methods.

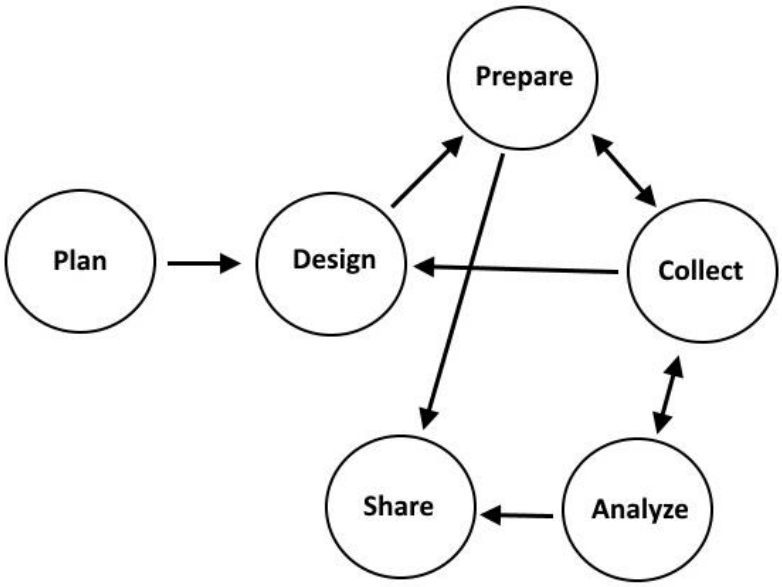

Figure 12: Case study steps (Yin 2014)

3.1 Plan

Planning is the very first step before a case study is launched. Without a plan, wether it is good or not, it is pretty much impossible to start doing a research. In normal cases the plan is made for an ongoing, or a future project. In this case, though, some of the information had already been gathered while ago when a relevant project was going on. The most important thing in planning, and actually for the overall project, is defining a case study research question. It should be built around the questions “how?” and/or “why?”. It is such an important task that people should be patient and give it enough time to fully develop to its whole potential. Building a study around the wrong or otherwise bad research question is not recommended, and could highly affect to the quality of the research. After the question and project subject definitions are done, it is time to get started. (Yin 2014, 11.)

Research questions in this thesis were built around usability of mobile devices especially for elderly users, who in this case are retired people over the age of 65. Precisely there was a need to get answers to question “what are characteristic usability issues in a mobile application developed for an elderly person?” Getting answers to questions “what are the most critical usability issues for elderly users?” and “how can they be understood and improved?” were also high in priority.

Background material from the CO'MON project field tests was utilized in this study widely. I personally created the questions for the field test interviews, gathered the feedback from them and analyzed it. User experience interviews, and their questions, were also done by me.

3.2 Design

Once data is being collected, a research design is the logic that links it to the initial questions of study. Also at this point it is critical to finally define the “case”, or unit of analysis to be studied. It is a good idea to set some limitations to the case so it won’t get totally “out of hands”. Having clear borders helps keeping the case study together. Case study research has five important research design components. They are: a case study’s questions, its propositions, its unit(s) of analysis, the logic linking the data to the propositions, and the criteria for interpreting the findings. (Yin 2014, 29.)

Plenty of information was searched about the basic heurestics of mobile devices and user interfaces to find important features that should be included. Getting knowledge about the points and reasons that actually make an interface or device easy and enjoyable to use without any barriers that prevent the user from getting started, such as too complicated interface, was essential. This all specifically from the view of an elderly user.

During the design process it had to be pointed out wether the study was going to be a single or multiple case study. This case study follows the single case study method, but uses multiple methods to examine the same case. Units of analysis were different elements, features and functions of a user interface. Companions (application) functionality was fully investigated in different situations and figured out if the application actually was worth it for future development, and if it was, what were the most critical needs for patching. During the interviews it was important to get more valuable information about the needs and desires of an elderly user.

The Confident Motion (CO'MON) project gave the basic guidelines and the idea for this case study. Later on focus was more on elderly userbase and their values and needs. Many issues were pointed out during field testing and interviews of CO'MON that required closer study. It is easy to say needs of elderly users differ a lot from the needs of younger users and that is why they require different features from the applications.

Information was searched about properly executed usability and heurestics of application designing. Also literature related to aging and possible issues it may cause that could affect to the usability of an user interface in a mobile device was examined. Nielsen's heurestics and Shneiderman's eight golden rules, for example, gave a good overview about the important features in a well-made application, or user interface. Also other sources gave plenty of crucial information related to application designing.

3.2.1 Designing CO'MON interviews

There were two separate interviews, so they had to be designed twice. The first interviews were fully related to CO'MON-project, and the usability of Companion application. In the second one, called user experience interviews, goal was to get more overall basic information about the features elderly people consider important in mobile applications. These two interviews gave a good overview from different aspects.

The first, CO'MON related interview, had two different sections: questions about the graphical interface, and usability related questions, which were executed as a paper prototype test. My main responsibility was to create the usability part questions. Designing good scenarios for paper prototype testing, which could also return valuable information, took some time. The project team carefully read them through to make them as good and clear as possible, even though the time limit was strict. Presented scenarios had to be clear enough so interviewees understood them clearly and were able to give correct and precise feedback. It also gave a good opportunity to observate how the interviewed people reacted and operated in different scenarios. Their actions, views and ideas were collected for further investigation.

Once the actual interviews started after the second field testing phase ended, first interviews were made. To remove possible errors and practise interview strategy a bit more, the first interview was made to a person who was known better, in this case a relative.

Interviews were either face to face meetings, or phone interviews. Most of them were completed face to face and just a few by phone due to long distances. All the interviews in Finland were done in Finnish, but gathered data was translated to English for the final report. Interviews consisted of two parts, graphical part and usability part, so there were many questions. Each interview lasted about one to one and a half hours. There were 15 persons to interview and the interviews were implemented together between the project team consisting of two students and two project managers.

For the interviews, comprehensive structure was built consisting of questions about the graphical outlook and the usability of the application. As an example, figure 13 presents one of the questions presented during an interview. The idea in this question was to get information if the menu structure, colors and icons were clear enough, more precisely if the markings for bad signal, making a call and sending a travel invitation were presented clearly enough in Companions friend list. Precise question presented was "are the menu views shown in the pictures clear enough? How do you interpret the icons and colors presented around the texts?"

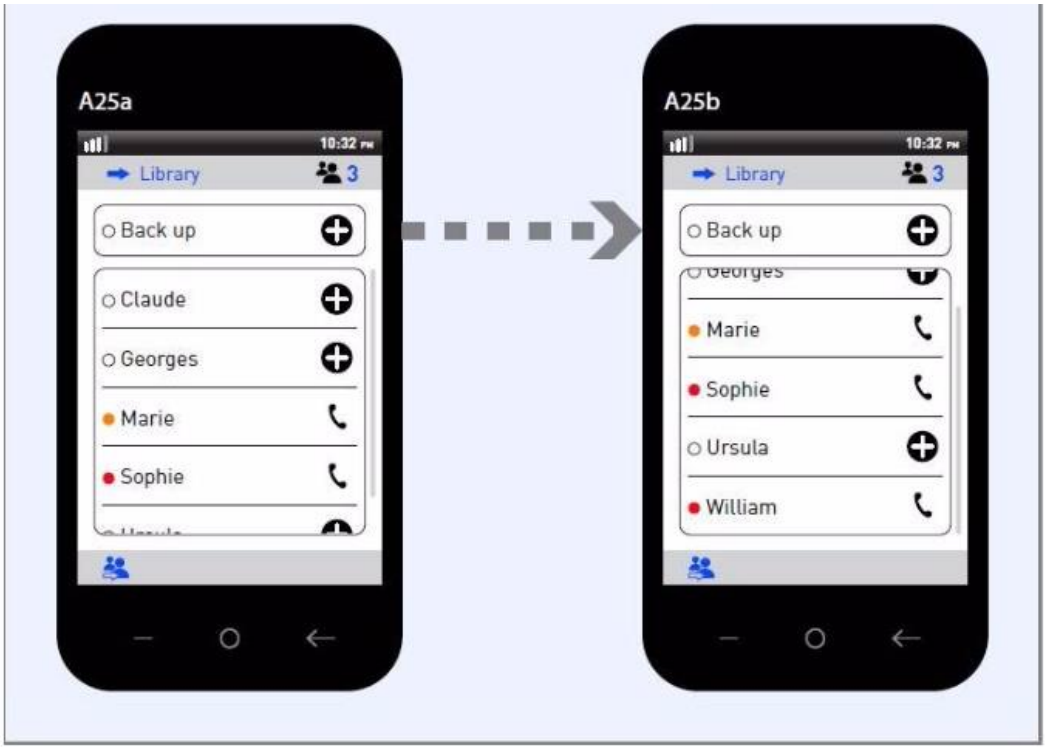

Figure 13: An example of a question introduced (CO'MON project materials 2014)

After the interviews were completed, the project team combined the gathered data and made a summary of it. Based on the summary, the project team was supposed to ponder profitability of the software development. Questions and scenarios presented in the interviews can be found in appendices 2 and 3.

3.2.2 Designing user experience interviews

For the second interview session (user experience interviews), which occurred later, questions were built by going through the studied material, such as Nielsen's heurestics and Shneiderman's eight golden rules, carefully to pinpoint important things interview questions should be focused to. A very basic and down-to-earth question pattern was made related to mobile device and application usage by elderly people in their every day life. Interviewed people was met face to face. Every person was retired, and over the age of 65, so they fit the study perfectly. Original goal was to have five different interviews, but one person had to cancel, so the final amount was four. Questions presented can be found in appendix 1.

3.3 Prepare

Case study type of research is often believed to be an easy method, which is a false assumption. In fact, it is among the hardest types of research due to the absence of well-documented procedures. (Yin 2014, 70.) Collecting case study data is one of the first things to get the project started with addressing the research question and the development of case study design. (Yin 2014, 71.)

Usually good preparation begins with the following steps: Defining the desired skills and values, training for a specific case study, developing a protocol for the study, screening candidate cases, and conducting a pilot case study. Making a good case study also requires different skills and values. This is a basic list of often desired attributes for a good case study: Asking good questions, being a good listener – not too stuck with old ideologies, staying adaptive, meaning taking new situations rather as opportunities than threats, having a firm grasp of the issues being studied and avoiding biases for example by being too sensitive to contrary evidence. (Yin 2014, 73.)

In this study, preparation started early on by going through the database related to the project that already existed. There was an access to the database so it was possible to read available information freely. There were lots of documents about the software design itself, and execution plans for testing and gathering information, and also debriefings about the project budget.

The questions presented during interviews were inclusive and gave valuable feedback. All the information received from the interviewees in CO'MON interviews was more than welcome and was taken into consideration for future development. Overall it was a very open minded process where there weren't any strict ideologies that couldn't be broken. For example, the feedback gathered from our first field test made a huge impact to the next patched version of Companion. The biggest issues were mostly fixed, even though it still had many flaws.

3.3.1 Interviewees and recruitment

The project team seeked for volunteer people for testing who fulfilled demands of the projects field testing part. There were several different criterias. A person who fulfilled the age of 65+, and had at least some sort of minor disability that could affect to daily routines, was happily accepted. The field test was supposed to be as realistic as possible, so having testers from the correct age group with some sort of disability, or disabilities, simulated the process more realistically which led to genuine feedback. The easiest way was to recruit known familiars, for example own parents or other relatives. This was mostly the case during the first field test. For the second field test Laurea recruited volunteers who had no connections to anyone from the test group. These volunteers were interviewed once field testing was over. I personally continued testing in the second phase with the same relative I had worked with in the first phase. It was a very good way to obain information about the improvements in the application, as we had been testing it together before.

3.4 Collect

Case study evidence can be collected from many different sources. There are six different sources which are often used and using all of them gives a picture of mastering different data collection procedures. These sources are *documents, archival records, interviews, direct observations, participant-observation* and *physical artifacts.* Related to these six sources, four principles are very important for any data collection effort while doing a case study research. The first two are using multiple sources of evidence to cover the same findings, and creating a case study database containing all your case study notes, documentations, and other possible memos. The last two are about covering your sensitivity in maintaining a chain of evidence and exercising care when using electronic sources of evidence such as social media and so on. (Yin 2014, 102-103.) The image below (fig. 14) shows the data collection sources.

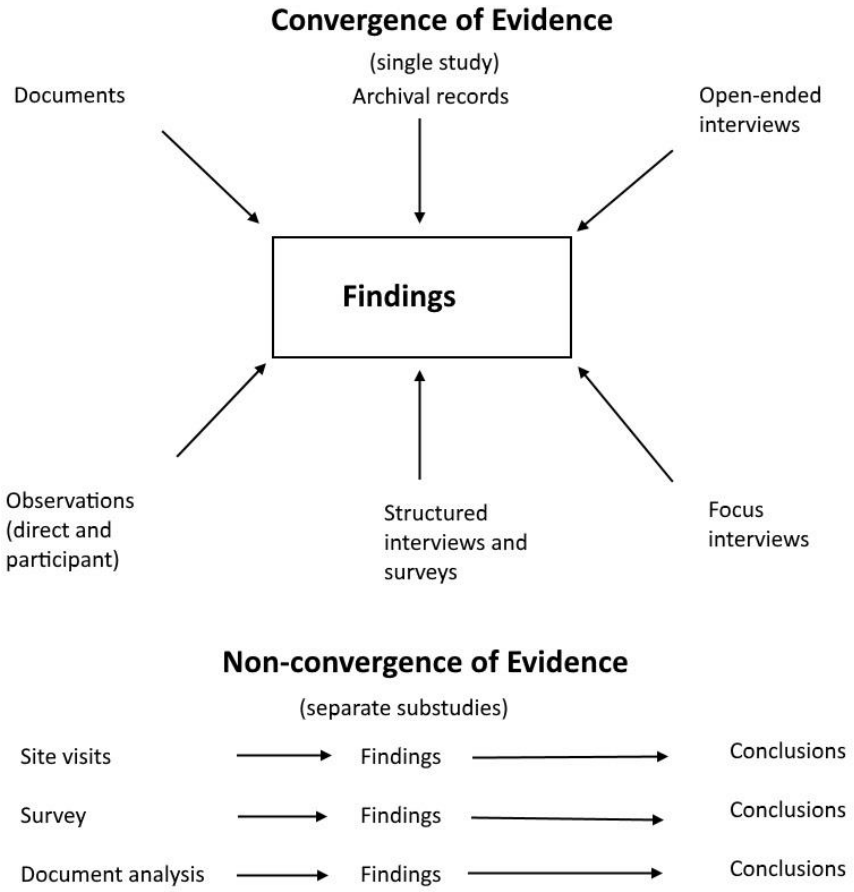

Figure 14: Collecting data - six points (Yin 2014, 121)

Especially when using sources from social media, people should be extremely cautious and suspicious. If the data is not linked to any reliable source, it could be just someones personal opinion, and that also often is the case. Using such "sources" as a fact in your own study can lead to disaster.

Figure 15 below shows the process of maintaining a chain of evidence. As shown, in the end the data gets gathered to a case study database and through that to the case study report. The same kind of chain also realized in this study. Through the initial questions a case study database was slowly built around the study protocol and evidentiary sources. Once all the necessary data was gathered and the database was "complete", it was turned into a case study report which was presented in the end.

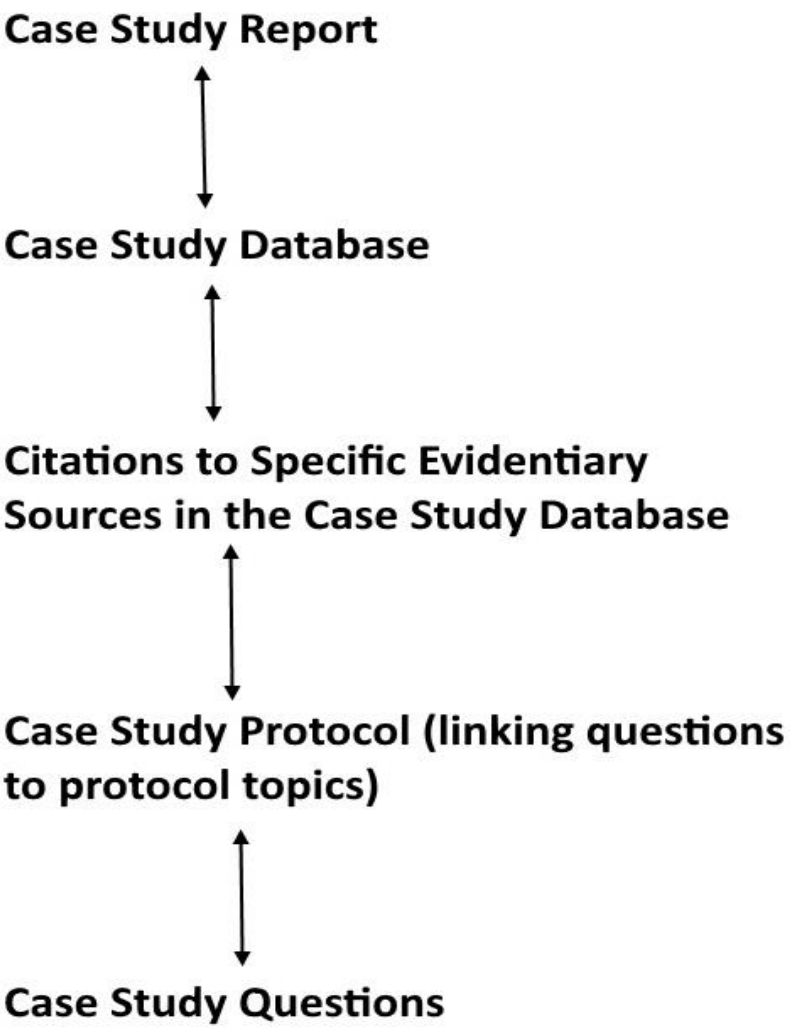

Figure 15: Maintaining a chain of evidence (Yin 2014, 128)

Most of the six data collection sources were used in this case study. Documents were used to gather basic knowledge of the project, and to gather information of important things about good usability, and clear interface design. For this purpose, Nielsen's heuristics and Shneiderman's eight golden rules gave a good perspective. Both project data and genuine knowledge about heurestics were needed and as well extremely helpful to build a proper structure for testing, interviewing, and analyzing the collected data. There were plenty of archival documents related to the earlier stages of the project and background information behind the project, which had to be studied before getting started.

Data collection for the study happened between January 2014 and March 2016. The data collection of this study was cumulative, and it was systematically used for a qualitative analysis. Collected data is from interviews and workshops, literature and discussions at interactions, discussions with elderly groups, notes and links. Collected data includes definitions, process

flows, requirements, best practice standards, theory, customer need and end user experience changes. According to CO'MON consortium the research was permitted to collect data for this thesis.

Observation was done during the CO'MON field tests. As I was personally involved in testing with another person, I was able to observe things and interaction closely. Personal notes were made all the time, especially when noticing things that should be fixed. First interviews were focus interviews. Reason for this was the fact interviewees had participated to field testing and had plenty of knowledge about the interview target, which was in this case Companion application. Interview had a strict framework consisting important questions and screnarios related to Companion. All main questions were asked from every interviewee plus couple bonus questions, depending if there was enough time left. Second interviews (user experience interviews) were more open-ended. These interviews were not CO'MON related at all. Getting information how elderly people uses mobile devices and applications in general gave an opportunity for less restricted answers.

3.4.1 CO'MON field testing

The field testing gave plenty of time to do closer observation on how the application functioned and how users managed with it. It is also stated that users learn different things compared to designers while performing their tasks, which is the reason a section for observing users in action should be included in every product development project. (Sinkkonen 2006, 21.) Goodwin (2009) agrees and points out that "a very useful method for evaluating design is users trying out the product or a prototype of it in practice. Asking them to perform different tasks one by one and inspecting how they manage can be very rewarding". (Goodwin 2009, 56.)

Testing was accomplished in two different parts with two different versions of the application, so the received feedback was quite comprehensive. Feedback was given all the time during field tests, so new needs and requests updated regularly. Basically testers were supposed to keep up a "diary" related to each journey with the application where they made notifications about their observations, such as possible errors and ideas for improvement. This kind of procedure made sure that enough feedback was received. Field testing was executed in Finland and Spain. Testing lasted from a couple of weeks to one and a half months. Information was gathered from the travelers during this time with three e-forms and from companions with one e-form. The first phase of testing was completed together with one or more elderly persons. Each tester received their own mobile phone from the project management for testing. The model of the phone was *Samsung Galaxy S4 mini*, which was a bit questionable choice for testing due to its small size. A bigger screen and buttons would have made it

much easier to use for elderly users and made more sense in this situation. This was also often mentioned in received feedback. Then again, this gave an opportunity to test the application in a smaller device and point out issues in that. The newest version of Companion was already installed to the phone, so it was ready to use once handed out.

First, mandatory part of testing, occurred during related course at school. After this it was possible to sign up for second phase of testing as a volunteer, which begun about half a year later. Volunteering to the second testing phase gave an interesting opportunity to see if the application had improved from the earlier versions.

For the second phase, the project team recruited a bunch of elderly people to try out the application. These recruits worked as pairs, and this allowed more specific data from actual every day cases without someone with possibly more knowledge about the application interrupting - in this case one of the students or a member of the project team, for example. The second phase lasted a bit shorter period of time as there was a deadline for the project, which was end of year 2014.

3.4.2 First CO'MON field test more closely

The field tests were a major part of the CO'MON project and plenty of valuable information was gathered during them, so for this reason opening both of them a bit more is a good idea. The first field test was full of extremely major issues. An unfortunate flaw happened just before the test was supposed to begin: a new version of the Companion application was released, and it was installed to all the devices that were used for testing. Due to lack of time, the new version was not tested before the devices were handed out for testing purposes. The new version had a major bug that prevented usage of the main function, following the travelers actions and route, completely. The problem already emerged at the point where the traveler was supposed to send out an invitation to his or her journey. It most often never came through to companion, and if it actually made it, the delay was way too long. The second issue, the worst of them all, appeared after accepting an invitation (in case it actually arrived), and when tracking was supposed to begin: the application crashed to some sort of fatal error (without any error message). This occurred every single time at the same point and there was no fix during the test period. These issues pretty much prevented proper testing totally. That is also why giving valuable feedback was very hard. Then again some valuable information was gathered from menu structure and its usage and overall graphical outlook of the application. In the end the feedback received was mostly confused and critical: what was the purpose of this broken application? At least it gave a clear picture of critical needs to the application designers.

These flaws mentioned were not the only ones found, just the major ones. Another notable issue was related to the functionality of menus. It was unclear in some of the menus that scrolling them to different directions was possible. Also touch of the menu buttons was inaccurate and they did not always react when pushed. It is good to keep in mind that the application was designed for elderly users, so this is a pretty major flaw.

3.4.3 Second CO'MON field test more closely

The second field test started around six months after the first one. The Companion application had been updated and many changes made. The new version of Companion patched random crashes and the GPS-tracking issue – the biggest issues there were. Due to this, proper testing was actually possible this time. New concept version also had a couple new features; a possibility to invite multiple companions to the same journey, which also allowed chatting in a group, and an icon that showed mobile devices signal strength for both the traveler and the companion. It was also one of the goals to get opinions if these new features were good and needed updates. Overall the second field test gave more information as the application actually worked as supposed. The volunteer testers also worked without assistance from any of the project team members, so it was possible to see how the application worked in reality.

3.4.4 Feedback received from the CO'MON field testing and interviews

Using Companion revived many different emotions and feelings in users. Some experienced it as exciting and interesting, some frustrating. It seemed like for many users the positive start turned to frustration and disappointment due to major issues in usability in the first field test, which is a shame. This also affected eagerness for follow-up testing.

The idea of the application was often praised; mainly the feeling of security it offered. Awareness of another person, in case something happened, was kept as one of the major assets in Companion. Clear basic logic and menus were also kept as strengths of the application. Testers informed that they needed a bit help in some of the functions, such as choosing the goal of the journey, and inviting a companion to the journey. These issues were solved quickly by a helping hand of another tester, who in this case was one of the students participating in the project. Elderly people mostly moved on feet, or used their own car – public transportation was not used that often during the field test. The functionality of keyboard inside the application was criticized for being hard to use, because the application could not be turned sideways on the screen. This is why bigger buttons for typing text could not be utilized at all. This was an issue that should have been fixed for the final product without a doubt.

Once field testing and interviews were completed, users answered to questions related to follow-up development of the application. They were about willingness of future usage, and possible payment of the application. It was also questioned if a safety wristband, which would include GPS-tracking and "an alarm button" in case of an emergency, was a good idea that would bring more feeling of safety. The possibility for a "spare friend service" was as well investigated and opinions about its practicality asked. This would had basically meant a service ran by a business from health sector, for example, that provided a person to accompany the traveler in case all other friends were unavailable. Feedback received was overall pretty mixed. Without the couple major issues mentioned above (crashing and GPS-tracking), feedback most likely would have been more positive.

3.4.5 CO'MON usability test

During the CO'MON interviews, a paper prototype method was used to gather feedback from the testers. The team developed many different scenarios of the application to A4-sized papers and made questions related to them. This was a great way to scout illogicalities and other errors that should be fixed. There were around 10 scenarios presented, depending a bit on how much time there was left. Couple of them were optional. Paper prototypes were also a good way to present wanted information due to bigger size compared to, for example, the screen of a smart phone. It was easier to introduce the scenario and observe how the interviewee operated with it. Different use cases gave plenty of important information about the current state of the application and its issues.

The image below (fig. 16) is about sending an invitation to companion(s). The color of the icon indicates sending the invitation, receiving, and accepting it. The main question was "*After sending invitations to three companions, you'll receive the following screens. How do you understand the icons and their colors? What do you think they mean?*"

Figure 16: Sending an invitation in Companion (CO'MON project material 2014)

For example, in this scenario the feedback from elderly users was pretty confused. Negative things mentioned were unclear menus and too small icons, which were mentioned several times, the "goal" icon (flag) was understood but the rest were unclear. "Traffic light colors" and their meaning weren't understood properly either.

After the interviewees gave their answers, related additional questions were presented. In this scenario (fig. 16) it was important to make sure the person understood what the icons and colors meant. To make sure it was clear, they were asked to explain how they ended up to their conclusion. In case they did not understand what the icons and colors meant, they were explained their meaning and after that asked what makes it hard to understand them. In the end suggestions for improvement and other possible ideas were asked. This example gives a good overview about the possible amount of little things that can be unclear for users and need to be redesigned.

3.4.6 Feedback received from the user experience interviews

After the user experience interviews were completed, received data from the elderly interviewees was analyzed and conclusions made about important needs, opinions and wishes for the future development of mobile devices and their applications. The interviewees had a bit different history and knowledge levels in mobile device and application usage.

Every interviewee had a smart phone in their use, so it was a familiar device for all of them. Two of them also had a tablet and preferred to use it whenever possible. Reason for this was bigger size, which made usability of tablet easier compared to smart phone. Also bigger screen was liked because it improved visibility. Three interviewees had an iPhone and one

was a Samsung device user. There were many different iPhone models in use: 4S, 5 and 6. Samsung device one person had was a Galaxy J5.

One of the interviewees had quite much knowledge about smart phones, and had used one with internet connection since Nokia Communicator from the early 21st century. Another person had owned a smart phone only for less than a year, and before this the phone used to be a regular device without any smart phone functions. Two interviwees had around three years of experience in smart phones. Only one of the interviewees considered herself as a more exerienced user.

Everyone used their phones daily, couple a bit more often – one even said "almost every hour". Things they used their phones for varied quite much. Making phone calls and using text messages were mentioned by everyone as a daily routine, which was not surprising. Making notes and using clock or alarm clock applications were also important for everyone. Taking pictures was very important for couple of them, as the device basically was the only camera they used during their trips. One person did not use camera at all. Using phone for finding information from internet was important for all of them, at least once a while.

Two interviewees had no experience about downloading new applications at all. They mostly only used the basic applications that came installed with the phone. Two others had downloaded plenty of different applications, especially one of them. They were mostly map, sports tracking, navigation and car parking related applications. Also social network and weather service applications were mentioned.

Once asked about things that makes applications good or bad, several different things were mentioned. Every single one mentioned user friendliness as the most important thing. Of course this is a wide definition and depends a bit on user preferences. It was also kept important that applications should be so simple to use that no separate instructions were needed at all. Application itself should provide information on screen if an unclear situation, such as new icon, shows up. Automatic GPS-tracking was kept as a very important feature in case an application supported this feature. Quality camera, overall clearness of the user interface and proper logic in usability were as well important.

Being able to switch font size was a desired feature. Also being able to move "backwards" in menus was kept important. One person mentioned bad experience about an application returning him back to the starting point after a wrongly made choice without possibility to get back to correct it without being forced to start all over again from the beginning. Too complicated usability and slowness of the application were commonly disliked.

Desired applications were, for example, a blogging service that included a word search which as well would give more suggestions about other similar blogs availeble. One person wanted a sports focused results service. We discussed about the possibility there actually were applications made for these purposes already, but they had not found good ones so far.

Second part of my interview handled questions about devices, their properties and possible issues with applications. Screen size of the devices they used was decent overall. One person preferred using a pad over phone due to smaller size of a phone, which made typing messages harder. Couple were very happy with their current devices and said they had picked their devices especially because of the proper size. One was quite happy with the current one, but said buying a bit bigger one is possible in the near future. The possibility to easily fit the device even to a smaller pocket was an important criterion for one interviewee. Button sizes were mostly kept good enough. People had only occasional issues with them.

Questions about graphical outlook of applications were also introduced to get information about possible issues the elderly interviewees had faced. It was a bit surprising to find out there had not been any bigger issues. Everyone seemed happy about the outlooks of the applications they had been using. Then again, it is important to point out the fact many of the interviewees used “basic applications”, which were included with the phone, and these applications are most often very polished. Bigger differences comes in once people download more applications from the application store.

Tactile feedback did not seem to be important at all. No one had paid any attention to it. Interviewees said vibration is good enough once you receive a phone call. General opinion was that applications they used functioned smoothly enough without too long delays or other issues that would have made the usability painful. Also bigger illogicalities were not mentioned. Couple examples of illogicalities faced during CO’MON project were given, but nothing similar had happened. Memorability of the applications they used did not cause too much problems for most of the interviewees. One mentioned sometimes there were minor issues with some applications, but after using them a bit more everything had been fine. It was also mentioned that applications with too many choices are not good at all.

Question about information of next steps or help provided by application itself gave a bit mixed answers. There had been issues for example with unclear wording, and one person wished for "explanation right next to the words" in these cases. Also a “question mark" next to an answer field that offered related information was a wished feature.

Interviewees had only seen a few application crashes in the applications they had been using. Information they received about the crash was mostly just a notification about an error that

has occured, but nothing more. No solutions were offered. Only one person said he had quit using an application due its bad functionality compared to another similar one. This was an application used for parking a car. One interviewee said “she was such a novice user she rather blamed herself instead of the application if there were problems”.

3.5 Analyze

Analyzing case study evidence can be difficult because the analyzation techniques have still not been well defined. In the beginning it is possible to play around with the data and try different patterns to find the best possible way to analyze it. Anyhow, there are four general strategies for the data analyzis. One strategy is called *relying on theoretical propositions*. The idea behind it is to follow the theoretical propositions that led to the case study. A second strategy is called *working your data from the “ground up”*. In this strategy, instead of thinking about theoretical propositions, you should “pour through your data”. As a result of earlier “playing with the data” or noticing a pattern for the first time, it is now possible to find that some part of your data may suggest a useful concept. A third possible strategy is *developing a case description*. This means organizing the case study according to some descriptive framework. This strategy works in its own, but it is possible to use it as an alternative for either of the first two strategies in case there are difficulties in using them. This basically means a situation where you have collected a lot of data without having settled on an initial set of research questions or propositions, which makes it hard to rely on the first strategy, or you may not have been able to make any useful concepts out of your data which kind of makes it difficult to use the second strategy. The last strategy is *examining plausible rival explanations*. It basically works in combination with all the previously mentioned three. The first strategy might have included rival hypotheses, the second strategy may produce rival inductive frameworks and the third one may involve alternative descriptions of the case. (Yin 2014, 136-142.)

Analyzing the gathered data in CO’MON project started by categorizing it to different groups. During the interviews, the received data was divided to positive and negative feedback. There was also a spot for other comments, that often gave the most valuable information and new suggestions. Once every interview was done, the received data was fully analyzed and split into more specific groups under each asked question or presented scenario. These were included in the final report. All the received feedback was gone fully through and divided into correct groups. After this was done, it was easy to point out things that were mentioned more often. These points were highlighted in the final report as very essential. Basically these issues should’ve absolutely been fixed in the future versions.

Every interviewed volunteer tester had an own, specific number which came after a number marked to the mobile phone he or she was using during the field test. Data gathered during field testing and interviews were divided by the number so it was basically done anonymously. As every interview had its own forms, in the end there were lots of them. It took a while to go through each one of them and transfer data to different shape.

Information received from the usability test during the interviews, which was completed as a paper prototype test, was analyzed through observation at the interviews and by the scenario focused answers received. Observation itself gave interesting information in some cases if, for example, user was totally lost and didn't know what certain elements meant and how to continue.

Feedback for each question and scenario presented in the interview was analyzed. Once it was done, the received positive, negative, and constructive feedback was gathered for the final report. All questions were presented separately in a powerpoint presentation and the most important feedback typed down under each presented scenario.

The user experience interviews were analyzed by going through answers to each presented question one by one, and pointing out the most the most important things mentioned. In the end, an own chapter was made for the received feedback.

Figure 17 shows one of the scenarios presented in the CO'MON interviews. The received data from the scenario was split into different groups and most important points moved to the final report. The final report consisted of the most important feedback to each presented question and scenario. This was fully presented to the international project team, which later on made decisions about the possible future development.

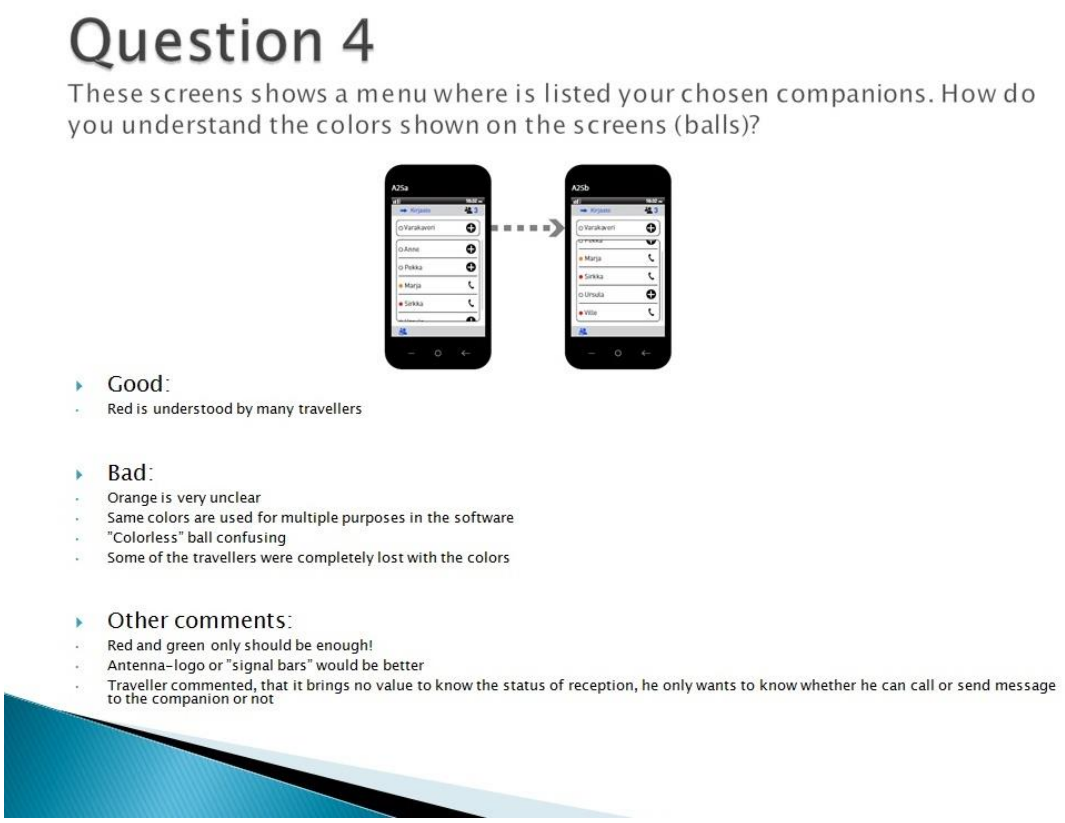

Figure 17: An example of presentation of analyzed data (CO'MON project material 2014)

3.6 Share

In the end of the case study, conclusions will be shared which means bringing its results and findings to closure. It does not matter how the report is made – similar points affects to the sharing process. This part is often considered as most rewarding in a case study process.
It is important to define the audience of the study early on, having enough time to compose textual and visual materials for the final presentation, and also show enough evidence for the readers so they can reach their own conclusions. A case study should be reviewed and re-composed as many times as needed to get it done well enough. (Yin 2014, 176.)

The reporting formats of a case study are divided into four categories: *single-case study, multiple-case study, option for either a single- or multiple-case study* or *option for multiple-case study only*. A case study composition can be split into six different categories with different purposes. Table below (tab. 1) explains more about the categories and the best situational usage for each of them.

TYPE OF COMPOSITIONAL STRUCTURE	Purpose of Case Study		
	Explanatory	Descriptive	Exploratory
1. LINEAR-ANALYTIC	X	X	X
2. COMPARATIVE	X	X	X
3. CHRONOLOGICAL	X	X	X
4. THEORY-BUILDING	X		X
5. "SUSPENSE"	X		
6. UNSEQUENCED		X	

Table 1: Case study composition categories (Yin 2014, 187)

Description methods of the case study should also be considered from different perspectives. The description can be either long or short depending the audience's preferences. Some general information about case study research methods are probably a good idea to give, as not everyone are familiar with them.

Key case study issues should stand out and be presented well enough. These are:

a) a careful wording of the research question(s). A logical need leading to conducting a case study should be shown.
b) the definition and selection of cases
c) a data collection profile convincingly portraying the data and giving in-depth information about the case
d) an explicit and clear analytic strategy.

High standards should be set for describing methods including good readability, credibility, and concern with confirmability.

In this case, the target audience was the CO'MON consortium. Multiple different ways were used to collect information and data during this case study research. Reading different research related books and academic articles gave a good first touch for the project which was later on fulfilled with field research and interviews. Data gathered from the field research and interviews was carefully analyzed and presented in a form of final documentation, which was sent to the project managers and leaders.

Building an interview gave lots of new ideas and highlighted current issues in the application. Some of the issues were not familiar at all for the project team, but were pointed out by the elderly test users – the real target audience of the application. This underlined the importance of testing completed by the actual users. Collected data was widely utilized to the development of Companion.

4 Definition of usability for elderly people

Plenty of information related to reasons behind good usability were found and collected. Good usability is defined by many moving and evolving parts. It is a total of many different composers. It also matters what kind of a userbase there is; many definitions behind good usability are connected to pretty much every design, but should be customized depending on what kind of a product it is and what kind of users there will be. For example, if the userbase is going to be full of very experienced users, it is quite pointless to create a "too simplistic" interface. This naturally goes the other way around as well.

According to Nielsen (Nielsen 2012) good usability is defined by five quality components, which are *learnability, efficiency, memorability, errors* and *satisfaction*. A product with good usability should be easy enough to learn – at least the basic functions of it. We live in a hectic world full of different options to choose from, meaning people often will not spend too much time learning usage - they will rather move on and seek for another product instead, if the one they are trying seems too complicated. Especially impatient users, which there are plenty of, will move on quickly. From the point of efficiency, the product should work smoothly once the basics have been learned. Tasks should be completed fast, and the product be designed and coded well enough to guarantee fast experience. Even though the product might work logically and menus with graphical outlook be clear, poor optimization can ruin it all. Continuing using a product even after a longer break should be easy and simple. It must not have any kind of "roadblocks" to prevent former users returning. Even an idea of too complicated things that should be re-learned pushes many users away. This highlights the importance of good memorability. Things should be kept as simple as possible without any additional memory load for the user.

An example of bad error execution was given above (fig. 8). Nothing is more frustrating than an application crashing without giving any feedback, or information what actually happened, let alone a solution for the problem. Especially a case where an application crashes, gives no feedback on what actually happened, and causes the user to lose already produced data is devastating. This is probably the worst possible advertisement for a product, which also reminds of the importance of an automatic saving feature in an application. This prevents the worst possible scenarios.

Satisfaction is a reward for a well designed product. This feeling is not achieved daily when using mobile applications. As the selection is huge, the amount of poorly executed applications is remarkable as well.

All these factors mentioned should be executed very well at first hand. Because there are so many other products out there, there might be only one chance to make a breakthrough. Without giving a good first impression it can be very hard to fix the issues later on, and try to restore faith in unhappy users. If Companion, for example, was released to the public market during the latest tested version, it would have been a suicide for the product with all the issues it had. It would have required plenty of polishing and redesigning some of the necessary features to make it an interesting and desirable product for elderly users.

It is important to design and think through how the user interface functions in reality once all the needed heuristic standards are defined. Locations, sizes, and touch areas of buttons must be designed and tested well. Testing should also be done by numerours persons with different abilities. Things such as hand size already matter a lot. Too small buttons for bigger fingers make usability sloppy. This is also the part where usage of tactile feedback should be considered.

Human memory, its capacity, and how it actually works is very crucial to take into consideration in an application designing process especially when it is directed at elderly people. The amount of persons with at least slight issues with memory increases considerably after a certain age is passed. It has been stated (American Psychological Association 2006) that some people might already begin to have issues with remembering things, or multitasking at their 40s. Memory-related issues get more common and strengthen once people age more, but this naturally does not mean everyone would suffer from them. This highlights the importance of keeping memory load of an interface as minimal as possible. Not only an application with too much unnecessary information that should be remembered slows down the usage and makes it unpleasant, but it could also scare elderly users away as they might start thinking they are not good enough and feeling insecure. This kind of reaction was noticed during the field tests in CO'MON project and it was also mentioned in user experience interviews. That said, application design should follow Sheinderman's (2010) rule number eight, which is *reduce short-term memory load*. Interfaces where users must remember information from one screen to another should be avoided as much as possible.

Goodwin's (2009) research dealt with icon management and their graphical outlook in an interface. Based on that and my own findings, icons should be very clear and easy to understand. As the screen is often small and icons have limited space, the graphical outlook should not be too complicated; a too complicated outlook will make icons look messy, and because

of that, hard to understand. Such things will slow down the process and make usability unenjoyable leading to unhappy users that might in the worst scenario quit using the application for good. The color scheme should also be planned well. It should remain rather neutral; too colorful and flashy interfaces easily drive users away. Naturally there are exceptions too, but they should be thought carefully.

We all have a certain feeling of the meaning of some specific colors; for example red is often understood as negative and green as positive. Combining basic mental models of colors too much could be disastrous. For example, if an “accept” button is red and “cancel” green, it could confuse even a more experienced user.

Feedback received from the usage of Companion application referred to too small or unclear icons many times. Issues with unclear meanings for different colors used were also mentioned more than once. As a conclusion, special attention should be paid to icons and how they are presented in a design for elderly people. It is critical that every icon and its meaning is understood or otherwise the user, in the worst case, might not be able to continue using the application as the situation is too unclear.

Conclusion about the importance of minimized memory load came very clear especially after receiving feedback from the elderly users through field testing and interviews. It is an absolute must to keep the load minimal in a user interface designed for elderly users. It is highly likely that they will stop using the application if it is even remotely too complicated, and makes them feel insecure and not good enough. In a design for elderly users, using different terminology, for example, for same elements in menus is an extremely bad thing to do. Once again, this creates confusion, which can easily result in the user giving up. Conclusion after observing elderly users more closely is that it does not necessarily require many illogicalities or unclear situations, and many of them are willing to give up, mostly due to the feeling they are not skilled enough to use it. Even one unclear or confusing situation can be enough for some of them. The application crashing without any feedback or solution given to the user during field testing in CO’MON project demonstrated how things should not work quite accurately. Frustration was noticed in elderly users after errors continuously appeared without any solution. It highly affected their motivation to continue testing. When the design is focused on elderly users, it is necessary for the user interface to keep them updated on every single selection done, and give clear feedback at the same time.

4.1 Overview of usability in Companion

Reflecting Companion and its functionality to Nielsen's heurestics (Nielsen 1995), many differences and elements to improve can be found. Visibility of the system was not clear enough; users did not receive enough information on what was going on and the delays were way too long time after time. System messages were insufficient. This was deeply highlighted in the crashing issue where the user did not receive any information at all. Then again the wording used in the application was clear enough and did not confuse users too much. User control and freedom was not flawless either. If an error occurred, so called "emergency exits" were hard to find. In fact, it was unclear that the user was able to scroll in some of the menus as there was no proper sign to indicate that it was possible.

Error prevention was one of the biggest issues there was. Once an error occurred, such as an application crash, no information was provided at all. Naturally an error free situation is desired, but especially at prototype stage it is hard to achieve.

User memory load was handled rather well. There were not too many elements that had to be remembered from one menu to another. The menu structure did not have too much unnecessary information either. There could have been slightly more information about some of the selections and especially icons that had an unclear meaning, though. Modifying user actions was still under construction. For example, favorite locations were asked from the testers and programmed into the application before handing out the test phones. This would have been different in the final product though, and it was not that relevant during field tests.

A short manual about the usage of the application was given to the users, but it only consisted of the very basic information. It was only a prototype though, so expecting a full manual is not realistic. Things tend to change all the time during designing and testing process so it is pointless to waste resources in building a manual which might not be recent the next day. The manual seemed to be good enough for this purpose though, as it was mentioned as a positive thing a couple of times in the received feedback.

In the end, some of the points were executed well, and some had plenty of room for improvements. Expecting a final product with perfect functionality is dumb, as as we are talking about a prototype for testing purposes. The reason for the testing naturally is to find and improve these issues.

4.1.1 Conventional issues in Companion

One example of possible conventional issues is “traffic lights” used in a product. We all know the meaning and differences of the colors used in traffic lights (green, yellow and red). Mixing these instantly causes problems of understanding and general confusion. If, for example, red means “ok” or “proceed” and green “cancel”, the situation will already be confusing and most likely hard to understand as it breaks our mental models we are used to.

Figure 18 presents usage of “traffic light” colors in one scenario during CO’MON project. In this example colors did not exactly break conventions or mental models, but their meaning was very hard to understand properly.

Figure 18: Example of "traffic light" color usage (CO’MON project material 2014)

Another example, which broke mental models, was the usage of “V” for marking a successful event (fig. 19). This disturbed elderly people who had learned already back in their school days that “V” refers to an incorrect answer. This used to be a common way to mark it back then. In Companion application the “V” mark was used to inform about a successful selection. Feedback about this was received from many inviduals who were testing the application. As a conclusion, this error should have been immediately fixed in the next version of the application.

Figure 19: Example of V-mark usage in Companion application (CO'MON project material 2014)

The usage of unclear logos or icons make usability harder. They should remain clear and point out their meaning at first glance. This gets highlighted even more when the user is older. Already minor issues, such as slightly weakened eyesight, does not support unclear, too small or complicated icons or logos. In case there is a very good or necessary reason to break conventions, the solution should be considered many times especially from the user's point of view. Before this, the actual users naturally need to be defined.

When it comes to interfaces designed for elderly people, breaking conventions could have a much bigger effect. As learning new things is not as fast as it used to be, also making changes that has a huge impact to usability is not a good thing to do. In the worst possible scenario the user quits using the product completely if it changes too much.

4.1.2 Used materials and methods

For the CO'MON interviews, two different portions were built: one for graphical design of the application, and one for the usability and user interface. Both portions were included in each interview and they reinforced each other. Paper prototype" –technique was used for several different scenarios. The idea was to see how the interviewed person understood the scenario and was he or she able to solve it correctly. Mistakes, illogicalities, and ideas for improvement were collected for later usage.

4.2 Conclusion of CO'MON

Overall the project was interesting and gave lots of new ideas. It also taught a lot about software development process and showed different sides of it. The amount of background information needed before it is even possible to start developing a new application for some specific purpose is considerable.

In the CO'MON project it became very clear that the application had lots of different issues. Not only did the application have issues in its functionality, such as random crashes and other major delays, but also interface designing and usability had plenty of problems that would have had to be fixed in case the application was actually released to public sales. It seemed like the programmers of the application did not always focus on correct userbase. Mental models were not thought through properly, especially from a view of an elderly user. Examples shown before, such as the "V"-mark usage, and the unclear "traffic light model" highlighted this even more.

4.3 Results of the study

Characterestic usability issues in a mobile application developed for elderly users are often related to vision, audio, mental and physical states. As people age, these elements slowly weaken, which may cause new issues in many situations that used to be very obvious before. Cultural differences, mental models, gained life experience and through that view of life are often distinct compared to users from younger generations. Table 2 presents findings on important factors related to aging and issues, which affect user interface usability aging might cause. The table is divided into five different parts: it consists of different aging related attributes, which are visual, audio, physical, mental and cultural attributes. Those attributes are compared with different issues, which are aging related issues and issues in usability. Prior studies on each attribute are listed in the "Researched by" –cell. Also personal observations and possible solutions in interface designing for elder people are included.

Aging and usability related attributes	Aging related issues	Issues in usability	Researched by	Personal observations	Possible solutions
Visual attributes	-Weakened eyesight	-Harder to read small text -Recognizing icons -Harder to recognize colors -Issues with smaller screens	-Nielsen (1995;2012) -> usability -Pattison&Stedmon(2006)->assist with tacticle feedback -Goodwin(2009) -> clear icons -Leung et al. (2009)-> issues with graphical icons	-Users did not understand all icons inside Companion application -Small size of the test phone was criticized	-Design big and clear icons -Keep color scheme neutral -Overall clear graphical outlook -Assist with tactile feedback to confirm selections etc -Give an opportunity to switch font size
Audio attributes	-Weakened capability of hearing -Harder to hear certain frequencies	-Unable to understand by hearing what is happening -> confusion	-Pattison&Stedmon(2006)->audio issues	-Companion-application did not use audio feedback	-Extremely clear audio -Include text with audio -Assist with tactile feedback if audio is important
Physical attributes	-Slower & inaccurate hand movement -Loss of strenght & dexterity	-Harder to use touch screen -Pressing small buttons	Pattison&Stedmon(2006)->loss of strength&dex.	-Users had issues with small buttons in Companion application -Interviewees in user experience interviews didn't find tactile feedback important	-Design big enough touch buttons -Buttons should be accurate and react fast

Mental attributes	-Weakened memory -Harder to learn new things -Possible "techno-phobia" -Possible frustration and insecurity with new complicated stuff	-Bad execution of memorability in an application	-Page(2014)->harder to learn new -Pattison&Stedmon(2006)->techno-phobia -Grindrod(2014)->clear wording	- Frustration was noticed once issues occurred during field testing	-Minimize memory load of an interface -Keep user interface simple -Clear error messages -Enough assist (help&tips) -Clear wording
Cultural attributes	-Harder to adjust to new technology -World has changed a lot -Different life experience compared to younger users	-Wrong mental models -Wrong conventions	-Sinkkonen (2006)->mental models	-Illogicalities found in CO'MON-project -Conventional issues with Companion application.	-Design icons etc from a view of an elder user -Enough background information about elder users and aging -Testing & observation with elder users

Table 2: Aging and interface usage related results

The crucial elements of a user interface in a mobile device targeted at elderly people differ from "regular" user interfaces. Some specific features are often more important due to rather normal and common issues aging brings to many of us. For example, eyesight often weakens during years and does not recover. This makes having a clearly designed graphical outlook and simple icons important. Icons must be big and clear enough: too many details can easily make them look unclear and hard to understand as the size of icons is quite small. Also used colors should be thoroughly considered and made sure they will not get mixed together. This could basically lead to a situation where text is hard to understand due to poor color choices for the text and background.

Another rather common issue is weakened memory, which also complicates usability as it slows down the process of learning. Importance of memorability becomes more important.

Here, a simple menu structure without too much information at once gains significant importance as it can be of help in the slowed down learning process of elderly people.

It was found out in the user experience interviews that elderly people did not find tactile feedback important at all. As the sampling was quite small, it is highly likely that it is kept as an important feature by some other elder users, though. For example, Pattison and Stedmon (2006) stated that tactile feedback can be a great help for people with poor vision. It is also possible that this feature is kept more important by younger users than elder users. I personally think the feature is most often very good and handy in my own use, as long as it is executed correctly. However, getting vibration feedback on irrelevant information can be very annoying.

Usage of an interface by older users may be clumsy. Aging can create issues with e.g. coordination, which might result in the difficulty of pushing small buttons accurately. Issues like this combined with lack of experience can make things twice as hard. This is why touch buttons should be considered as an extremely important element in an interface directed at elderly users. Elderly users often mentioned tiny buttons as an issue during CO'MON field tests, and also in both executed interviews. Even though device size itself matters a lot in this issue, it is still possible to affect button sizes, their locations and overall structure inside the user interface. Designing buttons properly makes usability much more pleasant, even on a smaller device. The testing device used in field tests (Samsung Galaxy S4 mini) was quite small in size compared to some other devices available, but there were other reasons that made button usability harder as well. For example, the touch buttons inside Companion application were not accurate enough, which made usability less enjoyable. They also did not react every time pushed, and this created a lot of confusion in elderly users as desired selection did not happen. Small button size is one of the major reasons why elderly people often prefer a tab over a phone. Naturally, the size of the device and the screen affects this as well.

Easy and user-friendly usability cannot be too much underlined. This was mentioned several times during the interviews and field testing sessions by the elderly people. For elderly users, an easy and simple interface with very polished usability is even more important. Many interviewees stated that they were ready to quit using an application if the usability seemed too complicated to start with. Good and clear first impression is crucial. This gets accomplished once important elements of a user interface are designed and tested carefully. Elderly users should be involved in testing, as otherwise it can be very hard to see and understand how things should work from their viewpoint. It was also noticed in CO'MON project observations that if the user interface was even slightly too complicated, it was a total turnoff for an elderly person with minimal experience on mobile solutions.

Proper instructions, especially during the usage of a product, was wished for by many of the elderly users in interviews. Instructions should be clear and fast to learn. Most important things should be explained clearly, and if needed, tips should be provided on the screen during the use. With proper instructions it is less likely that a new user will give up right away. Once a problematic situation appears, it is important that needed help is easily available. People do not necessarily want a huge book of instructions anymore these days, instead they prefer shorter ones with the most important things highlighted. In case it is absolutely necessary to have additional instructions, the whole should be designed well, and it should only include the absolutely necessary information to keep it short and pleasent enough to read. Seeing a huge wall of text often just scares the users away. As a conclusion for instructions, designers should aim at including all needed information inside the user interface.

Based on the received feedback and observations, it was obvious that receiving feedback from each chosen action inside an application is an extremely helpful and desired feature among elderly users. It is important especially for an insecure user to get information for most, if not all, actions made to keep on track. For less experienced people it is considerably harder to recover after they have lost track.

Personal observations of significant subjects in user interface design focused for older people can be seen sorted out in the table (tab. 3) below. The purpose of this table is to present findings in usability issues, negative reactions seen in elderly users once an issue occurred and offer possible solutions. Discoveries are from CO'MON project and user experience interviews.

The table is divided to five different fields. The subject field presents the main part that is important to pay attention to when designing an interface. The usability issues field is about the matters noticed during the case study related to applications' different sections. A summation of reactions that elderly people showed is provided in the Negative reactions column. The solution field offers a possible solution for interface design for each different usability issue. Additional notes are related to the CO'MON project or user experience interviews and are presented in the final column.

Subject	Usability issues	Negative reactions	Solution	Notes
Touch buttons	-Small touch buttons -Inaccuracy -Visually unclear buttons	-Wrong or missed selections -Hard to hit targets -Significant confusion: was the selection approved?	-Large buttons -Accurate buttons -Feedback for user e.g. tactile or visual	-Issues in field tests due to small buttons (Companion) -Inaccuracy in virtual touch buttons (Companion) -Tactile feedback was not kept important (User experience interviews)
Menu structure	-Unclear guidance on possibilities to scroll menu in different directions -No icon for demonstrating possibility to go back or forward in menu	-Hard to perceive totality -Frustration due to unclear menu structure -Slow, unpleasant usability	-Clear paths in menu structure -Clear icons for navigation (back, forward etc.) -Clear wording	-Issues in menu navigation confused elderly users (Companion)
Graphical design	-Bad color scheme -Unclear icons -Small icons -Small text -Too many different elements	-Ostentatious elements are very hard to follow -Hard to learn-> slows down the use -Frustration	-Simple colors -Essential information only -Larger components -Extremely clear icon design -Similarity in design	-Overall graphical design was liked (Companion) -Tablet preferred over mobile phone due to bigger screen size and bigger text/icons (User experience interviews)

Help, assistance and tips	-Selections without assistance/information of their meaning -Difficult to find information -No simple instructions (e.g. short manual)	- Quitting the usage of the application without proper assistance in problematic situations	-Help available in each menu -Information about each possible selection -Selection related assistance offered during the usage -Internal UI guides	-Elderly users wanted simple tips to assist application usage (e.g. "?" next to selection for giving more information) (User experience interviews)
Memorability	-Too much information in one menu -Information that must be remembered from menu to another	-User does not remember necessary information and cannot continue selections properly -Confusion -Slowing down of usability	-Essential information only -> minimal amount per each menu -All required information on display -No need to memorize information	-Elderly praised the application for easy usage without too much to remember (Companion)
Selection feedback	-No menu selection feedback -Unclear view of possible selections	-Confusion: was the selection correct or not?	-Clear feedback received from every selection	-Feedback from selections was a wanted feature (User experience interviews)
Conventions	-Culture and generation-specific meanings	-Misunderstood action or possible selection -Wrong menu decisions	-Background study for used icons (e.g. v-mark in Companion)	-Conventional issues caused problems for the elderly (Companion)

Error prevention and recovery	-System crashes -No error message given about crash -No solution for fix/recovery	- Confusion and frustration - Blaming self for mistakes - Possible quitting of usage	-Extremely clear error messages - Showing explanations for errors - Offering possible solutions	-Some elderly testers were ready to give up testing after mysterious errors (Companion) -Elderly may believe the error is their fault (User experience interviews)

Table 3: Observations based on CO'MON project and user experience interviews

Understanding what the characteristic issues in a design for elderly users are, plenty of observation is required. Doing testing together with elderly users gives much important insight that can be used in a designing process. This is extremely important, as it is very hard to notice the same issues the target group does. After understanding what elements are found important by the elderly users and the underlying reasons, it is possible to improve the usability and optimise it specifically for their needs. Designers must take possible limitations related to visual, audio, physical and mental states into consideration and review different possibilities. Understanding how a certain element functions from the viewpoint of an elderly person is not obvious. It is good to keep in mind the possible differences in their view of life and overall life experience as well. Things are very different for each generation. The world has changed, and especially technology advances extremely fast. Conventions should be thought carefully from different perspectives, as also cultural differences make a significant difference.

5 Final conclusions

After the CO'MON project ended, the development of the Companion application did not continue. The application had plenty of potential, and the idea behind the project of assisting elderly people in their every day routines was absolutely great and important. The people interviewed also thought the idea behind the application was great, and felt it was designed for an important cause and had plenty of potential. Yet still, it had many different smaller and bigger issues in both design and functionality. Perhaps one day it will be resumed and polished properly.

5.1 Evaluation of research

Overall, the research process went pretty much according to plan. Some of the people interviewed were familiar, especially in the user experience interviews, which could have a small effect on the interpretation and reliability of the results. Also, the user experience interviews only had four participants, which is quite small sampling. With bigger sampling it would be possible to get more accurate and reliable information.

5.2 Usefulness and suitability of the results

Information in this thesis can be helpful for example for developers and graphic designers during the designing process of a new application for elderly people. It consists of information that is very important to take into account in pretty much every design process, and also the specific needs for a design focused at elderly users. Heurestics and other guidelines inspected are there to remain, meaning they will not be changing much in the near future. Of course, some differences are possible as technology improves constantly and new solutions are created. These guidelines are completed with observations gathered during my studies to create a good overview on how an interface should be built for elderly users and which elements of it are important.

5.3 Themes for further research

Plenty of information gathered and analyzed in this thesis is and will be relevant in different mobile solution projects for elder people in the future. The differences between elderly users and their habits are much bigger than between younger people, and this is why surveys can be very important part of a designing process. They should consist of a large amount of people to get enough valid information.

It was noticed during the interviews that some of the interviewees had a very limited amount of knowledge on applications and their usage. One reason for this was simply the fact that they did not use many applications and almost never downloaded new ones. Once it comes to younger users, pretty much everyone knows the basics well and use plenty of applications all the time. Information about new, interesting applications also spreads fast, as they are often “hot topics” in conversations. Between elderly people this does not happen as often, if at all. This is one reason why channels used for introducing new applications for elderly users should be thought of thoroughly. Spreading information about new applications and their features to elderly people can be a somewhat difficult task. Not as many of them follow (social) media, or application-related sites or conversations as much as the youth and this already creates its own difficulties when it comes to bringing new applications to their knowledge. Finding the

best possible way to spread information and make sure it actually reaches the target audience is very critical, as hard as it might be.

As a follow-up project, it could be interesting to ponder how a well-designed application for elderly users is able to reach its audience and get them interested enough to start using it regularly.

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Unpublished material:

CO'MON project materials

List of figures:

List of tables:

7 Appendices

Appendix 1: User experience interview questions

General information:

1. Do you have a so called “smart phone”?
2. In case you do, what model it is?
3. How long you’ve had one? Do you consider yourself as an experienced user?
4. How often you use it?
5. What do you usually do with your mobile device?
6. Have you downloaded any new applications to your smart phone? If you have, what kind of applications?
7. What kind of functions makes an applicaton good in your opinion?
8. What kind of functions makes an application bad or hard to use?
9. If you could affect, what kind of applications and specific functions inside them you would like to see in the future?
10. Your personal user experiences, if anything special in mind?

Device specs and usability:

1. Has the screen size of your mobile device been big enough or has there been issues with too small screen, for example, that makes usability harder?
2. Has there been any issues with too small buttons or “virtual press keys” inside the applications? Have they made usability harder or slower?
3. Has there been any issues related to graphical outlook of an application, such as too small and unclear icons or badly designed color scheme?
4. Do you think “tactile feedback” (=vibration feedback) has been overall handy and useful in applications, or has it caused for example confusion?
5. Has the applications worked “smoothly” enough, meaning no extra loading times or slow/painful moving from menu to another, for example?
6. Have you faced any illogicalities? For example, usage of V-mark, traffic lights etc….? (Examples explained here)
7. Memorability: have the applications been simple enough to use, or required too much information to remember? For example, forced to remember information from one menu to another, which has caused issues?
8. Have the applications provided enough information about next steps? What about help if needed in an unclear situation? (Like a pop-up help tip or help menu)
9. Have you faced minor or major errors during your application usage, such as error messages or application crashes? In case you have, have they been easy to understand and has there been a solution or other tips available?
10. Have you quit using an application due to bad usability? If you have, what was the reason?

11. Other examples, improvement ideas or wishes from mobile application designing?
12. Do you have an example of a good usability in some application you've used? If you have, what kind of?

Appendix 2: CO'MON usability test questions for companions

Uusi konseptiversio sisältää muutaman uudistuksen verrattuna vanhaan. Esittele ne lyhyesti Matkakumppanille ja esitä muutama kysymys niitä koskien:

A. **Useat matkakumppanit samalla reissulla. Mahdollisuus kutsua useita kumppaneita mukaan samalle matkalle. Tämä ominaisuus mahdollistaa myös kommunikoinnin ryhmässä.**

-> Onko useiden matkakumppanien osallistuminen samalle matkalle mielestänne hyödyllistä? Miksi? (Voiko se esim. lisätä matkaajan turvallisuuden tunnetta kun hän liikkuu yksin ulkona tai vähentää etäkumppanin huolta matkaajan selviytymisestä poikkeustilanteissa?)

-> Minkälaisessa tilanteessa useammasta etämatkakumppanista voisi olla hyötyä? Miksi?

B. Kuuluvuuden näkyminen, miten hyvä kuuluvuus matkaajalla / matkakumppanilla on.

-> Onko kuuluvuuden näkyminen sinulle tarpeellinen ominaisuus?

-> Minkälaisessa tilanteessa siitä voisi olla hyötyä? Miksi?

TÄSTÄ ETEENPÄIN KYSYMYKSIIN LIITTYY KUVA. ANNA TEHTÄVÄNUMERON MUKAAN NIMETTY KUVA HAASTATELTAVALLE KYSYMYKSEN AJAKSI!

1. Saat Clairelta kutsun olla hänen matkakumppaninsa (näyttö B4). Miten tulkitset seuraavien näyttöjen informaation (B5 – B7) ja niissä näkyvät kuvakkeet?

Jatkokysymykset jokaiselle näytölle:

- Käyttäjä ymmärtää näyttöjen informaation ja ikonien merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen
- Käyttäjä ei ymmärrä näyttöjen informaation ja ikonien merkitystä -> Selitä, mitä näytöillä ja niissä esiintyvillä ikoneilla pyritään viestimään -> Kysy: Mikä tekee näyttöjen informaatiosta ja/tai niissä esiintyvistä ikoneista vaikeita tulkita? -> Kysy: Tuleeko mieleesi jokin parempi tapa viestiä asiasta?

➔ *B4 –ruutu ilmoittaa kutsujan nimen sekä hänen matkakohteensa. Valikossa voi joko hyväksyä tai peruuttaa kutsun. Siitä voi myös katsoa kohteen kartalta oikean puolimmaisesta kuvakkeesta. Kutsua ei siis ole pakko hyväksyä vielä kuvan B4 tilanteessa, vaan karttasijainnit (sekä henkilön sen hetkinen sijainti että kohdepaikka) voidaan tarkistaa ensin kartalta ja vasta sitten hyväksyä kutsu (kuva B5).*

➔ *Jos kutsun hyväksyy, ruutu B6 näyttää kaikki aktiiviset matkaajat. Voivat olla matkalla eri kohteisiin.*

➔ *Viimeinen ruutu(B7) ilmoittaa matkaajan puhelimen signaalin sekä sijainnin kartalla. Näytön ylälaidassa näkyy myös matkaajan nimi ja hänen määränpäänsä.*

➔ *Kuvan B6 ylälaita ilmoittaa monenko matkakumppanina toimii kyseisellä hetkellä. Sen alapuolella listassa kumppanit eriteltyinä.*

Näytöt B4-B7 Kutsu matkakumppaniksi / ryhmän jäsenet

2. **Miten tulkitset näytön B13 vihreän kuvakkeen? Mistä se mielestäsi viestii?**

Jatkokysymykset:

- Käyttäjä ymmärtää ikonin/kuvakkeen merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen
- Käyttäjä ei ymmärrä ikonin/kuvakkeen merkitystä -> Selitä, mitä näytöllä pyritään viestimään -> Kysy: Mikä tekee näytöstä vaikeaselkoisen? -> Kysy: Tuleeko mieleesi parempia ilmaisutapoja?

3. **Painettuasi vihreää ikonia (näytöllä B13) näyttöruudulle ilmestyy valikko, jossa näkyvät kaikki matkaajat, joiden matkakumppani olet (näyttö B14). Miten tulkitset valikossa näkyvät kuvakkeet ja niiden antaman informaation?**

Jatkokysymykset:

- Käyttäjä ymmärtää ikonin/kuvakkeen merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen

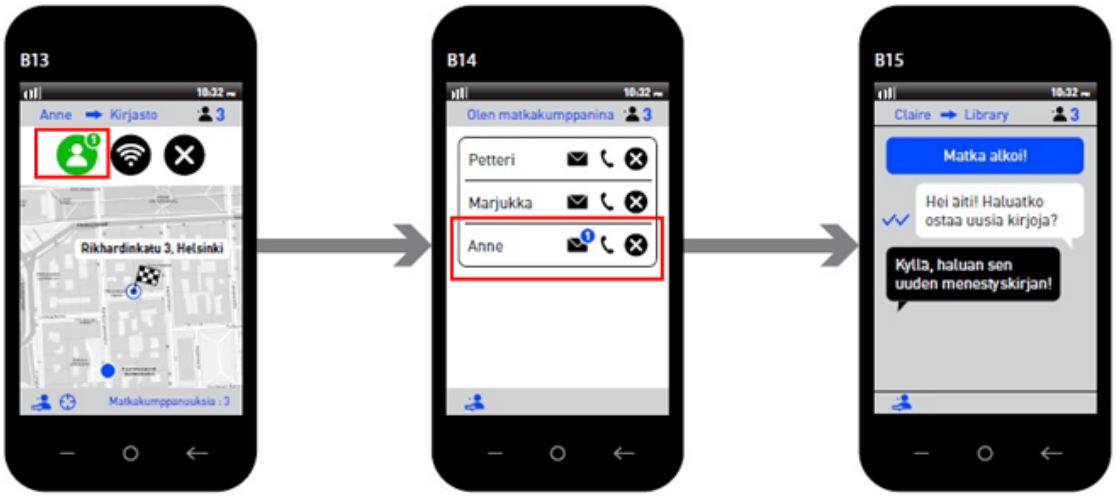
4. Käyttäjä ei ymmärrä ikonin/kuvakkeen merkitystä -> Selitä, mitä näytöllä pyritään viestimään -> Kysy: Mikä tekee näytöstä vaikeaselkoisen? -> Kysy: Tuleeko mieleesi parempia ilmaisutapoja?

5. **Painettuasi valintalistassa (näytöllä B14) Marien kohdalla näkyvää kirjekuorta esittävää ikonia, näyttöruudulle ilmestyy näyttö (B15). Miten tulkitset tämän näyttöruudun ja siinä näkyvät ikonit?**

Jatkokysymykset:

- Käyttäjä ymmärtää ikonin/kuvakkeen merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen
- Käyttäjä ei ymmärrä ikonin/kuvakkeen merkitystä -> Selitä, mitä näytöllä pyritään viestimään -> Kysy: Mikä tekee näytöstä vaikeaselkoisen? -> Kysy: Tuleeko mieleesi parempia ilmaisutapoja?

➔ *Vihreä kuvake, jossa pienellä numero ilmoittaa, että joltakin matkakumppanilta on saapunut viesti*
➔ *Viesti näkyy myös lähettäjän nimen kohdalla, kuten ruudussa B14*



Näytöt B13, B14, B15 Viestin vastaanotto ja lukeminen

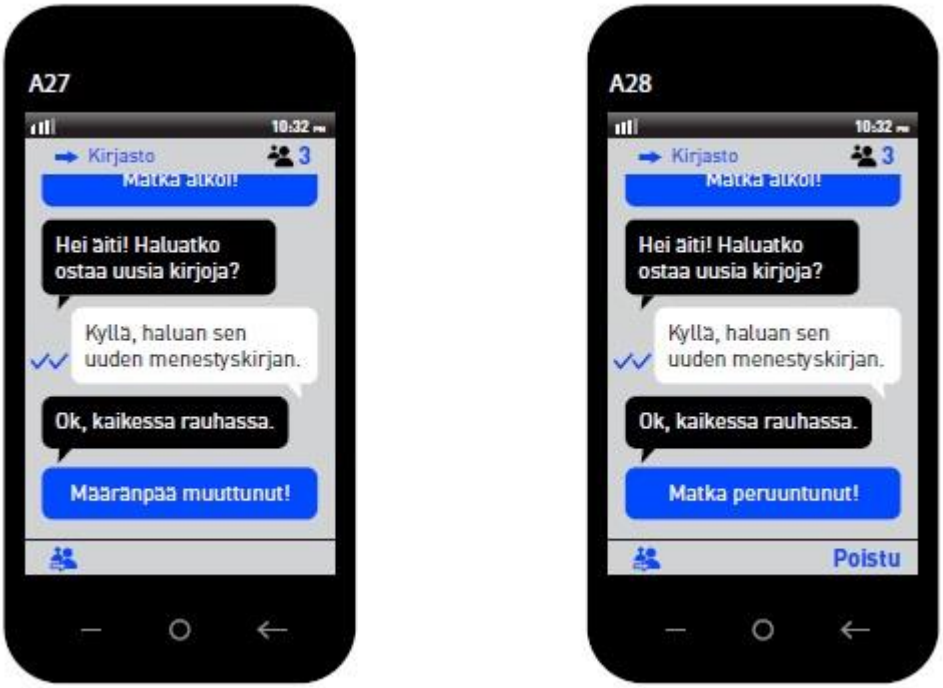
6. Miten tulkitset seuraavien näyttöjen informaation ja niissä näkyvät kuvakkeet?

Jatkokysymykset:

- Käyttäjä ymmärtää näyttöjen informaation ja kuvakkeiden merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen
- Käyttäjä ei ymmärrä näyttöjen informaation ja kuvakkeiden merkitystä -> Selitä, mitä näytöillä ja niissä esiintyvillä kuvakkeilla pyritään viestimään -> Kysy: Mikä tekee näyttöjen informaatiosta ja/tai niissä esiintyvistä kuvakkeista vaikeita tulkittavia? -> Kysy: Tuleeko mieleesi jokin parempi tapa viestiä asiasta?

- Kysy: Miten haluaisit toimia?
- Kysy: Miten lähdet toteuttamaan tätä tavoitetta eli mitä teet seuraavaksi?

➔ *”Matka alkoi” –keskusteluikkunassa informoi matkan alkamisesta*
➔ *”Määränpää muuttunut” ilmoittaa matkan päämäärän muuttumisesta*
➔ *”Matka peruuntunut” kertoo matkan peruuntumisesta kesken*



Näytöt A27, A28 Matkakohteen muutos / matkan peruuttaminen

Appendix 3: CO'MON usability test questions for traveler

Useat matkakumppanit samalla reissulla. Mahdollisuus kutsua useita kumppaneita mukaan samalle matkalle. Tämä ominaisuus mahdollistaa myös kommunikoinnin ryhmässä.

-> Onko useiden matkakumppanien osallistuminen samalle matkalle mielestänne hyödyllistä? Miksi? (Voiko se lisätä esim. turvallisuuden tunnetta kun liikutte yksin ulkona?)

-> Minkälaisessa tilanteessa haluaisitte kutsua useamman etämatkakumppanin? Miksi?

Kuuluvuuden näkyminen, miten hyvä kuuluvuus matkaajalla / matkakumppanilla on.

-> Onko kuuluvuuden näkyminen sinulle tarpeellinen ominaisuus?

-> Minkälaisessa tilanteessa siitä voisi olla hyötyä? Miksi?

1. **Onko matkakumppanien valintaan tarkoitettu näyttö mielestäsi selkeä? Miksi?**

Jatkokysymykset

- Jos ei, niin olisiko jokin muu toteutustapa mielestäsi parempi?

➔ *Hahmottaako haastateltava "lisäämiskuvakkeen" selvästi (+-logo)*

➔ *Ymmärtääkö hän kuvassa A3c tehdyt valinnat? (Valitut matkakumppanit merkittyinä V-merkillä)*

Näytöt A3a, A3b, A3c Matkakumppanin/kumppanien valinta.

2. **Kun olet lähettänyt pyynnön kolmelle matkakumppanillesi, sovellus näyttää seuraavanlaiset näyttöruudut. Miten tulkitset näyttöjen kuvakkeet ja niiden värit? Mistä ne mielestäsi viestivät?**

Jatkokysymykset:

- Käyttäjä ymmärtää ikonien ja niiden värien merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen
- Käyttäjä ei ymmärrä ikonien ja niiden värien merkitystä -> Selitä, mitä ikoneilla pyritään viestimään -> Kysy: Mikä tekee ikoneista ja niiden värivaihtelusta hankalan tulkita? -> Kysy: Tuleeko mieleesi jokin parempi ilmaisutapa?

  ➔ *Punainen kuvake = kutsu lähetetty, keltainen = kutsu vastaanotettu, vihreä = kutsu hyväksytty*
  ➔ *Keskimmäinen kuvake kertoo kutsutun henkilön puhelimen signaalin voimakkuuden*
  ➔ *Kysy kaikista kuvakkeista. Kuvakkeita ei merkitty erikseen, koska kuvasta tulisi liian epäselvä*

Näytöt A10a, A10b, A10c Kuvakkeen väri antaa tietoa matkapyyntöviestin lähtemisestä, perillemenosta ja hyväksymisestä.

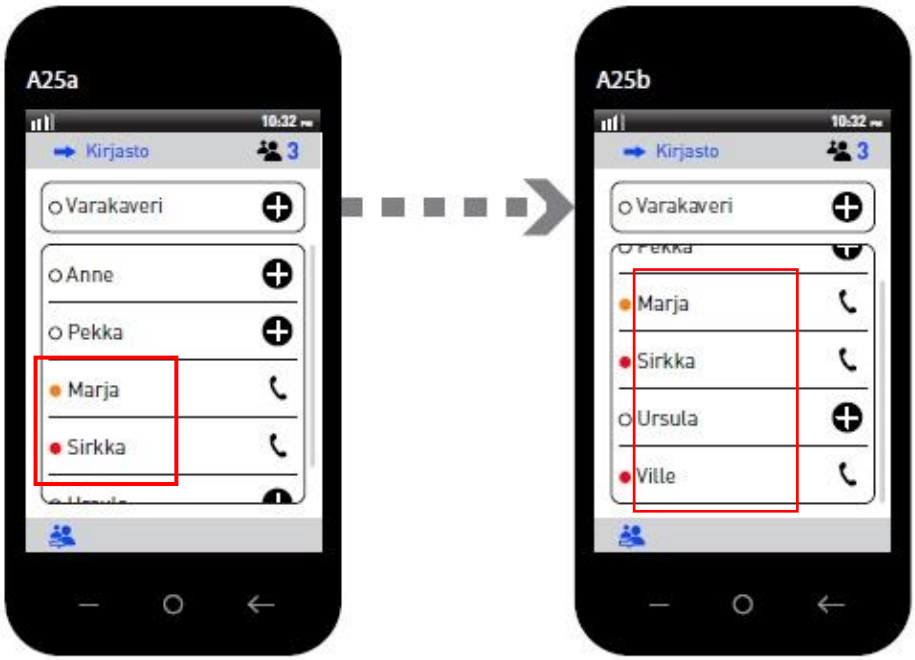
3. **Näillä näyttöruuduilla on kuvattu valikko, johon on listattu valitsemasi matkakumppanit. Miten tulkitset näytöillä näkyviä värejä (pallot)?**

Jatkokysymykset:Käyttäjä ymmärtää ikonien ja niiden värien merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen

- Käyttäjä ei ymmärrä ikonien ja niiden värien merkitystä -> Selitä, mitä ikoneilla pyritään viestimään -> Kysy: Mikä kuvake on vaikea ymmärtää? -> Kysy: Miksi?

  ➔ *Oranssi = huono kuuluvuus*

➔ *Punainen = ei kuuluvuutta, kutsua ei voi lähettää ollenkaan*



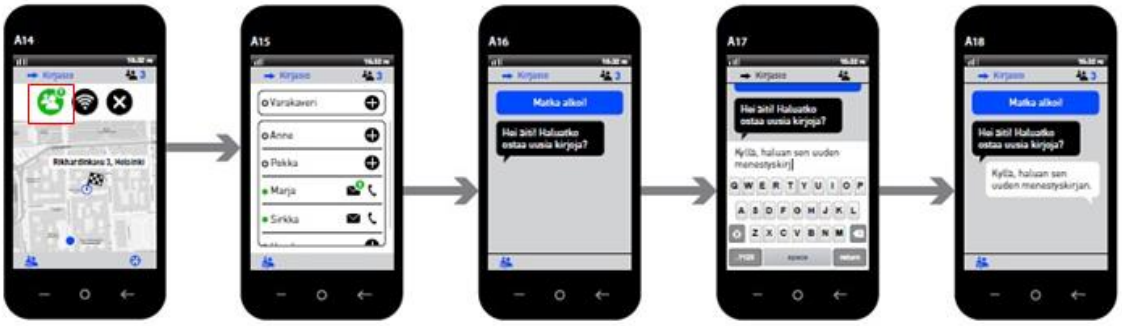
Näytöt A25a, A25b Huono kuuluvuus, soitto ja matkakutsun lähettäminen

TÄSTÄ ETEENPÄIN KYSYMYKSET 5-9 OVAT HAASTAVAMPIA. HAASTATTELIJA KYSYY TILANTEEN JA AJAN MUKAAN. LOPUSSA VIELÄ KAIKILLE TULEVA KYSYMYS!

4. Miten tulkitset näytön A14 vihreän kuvakkeen? Mistä se mielestäsi viestii?

Jatkokysymykset:

- *Käyttäjä ymmärtää ikonien/kuvakkeiden ja niiden värien merkityksen (oikein tai väärin)* -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen
- *Käyttäjä ei ymmärrä ikonien/kuvakkeiden ja niiden värien merkitystä -> Selitä, mitä eri näytöillä pyritään viestimään* -> Kysy: Mikä tekee näytöstä vaikeaselkoisen? -> Kysy: Tuleeko mieleesi parempia ilmaisutapoja?

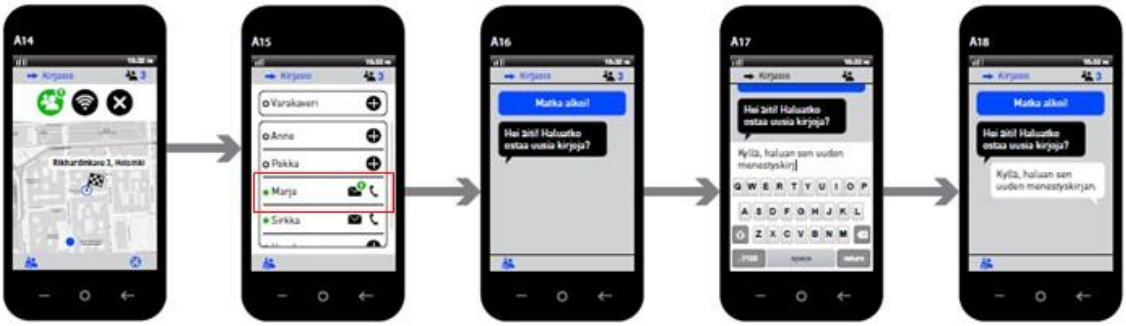


Näytöt A14, A15, A16, A17 ja A18 liittyvät viestien lähettämiseen ja vastaanottamiseen

5. **A15: Painettuasi vihreää ikonia (näytöllä A14) näyttöruudulle ilmestyy valikko, johon on listattu matkakumppanisi (näyttö A15). Miten tulkitset valikossa näkyvät ikonit?**

Jatkokysymykset:

- *Käyttäjä ymmärtää ikonien/kuvakkeiden ja niiden värien merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen*
- *Käyttäjä ei ymmärrä ikonien/kuvakkeiden ja niiden värien merkitystä -> Selitä, mitä eri näytöillä pyritään viestimään ->* Kysy: Mikä tekee näytöstä vaikeaselkoisen? -> Kysy: Tuleeko mieleesi parempia ilmaisutapoja?



Näytöt A14, A15, A16, A17 ja A18 liittyvät viestien lähettämiseen ja vastaanottamiseen

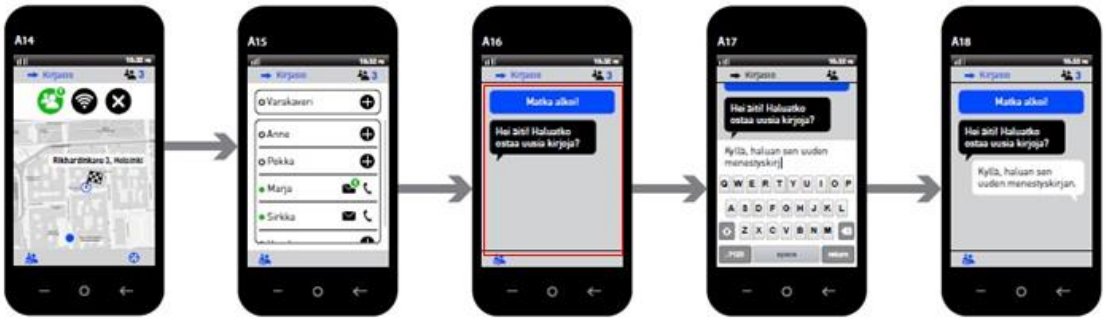
6. **Painettuasi valintalistassa (näytöllä A15) Marien kohdalla näkyvää kirjekuorta esittävää ikonia, näyttöruudulle ilmestyy näyttö(A16). Miten tulkitset sen?**

Jatkokysymykset:

- *Käyttäjä ymmärtää ikonien/kuvakkeiden ja niiden värien merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen*
- *Käyttäjä ei ymmärrä ikonien/kuvakkeiden ja niiden värien merkitystä -> Selitä, mitä eri näytöillä pyritään viestimään ->* Kysy: Mikä tekee näytöstä vaikeaselkoisen?

➔ *A14 –kuvassa oleva ”numero 1” vihreässä logossa kertoo, että henkilölle on saapunut yksi viesti*

➔ *Kuvan A15 –listasta käy ilmi tarkemmin keneltä viesti on saapunut*
➔ *Painamalla henkilön nimeä, jolta viesti on saapunut, pääsee näkemään viestin sekä vastaamaan siihen*



Näytöt A14, A15, A16, A17 ja A18 liittyvät viestien lähettämiseen ja vastaanottamiseen

7. Miten ymmärrät näyttöruudun kuvakkeissa ja niiden väreissä tapahtuvat muutokset? Mistä ne informoivat sinua?

Jatkokysymykset:

- *Käyttäjä ymmärtää ikonien ja niiden värien merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen*
- *Käyttäjä ei ymmärrä ikonien ja niiden värien merkitystä -> Selitä, mitä ikoneilla pyritään viestimään -> Kysy: Mikä tekee ikoneista vaikeita tulkita? ->* Kysy: Tuleeko mieleesi jokin parempi ilmaisutapa?

➔ *Keskimmäinen kuvake kertoo matkaajan kuuluvuuden, mitä enemmän ”palkkeja”, sitä parempi.*
➔ *Vasemmalla olevan kuvakkeen muuttuessa punaiseksi, on yhteys kadonnut kokonaan. Vihreä väri kertoo yhteyden olevan taas olemassa.*
➔ *Ruksi = matkan päättäminen*

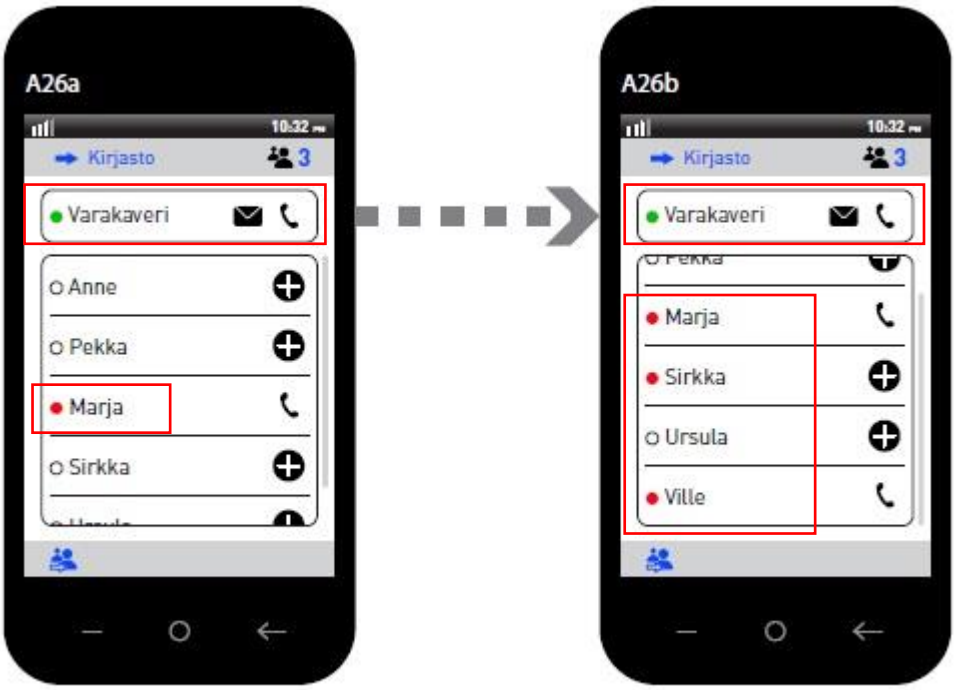
Näytöt A22, A23, A24 Kuuluvuus.

8. **Matkan aikana näytössä näkyvä ”Varakaveri”-vaihtoehto aktivoituu (aikaisemmassa versiossa varakaveri). Mitä näytön muuttuneet värit ja kuvakkeet mielestäsi tarkoittavat?**

Jatkokysymykset:

- *Käyttäjä ymmärtää ”Varakaveri”-vaihtoehdon aktivoitumisen merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen*
- *Käyttäjä ei ymmärrä ”Varakaveri”-vaihtoehdon aktivoitumisen merkitystä -> Selitä, mitä sillä pyritään viestimään ->* Kysy: Miksi ”Varakaveri”-vaihtoehdon aktivoitumista oli hankala tulkita? -> Kysy: Tuleeko mieleesi jokin parempi tapa viestiä yhteyden katkeamisesta matkakumppaniin ja varakumppanin aktivoitumisesta?

➔ *Varakaveri –vaihtoehto vihreänä tarkoittaa varakaverin olemista aktiivisena*
➔ *Kuvassa A26a sekä A26b näkyy, että Varakaveri –toiminta on aktiivisena, sillä jokainen henkilö on punaisena, eli ilman yhteyttä.*



Näytöt A26a, A26b Varakaveri - Kaikkien matkaseuralaisten menettäessä yhteyden (esim. huonon kuuluvuuden takia) aktivoituu varakaveri. Se aktivoituu itsestään.

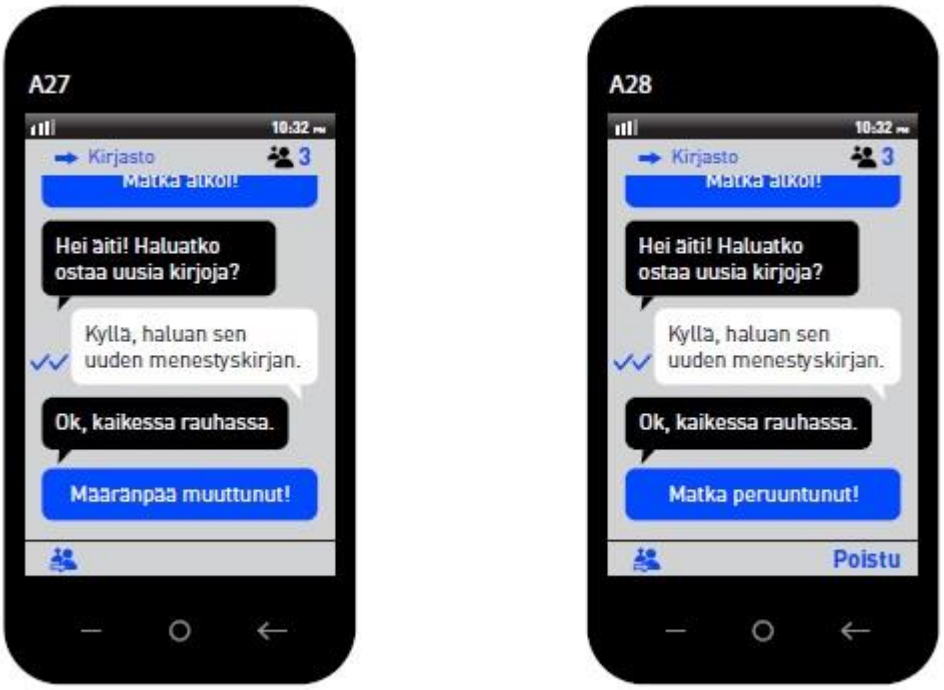
9. **Miten tulkitset seuraavien keskusteluikkunoiden tapahtumat?**

Jatkokysymykset:

- Käyttäjä ymmärtää näyttöjen informaation ja kuvakkeiden merkityksen (oikein tai väärin) -> Pyydä häntä selittämään, miten hän päätyi tähän johtopäätökseen
- Käyttäjä ei ymmärrä näyttöjen informaation ja kuvakkeiden merkitystä -> Selitä, mitä näytöillä ja niissä esiintyvillä kuvakkeilla pyritään viestimään -> Kysy: Mikä tekee näyttöjen informaatiosta ja/tai niissä esiintyvistä kuvakkeista vaikeita tulkittavia? -> Kysy: Tuleeko mieleesi jokin parempi tapa viestiä asiasta?

- Kysy: Miten haluaisit toimia?
- Kysy: Miten lähdet toteuttamaan tätä tavoitetta eli mitä teet seuraavaksi?

➔ *”Matka alkoi” –keskusteluikkunassa informoi matkan alkamisesta*
➔ *”Määränpää muuttunut” ilmoittaa matkan päämäärän muuttumisesta alkuperäisestä johonkin muuhun*
➔ *”Matka peruuntunut” kertoo matkan peruuntumisesta kesken*



Näytöt A27, A28 Matkakohteen muutos / matkan peruuttaminen