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Smartwatch and Intellectual Disability

Designing an app that improves the lives of people with an intellectual disability and their caretakers.

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ABSTRACT

It is becoming more difficult to provide care for people with an intellectual disability, due to the increasing demand for care. Earlier examples have shown that wearable technology like smartwatches can aid with the provision of such care by using the wide acceptance of watches among society and exploiting this by adding functionalities. During the design of such technological solutions, the focus is mainly put on quality of life of people with an intellectual disability, and no focus is put on the quality of life of caretakers. Therefore a smartwatch application is developed which aims to improve the quality of life of both stakeholder groups.

In order to improve the quality of life, the needs of the stakeholders need to be fulfilled. A need assessment for both stakeholder groups was necessary to determine which needs are unfulfilled. The resulting set of needs formed the basis of the ideation phase, which is the first phase of the used design process. During this phase it was decided that the project aims to fulfill the need for better communication with caretakers and the need to provide better personal care by developing an Android Wear application. The application runs on Android Wear smartwatches and allows caretakers to perform easy and quick communication with their clients and vice versa. The smartwatch application is required to be usable without any reading or writing skills, since people with an intellectual disability have limited conceptual skills.

A prototype of the suggested application has been made and was evaluated during the evaluation phase. The acceptance of the prototype's functionalities was assessed by testing the prototype with four couples containing a person with an intellectual disability and a caretaker. After the tests it could be concluded that caretakers accept both the functionalities, while most people with an intellectual disability accepted at least one functionality. It was concluded that the designed application is expected to fulfill the needs and thus improve the quality of life of people with an intellectual disability and their caretakers.

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1. INTRODUCTION

The amount of people with an intellectual disability (ID) in the Netherlands is growing. In 2011 160.000 people with an ID received care for their disability which cost 7 billion euros. This demand for care is growing, since the amount of people with a disability is increasing. This increase is caused by the fact that the life expectancy of people with an ID is growing, because of better care. It also became more difficult for people with an IQ lower than 75 to cope with an increasingly complicated society [1].

Care is mainly supplied by parents and caretakers, and while people with an ID are getting older, so do their parents. Even though people with an ID still want to leave as normal and autonomous as possible, they still require and ask for care. This care is becoming more difficult to supply by parents and caretakers, because of the before mentioned increasing demand for care and the aging of parents. This increase in demand for care can be slowed down by shifting the focus in care from what people with an ID need help with to what people with an ID can do. In order to do this, not only the knowledge from healthcare professionals is needed, but also the help from people close to the person with an ID.

Current methodology and technology is used in order to make people with an ID rely more on their own skills, for example the Own Initiative Model (OIM method) [2]. This method lets caretakers support clients to do more by themselves. While technology could be used to support this. An example of this kind of technology is the Beeldhorloge, a Dutch invention. The beeldhorloge is a watch that is connected to the internet and displays relevant reminders at the right times [3]. Unfortunately, after four years of functioning, the company supporting the device shut down the service, even though the device appeared to be a big help for both people with an ID and their caretakers.

Watches have been a widely accepted piece of technology in nowadays society. The use of this technology can be exploited by adding functionality in order to improve the needs of people with an intellectual disability. As explained, this has been proven by the beeldhorloge and it can thus be expected that smartwatches could play a major role in the use of technology in order to improve the lives of people with an ID.

Therefore, modern day technology can play a role in fulfilling the needs of people with an ID and their caretakers and thus improve their quality of life. While a focus is mainly put on improving the quality of life of people with an ID, almost no attention is put on the caretakers.

This leaves the caretakers and their patients with a set of unfulfilled needs, which gives room to improve their quality of life.

2. STATE OF THE ART ON IMPROVEMENT OF THE QUALITY OF LIFE OF PEOPLE WITH AN INTELLECTUAL DISABILITY USING TECHNOLOGY

2.1. Background research

Background information on the characteristics of intellectual disability and the concept of quality of life is required in order to understand the methods that are used during this research. The background research provides the definition of ID and a description of quality of life and how quality of life can be improved.

2.1.1. WHAT IS INTELLECTUAL DISABILITY

In order to understand the needs of people with an ID; the definition, categorization and characteristics of an ID need to be understood.

The Encyclopedia of Autism Spectrum Disorders by Volkmar [4] gives a description of the definition of ID written by Nevill and Havercamp. ID They describe that ID is a disability characterized by significant limitation in intellectual functioning, significant limitation in adaptive behavior, and the onset of these limitations before the age of 18. These limitations are expressed in conceptual (e.g. language, reading, writing, understanding of time and numbers), social (e.g. relating to others, self-esteem, social problem solving, rule following), and practical skills (self-care, health care, safety, transportation, technology and money).

The American Association on Intellectual and Developmental Disabilities (AAIDD) established that the above limitations could be measured using an IQ test, where an IQ test score lower than 75 indicates a significant limitation in intellectual functioning. Other classification systems also exist like the International Classification of Deseases-10 (ICD) and the Diagnostic and Statistical Manual (DSM). These systems are similar to AAIDD in terms of the use of IQ in order to define ID. In addition to AAIDD, DSM and ICD provide subgroups based on the IQ score. Here the following categories are supplied: mild (IQ 55-69), moderate (IQ 40-55), severe (IQ 25-39), and profound (IQ <25).

2.1.2. HOW TO IMPROVE QUALITY OF LIFE?

In order to build a service which improves the quality of life, the theory behind how to improve the quality of life of the stakeholders needs to be understood.

Quality of life is a complex construct which can be seen from multiple perspectives and can be used in many ways, as described by Wehmeyer and Schwarz [5]. Quality of life is often

mentioned together with the self-determination theory by Deci and Ryan [6] in the context of ID. That is why Wehmeyer and Schwarz conducted a research to prove the relationship between Self-Determination and the Quality of life for adults with an ID.

Wehmeyer and Schwarz describe that "quality of life is best viewed as an organizing concept to guide policy and practice to improve the life conditions of all people" [5]. This means that the quality of life could be used as a framework to reflect on peoples desired conditions of living in order to improve it in practice. They also describe that quality of life exists out of eight core principles: emotional well-being, interpersonal relations, material well-being, personal development, physical well-being, self-determination, social inclusion and rights. They state that these eight factors are relevant to all people, and quality of life is "experienced when a person's basic needs are met, and is enhanced by integration and by enabling individuals to participate in decisions that impact their lives.". From this description it can be deduced that in order to improve quality of life, the needs of the stakeholders have to be met.

Wehmeyer and Schwarz have proven that the relationship between self-determination and quality of life exists [5]. They found that people with an ID who experienced higher self-determination, also experienced a higher quality of life. Therefore, quality of life could be improved by improving a person's self-determination.

A person's self-determination refers to the Self-Determination theory. This theory implies that people have three basic needs: autonomy, competence and relatedness [6]. These needs have to be satisfied in order for a person to function effectively and experience psychological well-being. Deci and Ryan state that these needs are supported by motivation, which could be divided into autonomous motivation and controlled motivation. Here autonomic motivation consists out of intrinsic motivation (for example: "I paint, because I like to paint") and self-regulated motivation (for example: "I brush my teeth, because it is usual to brush my teeth."). This type of motivation causes people to feel self-endorsed about their actions, and thus experiencing a higher self-determination. On the other hand, controlled motivation consists of external regulation where behavior is caused by external factors like reward or punishment (for example: "I'm doing my homework, because otherwise I have detention at school"). This type of motivation causes people to feel pressured to behave in certain ways.

2.2. Problem analysis

In order to fulfill the needs of people with an ID and their caretakers, it is important to know which needs exist. This section delivers a problem analysis, which consists of important

information on the needs of people with an ID and those of their stakeholders. This information is acquired through a literature research and interviews with both stakeholder groups. This section answers *SQ3 and SQ4* by first describing what the needs people with an ID have and what needs their caretakers have. The section is closed by a conclusion, summarizing the findings.

2.2.1.   LITERATURE RESEARCH ON THE NEEDS OF PEOPLE WITH AN ID AND THEIR CARETAKERS

The literature research gives an overview of the needs that people with an ID and their caretakers have. Having this overview is relevant in order to know what needs have to be fulfilled in order for their quality of life to be improved.

2.2.1.1.   *Method of the literature research*

This literature review is based on articles that have been peer-reviewed and are found in the digital library of the University of Twente. These articles were found by first defining constructs that were important for this research and then defining synonyms which could help find articles using a different terminology. These constructs and their synonyms were used to form search terms which were adjusted to acquire more in-depth in information about the different subjects.

2.2.1.2.   *Results of the literature research*

The literature research delivered a large amount of needs, supplied by existing literature containing researches about the needs of people with an ID and their caretakers. The needs that are found during these researches are summarized in this section.

The needs of people with an ID according to existing literature

Schützwohl et al. [7] describe that most people with an ID have a need for help in "lower order areas" and "higher order areas", where higher order needs are least met. These areas refer to areas in Maslow's hierarchy of needs, which is an order of most basic to most "luxurious" needs. Lower order needs are mainly met and include psychological needs and safety needs (e.g. money budgeting, welfare benefits, daytime activities and accommodation). They also describe the most unmet needs that were found during their research. These needs are in "higher order areas", such as sexual expression, social relationships, basic education, and help with minor mental health problems (e.g. anxiety and depression). This article also describes the needs with the highest proportional differences in met and unmet needs. These needs are also in higher order areas and, like the needs that were unmet most often, sexual expression and help with minor health problems. Three other needs that had high proportional differences were the help with major health problems, help with substance misuse and communication.

Durbin et al. [8] explain that people with an ID are most likely to have several unmet needs in relation to people with mental health problems without an ID. The identified unmet needs are in transportation (the disability to use public transportation), self-care (the person's hygiene forms a medical/social risk), safety to others (persons' behavior places other people at risk), social relationships (person risks violence in current relationship or is lonely due to the absence of intimate relationship), information on their condition (lack of information about condition or treatment), access to telephone, and basic education (difficulty reading, writing and understanding language). Influencers like age, gender and time in the care program are not taken in account by these results. By adjusting the analysis to these influencers different results were described. The adjusted results showed that clients with an ID and a psychiatric mental health diagnosis are more likely to have unmet needs for transportation, self-care, information on treatment on their condition and basic education.

Vilaseca et al. [9] describe the needs of people with an ID in Catalonia, Spain. The authors describe the top five individual needs. These needs are for general and specialized healthcare services, leisure services, personal assistance, and psychological support. The families of people with an ID explain that their relatives have unmet needs for aid with adapting the home, speech and language services, alternative and augmentative communication systems, lifelong training services and technical assistance for visual and auditory disabilities. The authors also state that intermediate needs are defined as the provision of help and guidance at inclusive schools, aid for behavioral disorders, psychological support, physical therapy, psychomotor activity services, service coordination and guidance in education, in work and in leisure services.

Shaw, Cartwright and Craig [10] focus on the housing needs of people with an ID. The authors conclude that people with an ID have the need for housing with friends or peers who also have an ID. They also state that living with peers benefits companionship, friendship, social interaction and their sense of community. People with an ID have explained that they prefer not to live in company of their parents. Not living under the supervision of a parent gives people with an ID greater autonomy and control over their own personal space and it gives them more choice on how they want to spend their leisure.

In total, eleven different needs can be deduced from these papers. In summary, these needs contain: accommodation, daytime activities, money, sexual expression, social relationships, basic education, safety to others, help with minor mental health problems,

transportation, self-care, healthcare services, speech and language services, and access to telephone. Of these needs, daytime activities and help with minor mental health problems are confirmed by Schützwohl et al. and Vilaseca et al. healthcare services is confirmed by Durbin et al. and Vilaseca et al.. Finally, Welfare/self-care, accommodation, and social relationships are confirmed by three of the four sources. It can thus be concluded that these needs are the most important to be fulfilled.

The needs of caretakers according to existing literature
Existing literature has put focus on the needs of different caretakers in different ways. Wark, Hussain and Edwards focus on the needs of nurses [11], as do Clearly and Doody [12]. Vilaseca et al. and Shaw, Cartwright and Craig also put a focus on the needs of parents of people with an ID [9] [10], while Davys, Mitchell and Martin specifically described the needs of fathers of children with an ID [13].

Next to the needs of people with an ID, Vilaseca et al. [9] did also focus on the needs of parents of people with an ID. The authors describe that the most important needs of families are: information about legal rights, information about where to get services for the family member, information about planning for the future and money to help pay the bills. They also describe which needs have the biggest difference in being met and unmet. These needs are in household support for caring for the family member with an ID, money, information about planning for the future, parenting or family training, respite care, information about services available for the family member with an ID, services for the specific disabilities and services for the family.

Davys, Mitchell and Martin [13] focus on the fathers of people with an ID. They explain that fathers of children with an ID show lower stress levels when they have a job. That is because they have the availability of occupations other than taking care of their child, which explains the need of employment. After learning about the diagnosis of their children, fathers often have the need for information. This helps them to understand the cause of their child's condition and how they can improve the situation.

Shaw, Cartwright and Craig [10] also mentioned a need that was on the parents' side. The researchers describe that once parents of people with an ID grow older, they become unable to care for their child. Thus we see a growing in the need for transition to formal housing and support, away from the parents.

Wark, Hussain and Edwards [11] focus on the training needs of nurses who take care of people with an ID. They have established five problem areas in the training of nurses: generic training issues, medical training issues, emerging ageing issues, mental health and the quality of life. Generic training issues include the inability to educate the general public about the disability of their clients, the lack of training on record keeping in order to assess medical changes of clients over time and the lack of attitude training. Medical issues that are addressed are: medical management, issues with dementia and diabetes, the understanding of medication, the lack of training in observation skills to detect early changes in health and the understanding of health issues. Emerging ageing issues are: the support of dietetics, the lack of knowledge on how to provide appropriate physical support, the lack of generic aged care courses for disability service providers, specialist equipment usage, understanding the aging process and different support needs at the different stages of aging and personal care needs. Mental health issues that are described include the inability to understand emotional issues of clients and the missing of skills in supporting other clients in dealing with ageing issues of their peers. Finally, quality of life issues are described: nurses lack knowledge on how to maintain quality of life during the ageing process by the use of person centered planning and quality of life management.

Clearly and Doody [12] focus on nurses of people with an ID and dementia. They explain that nurses of people with an ID have a need for knowledge about dementia. This helps them in early diagnosis of dementia, which prevents its symptoms to be a burden to them in the future. The nurses also have a need for the comforting of people with dementia from distress by treating the causes of distress like thirst, incontinence and pain. Also a need for a multidisciplinary team, behavioral assessments and support plans is described. These three methods help with developing the right support approach for the clients. Finally, there is a need for coping with people with an ID and dementia and its challenges.

It can be concluded that even though the needs of different kinds of caretakers are different, information about services, aging of the person with an ID and about the disability is a common need which is described by four sources. It can also be concluded that there is an unfulfilled need for personal care for the person with an ID. Also the planning for the future is a common need described by Vilaseca et al. and by Clearly and Doody. Finally, behavioral assessment is an occurring need described by Wark, Hussain and Edwards and Clearly and Doody.

2.2.1.3. Conclusion of the literature research

It can be concluded that needs of people with an ID are for: accommodation, self-care, daytime activities, communication, money, sexual expression, social relationships, basic education, safety to others, psychological support and healthcare services. Of these needs, the needs for accommodation and social relationships are the most important to be fulfilled. Next to that, unfulfilled needs of their caretakers are: the need for information about services for people with an ID and their relatives, information about the disability and information about aging with ID, but also the planning for the future, personal care for the patient and opportunities for behavioral assessment are unmet needs.

The information provided in this section is an important step in developing technology solutions that fulfill the unmet needs of people with an intellectual disability and their caretakers. This helps with eventually putting less pressure on caretakers of people with an ID and thus helps to cope with the increasing demand for care.

Because the articles mainly provided quantitative data about the needs of people with an intellectual disability and their caretakers, it is important to perform research of qualitative nature on the unmet needs. Thus, further qualitative research needs to be conducted on the unmet needs of people with an ID and their caretakers. This helps to gain a better understanding in how these needs could be met and how technology could play a part in this.

2.2.2. INTERVIEWS ON THE NEEDS OF PEOPLE WITH AN ID AND THEIR CARETAKERS

As mentioned in the previous section, the sources used in the previous chapter mainly supplied an overview of existing needs, it is important to collect qualitative information on the needs of people with an ID and their caretakers in order to obtain a more in depth view on the needs of people with an ID and their caretakers. This helps in finding concrete needs of which ways to fulfill them can then be explored. To do this, qualitative semi-structured interviews are conducted to get a better understanding of their current state of self-determination and the acceptation of technology of people with an ID and their caretakers.

2.2.2.1. Method of the interviews

To acquire the needed information, four sets of interviews will be conducted with people with an ID and their caretakers. The participants are acquired by contacting Talant, a Dutch healthcare organization specified on people with an ID. Together with Talant a meeting has been set up on the 22nd of March 2017 in one of their day care locations so that the interviews can be held in a

comfortable environment. On this day 4 caretakers and 4 people with an ID will be interviewed, including an interview with a former user of the "Beeldhorloge" and her father. During this interview the same sets of questions will be used.

Two separate sets of questions are designed based on the research questions and constructs above. One set of questions is for the person with an ID (Appendix 9.2) and the other is designed for the caretaker (Appendix 9.3). All participants are interviewed separately, starting with the caretaker and then followed by the person with an ID. Here the caretaker will be at the interview, so that the person with an ID feels more at comfort and so that the caretaker can give feedback after the interview.

To get an idea of how much people with an ID are willing to accept technology, it is important to know how familiar they already are with technology, what methods are currently used to improve their daily lives (question 6, 7, and 8) and what kinds of (wearable) technology and methods they already use (question 3, 4). Then it is important to know how willing they are to use technology to improve their daily lives (question 25, 26) and how they think technology can improve their lives (question 27).

Next, to be able to describe to what extent people with an ID feel autonomous or can be autonomous, it first is important to understand how someone with an ID lives with an ID and what the skills and knowledge of a person with an ID are (question 5, 21). Then what the daily routine of a person with an ID looks like (question 2) and what irregularities can appear in their daily routine (question 1), to learn about their activities. Finally, it is important to know what kind of problems they have to face (question 22, 23, and 24), how they behave when facing these problems and what the caretaker worries about when the person with an ID is alone.

Then, to learn about the relatedness people with an ID feel, it is important to understand how they feel related (question 10) and what separates them (question 12). Also how they interact with each other (question 9, 14, 15, and 16), what they like about interacting with each other (question 11) and what kind of problems are in their interaction (question 13, 17) is important. Then it is needed to know what is important in their interaction (question 18, 19) and how they prefer to interact (question 20).

To get an idea of how much caretakers are willing to accept technology, it is important to know how familiar they already are with technology, what methods are currently used to improve the daily lives of people with an ID (question 7, 8, 9) and what kinds of (wearable) technology they already use (question 5, 6). Then it is important to know how willing they are to

use technology to improve their daily lives (question 26, 29) and how they think technology can improve their lives (question 28).

Next, to be able to describe to what extent people with an ID feel autonomous or can be autonomous, it is important to understand how someone with an ID lives with an ID and what the skills and knowledge of a person with an ID are (question 6, 22). Then what the daily routine of a person with an ID looks like (question 3) and what irregularities can appear in their daily routine (question 2), to learn about their activities. Finally, it is important to know what kind of problems they have to face (question 23, 24, and 25), how they behave when facing these problems and what the caretaker worries about when the person with an ID is alone.

Then to learn about the relatedness people with an ID feel, it is important to understand how they feel related (question 11) and what separates them (question 13). Also how they interact with each other (question 10, 15, 16, and 17), what they like about interacting with each other (question 12) and what kind of problems are in their interaction (question 14, 18) is important. Then it is needed to know what is important in their interaction (question 19, 20) and how they prefer to interact (question 21).

In order to store information, the interviews will be recorded using an audio recorder. This information is confidential and will only be used for this research. In order to inform parents and caretakers about these interviews and how they will be performed, forms for informed consent have been sent out, which can be found in Appendix 9.4 and Appendix 9.5. Only participants who can show a signed form of informed consent can take part in the interviews.

2.2.2.2.   Results of the interviews

The following results are derived from the interviews in regard to the acceptance of technology, autonomy and relatedness. These are the results of the interviews of the four participants with a mild ID in the presence of the caretakers and the interviews with four caretakers. Three of the caretakers work at a community workshop for people with an ID and are in direct contact with the people with an ID who go there. The final caretaker is the father of one of the clients who goes to this community workshop.

Technology acceptance of people with an ID

Starting with technology acceptance, it can be said that all clients are familiar with technology like smartphones and tablets, and are using them as well. Phones are mainly used to stay in contact with relatives or friends, while they are barely used for applications or social media, because the use of social media is probably prohibited by caretakers. Computers and tablets

are mainly used to play simple games like puzzles, memory trainers, and word games or to browse the internet for information about their interests. This simplified use of technology, indicates a low level of affinity with technology.

Not all clients were familiar with the use of watches; three out of four clients used a watch. However, only two of the participants with an ID were able to read the time. The client who has used the Beeldhorloge before, however, was not. This is probably due to a lack of the understanding of the concept of numbers in relation to time, which is a characteristic of ID, as explained in section 2.1.1.

When asked whether the clients already use technology or other methods to improve their lives, they mainly talked about caretakers who guide the clients throughout their day or help them with the household. One person described the use of a task list, which she has to work through and which keeps her active. This indicates a (fulfilled) need for guidance at work and at home. These forms of help are used almost daily for clients who live by themselves, while clients who live in in a house for groups receive care every day.

When clients were asked on their opinion on how (wearable) technology could improve their lives, they mainly state that their lives do not need improvement. Only when an example was given of the use of technology, they were able to see the use of that particular example. This indicates that the clients only know what they want, if they are able to experience it. However, only one client has indicated that her life could be improved by the availability of a car, which expresses a need for easy transportation.

Three out of four clients have indicated that they do not like the idea of technology taking over tasks performed by a caretaker, including the client who is familiar with the Beeldhorloge, even though she told that it was useful. Again, this could be explained by the fact that they do not know what could be meant by technological help, unless they are able to experience it. Two of these people also stated that they would rather be taken care of by humans, because they prefer human contact over artificial contact. The client who did like the idea of technological help, referred to the fact that she would rather have technology do all of her household, so she wouldn't have to do anything or the fact that she thought that interaction with robots is funny.

The three clients who disagreed with having technology taking over the tasks of the caretaker, also didn't like the idea of technological help at all. These clients think that they could live without the technological help and see no use in it. The client who thought that technological

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help could be useful, liked the idea of having (intelligent) technology around her, which she can interact with.

Autonomy of people with an ID

Next, autonomy was discussed. Autonomy was assessed by asking about the weekly schedule of regular activities of the clients and asking about their daily routine and the problems that they face during their day. Also attention is being put on what the clients are skilled in.

 All four clients went to one or two community workshops, which they referred to as "work". These workshops provided both creative activities, like painting and pottery, and also sports and activities like helping out at nearby schools or kindergartens. During office hours on weekdays, all clients' schedules were filled with such activities at these community workshops. During leisure at home, they often filled it with watching television, playing games, handcrafting, social interaction with caretakers and sports.

 When asked about their skills, all clients liked to point out their hobbies or work activities. Only two clients also pointed out their household skills, like cooking, cleaning and doing laundry. This is probably due to the fact that the interviews were taken in the work setting. It could be expected that when the interviews are taken at home, different answers occur.

 When the clients are asked whether there were recurring needs for help, they replied negatively, stating that they barely need help, however when asked if they ever have to face problems, only two clients replied that they ask the caretakers for help and will accept help with the problem some time later. Unfortunately, only one client was willing to talk about these problems, because the other client did not want to talk about her problems due to her privacy. The other client indicated that she faces loneliness and boredom. Boredom was often solved by asking a caretaker for inspiration to do an activity. This indicates a need for guidance in leisure.

 A problem that is faced by all clients is forgetting activities and items. When asked about what kind of things they forget, only one client replied that she never forgets anything. This client is also known for her ability to find all lost items in the community workshop. The other clients all answered the forgetting of items either at home or during an activity like doing groceries. When asked about how they deal with this, the reply that they accept their mistake and go on without the forgotten item.

Relatedness of people with an ID

Last is relatedness, where the relationship of the client with the caretaker is assessed. This is being done by determining the way clients communicate and interact with their caretakers, what

they like about the interaction with caretakers and how they feel comfortable with their caretakers. A look is also taken at problems in their interaction; what do not clients like in the interaction with their caretakers and how they feel uncomfortable. Finally, a look is taken at what is important in the interaction.

All clients interact with each caretaker at least one time a week at the community workshop. Unknown is how often they interact with homecare, since it is unknown how many different caretakers are available during a week. When one client was asked about how often she was with her father, she replied only two times a week.

Even though this client sees her father only two times a week, she calls him every night. On the other hand, telecommunication between clients and caretakers at the community workshop almost never occurred, except during groceries and when a client signs out for the day. However, all clients talk to relatives over the phone. Also caretakers at home are called when information is needed about everyday tasks, like cooking. This indicates a need for easy communication with caretakers whenever a client needs help.

Whenever clients felt the need to talk to a caretaker they almost always have the possibility to go to someone. There also is a weekly or daily moment where the client can talk to a caretaker at home. However, when a client still feels the need to talk to someone, and this is not an option, all clients who responded to this question patiently wait until an opportunity occurs.

Appointments between clients and caretakers are almost never done over the phone. All appointments are either made verbally, or written in a calendar or schedule. Except appointments with relatives are done over the phone, as indicated by client 4.

When asked what clients like about their interaction with the caretakers, they reply the work and leisure activities that they do with the caretakers (intrinsic motivation). One client indicated that she likes the fact that she could always go to a caretaker with her problems and talk about it. On the other hand, what is disliked in the interaction is the necessity to perform tasks that they do not want to do, but are important, for instance financial bookkeeping (extrinsic motivation).

When asked about how clients feel comfortable with the caretaker, they answer that they feel like home with them that they feel welcomed and that they understand that they need the

help provided by the caretakers. Instead, one client indicated that some caretakers made her feel insecure about herself and that she would like to live other people's lives because of this.

When asked about what is important to the interaction, clients explain the need to talk about their daily experiences, but also problems that need to be discussed. They all explain that they want to have the ability to talk whenever a problem occurs, but also at the end of the day in person.

Technology acceptance of caretakers
Starting with the technology acceptance and affinity of the caretakers, it can be said that all caretakers like working with new technology if it is perceived as functional. They are prepared to invest time and effort in learning how to work with it and feel comfortable doing this if the technology is accessible. One caretaker added that she feels scared to break devices when she starts working with it, so she only feels comfortable working with it if she is sure that she can not harm the system. This indicates that the caretakers have a relatively high affinity with technology.

At the community workshop, caretakers explained that they learned to use the OIM (Own Initiative Model) method with their clients. This method encourages caretakers to not take too many tasks from their clients, but encourage the clients to perform these tasks themselves. However, this method is barely used. They also explained the use of a computer application which puts them in contact with the caretakers at home. This application requires the caretakers to write a report every day about the clients about their progress and events. The system also supports planning for the future. The caretakers also make use of pictograms in order to make a schedule or task list for all clients, because these clients can't read. Finally, the father of one of the clients reported that he and his daughter used the Beeldhorloge, which is a watch that notifies the person with an ID of tasks or reminders at chosen times using pictograms. This added structure to her day and made it easy for her dad to wake her up from a distance.

When asked whether caretakers prefer technology to take over the support they provide, they replied that if it is perceived as functional or adds efficiency they are prepared to do this. However, they dislike the idea of completely removing their contact with the clients and letting technology take over all their tasks. They add that it is best if clients are able to perform the tasks themselves and if they can go to a real person if they want to talk.

When asked about how caretakers think wearable technology can improve their lives, they all reply that a smartwatch which notifies the client of tasks is very appealing. They all

agree that this adds structure to the day of their clients, but other than that, they couldn't explain other ways in which wearable technology could support them. Furthermore, all caretakers explained that they would use technology in order to improve their lives.

Autonomy of people with an ID as perceived by caretakers

Next, autonomy is discussed. In order to assess the autonomy of people with an ID, caretakers are asked about the skills of their clients and what they need help with. Also information is gathered about problems that people with an ID experience and how these problems are fixed.

When asked about the skills of the clients, the caretakers reply that their clients are very social and that they are focused on their activities. On the other hand, when the caretakers are asked about what their clients need help with, they reply with everyday tasks and with problem-solving when the clients feel fed up. One caretaker also replied that a client experiences laziness. This explains that clients have a need for self-care and help with everyday tasks.

Recurring problems that are mentioned are when clients do not understand something or do not know what to do. It also occurs that clients feel depressed or lonely when they are alone. These problems are mainly solved by having a talk with the client by either in person or through telephone. This again explains that clients experience a need for easy communication with their caretakers.

Caretakers who are more experienced with the clients also worry about the feelings and activities of their clients when they are not together. They often worry about their happiness and activities. However, the father of one of the clients explained that he doesn't worry, since he has made clear appointments with his daughter with regards to safety. He only worries about the well-being of the people around his daughter. He worries that she is a burden to the people living around her apartment, due to her loud voice.

When caretakers talk about the forgetting of their clients, on one hand they explain that most clients forget tasks on purpose, because they are not motivated to do these tasks. On the other hand, when a client experiences a task as fun, they barely forget about it. When this occurs, caretakers try to solve this problem by talking to the clients in order to motivate them to do it after all.

Relatedness of caretakers with people with an ID

Finally, the way caretakers experience the relatedness of the people with an ID is discussed.

It can be said that all caretakers see the people they take care of two or three times a week. Together they perform work-related activities (e.g. groceries and producing items for the

shop) or they perform leisure activities together for instance playing games and reading. Next to that, caretakers at the community workshop only maintain contact in person, while the father of one of the clients has daily contact over the phone. The caretakers also prefer this way of contact in making appointments with the clients, together with other methods like notebooks, pictograms and calendars.

Even though the caretakers have the opportunity to talk to the clients, they sometimes experience difficulties reaching the clients. This is due to the fact that the clients "zone out", or stay within their own mind. This means that they do not react to signals from their environment and thus that caretakers cannot directly talk to them. Caretakers attempt to solve this problem by having physical contact (e.g. putting a hand on the shoulder of the client) or giving the client a task, which sets the client's mind to something else.

The caretakers do generally like being with the clients. This is explained by the fact that some caretakers explain that they learn a lot from the experiences they obtain with the clients and because of the caring character of the clients. Activities that the caretakers like to perform with the clients are their daytime activities, because they like interacting with the clients. Instead, activities that caretakers dislike are obligatory tasks, like helping clients with visiting the toilet or having an unpleasant conversation or a conflict. However, these activities are not avoided.

When asked about how caretakers feel related with the clients, they all respond that they feel strongly related because of their duty to supply care and the fact that they perform the same activities during a workday. Also, witnessing the development of the clients over time and knowing their backgrounds makes caretakers feel more related. However, two caretakers explained that the difference in ability and the fact that caring for their clients is their job, separates them from the clients.

Finally, when asked about what caretakers want to communicate to the clients and how, the father of one of the clients responded with communicating to his daughter affection and compliments, because this makes her feel more appreciated and competent. Next to that, the caretakers at the community workshop responded with communicating them tasks and appointments, but also events or experiences that have an impact on the clients. The caretakers have a need for the ability to make clients feel like they can always talk to them.

2.2.2.3.   Conclusion of the interviews
From the previous results, it can be concluded that several needs exist for both clients and caretakers. It can also be said that caretakers would prefer the use of technology in order to

improve their lives and the lives of their clients and also feel comfortable doing this, while clients disagree with this use of technology. Next to that do caretakers experience a higher affinity with technology, while the clients' use of technology is quite simple. Not many technology solutions are used by the clients. One client used a Beeldhorloge, while other clients only use an iPad to play games on. On the other hand, caretakers use a system which keeps them in contact with other caretakers and offers the ability to plan for the future.

Addressed needs of clients are the availability of easy transport, guidance in leisure or daytime activities and easy communication with caretakers when necessary. Moreover, caretakers only indicated the need to make clients feel like they can easily talk to them, which makes the need for easy communication a common need.

2.2.3. CONCLUSIONS FROM INTERVIEWS AND LITERATURE RESEARCH

From both the literature research as the interviews, multiple needs can be deduced. It can be concluded that the needs of people with an ID are for accommodation, self-care, daytime activities, communication, money, sexual expression, social relationships, basic education, safety to others, psychological support and healthcare services. Of these needs, the need for daytime-activities, self-care and easy communication are supported by the results of the qualitative interviews, since clients desire the need to be able to easily communicate with their caretakers, feel bored because they do not know what to do during with their leisure or lack the ability to perform everyday tasks like cleaning and cooking.

Next to that, unfulfilled needs of their caretakers are the need for information about services for people with an ID and their relatives, information about the disability and information about aging with ID, but also the planning for the future, personal care for the patient and opportunities for behavioral assessment are unmet needs. Of these needs only the need for personal care is supported by the interviews, as easy communication offers a way to have better personal communication with the client.

2.3. Main research question

The above information explains that unmet needs are left, leaving opportunities to fulfill these needs using technology. It has been proven that wearable technology in the form of watches are an acceptable way of fulfilling these needs and thus improving the quality of life of people with an intellectual disability and their caretakers. This leads to the research question:

RQ: How to design a smartwatch application that improves the quality of people with an intellectual disability and their caretakers?

This research question is supported by the following sub questions:

SQ1: What are the needs of people with an Intellectual Disability?

SQ2: What is Intellectual Disability?

SQ3: What are the needs of caretakers of people with an Intellectual Disability?

SQ4: What current technology solutions fulfill these needs?

SQ5: What are possibilities to fulfill the unfulfilled needs of people with an Intellectual Disability and their caretakers by technology?

SQ6: What is a suitable technological setting for a smartwatch application in the context described?

SQ7: How to evaluate a smartwatch solution in the context described?

These sub questions first help with acquiring a better understanding of intellectual disability and the term quality of life and how to improve it. Then these sub questions help with defining the needs of people with an ID and their caretakers and finding current technology solutions that already fulfill these needs and finding unfulfilled needs.

2.4.   State of the art

When designing an application that improves the quality of life of people with an ID and their caretakers, it is important to understand how current technology and methodology fulfills the needs of people with an ID and their caretakers by aiding in the provision of care. This helps with the generation of new ideas and allows for inspiration on what currently works. Stock et al., Lancioni et al., and Murphy and Cameron describe technology solutions that are designed to fulfill the needs of people with an ID. These solutions contain: systems that help people with an ID access public transportation, applications that remind people with an ID of tasks at the correct times and a way of communication with caretakers.

2.4.1.   ACCESSING COMMUNITY RESOURCES

Stock et al. [14] describe a selection of technology solutions which help people with an ID use public resources, like transport and public information. They describe the use of simplified smartphones which help the users navigate by foot (e.g. Jitterbug). Moreover, the solutions in aiding the use of public transport are discussed. One of these solutions is the use of Computer Based Video Instructions which teaches people with an ID how to use public transport and to

get out on their destination. Other solutions consist out of devices that users can take with them on public transport. These systems use GPS and media instructions which tell the user what to do at the appropriate times. The article also describes the use of devices which aid in indoors navigation, where there is no GPS signal with the use of for example audio based devices by the means of audio instructions.

2.4.2. BEING REMINDED

Lancioni et al. [15] describe the use of simplified smartphone applications which remind the users of tasks at the appropriate times. The application does this by the use of media notifications like pictograms and recorded audio messages. When a task has to be performed, instructions for the task appear on the smartphone's display and, dependent on the user, an audio message describes the instructions.

Next to this solution, wearable solutions exist. Two examples of this could be given: the Beeldhorloge [3] and "Mijn Eigen Plan" [16]. The beeldhorloge is a device which notifies users of tasks and reminders at appropriate times using pictograms and pictures. These notifications are configured by a caretaker in a web application where he can fill the calendar and add custom pictures in order to make the notifications more understandable. Unfortunately, this device is not supported anymore, leaving its users with a broken watch.

Mijn Eigen Plan [16] is a smartphone application, similar to the application described by Lancioni, but adds smartwatch compatibility and other features. The caretaker has the opportunity to add instructions to a task, guiding the user or ask the user how he or she is feeling. Further than that, the application works similar to the beeldhorloge.

2.4.3. COMMUNICATING

Murphy and Cameron [17] describe the use of Talking Mats Ⓡ. Talking Mats Ⓡ is a low tech framework that aids people with an ID by helping them to communicate using pictograms that help them understand language and respond more effectively. Talking Mats Ⓡ is based on three sets of symbols that exist of topics, options relating to each topic, and a visual scale that allows participants to show how they feel towards each option.

2.4.4. METHODOLOGY

A previous mentioned method which is applied with people with an ID is the OIM method (Own Initiative Model) [2]. This model encourages caretakers to help people with an ID less, but make them think about how to solve their problems themselves. This teaches them about problem-

solving and about performing everyday tasks. This model also supports the shift that is appearing that puts more focus on the abilities of people with an ID instead of their disabilities.

2.4.5. CONCLUSION

It can be concluded that the previous solutions only fulfill a part of the needs of people with an ID, and very little focus is put on the needs of caretakers. The solutions described by Stock et al. only fulfill the transportation and access to telephone needs of people with an ID. Next to that, Lancioni et al. describe a solution which fulfills the needs for daytime activities, access to telephone and self-care. These needs are met by the use of smartphone applications or the use of smartwatches. These solutions also party fulfill the need for personal care for people with an ID, as it supports the services provided by caretakers. Then, the solution described by Murphy and Cameron only fulfills the need for speech and language services of people with an ID. Finally, methodology like OIM method supports the shift towards the focus on the abilities of people with an ID by encouraging them to be more independent.

2.5. Methods and techniques

The used design process during this thesis will be the "design process for creative technology". This design method is developed by Mader and Eggink [18] in order to "arrange a set of relevant methods in a coherent structure while emphasizing the parts and steps that are specific to Creative Technology". The design process that they suggest consists out of four phases: ideation, specification, realization and evaluation. This design process is illustrated in Appendix 9.1. Each phase starts with a set of results that are defined during the previous phase. In order to make a specific design process, this design process is to be adjusted.

The ideation phase, which starts with a design question, generates a product idea through the acquisition of relevant information and an idea generation. This could be done by using brainstorming, but also looking at related work in order to acquire inspiration. Also a list of needs could be collected by using a user-centered design method, including talking to stakeholders, making mock-ups, user scenarios or story boards. During this project, the user needs have been formed by looking at literature and performing interviews with stakeholders. The results of this are described in section 2.2. Then a better look is taken at the problem by describing it using personas en scenarios. Next, a look is taken at available technology in order to get a good picture of what is possible in order to achieve the goal. Finally, product ideas are formed during a brainstorm and from these ideas a final idea is chosen.

During the specification phase, prototypes are used in order to explore the design space. These prototypes are shortly evaluated in order to identify how functionality influences user experience and how user experience influences the functionality. This leads to a product specification, which leads to the realization phase. Because there is no time to develop and evaluate multiple prototypes, use scenarios and story boards are used in order to define an experience specification, while the defined needs and literature are used to define the functional specification. These two specifications make up the product specification.

The realization phase consists of the decomposition of the specification, the realization of the components and the integration of these components. Evaluation within this phase is performed in order to validate whether the end product meets the set specifications. The end product is then evaluated during the evaluation phase. During this phase, the architecture and the aesthetic design of the prototype are made, which can then be transformed into a prototype.

During the evaluation phase, functional testing is performed in order to verify that the developed application fulfills the needs it is designed to fulfill and this improve the quality of life of the stakeholders. This is done by the means of user testing. During this phase, the evaluation phase exists of testing the system with real users.

3. IDEATION PHASE

The design process starts with the ideation phase, during which a product idea is generated from a design question by the means of a user need assessment, technology assessment and idea generation. This chapter answers SQ 5 and SQ 6. First, a user need assessment is performed using scenarios, personas, and previously established needs. Next, a technology assessment is performed by looking at what current technologies are available and can be used in order to reach the goal. Finally, idea generation includes a brainstorm summing up multiple ideas in order to diverge and then converge to conclude with one product idea.

3.1. User needs

In chapter 2 the needs of people with an ID and their caretakers have been established. Since this is a broad set of needs, these needs are used in order to pick a set of needs that are focused on during this project. The user needs are then elaborated by making personas, and defining a scenario which explains the needs.

3.1.1. PERSONAS

In order to get a better understanding of the stakeholders and their characteristics, four personas have been generated based on the information that has been gathered during the background research and the problem analysis in chapter 2. These personas can be found in Appendix 9.6. Two of these personas describe a person with an ID. The other two personas describe a caretaker, one is a parent and the other is a caretaker at a community workshop.

An important characteristic of people with an ID is that they often have trouble with reading and writing. This depends on the severity of their ID, and is thus a personal characteristic. They are also in touch with a caretaker at least once a day, either at home or at a daycare. They are somewhat familiar with technology, but do not have access to all services depending on their ID, because it might be too difficult to them. This means that they generally have a low affinity with technology

Caretakers on the other hand, are not necessarily in touch with their clients or relatives daily. They are very enthusiastic about providing the correct care, but also need the chance to rest from providing this care.

3.1.1. NEEDS

During the background research, the needs of people with an ID and their caretakers have been assessed. One of these needs has to be chosen in order to design a specific application that

fulfills this need and thus improves the quality of life of people with and ID and their caretakers. It has been concluded from the literature research and the interviews that the need for daytime-activities, self-care and communication with caretakers, relatives and friends are the most important needs. Caretakers mainly experience the need for the ability to provide more personal care.

The need for better communication with caretakers that people with an ID experience pairs well with the need to provide better personal care that caretaker's experience. Human communication is an important aspect of personal care, as described by Tarrant et al. [19]. Next to that, accessible information and communication is an important functionality of smartwatches. This means that the need for better communication with caretakers that people with an ID have and the need for improved personal care that caretakers have, are two relevant and fitting needs to be fulfilled during this project.

Furthermore, people with an ID often have a limited skillset and low affinity with technology, as concluded by the personas. This means that the person with an ID has to be able to use the application without having to read text in order to understand the use. Also, the application has to be simple enough for the person with an ID to use, because of the low affinity with technology. This means that the amount of steps taken during the use of the application should be small and that the application is intuitive and easy to learn.

3.1.2. SCENARIO

In order to get a better understanding of the problems and needs stakeholders have, a scenario has been generated displaying the communication problems that people with an ID and their caretakers face. The written scenario describes a specific problem, how it is solved, and how it affects the people involved based on the previously described personas. This scenario can be found in Appendix 9.7.

In this scenario, multiple problems are given on Karin's side: first the problem of Karin not being able to perform the task which she wants to perform and being unable to contact Linda to ask for help with the problem and Karin losing focus during her activity. The first two problems are eventually unsolved, because Karin still was not able to ask for help and perform her task. The problem of Karin losing focus is eventually solved by her caretaker having personal contact with Karin, but this has caused a problem on Linda's side, because she is unable to help all her clients at the same time.

3.2. Technology

Since watches are a widely accepted and used piece of technology, they offer a good opportunity to add functionality to them in order to fulfill the needs for people with an intellectual disability. Smartwatches are watches with functionalities other than timekeeping and are often an extension of the smartphone. Smartwatches offer these functionalities in varying ways and there are different ways to implement these functionalities and to use smartwatches. In this section these ways are discussed.

3.2.1. BUILDING A SMARTWATCH

With smaller microprocessors and easy to use modules, it is fairly simple to build a smartwatch and write your own software for the device. An Arduino Micro or Nano in combination with a small screen, a Bluetooth and/or Wi-Fi module and a battery make it possible to build a smartwatch. In addition to the mentioned modules, more components could be added, for example a microphone or a speaker. Then with the use of the Arduino programming environment, a program could be made that only facilitates the required functions. The acquisition and assembly of the smartwatch is relatively time costly, just as writing the software for the system.

3.2.2. EXISTING SMARTWATCHES

Smartwatches are widely available to the consumer. Several brands have released their own versions and OS's that can be used to reach the goal. Existing brands that produce smartwatches include Samsung, Apple, LG, Sony, Huawei, Fitbit, Motorola, Asus, Garmin, MyKronoz, Pebble and Fossil. These smartwatches run on different Operating Systems dependent on which phones they are compatible with. Some smartwatches are standalone and do not need a smartphone to pare with in order to function, while other smartwatches use Bluetooth to connect with a smartphone.

Different operating systems are Google's Android Wear, Pebbles OS, Samsung's Tizen and Apple's watchOS. Of these operating systems, Wear and Tizen are only compatible with Android devices, while Pebble OS and operating systems running on MyKronoz, Garmin and Pebble smartwatches are compatible with windows Phone, iOS and Android. Finally, Apples' WatchOS is only compatible with their own iOS operating system running on their iPhones.

Smartphones often have multiple sensors and modules build in in order to add functionality. Almost all smartwatches have Bluetooth functionality build in, while some also have Wi-Fi, GPS or can connect to the phone network. Next to that they have a touchscreen

and one or more buttons in order to provide in-/output functionality. This allows the user to read messages, but also scroll though menus and use applications. Feedback is often provided by a vibrating motor or a speaker which allow for audio or tactile feedback. Finally, smartwatches are often equipped with an accelerometer, a heartbeat sensor, a step counter, a sleep monitor, or a gyroscope in order to provide information about the user's physiology or activity.

Developing an application for an existing smartwatch is less time-consuming and prone to errors than building a smartwatch and writing software for the build smartwatch. It is relatively cheap and easy to build an application for Android Wear smartwatches using Android Studio. Android Studio is a free programming environment, used to develop Android applications easily by using the Java programming language.

Another argument in favor of developing an application for existing smartwatches is that existing smartwatches already facilitate some of the functionalities that are needed, like Bluetooth connectivity and the touch display. Also the build quality is significantly better than the expected build quality of a smartwatch that is built over the duration of this project. It is thus a wise decision to develop an application for existing Android smartwatches, because of the cost and time efficiency.

3.3. Idea generation

The project idea has been generated by performing a brainstorm session. This brainstorm session includes analyzing the previously selected needs that the application needs to fulfill, the chosen technological setting, the state of the art analysis and forming a mind map. This mind map helps with visualizing relevant factors and stimulates the formation of ideas. These ideas are then written down underneath the mind map.

This section answers SQ 5: What are the possibilities to fulfill the unfulfilled needs of people with an Intellectual Disability and their caretakers by technology? And SQ6: What is a suitable technological setting for a smartwatch application in the context described? This section provides answers to SQ5 by providing ideas of a technological solution that fulfill the needs of people with an ID and their caretakers. SQ6 is answered by the final idea, because the final idea is considered to be the most suitable technological setting.

3.3.1. BRAINSTORM

A brainstorm is performed in order to discover ways of improving the communication between people with an ID and their caretakers. This chapter describes the different ideas that have been brought up during this brainstorm.

The first idea is an application which lets the person with an ID select a desired caretaker to speak to using pictures of the caretakers. Then the person with an ID can use the smartwatches' microphone in order to speak in a message which is then send to the desired caretaker. The caretaker can then listen to the message on a smartphone and respond to it using either a phone call, a pictogram or a message.

The second idea is helping the caretaker with getting a client "back to the world" when a client is zoning out. It often occurs that clients are busy thinking about irrelevant things and are not concentrating on their own activity and environment. It is then difficult for a caretaker to make a client focus on the activity. This is often solved by applying physical contact so that the client notices the caretaker and retrieves focus. The idea is that in the case of such an event, the caretaker can select the client on a smartphone or smartwatch application, which then sends a "vibration message" to the client's smartwatch so that the smartwatch starts vibrating. The client can then stop the vibration of the watch by clicking on the screen of the watch. This might allow the client to retrieve focus if necessary.

This idea has been discussed with the critical observer, who suggested making the vibration message applicable in a broader context. This means that the message should not only be usable in the case of a person with an ID zoning out, but also allows the caretaker to remind the person with an ID for example to take her medicine. Giving the vibration message a variable meaning makes the use of the message flexible and thus usable in a wide variety of settings.

Not only can the vibration notification be sent by the caretaker, but can also potentially be sent by the user of the smartwatch application. Again, the meaning of this signal can be ambiguous and can be discussed by both parties. For example, the wearer of the smartwatch can send a vibration notification to the caretaker to quickly tell that the wearer of the smartwatch has arrived at the destination safely or can be used when the wearer of the smartwatch application has a speaking disability, which disables the user to use the voice recording of the application. This eventually leads to a "Yo" – like functionality inside the application [20], which allows users to send a binary message with a freely interpretable meaning.

The final idea which has been generated was to let clients send a pictogram to a relevant caretaker whenever the client needs help with an activity or problem. This pictogram displays the problem the client needs help with, which allows the caretaker to be able to anticipate on the problem.

3.3.2. FINAL IDEA

From the brainstorm described above, a final project idea has been generated. This final idea is to develop an Android Wear application designed for people with an ID which allows them to send voice messages to their caretakers. This app is combined with a smartphone application designed for the caretaker which allows the caretaker to react to voice messages and send a vibration notification. Both applications are used in different ways.

This idea has been chosen, because the idea of a picture messaging app does not seem to be functional on a smartwatch, because in order to communicate efficiently, a lot of menus need to be built in containing caretakers, categories and the pictograms.

The smartwatch application lets people with an ID have an easy and quick way to contact caretakers by selecting a caretaker on the watch using pictures of the caretaker. When a caretaker is selected, the user can speak in an audio message which is then send to the caretaker's smartphone application.

On the smartwatch application the caretaker can then listen to the client's messages at an appropriate time and react to it if necessary by either calling the client, messaging the client or sending a picture to the client. Next to that, the caretaker can use the smartphone application to send a vibration message with a meaning that has been defined in discussion with the person with an ID (e.g. do not forget to take in the medicine). The caretaker can use the smartphone application to send a signal to the smartwatch application which makes the smartwatch vibrate. The smartwatch will then continue vibrating until the user has pushed a button on the smartwatch.

This application should solve a certain set of communication problems people with an ID and their caretakers have and thus satisfy the need for better communication with the caretakers. Caretakers are also able to perform easier communication with their clients and thus provide better personal care. During the interviews it was often mentioned that when a client is in a need for contact with a caretaker, it might not be possible, because the caretaker is not available. If a client is able to read and write, the message is then written down. However, not all people with an ID have such abilities and then have to remember the message until the caretaker is available to them. This enlarges the chance of the message not being received by the caretaker after all, because the message might be forgotten. With this application, the message can be delivered to the caretaker at the moment the client needs it to be. When a caretaker is not available, the message can be listened to at an appropriate time and the

caretaker can then act to it. People with an ID might also feel more at comfort, because they have been able to explain their problem verbally using the application. They might have the feeling that they are listened to at the right moment.

3.3.2.1. Increasing self-determination

This project should eventually result in an increased self-determination of the wearer of the smartwatch by increasing the user's sense of autonomy and relatedness by making communication more accessible for people with an ID. This is another way the developed application is expected to improve the quality of life of people with an ID, because as described in section 2.1.2, it has been proven that an increased self-determination leads to an increased quality of life.

Accessible communication is an important aspect of autonomy, which most people have, but people with an ID mainly do not, because they do not have the skillsets to use devices like mobile phones, computers, and applications like WhatsApp and Facebook, because of the low affinity with technology and the lack of basic knowledge like reading and writing. This application allows the use without any knowledge of reading and writing and allowing people with for example motoric disabilities to handle the application, because no delicate movements are needed in navigating through the application.

Accessible communication also enhances people's relatedness, because it allows people with an ID to communicate with others and feel like they belong with them. They are able to bond with their peers and caretakers in an easier way and thus experience an increased relatedness.

4. SPECIFICATION PHASE

During the specification phase, the project idea that was formed during the ideation phase is specified by generating an experience specification and a functional specification. The experience specification is based on use scenarios and story boards designed for the project idea. The functional specification is based on the defined needs of people with an ID and their caretakers and existing literature.

4.1. Experience specification

The experience specification explains the use of the smartwatch application by defining how the application is used, when it is used and what effects the application has, by who it is used and when it is used. Here, a use scenario explains this "How, When, What, Who, Where", while a story board explains the steps that are taken when the application is used.

4.1.1. USE SCENARIO

In the use scenario the use of the application is given. The use scenario explains who is using the application, when the application is used, where the application is used, how the application is used and what the outcomes are. This scenario can be found in Appendix 9.8 and is based on the scenario given in Appendix 9.7, but explains how the problems are solved using the proposed project idea.

In this use scenario, Linda and Karin experience the same problems as in the scenario given in Appendix 9.7, but Karin solves her problems by using the smartwatch application to send a voice message, to which her caretaker reacts whenever her caretaker finds it suitable. Linda also uses the application to prevent Karin from Zoning out by sending the vibration messages which makes Karin's watch vibrate.

Even though the explained use scenario is a case, it can be said that the application in this case is used by Karin, a person with an ID, and Linda, Karin's caretaker. The application is used in the home environment by these two users in a home-care context. The application is used both in the evening and during noon, when the need to use the application occurred. Thanks to the smartwatch and smartphone applications, the problems Karin and Linda experience are easier to solve.

4.1.2. STORY BOARD

A story board explains the steps that are taken by the user when the app is being used. The story boards show an example of the application's interface and how it's used to reach certain

goals. Four story boards have been made, which can be found in Appendix 9.9, 9.10, 9.11 and 9.12. These story boards describe sending a voice message, reacting to a voice message, sending a vibration notification and reacting to a vibration notification respectively.

4.1.2.1. *Voice message*

As explained during the above scenario, a voice message can be send by the user of the smartwatch application through the steps shown in Appendix 9.9. These steps are described as following:

1. The user taps the watch face of the smartwatch → a picture of a caretaker appears.

2. The user selects a caretaker by swiping left or right → a different caretaker appears.

3. The user swipes until the desired caretaker appears and taps on the picture → a different screen appears displaying a microphone. This indicates that the recording has started.

4. The user brings the smartwatch closer to the mouth and starts speaking in the recording.

5. When the user is done recording, returns the smartwatch back to its original position where the user can see and use the touchscreen properly.

6. The user taps the microphone icon → the microphone transforms into an envelope and it disappears from the screen. This indicates that the message has been sent.

When the message is received by the user of the smartphone application (the caretaker), the user can respond through the steps that are shown in Appendix 9.10:

1. The user unlocks the smartphone and taps on the notification that is displayed by the Android Operating System. → the application is opened and displays the voice message with an audio controller, information about the audio message and three buttons and a text field.

2. The user taps the play icon → the message starts playing and stops playing if the user taps the pause icon or when the message is finished.

3. The user listens to the audio message until the user has deduced enough information from the message.

4. The user selects one of the three ways of responding by either:

4.1.   Selecting the pictures icon → the application displays the library of pictures and icons

4.2.   Selecting the call icon → the application opens the call application and the phone number of the sender of the message is dialed.

5.   When a pictogram is selected to be send the next step is to:

5.1.   Selecting the correct pictogram in the library and pressing the send button → the application returns to the message history with the client.

4.1.2.2.   Vibration Notification

When a caretaker wants to send a vibration notification to the wearer of the smartwatch, the caretaker and the wearer of the smartwatch first have to discuss the meaning of the vibration notification and how it is interpreted. When this is done, the caretaker can send a vibration notification through the steps that are shown in Appendix 9.11. These steps are described as following:

1.   The caretaker unlocks the smartphone.

2.   The caretaker opens the application → the list of clients is shown.

3.   The caretaker selects the desired client → the message history is shown with a "BUZZ" button on the bottom.

4.   The caretaker taps the "BUZZ" button → the application sends a message to the smartwatch application and displays that the signal is sent.

Now the user of the smartwatch application can react to the vibration notification by making the smartwatch stop vibrating through the steps that are described in Appendix 9.12. These steps are described as follows:

1.   When the smartwatch receives the vibration message from the smartphone application, it starts vibrating and displays an "OK!" button on the screen of the smartwatch.

2.   The user of the smartwatch application taps the "OK!" button → the smartwatch stops vibrating and displays the watch face.

4.2.   Project requirements

The requirements that are defined follow the MOSCOW structure. This structure explains which specifications are vital for the system to reach its goal, which requirements could aid in reaching the goal, which requirements are not necessary in reaching the goal and which requirements are not important. These functions and requirements are based on the defined limitations, needs and information provided by the background research in chapter two.

4.2.1.   THE SMARTWATCH APPLICATION

Table 1: MOSCOW Requirements of the Smartwatch application

Must	Should	Could	Won't
M1. Be usable without any reading and writing skills.	**S1.** Support multiple caretakers	**C1.** Use tactile feedback when giving input (e.g. tapping, swiping)	**W1.** Recognize when a person starts and stops talking
M2. Provide feedback on actions	**S2.** Be compatible with both round and square screens.		**W2.** Be independent from a smartphone.
M3. Vibrate until the wearer has manually stopped the vibration.			**W3.** Be usable offline
M4. Deliver an audio recording clearly			
M5. Show pictograms received from a caretaker			

Table 1 contains the MoSCoW requirements of the smartwatch application. Based on the background research, a few requirements play a big role in designing an application for people with an ID.

People with an ID often lack the ability to read and write. This means that the application must be usable only though understandable pictograms and without the use of any reading or writing skills. This justifies Requirement M1. Furthermore, people with an ID often have a low affinity with technology and lack understanding about what is going on with the application. This means that the application needs to provide feedback on actions that the user is performing and

on what the application is doing. Thus justifying requirement M2, because without this feedback the user might get annoyed and stop using the application. The application must also facilitate the functionalities that have been defined in order to fulfill the needs that the application is designed to fulfill. This means that the smartwatch application needs to be able to record and send clear audio, display pictograms that have been sent by the caretaker and vibrate whenever the caretaker sends a vibration notification. Facilitating these functionalities means that requirements M3, M4 and M5 have to be met.

Next to that, requirements that are not too important to be fulfilled, but should be fulfilled are S1 and S2. These requirements are not too important for a functional prototype, but are important enough to be built in the application and could be left out of the prototype if time appears to be scarce. Requirement S1 is of importance, because during the problem analysis it became clear that people with an ID sometimes have many different caretakers in home-care, day-care and within family circles. Requirement S2 should be implemented, because making a smartwatch application compatible for all shapes of screens is relatively easy, but not important. This is due to the fact that the smartwatch model that is available during this project is a Sony Smartwatch 3 with a rectangular screen [21].

The only "could"-requirement, C1, is to provide tactile feedback on actions. This is supposed to make the provided feedback even more clear and understandable, but is only supporting requirement M2. This requirement is rather time costly and needs research on how tactile feedback could best be applied. Therefore, requirement C1 is not of a high priority to be fulfilled by the application that is developed during this project.

Unfortunately, boundaries need to be set, indicating what the smartwatch application will perform or support. This is mainly because of technical limitations, like use of the internet and the inability to make standalone applications for Android Wear. Because the internet is needed in order to send and receive messages from caretakers, the application will not be usable offline (W3). Furthermore, because the current version of Android Wear does not support internet connectivity, a smartphone application needs to be build, which receives messages from the smartwatch device and directs them to the internet and vice versa. This means that the smartwatch application will not be usable without a smartphone which manages the internet connectivity (W2). Finally, during the interviews it became clear that people with an ID sometimes have trouble speaking and thinking about what they want to say. Even though functionalities that detect when speech is stopped already exist, technology might have trouble

performing this detection with people with an ID, because they might take breaks to think about their message.

4.2.2. THE SMARTPHONE APPLICATION

Table 2: MOSCOW Requirements of the Smartphone application

Must	Should	Could	Won't
M1. Be easily understandable	**S1.** Be easy to learn about	**C1.** Allow the user to add pictograms to the library	**W1.** Be usable offline
M2. Provide feedback on actions	**S2.** Allow to replay audio messages at any time	**C2.** Allow the user to change the notification settings	
M3. Send notifications of received messages at appropriate moments	**S3.** Allow to control audio messages (Pause, play, fast forward)	**C3.** Allow deleting clients	
M4. Have the ability to call the client's phone	**S4.** Support multiple clients		
M5. Send pictures to the client			
M6. Send a vibration notification to the client			

Table 2 displays the MoSCoW requirements of the smartphone application. Since this application will mainly be used by caretakers, whose affinity with technology and basic skills are more advanced than with people with an id, the application has different requirements.

First of all, the user is able to navigate through the application using text, because caretakers do have the ability to read and write. However, the application must still keep the user from being annoyed by the application by being fast, responsive and intuitive. Therefore, the application must be easily understandable (M1) and provide clear feedback (M2). Next to that, the user of the smartphone application must be notified whenever a voice message is received, so that the user does not have to open the application once in a while to check for new messages. Therefore, requirement M3 needs to be met. The smartphone application also needs to facilitate the defined functionalities, which are reacting to a voice message by a phone call (M4) and sending a pictogram (M5) and sending the vibration notification (M6).

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Next to that, requirements that are not too important to be fulfilled, but should be fulfilled are S1, S2, S3 and S4. These requirements are not too important for a functional prototype, but are important enough to be built in the application and could be left out of the prototype if time appears to be scarce. Requirement S1 is based on the fact that caretakers have the need for information about the services for their clients. Since this application is a service which should allow caretakers to provide better personal care, the application needs to be easy to learn about. Requirement S2 allows caretakers to replay audio messages, because an audio message might not directly be understood. If a caretaker cannot replay the message, information is lost and the caretaker cannot provide the care that is needed. The same counts for requirements S3, because a caretaker might not understand a short section of a long message for example. Then the caretaker can rewind to that section and listen to it. The final "should"-requirement is that caretakers should be able to communicate with multiple clients. Many caretakers who work in day-care or home-care have many clients who they see on a day, as has been pointed out during the problem analysis.

Next, the requirements that are not important to be fulfilled are C1, C2 and C3. These requirements are more difficult to fulfill given the timeframe during which a prototype of the application needs to be developed. Because giving the user a fixed set of pictograms the user can work with is easier than making a dynamic library to which the user can add pictograms, requirement C1 is of low priority and could be added to the application if time allows this. The same counts for requirement C2 and C3, because the fulfillment of this requirement is not important for a functional prototype.

Finally, the only boundary is that in order to send and receive messages, a connection with the internet is needed. This means that the smartphone application will not be functional without an internet connection and thus will not be functional offline.

4.3. Functional Specification

The functional specification takes the above experience specification and defined requirements in account and specifies the functions that the system and its components must perform. In this case it explains what the smartwatch application must perform, what the smartphone application must perform and what the server must perform. This functional specification is based on the system functionalities that have been defined during the ideation phase.

First of all, the smartwatch application and smartphone application have to main functionalities: the voice messaging functionality and the vibration notification functionality.

The smartwatch application provides the sending of a voice message and reacting to a vibration notification, while the smartphone application provides the reacting to a voice message and sending a vibration notification. The server supports each functionality by allowing data storage and communication.

4.3.1. THE VOICE MESSAGE

The smartwatch application allows the user to send a voice message by selecting a caretaker visually and sending an audio recording to the selected caretaker. This means that the application has to display the caretakers who can be selected, record the audio into an audio file and send this file to the server. The server then needs to store this audio file and the data about the message, containing who sent the message, who receives the message, what time the message is sent and what kind of message it is (an audio message, pictogram or vibration notification).

Whenever a voice message is placed on the server, the smartphone application needs to retrieve this message and the audio file which can then be listened to by the caretaker. The caretaker can then react to the message by either calling the client by using a phone number retrieved from the server or by sending a pictogram which is stored on the server as well. When the caretaker chooses to send a pictogram, the smartphone application retrieves the pictograms from the server and displays them. The user can then select a pictogram, which sends a message to the server containing the filename of the pictogram, who sent the message, who receives the message, what time the message is sent and what kind of message it is.

The smartwatch application then receives this message from the server and retrieves the pictogram by the filename in the message. The pictogram is then displayed on the smartwatch.

4.3.2. THE VIBRATION NOTIFICATION

The smartphone application allows the user to send a vibration notification by selecting the desired smartwatch user and pressing the button which sends a message to server containing who sent the message, who receives the message, what time the message is sent and the type of the message, which is a vibration notification. The smartwatch application of the desired user then retrieves this message from the server and the smartwatch starts vibrating and displaying the "OK!" button.

5.   REALISATION PHASE

During the realization phase, the specified project idea is realized by adding different elements to the prototype add a time and exploring ways to make the application functional. This section explains the structure of the system, how the interaction works, how the different components interact with each other, which requirements from chapter 4.2 are met and which libraries are used.

5.1.   Product prototype

The eventual product prototype is a platform which consists out of two applications (see Figure 1: Platform structure) and an Android Firebase Server. One application is the caretaker portal, which is designed for the caretakers and handles the communication with the server. The other application is the client portal and consist out of two modules: the android wear module and the mobile

Figure 1: Platform structure

module. The Android Wear module is an android wear application that runs on android wear smartwatches. The mobile module runs on the smartphone that is connected to the smartwatch.
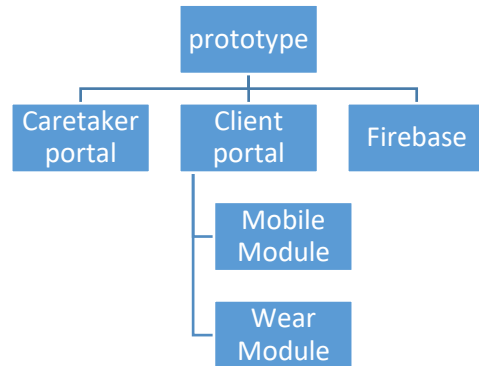
5.1.1.   ANDROID FIREBASE

Android Firebase is a set of products developed and hosted by Google. It offers products like an Authentication tool, a real-time database, analytics, and cloud storage [22]. Of these tools, the authentication, real-time database and cloud storage are used by the system in order to make it function. These tools are free and relatively easy to implement using the helper tool available in Android Studio.

The authentication tool allows users to create their account and sign in using their email address and password. This tool makes the system secure, because the username and password are stored by Google. The tool also offers an easy way of authenticating a user, which can be implemented in less than ten lines of code.

The real-time database is used to store user data, message information, contact information like which clients are connected to which caretaker and vice versa, and which pictograms are available. The structure of this database is displayed in Appendix 9.13. The database is updated whenever a user is created, a client is connected to a caretaker, and a message is sent. The database uses JSON data to store the data and allows the data that is

already received by the phone to be stored in the cache memory, so that it can be used offline. The database is also integrated with the authentication tool in order to only allow users who are authenticated to access the data.

The cloud storage is used to store profile pictures, pictograms, and audio recordings. It allows for growth of the users and only uploads and downloads files when users are online. When a user is offline while interacting with the cloud, the interaction is paused and resumed when the user gets back online. Also the cloud storage is integrated with the authentication tool in order to only allow users who are authenticated to access the storage.

5.1.2.   WEAR COMPANION LIBRARY

The Wear Companion Library (WCL) is a library that is created to make developing for android wear easier. The library reduces the amount of effort needed for performing tasks like recording audio on android wear, sending data and files between android wear devices and smartphones, and making HTTP requests by wear applications. Of these functions, recording audio on android wear and sending data and files between android wear devices and smartphones are used.

Because interaction with Firebase is not supported by Android Wear, WCL allows for an easy way to handle the interaction with Firebase by the mobile module, while the wear module records audio to a file, sends the file to the smartphone, which the smartphone then sends to the Firebase cloud storage and adds the message to the real-time database. The WCL also allows to send message data about pictograms and the vibration notification if any of those messages are received by the mobile module.

5.1.3.   CARETAKER PORTAL

The caretaker portal is the application designed for caretakers. The application contains seven activities and two custom classes. These activities are the login activity, register activity, caretaker menu activity, message history activity, message activity, settings activity, and the picture selection activity. The two custom classes are the user class and the message class, which contain user data and message data. These classes are used to save data to the Firebase real-time database and store data that is retrieved from the database. The structure of the application is designed to be easily understandable and the elements are designed to be self-explanatory, satisfying requirement M1 of the smartphone application.

5.1.3.1.   Login activity

The Login activity is the first activity that is launched by the application when the application is started or when the user logs out. A screenshot of the login activity can be seen in Figure 2: Screenshot of the login activity. This activity checks whether the user is logged in and if the user is logged in, whether the user is a client or a caretaker. If the user is a caretaker, the user is allowed to use the application and the client menu activity is launched. If the user is not logged in, the user is given the option to log in using an email and password and press the login button or register by pressing the register button, which launches the register activity. When a user decides to log in, a check on whether a valid email address and password are performed and the client menu activity is launched if the user exists.
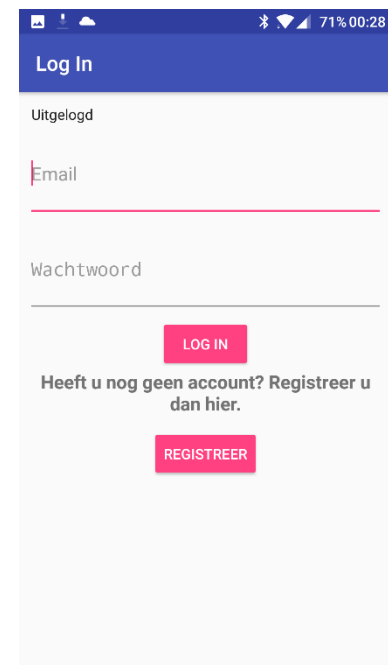

Figure 2: Screenshot of the login activity

5.1.3.2. Register activity

The Register activity can be started by pressing the register button in the login activity. As can be seen in Figure 3, the register activity displays a form in which the user can fill in a first name, surname, phone number, email address, password, the repeated password and select the user type, which is either a caretaker or a client. When a user presses the register button, the form is validated in order to check whether correct information is filled in at all fields and whether the password and the repeated password are equal. This helps the user fill in the desired password and rule out typing mistakes, causing the user to not know the correct password. If all information is correct, an instance of the user class is made using the filled in information and the user object is uploaded to the Firebase database and a user is registered by Firebase authentication. A check is then

Figure 3: Screenshot of the register activity

performed on whether the user is a client or a caretaker. If the user is a caretaker, the user is allowed to use the application and the client menu activity is launched.
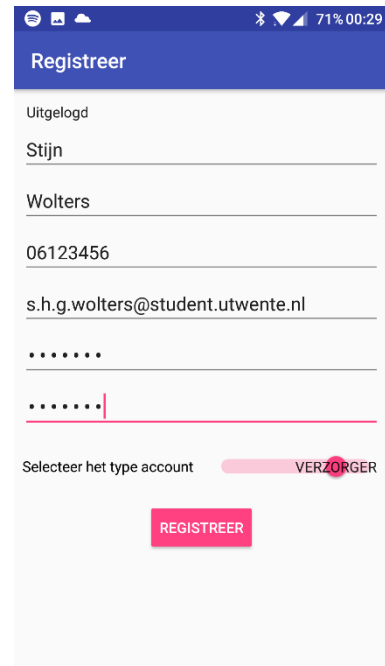
5.1.3.3. Clients Menu Activity

The client's menu activity retrieves the clients that are connected to the caretaker and displays them so that the user can select a client to interact with. The caretaker can add as many clients as necessary, fulfilling requirement S4, but does not allow deleting clients. As can be seen in Figure 4, the clients menu activity displays a list of the clients and a section where the user can fill in a client's email address and add the client to his contacts list by pressing the "add client" button. This activity also displays the options menu button in the top-right corner. When the user presses this button, a menu is opened in which the user can log out or go to the settings activity.

The client's menu activity retrieves the clients that are connected to the caretaker and puts them in an Array list, which is updated when a new client is added to the contacts. When the user decides to add a client to the contact list, the user fills in the
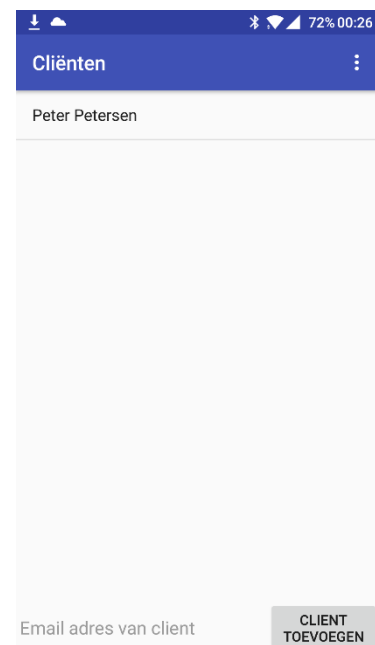
Figure 4: Screenshot of the client's menu activity

client's email address and presses the "add client" button. A check is then performed on whether the email address belongs to a registered user and the client is added to the contacts list if this is true. When the user selects a user from the list, the message history activity is opened by activating this activity and passing the user object as an intent extra.

5.1.3.4.   Settings activity

The settings activity allows the user to change the users profile picture. As can be seen in Figure 5, this activity displays the current user's name and profile picture. The user has the option to change the profile picture by pressing the "Change profile picture" button, which launches the phones gallery. The user can then select a picture from the gallery. When a picture has been selected, the picture is uploaded to the Firebase cloud storage with a filename specific for that user, which is constructed from the user's email address.

Figure 6: Screenshot of the settings activity

5.1.3.5.   Message history activity

The message history activity displays the messages that have been sent and received by the caretaker that form the interaction with the user that has been selected in the client's menu activity. As seen in Figure 5, this activity displays a list containing all messages that have been sent and received and a "Buzz" button. When the activity is activated, the message items that have been sent between the selected client and the caretaker are retrieved from the database and put in an Array list containing the message objects. These message objects are then displayed by explaining their message type, to who the message has been sent and when the message has been sent. This list is updated whenever a new message appears in the database. When this happens, the application displays a notification informing the user of a received voice message. The user can press this notification, which takes him to the message activity displaying the received message, fulfilling requirement M3.

Figure 5: Screenshot of the message history activity

When a message is selected, the selected message object is passed to the message activity as an extra of the intent. Then the message activity is started, displaying information about that particular message.

When the "buzz" button is pressed, a vibration notification is created as a message object. This message object is then send to the database, which causes the message to be added to the list. This means that the vibration notification is sent by the application, fulfilling requirement M6.

5.1.3.6. Message activity

The message activity displays information about the message and gives the caretaker options to react to the message. As can be seen in Figure 7, Figure 8 and Figure 9, information about the time and the type of the message is displayed in the top. In the middle section, the content of the message is displayed by displaying the pictogram, an audio player which allows the user to play, pause and rewind audio messages, or nothing when the message is a vibration notification. In the bottom section, two buttons are displayed which provide a way to react to a message and interact with the client by either sending a pictogram by pressing the left "pictogram" button or by calling the client on the client's phone by pressing the right "call" button.

Figure 7: Screenshot of message activity displaying a buzzer message

When the "pictogram" button is pressed, the select picture activity is opened and a user object containing the client to which the message has to be send is passed. When the "call" button is pressed, the phones call application is started and the client's phone number is dialed automatically.

This activity fulfills requirements M4, S2 and S3, because the user can call the smartwatch user, replay a voice recording at any time and control the audio message.
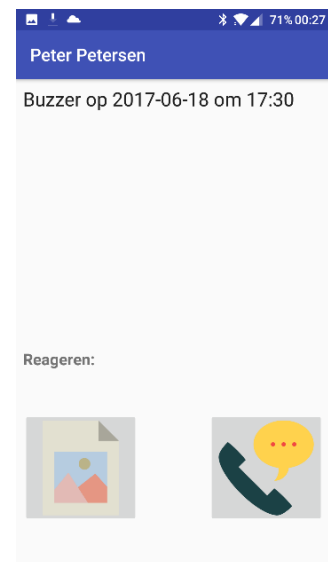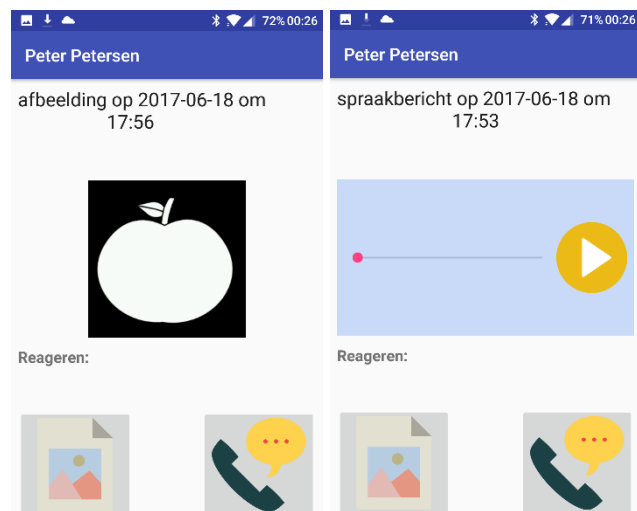

Figure 8: Screenshot of message activity displaying a pictogram message

Figure 9: Screenshot of message activity displaying a voice message

5.1.3.7. Select picture activity

The select picture activity allows the user to select a picture from the database and send it as a message to the client. As can be seen in Figure 11, the activity loads a list of the available pictures and their filenames from the Firebase database and lists these items with the name of the picture. When a picture is selected, the picture is shown, as can be seen in Figure 10 and the message can be confirmed. Then a message object is made containing the message information and the filename of the picture. This message object is then send to the database. The user thus sends a pictogram to the smartwatch user, fulfilling requirement M5.
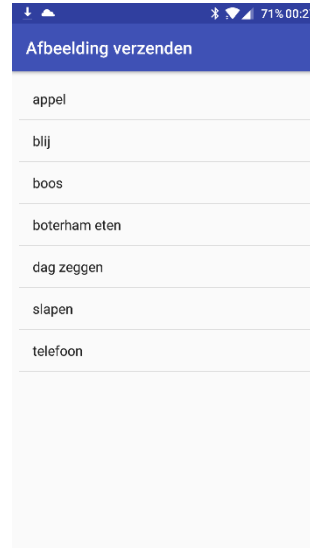
Figure 11: Screenshot of the select picture activity
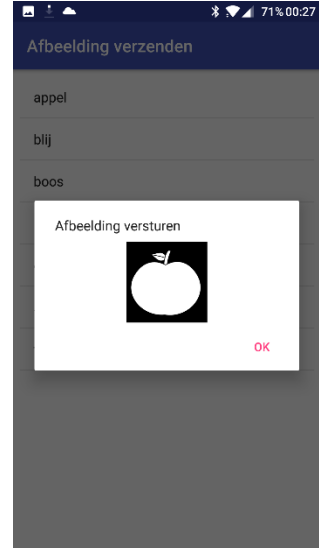
Figure 10: screenshot of a selected pictogram

5.1.4. CLIENT PORTAL

The Client portal contains two modules: the mobile application and the wear application. The mobile application handles the communication with the firebase database and authentication of the user, while the wear application handles recording of the voice messages and activating activities that display the vibration notification and the pictogram.

5.1.4.1. The Mobile application

The mobile application does most of the work on the background without displaying anything, except the login activity, the register activity and the main activity. When no user is logged in, the login activity which is explained in section 5.1.3.1 is activated. When the user decides to create a new account, the register activity is activated. This activity is explained in section 5.1.3.2. Both the login activity and the register activity are similar to the login activity and register activity in the caretaker portal, except the activities allow only users who are clients to use the application.

When a user is logged in, the application starts listening for changes in the database, indicating incoming messages. When a caretaker sends a message, a change is detected and the new message is loaded by the application. Then, a message is send to the wear application,

containing the filename variable of the received message from the caretaker. This data is then handled by the wear application.

The application also starts listening from messages coming from the smartwatch containing voice recordings. When such a recording is received, a file is made by converting the raw audio file that has been received from the wear application to a .WAV file, which can be played by the android Mediaplayer. This file is then uploaded to the Firebase cloud storage and a message is added to the database containing the client's id, the caretaker's id, the timestamp, the recipient Boolean, which is true, the read Boolean, and the file name. This should fulfill requirement M4 of the smartwatch application.

The wear application cannot be used without the smartphone application, which also needs to be connected to the internet. This fulfills requirements W2 and W3.

5.1.4.2.   The wear application

The wear application contains five activities: the watch face, the caretaker menu activity, the buzz activity, the pictogram activity, and the send file activity. The application listens on the background for messages coming from the mobile application and handles them accordingly. When a message is received from the mobile application, the wear application extracts the data from the message. This message contains a filename, which activates either the buzz activity or the picture activity. When the filename equals "buzz", the buzz activity is started and when the filename contains a different name, the picture activity is activated. No words are displayed in the smartwatch application and no writing is needed, fulfilling requirement M1 of the smartwatch application. The application is also made compatible with all screen shapes, including round and square screens, based on requirement S2 of the smartwatch application.

Figure 12: Screenshot of the picture notification

5.1.4.2.1.   The picture activity

The picture activity is launched by the wear application when it receives the filename of a pictogram from the database. The activity is based on requirement M5 of the smartwatch application. These pictograms are stored locally on the watch and the pictogram matching the received filename is displayed on the watch. The watch also starts vibrating for two seconds to notify the wearer of the smartwatch that a new pictogram has been received. Figure 12 shows a

screenshot of a pictogram notification of an apple. The activity closes when the user presses the image and returns to the watch face.

5.1.4.2.2.   The buzz activity

When the buzz activity is started by the application, the watch displays a button with the image of a "thumbs up" (Figure 13) and starts vibrating for 60 seconds or until the user presses the button, partially fulfilling requirement M3 of the smartwatch application. The activity closes when the user presses the button and returns to the watch face.

Figure 13: Screenshot of the buzz notification

5.1.4.2.3.   The watch face

The watch face displays the current time and acts as the homepage of the smartwatch (Figure 14). When the watch face is pressed, the caretaker menu is launched.

Figure 14: Screenshot of the

5.1.4.2.4.   The caretaker menu

The caretaker menu displays the pictures of four caretakers through which the user can scroll. In this prototype, no profile pictures can be loaded from the Firebase cloud storage and be displayed on the smartwatch because of a lack of development time, leaving requirement S1 of the smartwatch application unfulfilled. In order to give the user the feeling of selecting a caretaker, pictures of caretakers are stored on the smartwatch and when a picture is pressed, the message is always send to the same caretaker, because this prototype is developed to work functionally for the evaluation described in the next chapter. An example of how a caretaker is displayed in the caretaker menu is given in Figure 15.

Figure 15: Screenshot of the caretaker menu

When a picture is tapped, the file transfer activity is launched, which allows the user to record a voice message which is send to only one caretaker.

Figure 16: Screenshot of the record activity of WCL

5.1.4.2.5.   The file transfer activity

When the file transfer activity is activated by the caretaker menu, it starts looking for nodes to send a file to. When such a node is found (e.g. a smartphone that is connected to the smartwatch), the activity starts another activity which has been defined by the Wear Companion Library (Figure 16). This activity displays a blue-grey button with a white

Figure 17: Screenshot of an active recording
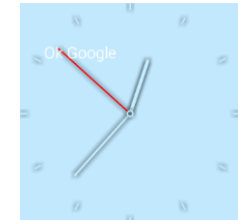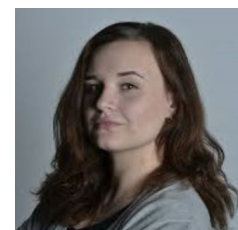
Figure 18: Screenshot of envelope

icon of a microphone in the middle. When this button is pressed, the recording is started and the button turns blue (Figure 17). When this button is pressed again, the recording is stopped and the saved file is send to the smartphone. Now an envelope is displayed (Figure 18), which moves to the top of the display, telling the user that the file has been sent. Feedback like this and the microphone button changing color provides the smartwatch user of feedback on performed actions based on requirement M2 of the smartwatch application.

5.2.   Interaction scheme

The interaction scheme given in Appendix 9.14 displays how all the different elements of the prototype communicate with each other. The interaction scheme describes the information flow between the different components and the users. The contents of the interaction scheme are described as follows:

Starting with the user logging in on the mobile module and the caretaker portal, the user enters an email address and a password. If a user does not have an account, the user enters the user data when registering. The user data, address and password are then saved and checked on the Android Firebase database and the email address and password are checked by the authentication service when a user logs in.

When the user of the smartwatch application sends a voice message, the user provides control input by pressing the buttons and the voice message to the wear module. The wear module then sends the recorded audio file to the mobile module, which sends it to the Firebase Cloud service accompanied with a message object containing information about the message. The Firebase database then sends the message to the smartphone running the prototype, which displays a notification to the user, accompanied by information about the sender of the message, the time and the type of the message. If the user opens the message, the audio file is downloaded and the user can provide control input to react to the message.

Next, when a caretaker chooses to react to a message, the caretaker provides the desired client from a list of clients which is downloaded from the firebase real-time database and the caretaker can send a pictogram or a vibration notification. If the caretaker sends a vibration notification, the smartphone application sends a message with a specific filename to the firebase server. If the caretaker sends a pictogram, the caretaker can choose a pictogram from a list which has been downloaded from the firebase server.

The mobile module of the smartwatch user then receives the message from the firebase real-time database and sends the filename provided by the message to the wear module. Depending on the filename, the wear application displays a pictogram according to the filename or the vibration notification. Before the vibration notification can be used, the caretaker and the client first have to discuss the definition of the vibration notification.

Finally, the caretaker can choose a profile picture. If the caretaker enters the settings activity, the current profile picture is downloaded from the Firebase cloud storage and displayed to the user. The user can then select a picture from the phone's memory, which is uploaded and saved on the firebase cloud storage.

6. EVALUATION PHASE

The prototype that has been developed needs to be evaluated in order to assess whether the application improves the quality of life of people with an ID and their caretakers.

6.1. Goal

The goal of this evaluation is to assess whether the developed application increases the quality of life of people with an ID and that of their caretakers. Because of a limited amount of time for this evaluation, only the expected improvement of the quality of life can be tested for both user groups. This section answers SQ 7: How to evaluate a smartwatch solution in the context described? An answer is given in the form of an example of how a smartwatch application can be evaluated by providing the way the developed application is evaluated.

In order to test the expected quality of life, the ability of the application to fulfill the defined needs is assessed. These needs explain a desired condition of living and, according to Wehmeyer and Schwarz [5], fulfilling this desire eventually improves the quality of life of the user.

The needs of which the fulfillment will be assessed are the needs that the developed application is expected to fulfill. These needs are the caretakers' need for an improved personal care and the people with ID's needs for better communication with caretakers, which includes accessible communication. The functions of the application are designed to fulfill these needs, so a look is taken at whether these functions are accepted by the users. This means that the users have to understand the functionality, are willing to use the functionality and are able to use the functionality.

6.2. Method

In order to test the acceptance of the functionalities by the user groups, four users from each group will be invited to test the application. The tests will be conducted with people with a mild or sever ID who work at a community workshop and caretakers who work at the same workshop, also caretakers who work in the home environment will be asked to use the application. These people have never seen the application before and could therefore look at it with a fresh view and provide information on how the application fulfills their needs. All participants are sent a consent form asking for permission to test the application, record audio of the participant and use the observations for this research.

Appendix 9.15 is an informed consent form that has been designed for the parents or caretakers of clients who allow their child or client to take part to the test. This form needs to be signed by both the researcher and the caretaker of the client in order for the client to be allowed to participate. The consent form is accompanied by a letter explaining relevant information about the test and who has access to the results. This letter can be found in Appendix 9.16.

A secondary informed consent form and information letter have been designed for the caretakers who participate to the test. The informed consent form has to be signed by the participant and the researcher for the participant to be able to take part in the test. This form can be found in Appendix 9.17 and is accompanied with the information letter found in Appendix 9.18.

The test will be conducted at the community workshop where participants will be available and at the home of a client, where caretakers who work in the home environment can also test the application. This allows to see the application in its natural habitat where participants feel at comfort and are readily available. Furthermore, testing at this location makes the test more accessible for people with an ID, because most of the time people with an ID are unable to travel independently. At the location, a quiet room is made available where the interviews can take place and the users can test the application.

Before the test, the participants are again asked for their consent and are made aware of their rights and are explained the goal of the test. They are allowed leave the test whenever they feel the need to and are allowed to say

In order to assess the fulfillment of the needs, participants are first interviewed about their experience with communication technology like smartphones and smartwatches in order to get a better understanding of their affinity with technology. This can later be used in order to analyze the usability of the system. These questions can be found in Appendix 9.19, and Appendix 9.20. During these interviews, first the caretaker is interviewed, followed by the client who is accompanied by the caretaker during the interview. This allows the caretaker to explain a question to the client, in case the client does not understand the question or does not know how to respond.

After these interviews, the caretaker and the client are shown an instructional video which explains the goal of the application, its functions and how to use it. The couple is also instructed to discuss a meaning of the vibration notification, where an example of the meaning is given by the researcher. Then the couple is instructed by the researcher to follow a predefined

set of instructions where the caretaker and client discover the application together and are instructed to think out loud, which is then recorded:

1) Client: Send the caretaker a spoken message about how you currently feel
2) Caretaker: Listen to the message and react to it accordingly with an image
3) Client: notice the image and tell the caretaker what it is
4) Caretaker: send the client a vibration notification
5) Client: tell what the received vibration notification means

Then the caretaker is instructed to go to a different quiet room and to listen to the voice recording that is received by the client a moment later and respond to it by calling the client and talk ask why the client is feeling that way. In the meantime, the client stays in the room with the researcher and is instructed to tell the caretaker what the client is feeling at that moment and why. Then when the client is called, the client has to tell the researcher who is on the other end of the phone and the researcher will put the phone on speaker mode, so that the conversation can be recorded.

During the complete test, the researcher stays with the client in order to take notes of what is happening and what is being said. These notes are later used for analysis of the results. The participants are also instructed to think out loud when using the application, so that their motives and thoughts are recorded to be analyzed.

After the test, the participants are interviewed again. First the client is interviewed in company of the caretaker. During this interview, the three core functionalities of the application are assessed, which are sending and receiving a voice message, reacting to the voice message and sending and receiving a vibration notification. This is done by asking questions about the usability of each of the functions. The used questions are derived from the System Usability Scale (SUS) [23], which is a quantitative usability scale designed by John Brooke containing 10 questions about the usability of a system.

The questions from the SUS give constructs which are used to assess the willingness of users to use the function, the ability to use the function and the ability to understand the function in this context. These questions are adapted so that they can provide qualitative information and are easy for the person with an ID to understand according to the guidelines described by Perry [24] for interviewing people with an ID. These interview questions can be found in in Appendix 9.19, and Appendix 9.20.

Next, the same usability questions are asked to the caretaker. These interviews are recorded, so that the recordings can later be transcribed and analyzed.

6.2.1.   LIMITATIONS

During a test, risks are present, which cause the test to not go as planned. These risks need to be summed in order to take them in account and prepare for the test not going as expected.

First of all is the unavailability of an internet connection. However, this chance is small, since smartphones should have access to a mobile data network (e.g. 3G, 4G). Also a chance exists of the location already having an accessible WIFI network, which the phones can connect to. In case none of these connections are available, the application will not work and another location needs to be found.

The second risk is the smartphones and smartwatches being out of battery. In this case, the application cannot run on the device and the test cannot continue. In order to eliminate this risk, chargers will be brought, since power sockets are available at the testing locations. Also mobile power banks will be brought so that the devices can be used while being charged without being connected to a wall socket.

Another risk is the participant not understanding the question that is asked during the interview. While caretakers are mostly capable of answering more complicated questions, people with an ID sometimes are not. Therefore, will a separate set of understandable questions created for this particular target group and will a caretaker be present during the interview, so that the caretaker can reformulate the question if necessary. This will give the participant a chance to understand the asked question and answer it.

A final limitation is the test taking too long. The test is supposed to take 15 minutes including watching the video and completing the tasks. After the test, the participants are interviewed, which should approximately take 30 minutes per participant. Experience has taught that caretakers tend to take more time to answer questions, because of their elaborate answers. This has occurred during a previous interview with very open and indirect questions, which can be answered in many different ways. That is why during the interview after the test more direct questions are asked. This steers the participant in the direction of answering the question in a desired way without giving too much unnecessary information.

People with an ID, on the other hand, tend to take more time to think about their answer, because they might not understand the question or do not know what to answer. When they

take too much time to think, asking the question in a different way often stimulates them to give an answer.

6.3. Results

The interviews that have been performed resulted in qualitative information about the participants' willingness to use the tested functionalities, ability to use the tested functionalities and ability to understand the tested functionalities. This information has been collected by analysis of the transcripts of the interviews and the notes that were taken during the tests.

6.3.1. PARTICIPANTS

In total, the prototype was tested with four couples consisting of a person with an ID and a caretaker. Three out of four couples have a client-caretaker relationship and one couple have a father-daughter relationship. The three caretakers that have been interviewed were caretakers at a community workshop, but also have experience in homecare.

The group of participants with an ID are all female, experience a mild ID and have ages varying between 22 to 53 years. Three out of four participants in this group are users of a smartphone. However, all participants from this group use either a laptop or a tablet or both in order to access the internet, watch videos or play games. This indicates that they have some sort of an affinity with technology. Finally, three out of four participants are familiar with wearing an analog watch. One participant explained that she does not need a watch, because she can read the time on her smartphone or on the clocks at the location.

The participants in the group of caretakers have an age varying between 39 and 79. Three participants are female and caretakers at the community workshop with experience in homecare. The final participant is male and is the father of one of the clients of the community workshop. All participants use a smartphone daily, but only one participant calls herself an experienced user of the smartphone. Furthermore do none of the caretakers have experience with smartwatches. Finally, all caretakers have experience with computers and tablets and use them daily either at home or at work.

6.3.2. USABILITY OF THE FUNCTIONALITIES

In order to assess the usability of all functionalities, all participants have been interviewed using questions from the System Usability scale that have been adapted in order to give qualitative information for each functionality and to be understandable for people with an ID. The functionalities that have been assessed the sending of a voice message on the smartwatch,

reacting to a voice message on the smartphone, sending a vibration notification on the smartphone and reacting to the vibration notification on the smartwatch.

6.3.2.1.   Sending a voice message

Three out of four participants liked to use the smartwatch application once or twice a day to send a message to their caretakers when they need help with a problem or have to update their caretakers about their whereabouts. They indicated that they normally do this by using the phone or the intercom in their homes, but prefer to use the smartwatch application. These three participants indicated that they like using the smartwatch application to send a voice message, because it offers a simple way to have contact with their caretakers. One person added that she was self-conscious about her voice because she thinks she does not speak clearly, which made it irritating for her to use the application. This made her like using the application less than the two other participants who like using the application. However, this participant, together with another participant felt confident when they were using the application to send a voice message, because they knew what they have to do and because they have an easy way to contact a caretaker.

The fourth participant did not see the use of the smartwatch application and indicated that she did not like to use the application in the future, because using the phone in order to communicate with her father is sufficient. This also made the application more irritating to use. She also preferred receiving a phone call over a pictogram, because she thought pictograms were "childish".

Participants were divided on what kind of a reaction to a voice message they prefer to receive. Two participants explained that they prefer receiving a phone call, because actually talking to someone allows for a more detailed transfer of information and is an already familiar way of communication. The remaining two participants explained that they prefer receiving a pictogram, because they are used to working with them and because pictograms are clear to the participants.

All participants thought that the application was easy to normal to use, because the actions are similar to the actions they already perform on smartphones (e.g. swiping, selecting). However, one client explained that using the application was not too easy, because the application was new to her. Two participants explained that this was the reason for the application to be complicated to them and that the might need help with using the application in

the beginning. On the other hand, the remaining two participants explained that they did not think the application was complicated at all and that they did not need the use of any help.

Participants indicated that it was easy for them to understand the application, but observations during the tests proofed otherwise. All participants agreed that they found it easy to learn how to use the application. However, none of the participants managed to send the first voice message after watching the instructional video without the help of the caretaker or the researcher. Only in a single case did a client manage to succeed on her own during the second time a voice message had to be sent. During all of the other cases, it was not clear to the participants when they had to talk into the watch and how they had to end the recording. Still, only two participants claimed that they had to learn a lot about the application to be able to understand it. However, when the participants were asked about the consequences of their voice messages, no participant thought that either a pictogram or a phone call could be received as a reaction to their voice messages.

6.3.2.2. Reacting to a voice message

The caretakers did not expect to receive many voice messages. Two of the caretakers at the community workshop explained that this functionality is not applicable to them, because their clients are always being supervised by a caretaker. These caretakers also explained that the application could be used very often, based on their experience with homecare. The other caretaker, however, explained that she might use it more often if she and her clients get used to using the application. Finally, the father of one of the clients expected that he will use the application to receive a voice message only once a week, because he thinks it will be necessary only once in a week.

Only one caretaker said that she felt confident when she was using the application to react to a voice message, because she sees using the application as a part of her job. All other caretakers explained that they did not feel confident when using the application to react to a voice message, because they had no experience with the application. These were also the caretakers who explained that they do not see themselves as being very experienced with smartphones.

None of the caretakers claimed they experienced irritation when they were using the application. The caretakers explained that they did not experience any irritation, because using the application is a necessary part of their communication. However, one caretaker added that she was wondering whether the voice message will be effective if the caretaker cannot respond

within a certain timeframe to a voice message to which a quick respond is needed. Another caretaker added that she found it inconsistent that you first have to make sure the client knows the meaning of a pictogram before you send it in order for a message to be clear.

None of the caretakers thought it was difficult to react to a voice message by sending a pictogram or calling the client using the application and added that they do not think they need help with the application in the future. However, two participants needed help with playing the voice message on the phone, because they did not understand that listening to the message is necessary In order to react to the voice message. Three participants also explained that they expect that using the application will be easier for them when the use to application more often. Similarly, all caretakers thought it was not complicated to react to a voice message by using the call-function. However, one caretaker added that she thought it was complicated to choose the right pictogram to send to the voice message she received.

All caretakers thought that reacting a voice message was well integrated in the application and thought that the integration of the functionality is logical and easy to understand. They also said that using the application to read to a voice message is not difficult to learn and that it was not a lot to learn. However, one caretaker admitted that she needed to ask a lot of questions to the researcher and learned to use the application that way.

6.3.2.3.   Sending a vibration notification
All caretakers expect to send a vibration notification to their clients at least once a week. They agreed that the functionality offers a quick and accessible way to contact a client. One caretaker added that it is easy for the client as well, because the vibration notification enables the client to be more flexible (e.g. no necessity to wait at the intercom for a caretaker to arrive).Another caretaker added that she liked that the vibration notification can have different meanings, so that she can use it with many different clients. One caretaker, however, explained that she would use it for homecare instead of at the daycare. Also the father of one of the clients thought he would use the functionality at least once a week, but not much more.

Because the functionality is easy to use and has a good intention, the caretakers felt confident using the functionality. They felt at ease, because they were sure that the message is clear and arrives at the clients. On the other hand, one caretaker did not get any confirmation on the smartphone that the vibration notification had been sent and tried to send it another time, causing the smartwatch to receive two vibration notifications.

All caretakers still agreed that the functionality was not irritating, nor inconsistent to use, despite the lack of confirmation. They explained that the meaning of the vibration notification has to be well defined with the client and other caretakers in order to be clear and inconsistent. Otherwise a client might be confused with the meanings of different caretakers.

All caretakers agreed that the functionality is easy and not complex to use on the smartphone application. They explained that the actions that have to be performed are common for a smartphone application and that the button to send a vibration notification is easy to find. They agreed that they did not need any help when they have to use the functionality, which was already confirmed during the tests when all caretakers managed to send a vibration notification independently.

All caretakers thought that very little had to be learnt before they could understand vibration notification. They did admit that the introduction video had helped them, and that they did have to search for the button during the first use. One caretaker added that the button could better be placed among the other two buttons for calling the client and sending a pictogram to the client. Still, all caretakers thought that the functionality was seamlessly integrated in the application.

6.3.2.4.   Reacting to a vibration notification

The people with an ID who participated to the tests were divided on the use of the vibration notification. Two participants liked the functionality and expected to use it in the future, because they thought it would be convenient to be reminded of tasks every now and then. They were confident when reacting to the message, because they knew what had to be done, one participant explained.

On the other hand, the other two participants did not expect to use the functionality in the future and did not like to receive a vibration notification. One participant did not like how the smartwatch vibrates, which she thought was irritating and prefers to hear a sound playing when she receives such a message. However, she did feel confident when using the functionality. The other participant who did not like the functionality also thought it was irritating, but refused to give a reason.

Receiving a vibration notification and reacting to it was neither easy nor hard to do for the participants. They explained that they had difficulties reminding what the discussed meaning of the vibration notification was, which the participant who thought the vibration was irritating called too difficult to do. She also added that she thought it was difficult to make the smartwatch

stop vibrating. This made the application complicated for her to use, while other participants the functionality was not complicated to use, because they thought the steps were easy to take. One participant, however, claimed that the functionality was too complex to use, but also explained that it was easy to react to the vibration notification.

Next to that, three participants thought that they do not need help in the future when they receive a vibration notification and have to react to it. They did add that they need to know what the vibration notification means, otherwise the do need help, but not with the application itself. One of these participants claimed that she also did not need any help during the test, while she needed to be told what to do multiple times when she received the vibration notification. One participant on the other hand, said that she might need help of her sister when she receives such a message, but gave no further explanation.

All participants understood the meaning of the vibration notification that they had discussed with their caretakers, but did not always understand that they had to press the button with a thumb on it on their smartwatch. Furthermore, two participants completely forgot what happened when they received the vibration notification. Even though, three participants found that it was easy to learn how to use the functionality. The other participant explained that she did not know what to do when she receives another vibration notification. When the participants were asked if they found it too much to learn, one participant answered that she did not have to learn a lot, while another participant claimed otherwise.

6.4.   Discussion of results

The above results describe gave qualitative information about the usability of the system and describe how understandable the functionalities are, how usable the functionalities are and whether the users want to use the functionalities. However, factors were present that could have influenced the results, like the emotional state of the participants and the way certain functionalities were demoed.

First of all, three couples of participants tested the application during the day at their community workplace. One couple tested the application in the evening, after a full workday. This caused the participant with an ID to be very tired and not cooperative. This might have had a negative influence on her answers during the interviews.

Second, the caretakers were not able to call the other participants on the other smartphone, because the smartphone that was used by caretakers to test the smartphone

application did not have a working sim-card. This problem was solved by having the participants act out a telephone conversation, while caretakers still had to initiate the conversation by pressing the call button in the smartphone application. This might have influenced the answers of the participants with an ID, because they might have not understood that they were acting out a telephone conversation.

6.5. Conclusion

In conclusion it can be said that the smartwatch application had an average usability, depending on the users' affinity with technology. The smartphone application was more usable, as explained by the caretakers who used the application.

It can be concluded that the functionalities of the smartwatch application are likely to be accepted by people with a mild ID. Three of the participants with an ID explained that they would want to use at least one of the functionalities of the application in the future, while one participant refuses this. The three participants who feel positive about the use are prepared to use all functionalities if the caretakers take their own preferences for what types of messages to receive in mind. Depending on the amount of experience the participants with an ID have with technology, they thought the application is usable to them if they use it more often. Using the application for a longer time also allows the users to understand the functionalities better.

In addition, it can be concluded that the functionalities of the smartphone application are likely to be accepted by caretakers, because the application was very usable to the caretakers. All caretakers want to use the functionalities and they all thought that the application is already usable, and becomes more usable when the application is used more often. They also thought that understanding the functionalities were easy to understand.

It can thus be concluded that the tested functionalities are likely to fulfill the need of people with an ID to have a better communication with caretakers and the need of caretakers to provide better personal care. Using the application fulfills these needs and thus improves the quality of life of people with an ID and their caretakers.

7.   CONCLUSIONS

During this bachelor project, a prototype has been designed of a smartwatch application and a smartphone application that improve the quality of life of people with an ID and their caretakers. The applications do this by allowing people with an ID to have better communication with their caretakers and allowing caretakers to provide better personal care. These are two needs of the stakeholder groups that the application fulfills. These two needs are a part of the result of a need assessment during the state of the art research. This need assessment resulted in many more needs that have to be fulfilled in order to increase the quality of life of people with an ID and their caretakers.

The designed smartwatch application fulfills the chosen needs by allowing people with an ID to send voice messages to their caretakers using a smartwatch. The caretakers can reply to such a voice message be either sending a pictogram, which is then displayed on the smartwatch, or calling the sender of the voice message. Furthermore, caretakers can send a vibration notification, which allows for communicating a simple, but flexible message to the user of the smartwatch application.

Evaluation of this prototype allowed for the conclusion that the designed application improves the quality of life of people with an ID and their caretakers. The functionalities that the application provides are accepted by caretakers and most of the people with an ID with which the prototype was tested. Because these functionalities are accepted, it can be said that the functionalities allow for the fulfillment of the needs that the functionalities are designed to fulfill and thus improve the quality of life of people with an ID and their caretakers.

7.1.   Further recommendations

In order to improve the application further, or to design another smartwatch application for people with an ID and their caretakers, changes to the design and functionalities can be made.

First of all, changes could be made to the interface of the smartwatch application. The first design change that can be made is having the first part of the caretaker menu be black, displaying only an animation describing that the user can scroll in order to select a caretaker. The second design change is to change the button on the vibration notification on the smartwatch. It was not immediately clear to any of the users that the thumb is a button, which can be pressed. The last design change is in the design of the message activity on the smartwatch application. The button to send a vibration notification can be added, in order for the user to use that functionality as a reaction to a voice message.

Finally, because the used evaluation was a qualitative short-term evaluation, extra certainty can be provided about the improvement of the quality of life of people with an ID and their caretakers by the application. This can be done by performing a long-term research on the perceived self-determination of the stakeholders. This research takes more time, but provides quantitative results on whether the application improves the quality of life of the stakeholders, because, as described in section 2.1.2, self-determination has a one-to-one relationship with quality of life.

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9. APPENDIX

9.1. Appendix 1: Design process for Creative Technology
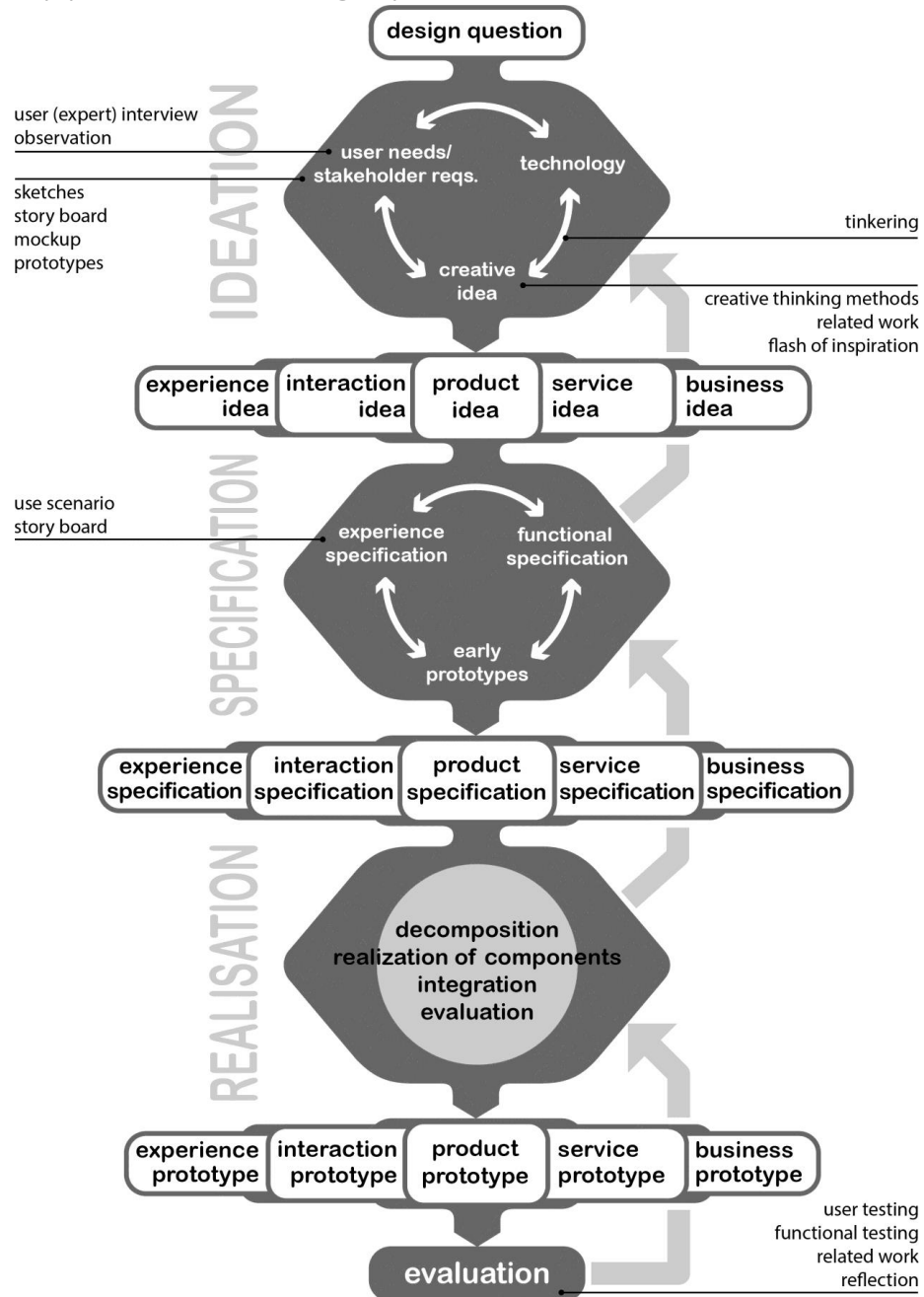
9.2.   Appendix 2: Interview questions for person with an ID

1) Wat doe je elke week?
2) Wat doe je elke dag?
3) Heb je een telefoon, tablet of computer?

    a)   If yes: wat doe je met je telefoon, tablet of computer?

    b)   If no: weet je wat het is en wat je er mee doet?

4) Draag je een horloge?

    a)   If yes: wat voor een?

    b)   If smartwatch: wat doe je met je smartwatch?

5) Kan je me vertellen hoe laat het is?

6) Wat voor dingen helpen jou elke dag?

7) Hoe gebruik je deze dingen?

8) Hoe vaak gebruik je dit?

9) Ben je graag met "CT"?

10) Hoe voel je je verbonden met "CT"?

11) Wat vind je leuk om met "CT" te doen?

12) Hoe voel je je niet verbonden met "CT"?

13) Wat vind je niet leuk om met "CT" te doen?

14) Hoe vaak ben je met "CT"?

15) Hoe vaak bel je met "CT"?

16) Hoe maken jullie afspraken?

17) Kan je "CT" wel eens lastig bereiken?

    a)   If yes: waarom dan?

    b)   If yes: Wat doe je dan?

18) Wat wil je graag aan "CT" vertellen?

19) Wanneer wil je graag met "CT" kunnen praten?

20) Hoe praat je graag met "CT"?

21) Wat kun je goed?

22) Waar wil je graag mee geholpen worden?
23) Vergeet je wel eens wat?
    a)   If yes: Wat vergeet je dan?
    b)   Wat doe je als je wat bent vergeten?

24) Heb je wel eens problemen als je alleen bent?
    a)   If yes: Wat voor problemen heb je dan?
    b)   Wat doe je dan?
25) Als je hulp krijgt, wil je dat "CT" dit doet of dat technologie je helpt?
26) Vind je het leuk om technologie (/technisch hulpje) te gebruiken?

27) Hoe denk je dat een draagbaar apparaat (/technisch hulpje) jouw leven kan verbeteren?

28) Hoe oud ben je?

29) Waar kom je vandaan?

9.3. Appendix 3: Interview questions for caretaker

1) Wat doet u elke week samen met "MU"?
2) Wat doet u elke dag samen met "MU"?
3) Werkt u graag met nieuwe technologie?

4) Hoe comfortabel voelt u zich met het leren werken met nieuwe Technologie?

5) Heeft "MU" een telefoon, tablet of computer?

   a) If yes: wat doet hij/zij met de telefoon, tablet of computer?

   b) If no: waarom niet?

6) Draagt "MU" een horloge?

   a) If yes: wat voor een?

   b) If smartwatch: wat doet "MU" met de smartwatch?

7) Wat voor dingen gebruiken jullie die het leven met een ID verbeteren?

8) Hoe gebruiken jullie deze dingen?

9) Hoe vaak gebruiken jullie dit?

10) Zijn jullie graag samen?

11) Hoe voelt u zich verbonden met "MU"?

12) Wat vindt u leuk om met "MU" te doen?

13) Hoe voelt u zich niet verbonden met "MU"?

14) Wat vindt u niet leuk om met "MU" te doen?

15) Hoe vaak bent u met "MU"?

16) Hoe vaak belt u met "MU"?

17) Hoe maken jullie afspraken?

18) Kunt u "MU" wel eens lastig bereiken?

    a) If yes: waarom dan?

    b) Hoe lost u dat op?

19) Wat wilt u het liefste kunnen communiceren?

20) Wanneer wilt u graag met "MU" kunnen communiceren?

21) Via welke methode communiceert u het liefst met "MU"?

22) Wat kan "MU" goed?

23) Waar wilt "MU" graag mee geholpen worden?
24) Heeft "MU" wel eens problemen als hij/zij alleen is?
    a) If yes: Wat voor problemen heeft "MU" dan?
    b) Hoe lossen jullie dit dan op?
25) Vergeet "MU" wel eens wat?
    a) If yes: Wat vergeet je dan?
    b) Wat doet u als "MU" wat is vergeten?

26) Als "MU" hulp krijgt, wilt u dat u dit doet of dat technologie "MU" helpt?
27) Waar maakt u zich zorgen om als "main user" alleen thuis is?

    a) Waarom maakt u zich daar zorgen over?

28) Hoe denkt u dat draagbare technologie jullie leven kunt verbeteren?

29) Zou u technologie willen gebruiken om jullie leven beter te maken?

30) Wat is uw leeftijd?

31) Waar komt u vandaan?

9.4. Appendix 4: Information letter for Interviews

UNIVERSITEIT TWENTE.

Betreft: toestemming voor deelname aan interview voor onderzoek *'Hoe ontwerp je een applicatie voor smartwatches dat het dagelijks leven van mensen met een verstandelijke beperking en de verzorgers verbeterd'*.

Geachte ouder/verzorger,

Op **woensdag 22 maart** kom ik, student van de Universiteit Twente, op de 2e han(d)s en Grietjes. Daar zal ik interviews afnemen met begeleiders en cliënten voor mijn bacheloropdracht. Deze interviews gaan over het dagelijks leven met een verstandelijke beperking en de acceptatie van technologie. Om deze interviews te ondersteunen, zullen er audio opnames worden gemaakt. Deze gegevens zijn confidentieel en zullen alleen worden gebruikt tijdens dit onderzoek.

Deelname aan dit interview kan enkel als u daarvoor toestemming geeft. **Als u akkoord gaat dat uw zoon/dochter hieraan mee doet, wilt u dan bijgevoegde toestemmingsformulier invullen, ondertekenen, en aan de begeleiding geven?**

Voor meer informatie kunt u altijd contact met mij opnemen.

Met vriendelijke groet,

Stijn Wolters
s.h.g.wolters@student.utwente.nl
06-27216174

9.5.   Appendix 5: Informed Consent Form for Interviews

UNIVERSITEIT TWENTE.

Betreft: toestemming voor deelname aan interview voor onderzoek *'Hoe ontwerp je een applicatie voor smartwatches dat het dagelijks leven van mensen met een verstandelijke beperking en de verzorgers verbeterd'*.

Als u toestemming geeft kunt u hieronder de gegevens invullen en ondertekenen.

Ik geef toestemming voor het interviewen van mijn zoon/dochter en het maken van audio-opnames van het interview.

Naam deelnemer…..…………………………………………

Datum….………………………………………………………

Ouder/verzorger….………………………………………..

Handtekening:

………………………………………………………………...

Contact informatie

Mocht u vragen hebben over dit onderzoek of geïnteresseerd bent in het onderzoek, dan kunt u contact opnemen met Stijn Wolters (s.h.g.wolters@student.utwente.nl).

9.6. Appendix 6: personas

Persona 1: main user

Patrick van Vliet is a 49-year old man with a moderate ID from Wolvega. He is receiving full-time care in a living group. His hobbies are swimming, cycling, and playing the WII in his living room or games on the iPad in his room. He comes from a family of five, where he has one brother and one sister and both his parents. He goes to a community workshop five times a week, where he performs simple woodworking projects. At this workshop, he works on items which are sold in the shop next to the workshop in order to get funding.

Patrick lives with five other people, but whenever he is in his room, he still feels bored and doesn't know what to do. He does not have access to the internet, because his parents think browsing the internet is too difficult and even dangerous to Patrick. He also often experiences problems with being late at the workshop, because he misses the taxi. This results in Patrick feeling uncomfortable and fed up. He also has trouble with operating home appliances like the dishwasher and the washing machine, because he can't remember how to interact with it, so he often asks for help of a caretaker, even though they are not always able to help him straight away. If Patrick experiences a problem, but can't talk about it immediately, he can't write it down, which causes him to wait until he can contact one of the caretakers at home or his parents. Sometimes Patrick has trouble focusing on his activity because he is thinking about something else.

Persona 2: Main user

Ankie Groenevelt is a 24-year old women who suffers a mild ID in combination with mild autism. She lives in Utrecht by herself, where she has daily contact with her father and a caretaker who helps her with cooking and the household. She also goes to a school three times a week, where she helps out at a kindergarten. She has a brother who visits her every month and her mother has passed away. During her free time, she likes to read, handcraft cards, play the piano and draw. In weekends she likes to go horseback riding and going for a coffee with her dad and her brother.

Even though she keeps a schedule, she experiences problems with unexpected events and keeping to her schedule. This results in her feeling unhappy and in need of contact with her father, who can calm her down. This is often not possible, because her father is busy with his work. If she encounters such a problem, she often writes it down so she can deal with it later.

Persona 3: caretaker

Hendrik Dokter is the 71-year-old father from Emmen. He is married to Marianne Dokter-Vijers and together they have three children: Lars, Paul, and Hanna. He is a retired plumber and has worked for 54 years. Nowadays he spends his day visiting friends and taking care of his grandchildren together with his wife. His hobbies are playing poker and billiards at the local club and going to the forest with their dog, Charly.

His son, Lars, is 44 years old and suffers a mild ID. He is in contact with him four times a week where they talk about events and practical things. Hendrik also organizes Lars' activities and financials. In order to do this, he visits him every week to make a budget and talk about the schedule. He does this, so that he can provide the best care possible to his son. In order to do this, he is always focused on the newest developments in care for people with an ID and making sure he has all information about the services he and his son need. Because Hendrik is away from home or busy with his grandchildren often, he often experiences the feeling that he doesn't know what Lars is doing or whether Lars needs his help. This makes him uncomfortable and he is not too keen on being away for longer periods of time.

Persona 4: caretaker

Henriette de Vries-van der Velden is a caretaker at a community workshop for people with ID. She lives and works in Goes and is 37 years old. She has been a caretaker at her workshop for 10 years and has been working in this field with a lot of enthusiasm. She is married to Guus de Vries and together they have a 7 and a 5-year-old daughter. She spends two nights a week singing in a choir and she enjoys watching Netflix with her husband. Since her youngest daughter is going to school, she is able to work at the workshop 3 days a week, while a friend of hers watches her children when she works.

Her favorite activities at the workshop are helping her clients making items that are sold and guiding the clients in selling these items. She dislikes bringing bad news to her clients or having arguments with them. She often experiences trouble with making sure all of her clients receive the care they need, because she and her colleagues are often not on the work floor while they are working on administrative tasks or are busy solving a problem with a client.

9.7.   Appendix 7: problem scenario

Karin is 32 years old and experiences a mild ID. She lives in a home with five other people with an ID. Karin is at home when she spills a drink on her shirt. She knows that if she doesn't wash the shirt right away, the stain will not be removed. However, because of Karin's lack of knowledge about the use of home appliances, she is not able to operate the laundry machine. Linda, Karin's caretaker normally helps Karin with doing the laundry, but Linda has just left for the day. This upsets Karin, because she is not able to wash her shirt at this moment. Karin also can't read nor write, so she cannot write a note explaining her problem so that Linda can help her solve it tomorrow. Karin throws the shirt in the laundry basket and puts on a new shirt. Because she was not able to solve her problem the way she wanted, she stays upset the whole night.

The next day, Linda arrives, but Karin has forgotten about the problem of the night before, because she threw the shirt in the laundry basket and didn't look at it anymore. When Linda is helping all residents of the living group with preparing lunch, she notices that Karin has lost her focus on preparing the food and started staring out of the window. Karin is "Zoning out", because she just remembered her problem from the night before. This keeps her from having lunch in time before her day activity, but because Linda is currently helping a different resident, she has to leave the person she is currently helping to help Karin, causing him to take more time having his lunch. She sits down next to Karin, puts a hand on Karin's shoulder and asks what is going on. Karin explains her thoughts and Linda proposes that Karin continuous having lunch and doing the laundry at the end of the day. This however, does not completely remove the stain and Karin stays not fully satisfied.

In the end, both Karin and Linda are not satisfied. Karin is unhappy about how her shirt turned out and how she was unable to solve the problem, affecting her mood. Linda is unsatisfied, because she is unable to give all residents the immediate personal care they need, causing her having to spend more time on caring for people, while she can't afford to spend that much time.

9.8. Appendix 8: Use scenario of the product

Karin is 32 years old and experiences a mild ID. She lives in a home with five other people with an ID. She has a problem with operating the laundry machine, because she does not know how to use it. Normally, she does the laundry with a Linda, her caretaker at home. Unfortunately, she has just spilled a drink on her shirt and she wants it cleaned, but Linda has gone home for the day and not knowing how to operate the laundry machine makes her upset.

Karin is wearing a smartwatch with an application which she can use to send a spoken message to Karin. So she decides to use the application. She touches the watch face, which then displays a picture of her mom. Then by swiping right she can scroll through pictures of her caretakers until a picture of Linda appears. Karin then taps on the picture of Linda and an icon of a microphone appears. This tells Karin that she can speak in her message. Karin brings the smartwatch closer to her mouth and she explains her problem. She then taps the microphone icon and the icon turns into an icon displaying an envelope. This envelope then moves to the edge of the smartwatch screen and disappears. This tells Karin that her message has been sent. Now Karin feels more at comfort and she can focus on a different activity until she receives feedback from Linda.

At that moment, Linda is sitting at home when she receives a notification on her smartphone saying she has received a new voice message from Karin. She is having dinner, which means that she is unable to react, since she and her husband have a no-phone policy at the dinner table. After Linda has finished her dinner, she gets her smartphone and taps the notification. This opens the application on her smartphone and shows her an audio controller, information about the audio message and three buttons and a text field. The buttons show a phone icon, a send icon and an icon of a picture. She taps the play icon on the audio controller and the message starts playing. After the message has played, Linda can choose to call Karin, send Karin an icon from a categorized set of icons and pictures or send Karin a text message using the three buttons and text field. Linda taps the call button which automatically dials Karin's phone number. Karin picks up her phone and during the following conversation are the instructions of using the laundry machine explained to Karin by Linda. Karin follows these steps and she finishes the phone call. A few hours later, Karin has a clean shirt which she can put on the drying rack later that night.

The next day, Linda is having Lunch with Karin and her housemates. While Linda is helping one of Karin's housemates with preparing his lunch, she notices that while Karin is

preparing her lunch, she starts being distracted and she stops with preparing while she starts looking out of the window in silence. Linda realizes that Karin is concentrating on things that are not relevant to her task and she grabs her smartphone. She opens the application and it appears to the main menu. This main menu shows a list of her clients with an options button in the top-right corner. Linda scrolls through the list of her clients until she finds Karin. She taps on Karin's name and the application shows her most recent history of audio messages sent by Karin. In the bottom she finds a big button saying "send buzzer", which she presses. A pop-up appears explaining that the message has been sent to Karin's smartwatch.

Karin notices that her smartwatch starts vibrating. Because this happens more often when she loses focus, she realizes that she has lost her attention and she presses the button on her smartwatch saying "OK". She then gets back to preparing her lunch so she can be finished eating in time for her day activity.

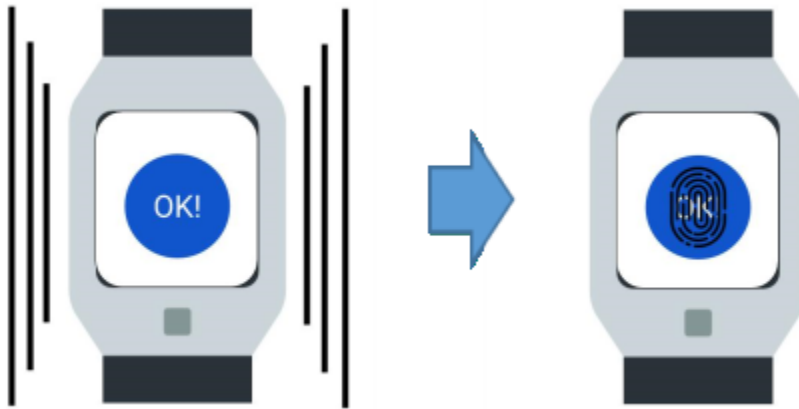## 9.9.   Appendix 9: Sending a voice message storyboard
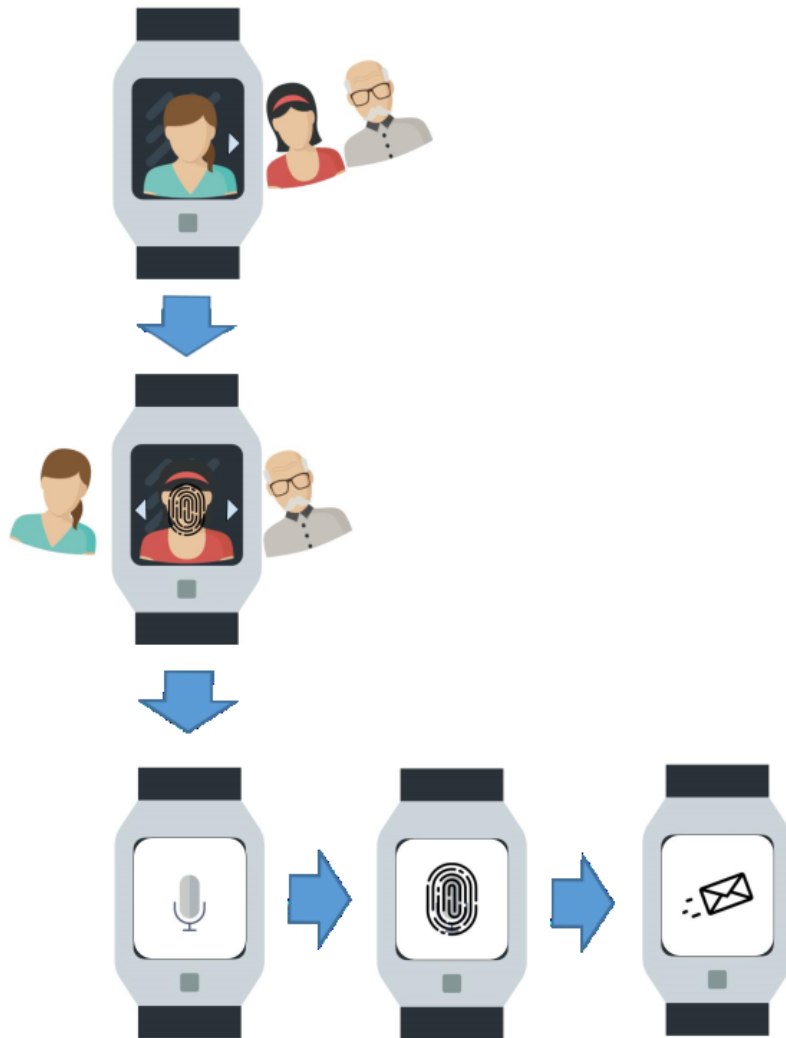
9.10.   Appendix 10: Reacting to voice message storyboard
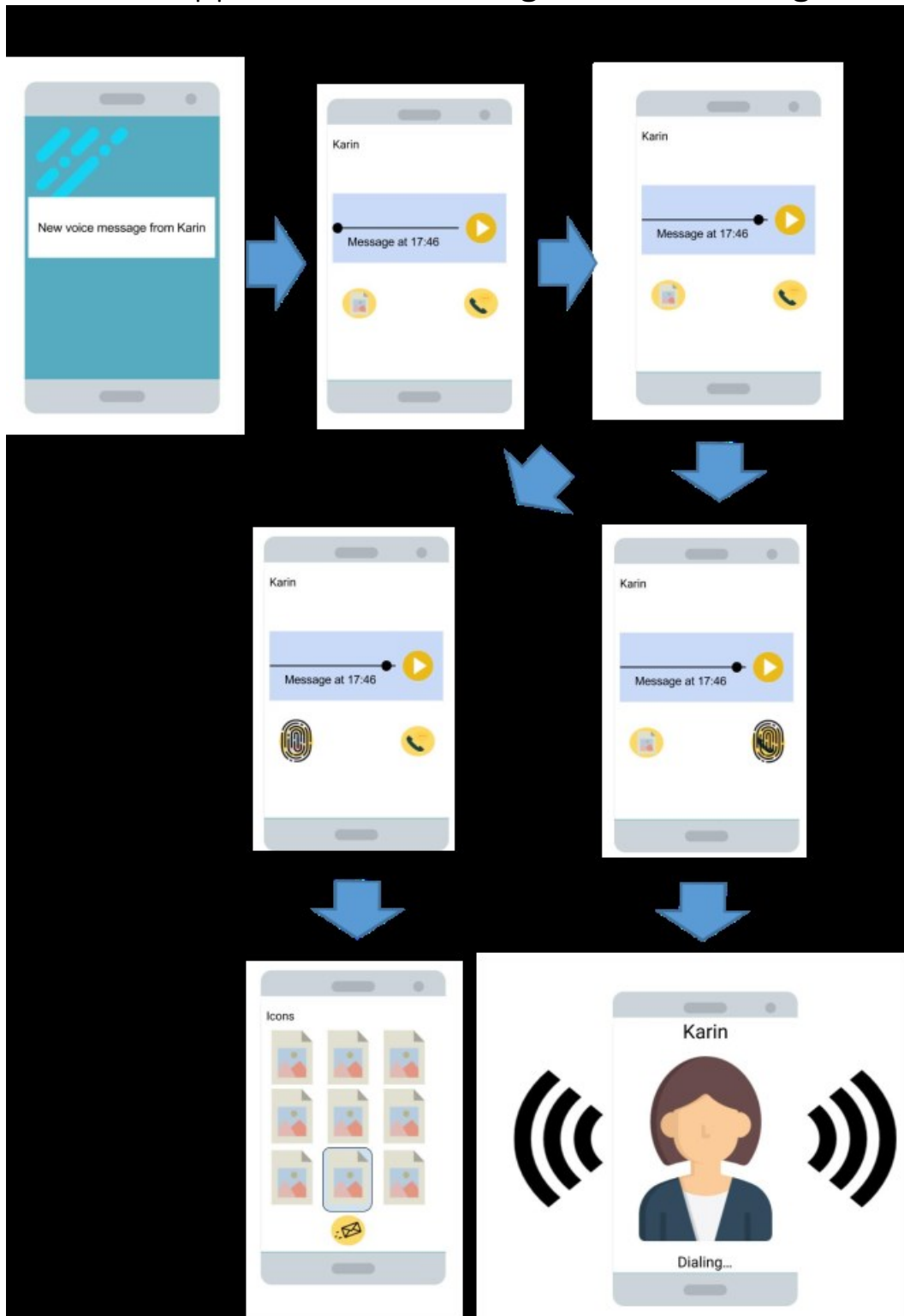
9.11. Appendix 11: Sending vibration notification storyboard

9.12. Appendix 12: Reacting to vibration notification storyboard

9.13. Appendix 13: Real-time database design

- Graduation Project
  - ClientsAsContacts
    - caretakerId
      - ClientId
  - Users
    - UserId
      - Email: (String)
      - Firstname: (String)
      - PhoneNumber: (String)
      - ProfilePicture: (String)
      - Surname: (String)
      - userId: (String)
      - userType: Boolean (Caretaker = true, client = false)
    - …
  - CaretakersAsContacts
    - clientId
      - caretakerId
  - Conversations
    - CaretakerId+clientId
      - Timestamp (String)
        - messageType = (String)
        - Filename = (String)
        - timestamp = (String)
        - recipient = Boolean (Caretaker = true, client = false)
        - Read = Boolean
  - Pictures
    - Picture name (String): filename (String)

9.14.   Appendix 14: Interaction scheme
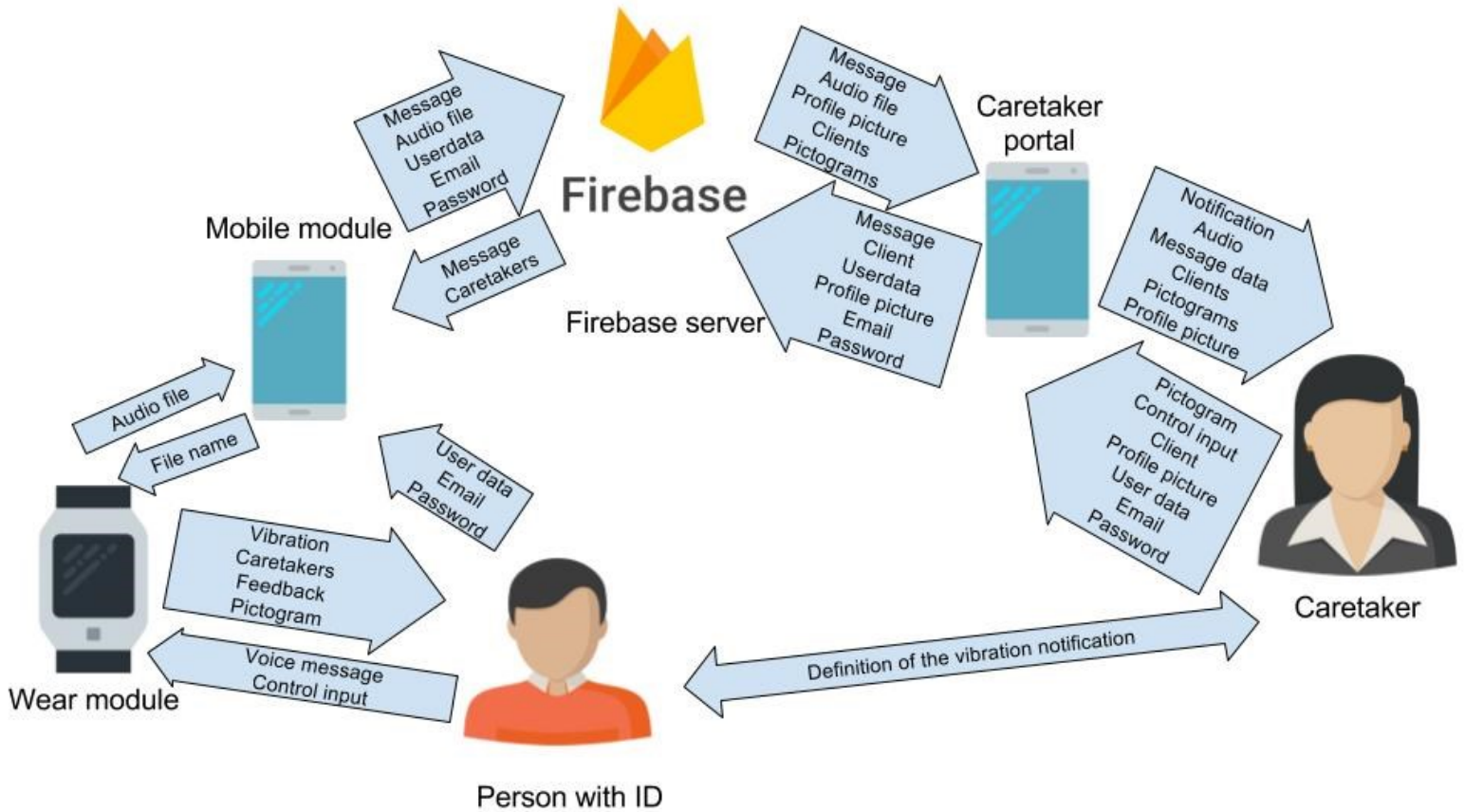
9.15.   Appendix 15: Informed Consent Form for evaluation test for Client

UNIVERSITEIT TWENTE.

Betreft: toestemming voor deelname aan gebruikers evaluatie van een ontworpen applicatie voor onderzoek *'Hoe ontwerp je een applicatie voor smartwatches dat het dagelijks leven van mensen met een verstandelijke beperking en de verzorgers verbeterd'*.

Als u toestemming geeft kunt u hieronder de gegevens invullen en ondertekenen.

- **Ik heb de informatiebrief gelezen. Ook kon ik vragen stellen. Mijn vragen zijn voldoende beantwoord. Ik had genoeg tijd om te beslissen of ik wil dat mijn zoon/dochter meedoet.**

- **Ik weet dat meedoen vrijwillig is. Ook weet ik dat ik op ieder moment kan beslissen dat mijn zoon/dochter toch niet meedoet. Daarvoor hoef ik geen reden te geven.**

- **Ik geef toestemming voor gebruik van de gegevens op de manier en voor de doelen die in de informatiebrief staan.**

- **Ik geef toestemming voor het maken van aantekeningen, het interviewen van mijn zoon/dochter en het maken van audio-opnames van de test en het interview.**

- **Ik verklaar hierbij dat ik mijn zoon/dochter volledig heb geinformeerd over het genoemde onderzoek.**

Naam deelnemer…………………………………………………

Datum…………………………………………………………………

Ouder/verzorger……………………………………………..

Handtekening ouder/verzorger: Handtekening onderzoeker:

……………………………………..   ………………………………….

Contact informatie

Mocht u vragen hebben over dit onderzoek of geïnteresseerd bent in het onderzoek, dan kunt u contact opnemen met Stijn Wolters (s.h.g.wolters@student.utwente.nl).

9.16.   Appendix 16: Information letter for evaluation test for Client

UNIVERSITEIT TWENTE.

Betreft: toestemming voor deelname aan gebruikers evaluatie van een ontworpen applicatie voor onderzoek *'Hoe ontwerp je een applicatie voor smartwatches dat het dagelijks leven van mensen met een verstandelijke beperking en de verzorgers verbeterd'*.

Geachte ouder/verzorger,

Op **woensdag 21 juni** kom ik, student aan de Universiteit Twente, op de 2e Han(d)s en Grietjes. Daar zal ik tests afnemen met begeleiders en cliënten voor mijn bacheloropdracht. Tijdens deze tests gebruiken de deelnemers de ontworpen applicatie en worden ze geïnterviewd over hun ervaring met de applicatie en de functionaliteiten die de applicatie te bieden heeft.

Deelname aan dit onderzoek is vrijwillig en u of uw zoon/dochter kan zich altijd bedenken om te stoppen, ook tijdens het onderzoek. U of uw zoon/dochter hoeft niet te zeggen waarom hij/zij stopt. Wel moet dit direct gemeld worden bij mij. De gegevens die tot dat moment zijn verzameld, worden gebruikt voor het onderzoek.

Om deze testen te ondersteunen, zullen er audio opnames en aantekeningen worden gemaakt. Elke proefpersoon krijgt een code die op de gegevens komt te staan. De naam en andere persoonlijke gegevens die u direct kunnen identificeren worden daarbij weggelaten. Alleen ik heb toegang tot deze gegevens.

Deelname aan deze test kan enkel als u daarvoor toestemming geeft. **Als u akkoord gaat dat uw zoon/dochter hieraan mee doet, wilt u dan bijgevoegde toestemmingsformulier invullen, ondertekenen, en aan de begeleiding geven?**

Voor meer informatie kunt u altijd contact met mij opnemen.

Met vriendelijke groet,

Stijn Wolters
s.h.g.wolters@student.utwente.nl
06-27216174

9.17. Appendix 17: Informed consent form for evaluation test for caretaker

UNIVERSITEIT TWENTE.

Betreft: toestemming voor deelname aan gebruikers evaluatie van een ontworpen applicatie voor onderzoek *'Hoe ontwerp je een applicatie voor smartwatches dat het dagelijks leven van mensen met een verstandelijke beperking en de verzorgers verbeterd'*.

Als u toestemming geeft kunt u hieronder de gegevens invullen en ondertekenen.

- **Ik heb de informatiebrief gelezen. Ook kon ik vragen stellen. Mijn vragen zijn voldoende beantwoord. Ik had genoeg tijd om te beslissen of ik wil meedoen.**

- **Ik weet dat meedoen vrijwillig is. Ook weet ik dat ik op ieder moment kan beslissen dat ik toch niet meedoe. Daarvoor hoef ik geen reden te geven.**

- **Ik geef toestemming voor gebruik van de gegevens op de manier en voor de doelen die in de informatiebrief staan.**

- **Ik geef toestemming voor het maken van aantekeningen, het interviewen van mij en het maken van audio-opnames van de test en het interview.**

Naam deelnemer…..…………………………………………

Datum….…………………………………………………

Handtekening deelnemer: Handtekening onderzoeker:

………………………….   ………………………….

Contact informatie

Mocht u vragen hebben over dit onderzoek of geïnteresseerd bent in het onderzoek, dan kunt u contact opnemen met Stijn Wolters (s.h.g.wolters@student.utwente.nl).

9.18. Appendix 18: Information letter for evaluation test for caretaker

UNIVERSITEIT TWENTE.

Betreft: toestemming voor deelname aan gebruikers evaluatie van een ontworpen applicatie voor onderzoek *'Hoe ontwerp je een applicatie voor smartwatches dat het dagelijks leven van mensen met een verstandelijke beperking en de verzorgers verbeterd'*.

Geachte heer/mevrouw,

Op **woensdag 21 juni** kom ik, student aan de Universiteit Twente, op de 2e Han(d)s en Grietjes. Daar zal ik tests afnemen met begeleiders en cliënten voor mijn bacheloropdracht. Tijdens deze tests gebruiken de deelnemers de ontworpen applicatie en worden ze geïnterviewd over hun ervaring met de applicatie en de functionaliteiten die de applicatie te bieden heeft.

Deelname aan dit onderzoek is vrijwillig en u kan zich altijd bedenken om te stoppen, ook tijdens het onderzoek. U hoeft niet te zeggen waarom u stopt. Wel moet dit direct gemeld worden bij mij. De gegevens die tot dat moment zijn verzameld, worden gebruikt voor het onderzoek.

Om deze testen te ondersteunen, zullen er audio opnames en aantekeningen worden gemaakt. Elke proefpersoon krijgt een code die op de gegevens komt te staan. De naam en andere persoonlijke gegevens die u direct kunnen identificeren worden daarbij weggelaten. Alleen ik heb toegang tot deze gegevens.

Deelname aan deze test kan enkel als u daarvoor toestemming geeft. **Als u akkoord gaat dat u hieraan mee doet, wilt u dan bijgevoegde toestemmingsformulier invullen, ondertekenen, en aan mij geven?**

Voor meer informatie kunt u altijd contact met mij opnemen.

Met vriendelijke groet,

Stijn Wolters
s.h.g.wolters@student.utwente.nl
06-27216174

9.19. Appendix 19: Interview questions for evaluation with client

Introduction questions

1. Heb je een mobieltje?
   1.1. Zo ja: wat voor een?
   1.2. Zo nee: waarom niet?
2. Heb je een horloge?
   2.1. Zo ja: wat voor een?
   2.2. Zo nee: waarom niet?
3. Gebruik je een computer of een tablet?

Evaluation questions

1. Hoe vaak denk je het horologe te gebruiken om stemberichten te sturen?
2. Vond je het sturen van je stembericht ingewikkeld, een beetje ingewikkeld of niet ingewikkeld?
3. Vond je het sturen van je stembericht moeilijk, normaal of makkelijk te gebruiken?
4. Denk je dat je hulp nodig gaat hebben van een technisch persoon als je een stembericht wilt versturen?
5. Wat denk je dat er kan gebeuren als je een stembericht hebt verstuurt?
6. Wat vond je het leukst: het plaatje of het bellen?
7. Vind je het niet of wel leuk dat je een stembericht kan sturen?
8. Vond je het versturen van je stem moeilijk te leren, een beetje moeilijk te leren of niet moeilijk te leren?
9. Was het sturen van je stem irritant, een beetje irritant of niet irritant?
10. Voelde je je zeker toen je een stembericht verstuurde?
11. Moest je veel leren om een stembericht te kunnen sturen?

12. Hoe vaak denk je de buzzer te gebruiken?
13. Vond je het reageren op een buzzer ingewikkeld, een beetje ingewikkeld of niet ingewikkeld?
14. Vond je het reageren op een buzzer moeilijk, normaal of makkelijk te gebruiken?
15. Denk je dat je hulp nodig gaat hebben van een technisch persoon als je op een buzzer wilot reageren?
16. Wat denk je dat er kan gebeuren als je een buzzer krijgt?
17. Vind je het niet of wel leuk dat je een buzzer kreeg?
18. Vond je het reageren op een buzzer moeilijk te leren, een beetje moeilijk te leren of niet moeilijk te leren?
19. Was het reageren op een buzzer irritant, een beetje irritant of niet irritant?
20. Voelde je je zeker toen je reageerde op de buzzer?
21. Moest je veel leren voordat je op de buzzer kon reageren?

9.20. Appendix 20: Interview questions for evaluation with caretaker

Introduction questions

1. Hoeveel ervaring heeft u met smartphones?
2. Hoeveel ervaring heeft u met smartwatches?
3. Hoeveel ervaring heeft u met computers en tablets?

Evaluation questions

1. Hoe vaak denkt u het platform te gebruiken om een stembericht te ontvangen van uw clienten?
2. Hoe ingewikkeld was het reageren op het stembericht met een plaatje? En met bellen?
3. Hoe makkelijk was het om te reageren op het stembericht met een plaatje? En met bellen?
4. Denkt u dat u hulp nodig heeft van een technisch persoon als u op een stembericht wilt reageren?
5. Hoe goed vind u dat het reageren op een stembericht is gentigreerd?
6. Hoe tegenstrijdig was het reageren op het stembericht?
7. Hoe moeilijk is het om te leren om te reageren op een stembericht?
8. Hoe irriterend is het om te reageren op een stembericht?
9. Hoe zelfverzekerd voelde u zich toen u op een stembericht reageerde?
10. Moest u veel leren voordat u kon reageren op een spraakbericht?

11. Hoe vaak denkt u een buzzer te versturen naar uw clienten?
12. Hoe ingewikkeld was het om een buzzer te versturen?
13. Hoe makkelijk was het om een buzzer te versturen?
14. Denk u dat u hulp nodig gaat hebben van een technisch persoon als u een buzzer wilt versturen?
15. Hoe goed vind u dat het versturen van een buzzer is gentigreerd?
16. Hoe tegenstrijdig vind u het om een buzzer te kunnen versturen?
17. Hoe moeilijk is het om te leren om een buzzer te versturen?
18. Hoe irriterend was het versturen van een buzzer?
19. Hoe zelfverzekerd voelde u zich toen u u een buzzer verstuurde?
20. Moest u veel leren voordat u een buzzer kon versturen?