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Older adults' user experience testing of five smart furniture prototypes

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The number of Finnish people over 65 years old is rising in the future. The life expectancy of the older people has also risen, which allows them to live longer in their own houses, but also increases the need for supporting services. Technology can be used to increase the independence, autonomy, and safety of the seniors.

This study was conducted in cooperation with the BaltSe@nioR project in the fall of 2018. The purpose was to study user experiences of seniors who participated in the BaltSe@nioR project's event. The study focused on which aspects of the presented prototypes would need most development for them to be usable, functional, and meaningful for the seniors. The study also gathered development ideas from seniors for further prototype development work.

This was a mixed method study, where the data was collected with questionnaires and observation. The questionnaires were collected from all voluntary seniors over 65-year-old. The observation was done in the MeWet home at Ulvila, where the seniors tested the smart furniture prototypes. Five of the presented prototypes were selected for this study: The Smart Chair, the Magic Mirror, the ReAble Chair, the 3D Printed handles and the Mobile robot with the fall detection boards. 43 questionnaires were received that met the criteria, and the data was analyzed by theory-grounded content analysis based on Garrett's chart of the Elements of User Experience.

The results indicated that the prototypes could support the coping of seniors at home in the future. Conclusion was that the functions important to the user increased the meaningfulness of the prototype. The seniors were mainly interested in these prototypes, and many experienced that the prototypes have the potential to add content and benefits to their lives, such as entertainment or a sense of security. The brand of the prototype should be for all, not only for seniors or disabled people. This type of early prototype testing was good, so that the user experience comes along on the early stages of the design process. This way resources would not be wasted unnecessarily.

Keywords: BaltSe@nioR project, functionality, meaningfulness, prototypes, seniors, smart furniture, usability, user experience, welfare technology.

CONTENTS

1 INTRODUCTION

The graph from Statistics Finland (2020) shows that the number of Finnish people over 65 years old is rising in the future. The life expectancy of the older people has also risen, which allows them to live longer in their own houses, but also increases the need for supporting services (Verma & Hätönen 2011, 6–9). The seniors want to live in their homes for as long as they can (Stenberg, et al. 2014). The quality recommendation prepared by the Ministry of Social Affairs and Health (2017, 28–29) aims to ensure the most functional and healthy aging possible. The versatile use of technology is described as one of the areas for achieving the goal. According to this recommendation, technology related to communication and housing, for example, can extend the length of time that seniors live at home. Technology can be used to increase the independence, autonomy, and safety of the seniors.

Many welfare technology products have been developed to support people's well-being. Some of them are targeted to seniors, but they might have had challenges in using these products. In product development, it is important to involve people from target group from the very beginning so that the product can be effectively developed and adapted to the user's needs (Nordlund, et al. 2014, 16). This is especially important when the product is designed for seniors. User-driven product development can be done in many ways, such as by studying the user experience. It can be described for example with Morville’s User experience Honeycomb model (2004) or Garrett’s chart of The Elements of User Experience (2011, 29).

This study investigates the older people’s user experiences of five smart furniture prototypes, as the desirability of products is greatly influenced by whether they are perceived as meaningful. The smart furniture term refers in this context to furniture that has technology implemented in it or it has been manufactured with the assistance of modern smart technology or it has some additional functionalities. The target group in this study is limited to over 65-year-old participants, referred as seniors. The study

focuses on the usability, functionality, and meaningfulness aspects of the seniors' user experience according to the Elements of User Experience (2011, 29), and to collect improvement ideas for prototypes. The study is conducted as a mixed method, and the results of the study are presented per prototypes. At the end, the significance of the results and possible topics for further research are discussed.

2 PURPOSE OF THE STUDY

The purpose of this study is to provide senior's insights from the user experience of smart furniture prototypes. The aim is to determine which aspects of the smart furniture prototypes would need most development to be usable and functional for the seniors. In addition, this study aims to explore meaningfulness of the prototypes and to gather ideas from seniors for further product development process of these prototypes. This study will also provide valuable insights for other smart furniture producers.

The research questions of the study are:

1. How do the seniors experience the usability of the smart furniture prototypes?
2. How do the seniors experience the functionality of the smart furniture prototypes?
3. How do the seniors experience the meaningfulness of the smart furniture prototypes?
4. How would the seniors improve these smart furniture prototypes?

3 STUDYING USER EXPERIENCE OF WELFARE TECHNOLOGY

3.1 Welfare technology development

Welfare technology is a quite new phenomenon and as a word it is still unknown to many people. Although health technology has already been used to some extent in hospitals, use of welfare technology is still relatively uncommon in people's homes in Finland. Viirkorpi (2015, 5) defines a technology as intelligence-containing technical solutions that, for example, can communicate with its user and control its own activities with the information it collects. Some of these technical solutions can be referred to as age technology, which is specifically designed to support the functioning and survival of older people in their homes (Viirkorpi 2015, 5). The welfare technology is defined as the technology that is aimed at promoting and maintaining health, well-being, or independent performance (Forsberg, Intosalmi, Nordlund & Suhonen 2014, 13; Viirkorpi 2015, 5). Welfare technology is a broad concept that contains a wide variety of products. It can mean for example robots or mobile applications, that are designed for enhancing welfare through smart technical solutions. This study focuses on one part of the welfare technology, the smart furniture. The term smart furniture is quite new, and it does not have clear definition yet. In this study, it refers to a furniture that has technology implemented in it or it has been manufactured with the assistance of modern smart technology or it has some additional functionalities.

Products designed for seniors should be designed to meet their needs (Stenberg, et al. 2014). Unfortunately, technological solutions are often designed from the perspective of young adults, so the special needs of aging are easily ignored (Isomäki, Päykkönen & Sankari 2003, 149). According to Viirkorpi (2015, 6), the welfare technology has often been developed based on service providers’ wishes, but different results could be obtained if it were developed from the users' point of view. If the interest in technology would come from a senior, he or she could devote more to use it. The results in national project related to supporting the good daily life of seniors and their living at home with aid from technology, showed that seniors are happy to tell about their needs and preferences if they are asked. The report stated that usually the

assumptions about the opinions of older people are not correct, so asking their opinion directly is worthwhile. Therefore, it would be wise to engage older people in the product design phase so that the product would become convenient for the user. (Nordlund, et al. 2014, 16.)

Welfare technology product developers do not always have a realistic view of the special requirements of age and different diseases. For example, the functional capacity of the elderly gradually deteriorates, and illness can accelerate it. Often the need for support arises first in so-called instrumental activities of daily living, and later in normal activities of daily living. The aim of developing assistive products should therefore be to help the user cope with their own daily lives. With the help of technological assistive products, the elderly can continue to be an active actors in their own lives. (Verma & Hätönen 2011, 9). Technological devices are at their best when they adapt seamlessly to a person's daily life and are easy to use (Goodman, Kuniavsky & Moed 2012, 212; Verma & Hätönen 2011, 9).

Product development can be done in many ways. One option is to develop the product through experiments. According to Hassi, Paju and Maila (2015, 49), this method aims to learn about the different aspects of the idea to be developed through many individual experiments. When developing new products, there is often a need for iterative development methods where user research gives valuable knowledge from using the prototypes. The results of the research can answer questions that have arisen before and guide in the further development process. (Goodman, Kuniavsky & Moed 2012, 36.) This kind of testing prototype phase is important, so that possible critical errors in the product are noticed before the product goes into production. When developing through testing, the focus is on the reactions and interactions of testers with the prototype. The purpose of the prototype is to provide the tester with an experience of what is being developed. The goal in using prototypes is to learn effectively with little effort. For example, it does not make sense to make a finished prototype if the need for the product is based solely on assumptions. (Hassi, Paju & Maila, 2015, 49-50).

3.2 Defining the user experience

The effective development of services and products requires service design. It is a process that focuses on developing not only a high-quality customer experience but also a service that works optimally for its provider and for everyone who participates in it (Interaction Design Foundation 2020). The customer experience (CX) is one part of the service design and it is an entity that includes everything related to the customer's experience of the product and the company that offers it. An essential part of a good customer experience is a good user experience and a functional user interface. The user experience (UX) includes all the functions that the user has with the product and the company, and its development aims to meet the needs of the user. The user interface (UI) is part of the user experience and it focuses on developing the visual design of the product or service and the user interface with which the user interacts. The Figure 1, created by the NBN Group, clarifies the connection between these different levels of service design well (Luk 2020). This study explores the testing of the prototypes from the user experience perspective of service design. The tested products are in the prototype stage, so they do not have customers yet. Therefore, the customer experience is considered unsuitable. Also, a mere inspection of the user interface was considered insufficient, as the aim of this study is to gain a broader view from the user experience.

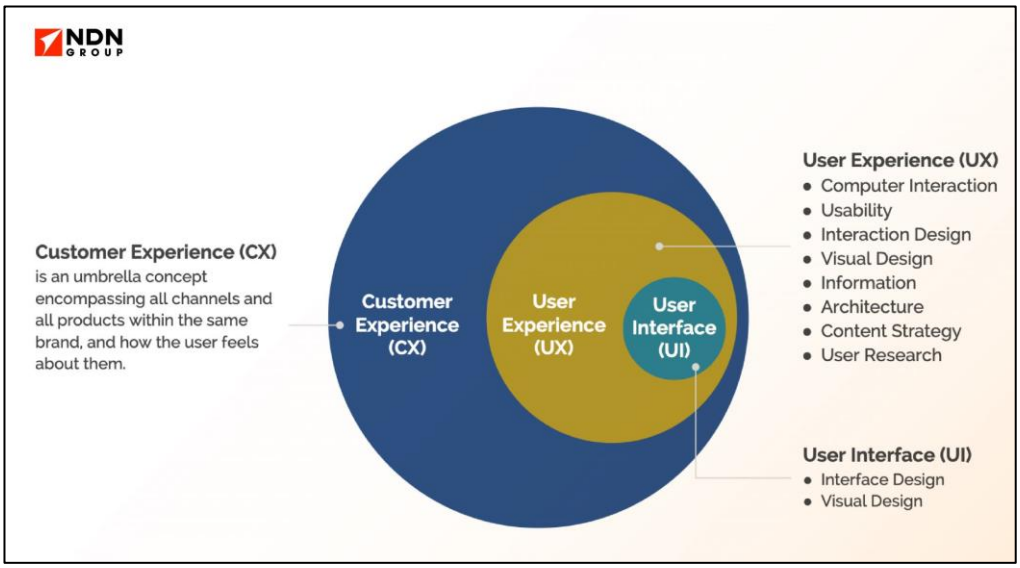

Figure 1. The service design aspects (Luk 2020)

Under the user experience, there are many different definitions that look at the same thing from slightly different perspectives. For example, according to Morville's Honeycomb model (Figure 2), the user experience can be divided into seven areas that affect to the quality of the user experience. Garrett opens different elements of the user experience even more in his own chart (Figure 3). Garrett's definition of different elements of user experience is chosen as the background for this study because it clearly breaks the user experience into different elements, making it easier to examine and develop them individually.

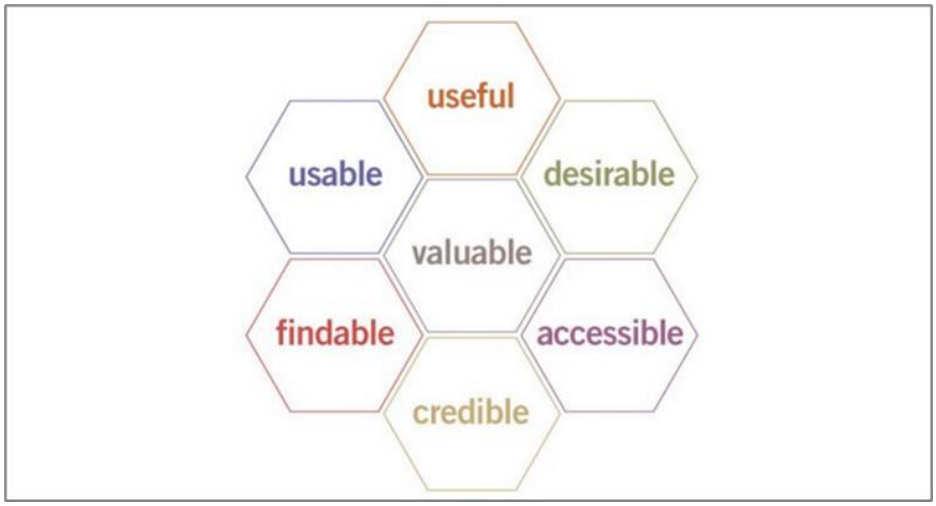

Figure 2. The User Experience Honeycomb (Morville 2004)

To clarify the concept and meaning of the user experience, Garrett (2011, 20-24) has created The Elements of User Experience chart (Figure 3). The chart divides the user experience into 5 parts, which are strategy, scope, structure, skeleton, and surface. The strategy part is divided into user needs and product objectives, that tells what the product must do and how for the user and for the people who build it. The scope level is divided into functional specifications, which tells what features the product must include, and the content requirements, that points out the needed content elements in the product. The next level is structure, where the interaction design and the information architecture show how the user understands the task and the structural design of the information. The information design is the first part of the skeleton part, that focuses on whether the information is understandable, for example data and visuals. The second part is the interface design that enables the user input and system output and checks whether they support interaction goals. The third part is the

navigation design that focuses on easy navigation and clear presentation. On the top level of the User Experience chart is the surface, where the sensory design defines how the product looks, feels, sounds, and thereby engage emotions.

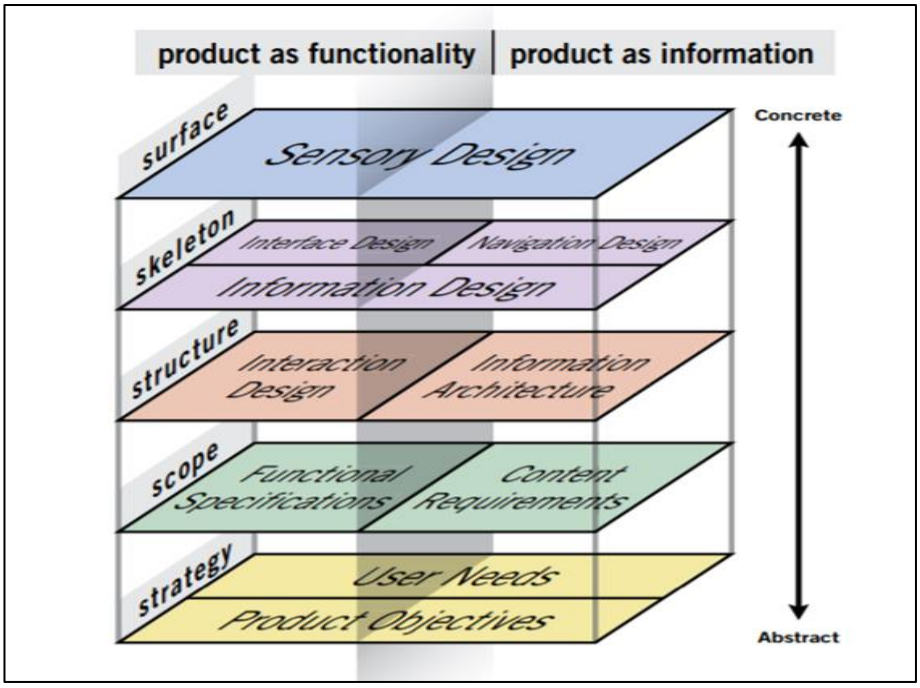

Figure 3. The Elements of User Experience (Garrett 2011, 29)

The term appearance in this study means the same as the surface in The Elements of User Experience chart (Figure 3), which is how the product looks, feels, and sounds. The usability term focuses on how easy the product's user interfaces are to use. In the Garrett's chart the structure and the skeleton elements deal also with usability, like how the user understands the tasks, navigation, and the information. The functionality term in this study focuses on if the product works as expected and on the product's contents, same as the scope element in Garrett's chart. The meaningfulness of the product is examined in this study from the user needs and whether they identify the product useful. The strategy element in Garrett's chart focuses also into user needs, that tells what the product must do and how for the user. (Garrett 2011, 20-24.) The questionnaire form created in the BaltSe@nioR project, which is also used in this study, is based on The Elements of User Experience from Garrett. However, different terms are used in the research questions as they are generally more understandable than the terms used by Garrett.

3.3 Previous seniors' user experiences of welfare technology in Finland

In the beginning of the study, a mapping was done to determine what kind of welfare technology and smart furniture the seniors have already been able to try out in Finland. The frame of reference was limited to research and projects on the user experience of older people in Finland, as the experiences of Finnish older people can differ greatly from those with different cultural backgrounds.

In Finland, the possibilities of welfare technology in the care sector have been explored through various national projects and studies. One of them was the KÄKÄTE project, which lasted five years. The aim was to support the good daily life of the seniors and their living at home with aid from technology. The project gathered experiences on age technology, its experiments in Finland, and its development and purchase. (Nordlund, et al. 2014, 5.) The KATE-project's goal was similar, as it aimed to develop services that support living at home through electronic services. Their target group included senior home care customers. (Juntunen 2013, 15.) The Virtuaalikymppi-project, that lasted five years, sought to activate cognitively and socially disadvantaged senior people through technology-mediated services (Lind 2013, 33-37). The four-year ITSE-project promoted the independent living of people with disabilities and older people. That project aimed to share knowledge about welfare technology that was available. (The Ministry of Social Affairs and Health 2005, 7-8.)

Seniors' own experiences have also been clarified to some extent. Wessman, Erhola, Meriläinen-Porras, Pieper and Luoma (2014) explored the experiences of people over the age of 75 years in using technology in everyday life. Their study found that a cell phone or landline phone was the most used, and some seniors also had a computer. They noticed that technology has the potential to improve the quality of life of older people, for example by bringing a greater sense of comfort or security. However, technology must be user-driven and simple, and adapt to everyday functions.

The use of serious games has increased in health sector. They refer to games that can be used, for example, for learning and rehabilitation. Some serious games have been developed, for example, to rehabilitate stroke patients and for individuals to promote

disease prevention and support well-being. (Koivisto 2016, 148-151.) The games, that were played with one of the prototypes in this study, can also be described as serious games, as its games are designed to activate the user.

Mäki (2011) made a study that looked at projects in Finland related to older people and technology. The study included projects where the technical tools had been tried by over 75-year-old people at their home or in a service home. The study found 52 projects in Finland, and there were few similar welfare products tested, like Welfare - Tv (Mäki 2011, 32-34). The study showed that much research has been done on technology with aged people, but fewer studies were conducted in which older people themselves shared their experiences. So, there is still a need for this kind of study.

Previous projects have produced information and concrete products to promote the well-being of older people. The ITSE-project found out that there was need for knowledge about available welfare technology, so they created a handbook from it (The Ministry of Social Affairs and Health 2005, 7-8). Also, the KÄKÄTE project produced several guides and studies on the topic (Nordlund, et al. 2014, 5). In studied projects, the problems with living independently at old age have been identified, for example, loneliness, memory problems, and long distances that make access to services more difficult. For those, KATE - project provided online services such as Skype networking and remote medical consultation (Juntunen 2013, 16-17).

In some places, the welfare technology devices are already in daily use. For example, Kauniala Hospital has already established Service TV to support war invalids living at home. Interactivity has been considered important in the service, and it has been used to provide homes with guidance and various group activities. An essential part of the success has been the free service to the customer and the adequacy of technical support. Service TV was also used in the home care of Pyhtää municipality, but it was abandoned when it was too heavy and a rigid tool for home care. Instead, they found a Videophone that allowed flexible contact with home care clients. The selection process of users who benefit from the device and have sufficient functional capacity was considered essential for the successful implementation. (Viirkorpi 2015, 26-28, 38-40.)

In the Virtuaalikymppi- project, an easy-to-use device was developed to assist with resource-based support for older people with memory impairment. Senior people, relatives, nursing staff and IT professionals were involved in its development. The device was used for playing, watching pictures, and remembering. According to user experience, the device contributed to the well-being of the seniors by increasing activity and providing stimulation and pleasure experiences. The project found that it was most enjoyable to use personal material, such as the user's own pictures. (Lind 2013, 33-37, 60-62.)

Some studies have found out that there have been challenges in the utilization of product, including difficulties in use and the unsuitability of the equipment for its intended purpose (Viirkorpi 2015, 5; Wessman, Erhola, Meriläinen-Porras, Pieper & Luoma 2014). For the utilization process to be successful, it was found useful that, in addition to the manufacturer and the user, a third party was involved in the process, e.g. home care. Familiarization with the device should be comprehensive and understandable, and it should seem useful enough in relation to the resources required to use the device. (Viirkorpi 2015, 9, 52.) It was also noticed that the actual development cooperation work with companies was challenging. Another problem was that in design, companies targeted seniors between 50 and 60 years of age, leaving older age groups completely excluded from product design. This may have been influenced by the lack of access to information on the technology needs of elderly. (Nordlund, et al. 2014, 61–62.)

The features of the technology that promote its usability is that the device is easy to understand, easy to use, familiar in appearance and blends seamlessly into the user's everyday life (Viirkorpi 2015, 52). Similar usability findings were found in these projects. Concrete usability challenges emerged in the skeleton and structure level. The use of colors, such as contrasts and lack of partition similarity, in the user interface was noted for development point (Juntunen 2013, 20-22; Lind 2013, 60-62). In the remote services, problems related to broadband connection, user interface and hard-to-use hardware were identified as the biggest challenges, not the user’s higher age itself. For example, the hardware did not consider the needs of the seniors in the choice of keyboard and mouse. (Juntunen 2013, 15, 20-22.)

Usability challenges in structure level showed that the product may require modification of physical characteristics to enable seniors to benefit from the interaction with the product. For example, a good chair is high enough with sturdy armrests and hard seat, which makes it easy to move in and out of the chair. If the senior's grip is weak, for example due to pain or weak force in the fingers, tools should be thick and lightweight. (The Ministry of Social Affairs and Health 2005, 15, 29.) On the scope level, the functionality of the application was identified as an essential development point (Lind, S. 2013, 60-62). Although, in the KATE project the participants were pleased that they had the opportunity to access the remote doctor's appointment and the smoothness of the remote reception (Juntunen 2013, 20-22).

In many studied projects, the goal was to identify user needs to develop products that were useful and meaningful to seniors. Studies showed that there was willingness to try new technology, but only few suitable testing opportunities. The KÄKÄTE- project aimed to promote the introduction and development of technology that considers the needs of the user. To enable this, the project highlighted e.g., the views and experiences of older people about technology, and these ideas were offered to welfare technology developers. (Nordlund, et al. 2014, 9, 13.) The KATE- and KÄKÄTE-projects found also that seniors were interested and ready to use e-services, but they needed a lot of encouragement and support to learn how to use electronic services (Juntunen 2013, 15; Stenberg, et al. 2014). Of course, there is always some seniors, that do not see the need to acquire technology but prefer to rely on the old familiar way of doing things (Wessman, Erhola, Meriläinen-Porras, Pieper & Luoma 2014).

The technology can be foreign to some seniors, and so they need support and guidance to use it, especially those who have no loved ones to help (Wessman, Erhola, Meriläinen-Porras, Pieper & Luoma 2014). The KATE project found that home care clients needed even more encouragement and support in using the equipment than could be provided. When technical problems came, customers did not want to call technical support because they suspected that they would be ridiculous. (Juntunen 2013, 20-22.) This challenge could be alleviated by involving seniors in product development at an early stage. It would make the product and its development process more familiar to seniors, and thus it could potentially lower the threshold for using the products and requesting assistance.

The welfare technology has been found to be beneficial for seniors' well-being, and it has brought excitement and refreshment to their daily lives (Juntunen 2013, 15). The background study revealed that understanding user needs still needs further research, also from the perspective of the elderly, and not just those aged 50-60. The projects examined did not pay much attention to the appearance of welfare technology products, except that the products should blend effortlessly into the everyday life of their users. Therefore, in this study, it was also taken into closer consideration. Previous projects have also shown that the user experience of a product is influenced in many levels. In all these different levels, the specific needs of older people, which may have been brought about by age or disease, should be considered at the development stage.

3.4 The BaltSe@nioR -project, WET research group and the MeWet home

This study was connected to BaltSe@nioR project which was the collaborative project between 10 countries in the Baltic Sea Region. This project provided innovative solutions to support enterprises in this area in welfare technology and furniture product development, that aimed to raise the comfort and safety of seniors' home living. This project was co-financed by the European Regional Development Fund within the INTERREG Baltic Sea Region. (BaltSe@nioR 2018.) The fact that the BaltSe@nioR project has been granted a funding shows that there is a need for this kind of development work.

This BaltSe@nioR project created collaboration between the traditional furniture industry and innovative ICT solutions. The project provided product developers with the opportunity to become more familiar with the user experience and thus develop products that are more usable for the seniors. The project focused on highlighting the specific needs and preferences of seniors and the problems they face while using traditional furniture. The project also provided information and experience on smart furniture to the seniors. The project involved various prototypes of smart furniture which project's developers had discovered to be needed in the everyday challenges of the seniors. (BaltSe@nioR 2018.)

Well-being Enhancing Technology (WET) is a multidisciplinary research group at the Satakunta University of applied sciences that aims to develop and research solutions that improve an individual's health and well-being through technology (Samk 2020). Some of the WET group members were involved in the BaltSe@nioR project, since this group acts as an interpreter with various parties and thus enable fruitful cooperation. The development frame of this WET group is Design for Somebody that places an individual's need in the center of the development process. To succeed in gaining of the needed knowledge, this group consists of professionals from several different fields. (Samk 2020.)

The testing of the prototypes in the BaltSe@nioR project took place in the city of Ulvila at the MeWet home, that works as a meeting place for welfare technology developers, companies, and users. The MeWet home stands for Multifunctional environment for Well-being enhancing technology. This place functions as a test environment for new technology and people can get acquainted with different welfare technology products there. The MeWet home is a smart home which can be adapted to residents' functional ability. Welfare technology that is used there supports independent living and aims to ease in mundane tasks. The MeWet home is also utilized as a learning environment for students from technology, welfare, and construction programs. (MeWet home 2020.)

4 METHODOLOGY

4.1 Approach and data collection

The purpose of this study was to map the user experiences of seniors from the use of smart furniture prototypes. This study was done with mixed methods, which Tashakkori and Creswell (2007, 4) have defined as "research in which the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or a program of

inquiry". This study was primarily a qualitative study where the quantitative data was used to supplement the qualitative data. The qualitative approach helps to understand for example experiences and opinions of an individual or groups, and it can be used to deepen the understanding of the subject under study (Bhandari 2020; Creswell 2014, 4). The advantages of qualitative study are e.g., the fact that it can be carried out in the natural environment of the subjects and it may reveal new challenges that have not previously been addressed. From the different qualitative research approaches, phenomenological study approach was suitable, because it is flexible and focuses on exploring a phenomenon by describing and opening the person's experiences. (Bhandari 2020.) According to Creswell (2014, 14), this approach is good for studying people's experiences that have participated in the phenomenon, which in this case was the using of smart furniture.

For gaining knowledge from seniors' user experience, the data for this study was collected with quantitative and qualitative data collection methods. The data was collected with questionnaires and observation methods, that were used in cooperation with the BaltSe@nioR project team. The BaltSe@nioR project collected questionnaires from the visitors at MeWet home, so this study was able to use that same dataset as secondary data. The data from observation was primary as it was done for this study. Combining qualitative and quantitative data provided more diverse understanding of the subject of the study than a qualitative or quantitative research method alone. Although the research questions were qualitative, the quantitative data also provided answers to how seniors perceived the different features of the prototype. Quantitative data provided an overview of user experiences in the study, and qualitative data made it possible to open the user experiences in more detail and provided suggestions for development. Qualitative data was used to create an understanding of user experiences.

Questionnaires can be divided into qualitative and quantitative options, depending whether they include open-ended or closed-ended questions. A questionnaire is good data collection method, since it is quite fast, low cost and objective method. It has some disadvantages though since the respondent can answer randomly or if the question is not read correctly. The answers to multiple choice questions are clear to analyze. The questions should be clear and have an appropriate number of answer

options so that it does not seem confusing or boring to the respondent. The answers to open-ended questions are more challenging to analyze, but they can also provide surprising answers. These can add value to a study and make it more unique. (Dudovskiy 2020.)

The questionnaires were collected from all voluntary seniors. After the demonstration and testing of the prototypes, some seniors filled in the questionnaires during the coffee break. Some of the participants filled in the questionnaires later, for example in a nursing home, due to a limited time for each group during the event. The questionnaire form that was used, was developed in Wellbeing Enhancing Technology research group at SAMK. The form was founded on Garrett's chart (2011, 29) that represents the elements of user experience. The first page of this questionnaire (Appendix 1) collected quantitative data type from the interest on welfare technology on a general level, and asked the respondent for background information, such as gender, age, and work status. This page also asked to evaluate different parts of user experience from the prototype, such as visual design, interaction design, and user needs. Four different answer options were given for the evaluation, such as poor, sufficient, good or cannot tell. The second page of the questionnaire used open-ended questions to which respondents had the opportunity to share their thoughts more broadly. It asked for development ideas, purpose ideas for use, and respondents' experiences of the testing situation.

In observation data collection method, the researcher is taking notes or recording in the same place as the respondents. The observation is as a method very flexible, and it allows the researcher to get near to the studied phenomenon. Disadvantages are, that observing takes some time to conduct, and there is high possibility that the researcher influences the original material or makes errors of interpretation. When observed, it is also possible that the presence of the researcher affects the activities of the subjects. Observation can be carefully structured and have defined schedule and variables. (Dudovskiy 2020.) Observation method helps identify how much people are willing to do when trying out products (Goodman, Kuniavsky & Moed 2012, 240).

The observation part of this study was done in the MeWet home, where the seniors tested these smart furniture prototypes. The seniors and their reactions were observed

without intervening by the researcher from the background. The observation focused on nonverbal communication and reactions, like how seniors got excited, was there hesitation, how they reacted to challenges and did they try again. Participation of the other attendants and their mutual communication was also observed. The observations were recorded on a computer by note-taking on Words, divided by prototypes and then to prototype's overview, interests, challenges, fears, and development ideas. In this study, Garrett's chart (2011, 29) could have served as the framework for the observation. However, the researcher did not yet have a clear observation framework prepared at the time of the BaltSe@nioR event, so the observation was performed in a less structured way. After the observation days were done, the observations were compared among the project team to avoid possible mistakes that might be caused by interpretation bias.

According to Garrett's chart (2011, 29), the user experience is a complex entity that includes, for example, the user's interaction with the product and the identification of user needs. It is challenging to obtain information about the user's interaction with the product, for example with a questionnaire. For this purpose, the observation method was found more suitable. Again, it is challenging to gather information from the needs and desires of user regarding the features of the product by observing. The questionnaire was found to be more suitable for this purpose. The observation method complemented the data from questionnaires and deepened understanding of the user experience. This method offered relevant knowledge from the seniors, that they necessarily could not tell themselves (Huotari, Laitakari-Svärd, Laakko & Koskinen 2003, 53). It was a good method to collect data from seniors' facial expressions, first reactions and communality and it also helped to sense the atmosphere. These valuable details were collected more effectively with observation method rather than by making interviews.

4.2 The test event and data sources

The introduction and testing of the prototypes took place in the MeWet home at Ulvila 19.- 23.11.2018. People were invited by the BaltSe@nioR project manager from various fields and with varying abilities to use these prototypes. The visitors were

invited to the event by sending advertisement from it to several nursing homes for seniors. However, the test event was also open to other interested parties and was advertised on local media. Two days of the event were reserved for the end-users to test these prototypes. On the first test day there was 42 participants, of which 75% were seniors. Others were caregivers and few were students. The second day was planned for other user groups including people with some disability and health care professionals. On the second day, there were 54 participants, of which approximately half were persons with some disability, and the rest were students and caregivers. Most of the seniors came from nursing homes in groups with their caregivers or assistants; from Diavillla, Attendo Latokartano, Monituote, Torpparintupa and Rehabilitation center Kankaanpää. These parties were selected for collaboration by the BaltSe@nioR project team. Each group had a maximum of 20 people and each group had about 1.5 hours in the MeWet home.

The non-probability sample method was used in this study. A method like this is not suitable for generalization or probability verification of the entire population but is an excellent method of acquiring knowledge from population that is studied less. The people involved participated in the event voluntarily, so a voluntary response sample would be appropriate method. (McCombes 2019.) The questionnaires were collected from all voluntary respondents, and total of 145 questionnaires were returned. From them only the answers of Finnish seniors over the age of 65 were selected as a sample group of this study. Studying over 65 years old participants was good option, because it was cost-effective and the participants in the MeWet home were accessible and the acquired dataset was manageable (Bhandari 2020).

A total of 43 questionnaires were received that met the criteria. They were answered by seniors between 69-89 years, and the average age of the respondents was 82 years. 75% of the respondents were females. The questionnaires received per prototype were: ten for the ReAble Chair, eight for the Smart Chair, nine for the 3D Printed handles, seven for the Magic Mirror and nine for the Mobile robot with fall detection boards. The event was attended also by young students, their teachers and project partners from abroad, but their feedback was excluded from the study. Eight questionnaires lacked information about which prototype the feedback was from, so these were also

ignored. The observation could not be precisely limited to a certain age, as the ages of the respondents became clear from the questionnaires after the observation situation.

The smart furniture prototypes were presented by the BaltSe@nioR project's workers or the prototype's developer in the event. Some of the prototypes were presented for the seniors, but some prototypes were there at the background and did not get much attention. For this study, five prototypes were selected in collaboration with project workers and these prototypes were also the most featured and tested ones. The prototypes tested in this study were in such a phase of development process, that seniors were able to concretely test their features, and thus better understand the potential of these prototypes.

The first prototype was The Smart Chair (Figure 4) and activating games with the Yetitablet (Figure 5). The Smart Chair is developed in collaboration by the Junet company and SAMK and it is designed for the seniors or those who have difficulty in exercising. The Smart Chair is a normal everyday chair with sensors on the seat that measure pressure. With these sensors, the chair detects the person's movements, for example if the person is sitting or standing. This chair can be used to play games when connect-ed to a tablet. It makes training and exercising easier and fun. The chair helps the user to maintain a better physical condition, and people with physical disabilities benefit most from it. (BaltSe@nioR-project 2018.) The games that were tested were ball throwing, ski jumping and snowboarding games with the Yetitablet. It is a giant Android tablet that has multiple touch points for teamwork. Using this tablet can improve the way people learn, communicate, and collaborate. It can be used for example for playing or as a learning platform. (Yetitablet 2020.)

Figure 4. The Smart Chair.

Figure 5. The Yetitablet.

The second prototype was the ReAble Chair (Figure 6), which purpose is to collect information about how the user gets up from the chair. Getting up is a physically demanding task, and people tend to do it differently. The measurement can provide information on the person's exercise habits and this information can be used to assess physical performance. The movement is detected by pressure sensors in the handles and in the seat. The chair looks and feels normal, so the person sitting there may not know that his or her performance is being measured. This way the user can behave naturally. Other functions can be added to the ReAble Chair, for example exercise games controlled by pressure sensors. (BaltSe@nioR-project 2018.)

Figure 6. The ReAble Chair.

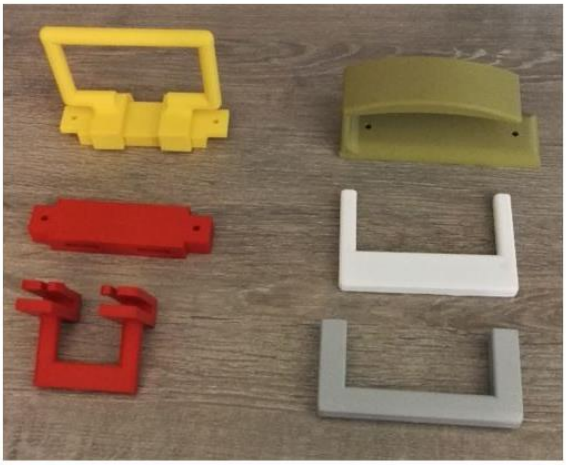

Figure 7. The 3D Printed handles.

The third prototype was the 3D Printed handles (Figure 7), which were created with 3D printer from plastic in the Satakunta University of Applied Sciences. These 3D printed door handles can be customized before printing to meet person's individual needs. They can be used, for example, in retirement homes where the handles can be changed when the occupant changes. This is a good option, since these handles are quite cost effective to produce. (BaltSe@nioR-project 2018.)

The fourth prototype was the Mobile robot (Figure 8) with fall detection boards. One part of this prototype was the fall detection boards on the floor level, that communicate with the robot with the sensors in the boards. These sensors monitor a person's movements in the room, and they can distinguish if the person is fallen. In this case, the fall detection boards report it to the Mobile robot which then goes to the fallen person. The robot is equipped with two handles, so it can help the person to stand up. In addition, for example a mobile phone can be placed on a wooden platform on top of the robot to be transported to the fallen person. The Mobile robot recognizes speech, so the person can confirm their need for help to the robot simply by saying "yes". (BaltSe@nioR-project 2018.)

Figure 8. The Mobile robot.

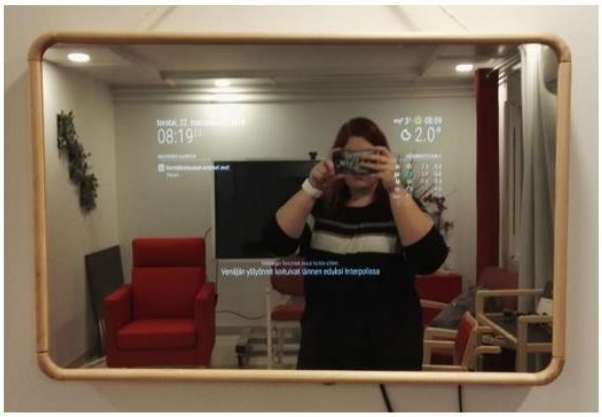

Figure 9. The Magic Mirror.

The fifth prototype was The Magic Mirror (Figure 9) that consists of three parts: a hidden computer, a display, and a semi-transparent mirror. It can display, for example, time, calendar, news headlines and weather, and other information that does interest the user. It can help the user remember the events of the day ahead while brushing their

hair in front of this mirror. The application modules in the mirror can be changed and, for example, relatives could send a message to the mirror to inform the user that they are coming to visit. Many user profiles can be added to this mirror, and with the face recognition system in the mirror, the contents of the mirror can be customized for multiple users. The mirror can also keep a record from the use of the mirror in its database, which can be monitored, for example, by family members. (BaltSe@nioR-project 2018.)

4.3 Data analysis

The collected data for the study came in three different formats, so a few different methods were used in the analysis. The questionnaires of over 65-year-old Finnish seniors were separated from the rest, and then they were grouped according to 5 prototypes that were: The Smart Chair, the ReAble Chair, the 3D Printed handles, the Magic Mirror, and the Mobile robot with fall detection boards. The first page of the questionnaire contained information from which it was possible to make a quantitative analysis. The answers to the questions on this page could be converted to numbers for data processing. The answers on paper were transferred to Excel and organized by creating spreadsheets of raw data in Excel with one subject of data in each row and the data fields in the columns. The answers were then combined according to the headings on the questionnaire so that they gave results according to The Elements of User Experience chart (Garrett 2011, 29). This gave a percentage of answers to the different options, which could then be visualized. In this study the statistical data was used to describe the characteristics of the respondents and to provide an overview of user experiences from the prototypes.

The data on the second page of the questionnaire and the field notes from observation were analyzed by theory-grounded content analysis. According to Dudovskiy (2020), the content analysis means categorizing the data that is collected example from behavior or speech, and to classify and summarize the data. Since the seniors' user experiences of smart furniture prototypes were studied, The Elements of User Experience (Garrett 2011, 29) was used as a theorical foundation for the thematic structure. The collection of data was also based on the same themes, so it was natural

to use the same themes in the data analysis phase (Tuomi & Sarajärvi 2009, 93). The analyzed data could then be clearly organized and more comprehensibly connected to the information already collected on the topic.

On the second page of the questionnaire, the answers were written to open-ended questions on paper. The data from the papers was translated from Finnish into English and transferred manually in electronic form to Word. The answers were arranged in a table, one data unit per row. Some answers were cut into smaller units in multiple rows when they contained a lot of text, so that the data could be combined more easily later (Goodman, Kuniavsky & Moed 2012, 426-427). After organizing the data, the first step in analysing was to give codes to data units. A code is a word that describes the content of data, and the data can be categorized based on code groups (Goodman, Kuniavsky & Moed 2012, 425). Each sentence or phrase in the table were given a code that described the content. The coding was done manually since the amount of data was reasonable. The codes were then searched for similarities and collected under themes derived from the Garrett's chart: Visual design, interface design, interaction design, functional specifications, user needs. At the third level, these sub-categories were further combined into categories that were in line with Garrett's elements (2011, 29), such as scope. In the abstraction phase, the empirical material was connected to the theoretical concepts created by Garrett (Tuomi & Sarajärvi 2009, 108-117). The third source of data was field notes written in Word, which were collected in the observation situation. They were analyzed in the same way as the answers to the open-ended questions.

Qualitative data analysis is characterized by the fact that the researcher's own reasoning ability greatly influences the outcome. Therefore, the results of the analysis are difficult to reproduce. (Dudovskiy 2020.) According to Goodman, Kuniavsky and Moed (2012, 446), in addition to a clearly constructed framework, a successful analysis has quotes from the original answers that enliven the analysis. This way prototype developers can identify more clarified information of essential areas for improvement.

5 RESULTS

In this chapter, the results of the study are described by prototype, as it can provide more information about the experience of the groups that tested the prototypes. The general interest in advanced technologies was calculated from 43 questionnaires from seniors. Figure 10 shows that most of the seniors had at least some interest in advanced technology. The figure does not necessarily give a realistic picture, as some of the respondents gave their opinion on the question for each prototype. However, some respondents may not have given feedback on all prototypes, so the figure is more indicative.

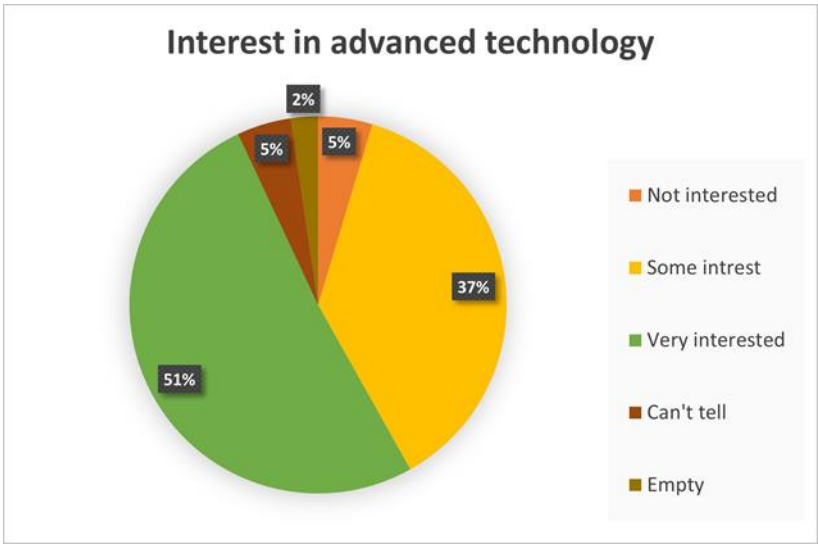

Figure 10. General interest in advanced technology among seniors.

5.1 The Smart Chair prototype user experiences

Seniors gave the Smart Chair prototype 3,8 stars on average on the questionnaire. The Figure 11 shows that this prototype was experienced overall good among the seniors. The usability of the Smart Chair was experienced good, because sitting posture was good, and the chair was not too big. On the observation, one person that tried playing, felt that she did not understand how to play, but still she got good points from the game at first trying. The Smart Chair prototype was experienced fun and activating with its

games, and few wanted to try it again. One person said that playing with this chair could be a good morning activity.

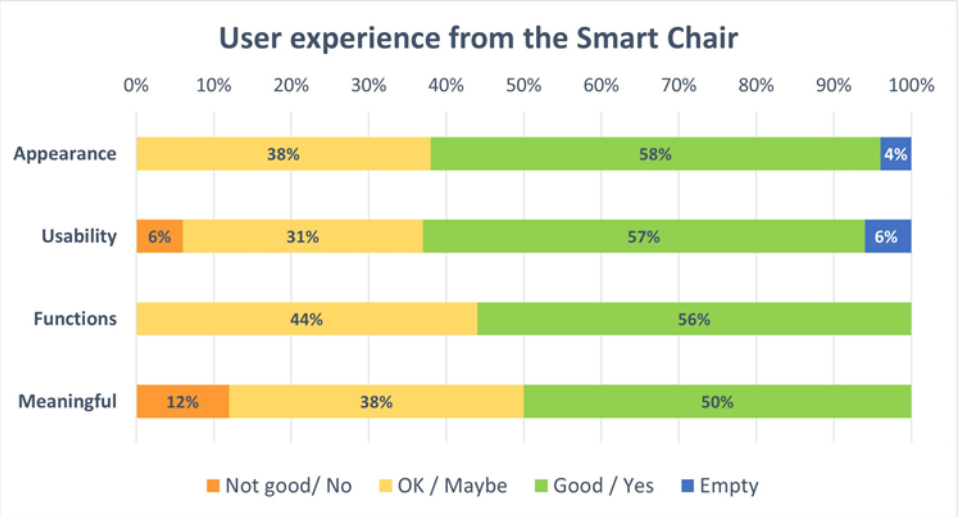

Figure 11. Seniors' user experience from the Smart Chair prototype.

Both questionnaire answers and the observation showed that functionalities in the Smart Chair were experienced fascinating and exciting to most seniors, for example the throwing balls game. The observation showed that the seniors were fascinated from the winter games, particularly from those that were already familiar to them, such as ski jumping. One senior was surprised that the sitting cushion was the game controller.

The answers in the questionnaire showed, that the Smart Chair prototype was experienced meaningful, as it would be used for entertainment and maintaining or increasing physical health. The observation showed that the Smart Chair seemed to be the most invigorating and socializing prototype since seniors were laughing and cooperating. Playing with the Smart Chair in the event was entertaining and amusing for the seniors. This prototype was very participatory and activated the whole group, for example some persons were playfully competing while playing the game and other seniors gave advice to the player. Many seniors that watched other person playing, were copying the players movements, and empathizing with the player. Seniors with wheelchairs or rollators were not so excited, probably because of their physical challenges to use the chair. One person noted that this could become an addicting game.

On the questionnaire, one senior wrote that the Smart Chair prototype needed improvement in information design, so that it would be more understandable. On the observation, seniors ideated new games and possible places where it would be nice to use this chair, for example in the waiting rooms in hospitals. Some seniors thought that the game controller cushion should be movable, so that it could also be used on the wheelchair.

5.2 The ReAble Chair prototype user experiences

Seniors gave the ReAble Chair prototype 3,9 stars on average on the questionnaire. The Figure 12 shows that 10 % of the seniors did not consider it meaningful, but overall user experience was felt quite good. On the questionnaires, the usability was experienced good, as the ReAble Chair was found easy to use, and comfortable. On the observation event, some seniors wanted to try it, after someone else tried it first and got excited.

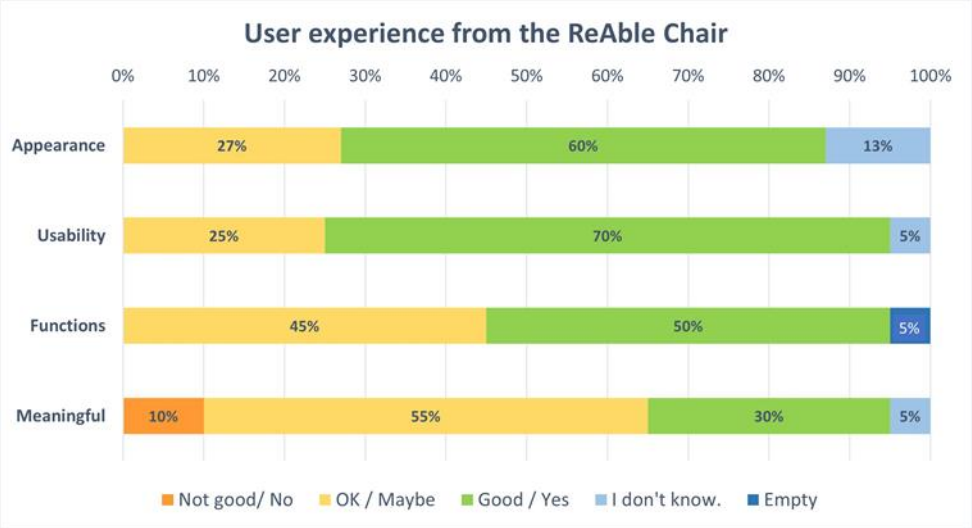

Figure 12. Seniors' user experience from the ReAble Chair prototype.

The questionnaire answers showed that the functionalities and working method of the ReAble Chair prototype was considered understandable by most of the seniors. Seniors would use it for body condition measurement, and "*in everyday situations*". Some seniors experienced that the chair should have more variety, not analyzing only one sitting situation. When one woman tried the prototype in the observation event, the

chair showed that the pressure was uneven in the armrests. She was surprised that the prototype was able to pinpoint the same place she had pain.

Meaningfulness answers on the questionnaires indicated, that the ReAble Chair prototype was experienced exciting prototype to try, but most seniors did not see that they had a real need for this device. Although, several seniors came up with other options where the ReAble Chair could be meaningful, for example in different situations or with other user groups. On the observation, one person said that medical staff have already more precise diagnostics, so this was not experienced so meaningful. Some seniors wondered if the device will be too expensive compared to its features.

For the ReAble Chair prototype to be more usable, few answers on the questionnaires suggested chancing the prototype's interface design, for example to add different seat width options. One senior suggested adding screen, so that the user can also see graphics of the measurements. On the observation event, some seniors suggested to put a pressure sensor mat also on the floor in front of the chair, so that standing position could also be measured. Other possible function mentioned was that the chair could vibrate when the user stays immobile for too long. One person ideated that there could be assistance on the chair for getting up.

5.3 The 3D Printed handles prototype user experiences

Seniors gave the 3D Printed handle prototypes 3,1 stars on average on the questionnaire. The Figure 13 shows that specially the usability and appearance of the prototype were experienced good among the seniors. The user experience from the usability was seen very good overall in the questionnaires. On the observation, few seniors tested the durability of the handles by slightly bending them. Some challenges in usability were noticed, for example if the user is in wheelchair or when the handle is down and protruding, the user could hit leg onto it.

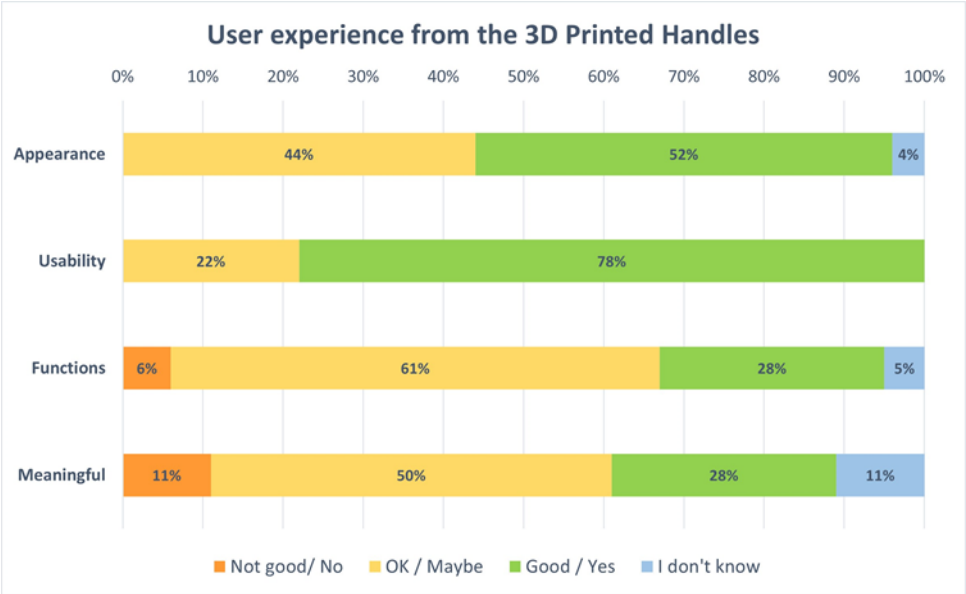

Figure 13. Seniors' user experience from the 3D Printed handle prototypes.

Functionality of the 3D Printed handles was clear to the seniors, and they would use them as an assistive tool according to the questionnaire answers. Many seniors on the observation event experienced that the 3D Printed handles had a real potential, since the handles can be customized individually.

On the questionnaire answers, the meaningfulness of this prototype varied; a few seniors did not find the product meaningful for themselves while one person was sure, that the 3D Printed handles "*will certainly enter the market*". The 3D Printed handles aroused nicely conversation in groups on the observation event. Many seniors experienced these very interesting, and one person also wanted to buy these handles for himself. Some seniors highlighted that they prefer buying Finnish products.

According to the questionnaire answers, some seniors would improve the visual design of the 3D Printed handles, for example material or color. Some would change their interaction design, like shape, so that the handle would be easier to use. On the observation event, few seniors noted that the handles could be assistive products, without being branded as medical tools. They should also be marketed with 'design for all' ideology, instead of stigmatizing them for people with special needs.

5.4 The Mobile robot with fall detection boards prototype user experiences

Seniors gave the Mobile robot with fall detection boards prototype 3,3 stars on average on the questionnaire. The Figure 14 shows that the user experience from this prototype was experienced less good than in other prototypes among the seniors, and it shows that this prototype needs more development on many levels. On the observation event, the Mobile robot with fall detection boards aroused curiosity among the seniors, and few wanted to test its rigidity and get a closer look at it. Many seniors wondered, if the Mobile robot was sturdy enough, for example is it able to help a 100kg man to get up without falling to its side. Although one senior noted that some of the existing walking aids can easily slip away from the user. In this case, the Mobile robot's heavy weight was indicated as a good thing. Some of the seniors questioned would it be usable for users with epilepsy or hemiplegia. Some limitations for the usability were recognized, for example, some apartments have high doorsteps, or there is not enough space to use a big robot. The accuracy of the Mobile robot's voice recognition was a concern for few seniors, for example can it understand unclear talk.

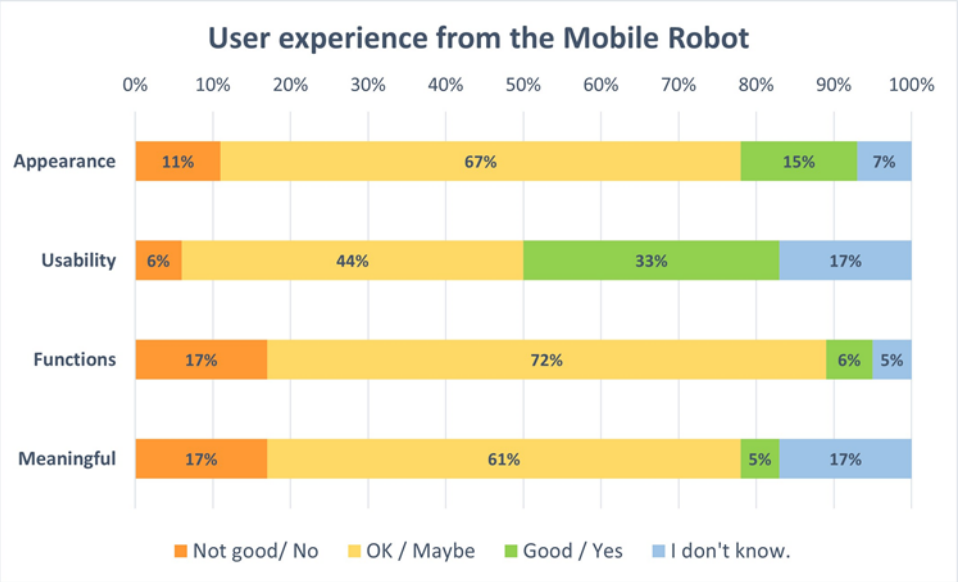

Figure 14. Seniors' user experience from the Mobile robot with fall detection boards prototype.

The questionnaire answers indicated that seniors seemed to understand the Mobile robot's and fall detection boards' working principles, and they would be used to increase the user's feeling of well-being and safety. On the observation event, seniors

were interested of what kind of functionality the Mobile robot with fall detection boards had, for example does the robot follow the user, open doors, or move obstacles from ahead. Other interesting functions were technical features like charging ability, sensors in the boards, and few were asking about price. Few seniors were amazed when they saw the Mobile robot moving towards them. One senior threw humor about the robot's functionality, and suggested that it could also call the undertaker, so that the dead body would not be rotten in the apartment.

The meaningfulness in the prototype of the Mobile robot with the fall detection boards were seen on the questionnaire answers and many seniors found it interesting. It could help disabled people or the ones that live alone in their homes. Some said that the Mobile robot with fall detection boards could be helpful in the rehabilitation phase after some operation. Few persons recognized that they would need it. Although some seniors said that they would not want it. Some seniors liked the Mobile robot, and some found it funny. The robot was considered more meaningful if it had more functions. It was noted that the Mobile robot with fall detection boards will be part of the future, but the prototype still needs development. Few seniors on the observation event thought that the fall detection boards with sensors could be enough for bringing security, for example for person with epilepsy or person who does not have enough cognitive skills to use safety wristband. The price interested seniors, and some were shocked by the high price. The idea of renting this Mobile robot with fall detection boards for the time that the user needs, got approbative nodding among seniors. This prototype aroused confusion and skeptical reactions in some seniors. Few seniors raised the concern that if the robots will replace nurses in the future.

The questionnaire answers showed that seniors would improve the information design of the Mobile robot with fall detection boards, so that the robot would understand Finnish language, and other words than "help". More of the functional specifications were also wished, for example a robot hand or stabilizing legs to the robot. One person would use it as moving platform to move heavy stuff, like shopping bags in the apartment. One senior drew attention to the visual design of the prototype, hoping it would not look "*so robotic*". In the observation event, many seniors suggested that the robot should have vacuuming function, which was considered useful addition. Several seniors said that the Mobile robot should have a lifting function, so that it could help

lift the user, for example if the user's feet forces were weak. If the robot had some supporting gears for walking, it could help the user in nightly toilet visits, since it would know the route to toilet. One idea was that there could be a safety phone or a camera on the robot, to be able to contact remotely caregivers, or that the robot itself could call help if necessary. Some seniors noted that this prototype should not be branded for seniors.

5.5 The Magic Mirror prototype user experiences

Seniors gave the Magic Mirror prototype 3,2 stars on average on the questionnaire. The Figure 15 shows that the Magic Mirror prototype was experienced least meaningful prototype among the seniors. According to the answers on the questionnaire, the appearance of the Magic Mirror was liked, "*very good apparatus*" as one person said. One person experienced that the mirror could be useful, but guidance for using it is needed. Few challenges in usability were noted; the contrast, size and color of the text needed fixing, for example white text was hard to see for people with eye problems. Some seniors said on the observation that the mirror was stylish and beautiful, and few were surprised from the Polish wooden frames. Managing the Magic Mirror's applications and user accounts sparked debate, like who would add information to it, the user, or the caregiver. Seniors also pondered how to add information; it should be easy and possibly it could be done remotely with a phone app, for example.

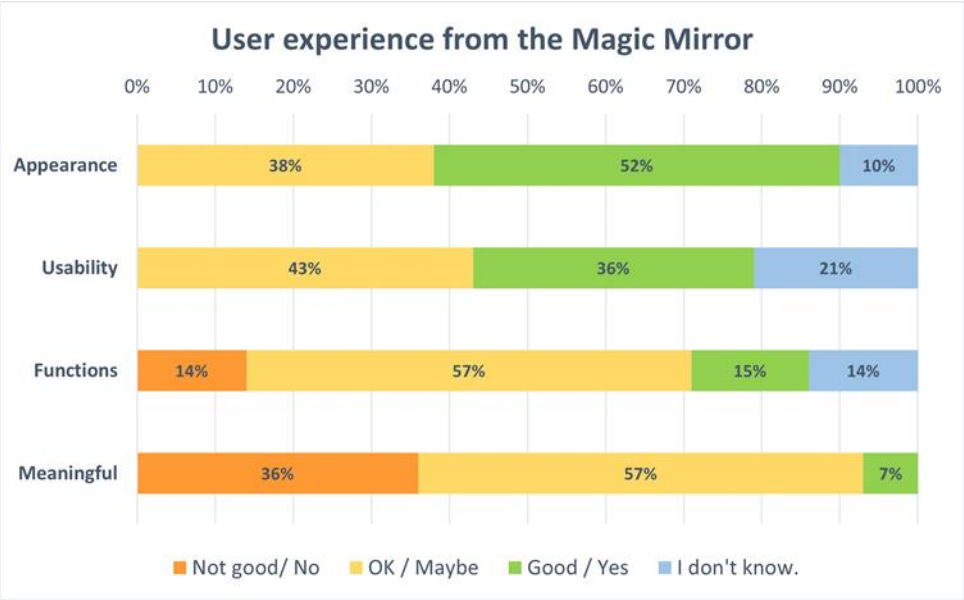

Figure 15. Seniors' user experience from the Magic Mirror prototype.

The working method of the Magic Mirror prototype seemed understandable for seniors, and they wrote on the questionnaire answers that it could be useful in daily life with its reminder function. Some seniors were surprised by its features and one said that this was a good example of a good service design. On the observation, the reliability of the mirror was pondered by few seniors, as well as the communication features. Also collecting user data was interesting function for few seniors. The seniors experienced it important that the quantity and quality of applications and the content displayed in the Magic Mirror can be customized to their own preferences.

The questionnaire answers indicated that the Magic Mirror's considered meaningful by many seniors, as it would be used to personal information and time management, for example as calendar, and for communication. Some seniors gave critic and improvement ideas, and few seniors did not see the need for this prototype. On the observation event, the Magic Mirror aroused a lot of conversation among groups. Several seniors were really interested of this and asked where they could buy it. Few others instead were questioning, what is the value of this mirror, for example compared to a smart phone. Many seniors were interested about the price, and the mirror was experienced more meaningful if it were made in Finland, but seniors noted that the price would be more expensive in that case.

The answers of the questionnaires showed that many seniors would improve the functional specifications of the Magic Mirror prototype by adding audio features on the device, such as speech recognition, dictation option and voice reminders. However, some seniors found the talking mirror strange. Some seniors would improve the information design of the Magic Mirror by increasing the font size. On the observation event, seniors ideated multiple different content ideas for the Magic Mirror, for example for autistic users an application that shows information in pictures could be useful. Other ideas were videos for exercising and for skill training, for example a video of how to wash teeth in the corner of the mirror while the user can do it simultaneously in front of the mirror. The Magic Mirror could also be used in remote speech therapy and occupational therapy. It is possible to put multiple user accounts in the mirror, which are visible only to the account owner. This feature could be utilized in nursing homes where caregivers would see different content than clients. A few seniors pointed out that the mirror feature is not suitable for people with dementia, since they do not recognize their own reflection from the mirror, and thus could fear it. Another point worth noting was that the reflections of lighting in the room might interfere with seeing the contents of the mirror.

Overall, the testing event of these prototypes aroused mostly positive feelings and seniors gave positive feedback. Most of the seniors were interested of these smart furniture prototypes, and one person was surprised from them. Some seniors said that it was good to have information from new welfare technology products and they considered this event important. The representations were considered clear and demonstrative and some seniors encouraged the project team to continue development work. This kind of collaboration work and creating new innovations were praised by many seniors. Few seniors would have wanted more demonstration and more information from the prototypes.

6 CONCLUSION AND DISCUSSION

6.1 Key findings

The purpose of this study was to provide senior's insights from the user experience of smart furniture prototypes. The aim was to determine which aspects of the smart furniture prototypes would need most development to be usable and functional for the seniors. This study also explored meaningfulness of the prototypes and gathered ideas from seniors for further development of the prototypes. This study was done with mixed methods and the data was collected with questionnaires and observation methods. The study and the methods used were grounded on Garrett's chart of the Elements of User Experience (2011, 29), which divides the user experience into five elements: strategy, scope, structure, skeleton, and surface. Using these methods, I obtained valid answers to the research questions.

The results of this study were largely aligned with previous studies, as they raised the similar themes and concerns. One goal was to get development ideas for the developers of these prototypes, and ideas came in abundance. The seniors expressed a variety of development ideas regarding the usability and functionality of these prototypes. The results surprised how enthusiastically seniors gave their development ideas, and how diverse they were. In line with the objectives of the quality recommendation prepared by the Ministry of Social Affairs and Health (2017, 28–29), these prototypes have the potential to maintain health and functional capacity, and they can support the coping of seniors at home in the future. The observation showed that learning and using welfare technology needs lot of encouragement, as the previous projects had also discovered (Juntunen 2013, 15; Stenberg, et al. 2014). Many seniors highlighted that the product should be branded for everyone, not only for seniors or disabled people.

On the surface level of The Elements of User Experience chart (Garrett 2011, 29), The Magic Mirror was most appealing by its visual design. The results confirmed the same finding which the previous studies had noticed (Goodman, Kuniavsky & Moed 2012, 212; Verma & Hätönen 2011, 9; Viirkorpi 2015, 52; Wessman, Erhola, Meriläinen-Porras, Pieper & Luoma 2014); the product should be easy to use and understand, and

it should blend into the user's everyday life. On the structure and the skeleton levels of the chart (Garrett 2011, 29), the best usability was experienced with 3D Printed handles. Similar usability challenges were found, as Juntunen (2013, 20-22) and Lind (2013, 60-62) had found, such as the importance of using suitable colors as well as consideration of contrast so that the product would be usable. The Smart Chair had the best functions on the scope level of the chart (Garrett 2011, 29). From the analysis of the answers, it could be concluded that on the strategy level (Garrett 2011, 29), the functions important to the user increased the meaningfulness of the prototype. Seniors experienced the 3D Printed handles as the most meaningful to themselves. More than one fifth of the respondents did not consider the Mobile robot with fall detection boards and the ReAble Chair significant for themselves. This is probably because their prototypes were more unfinished than others.

The research contributes to previous knowledge by providing more information to welfare technology product developers about the user experiences of older people. The study was worth doing, as it provided valuable information on seniors' user experiences with these smart furniture prototypes, and lots of development ideas. The previous studies did not pay much attention to the surface (Garrett 2011, 29) of welfare technology products, but this study showed that the appearance of the product also matters to seniors. The appearance needs to be pleasant and "*so that it wouldn't resemble a machine*". The observation method clearly illustrated how some of the prototypes activated the whole group and brought communality among the seniors.

Doing research taught me that the study progresses more smoothly when it is well planned. When I did the study, I was most surprised at how happily and boldly the seniors shared their experiences and ideas to improve the prototypes. I previously assumed that most seniors were not very interested in new technical devices, but I found this assumption to be incorrect. The mean age of the respondents in this study was 82 years, so this clearly reflected the views of the elderly. I consider this study important because there will be more and more seniors in the future, and they will live longer. For this society to be able to care for a wider elderly population in the future, efforts must be made to support their well-being and living at home. In my view, this goal can be boosted by the development of smart furniture and other technologies that increase well-being. The importance and meaning of welfare technologies seems to

grow when their content is familiar to the user, such as ski jumping. This, too, speaks in favor of involving seniors in development to better understand the wishes of seniors.

6.2 Reliability and validity of the study

The checklist that Elo et al. (2014, 3) had created for improving the trustworthiness of a content analysis study, and the criteria for assessing qualitative research from Kitto, Chesters and Grbich (2008, 244) were used to assess the reliability of the study. The qualitative data collection methods were suitable for this study, as the observation was a suitable method for gathering peoples' experiences and provided complementary information together with the questionnaires. The research questions could have been defined even more clearly based on the headings in the questionnaire, but then again, those terms were generally difficult to understand.

The reliability of the observation was ensured after the observation days by comparing observation notes with the panel of other observers to avoid possible mistakes that might be caused by interpretation bias. Potential malfunctions of the prototypes, the seniors' lack of courage to test the prototypes, and the reduced observer's alertness, for example due to poor night's sleep, were identified as potential risks associated with observation method. In the observation situation, the researcher sought to be neutral and discreet in the event so that the subjects' behavior would not change due to awareness of the observation. The subjects did not pay any more attention to the researcher than to the other members of the BaltSe@nioR project. The researcher was aware of her slow handwriting, so the observation notes were saved directly to the computer. Observation with more structured support form could have provided more detailed notes.

The questionnaire, which was the tool for data collection, had already been developed at SAMK based on the Garrett's chart, so it was found to be valid. Asking age of the respondents was relevant as the study sought answers from people over the age of 65. Since some seniors had answered only partly on the questions on the first page of the questionnaires, the reliability of the data would have been poor in statistics, and unfeasible to make accurate conclusions. That was why this study focused more on

combining the qualitative data from the questionnaires with the findings from the observation. The observation method added value to the results, for example in the case of the Mobile robot with the fall detection boards, as not much information was acquired from the questionnaire.

The validity of the study structure could have been increased by deciding at an earlier stage the age limit for the sample group before making observations. So, the observations may also include data from younger people. On the other hand, when observing, people were not asked about their age, so that age limiting would have been done only based on guessing. However, this delimitation would have been able to exclude at least the findings from young people.

Validity of thematization was achieved by using The Elements of User Experience (Garrett 2011, 29) that has been studied before and has strong theory as a basis. When analyzing the texts, the information was combined according to the codes, but examples of some of the answers are direct quotations. The stability of this study was secured by having only one researcher who used the same coding method to all collected data. The study sought accuracy through careful coding.

The data was collected from a real event and not, for example, as an online survey that could be answered with a false identity. There is a possibility that language translation could have modified the content of the text or its tone. The identified problem in the study was the interpretation challenge in understanding some of the answers because of the unclear handwriting. The credibility of a study is affected by the influence of the researcher herself on the results. The researcher had no direct contact with just a few of the subjects she assist-ed in writing the answers to the questionnaires. In these cases, it was tempting to ask clarifying questions from respondents, but the researcher consciously adhered to the questions in the form.

The reliability of the results was influenced by the different labelling methods used by the respondents. The accuracy could also be reduced if the respondents did not understand the questions as intended. For example, when marking stars, some of the respondents marked one star in the center, while another responded three of the left. Because of these, there may be errors in the interpretation. Some seniors gave their

opinion from all prototypes, but most gave only from one or two prototypes. This was understood from the similarity of the handwriting on some questionnaires. This will probably distort the answer to overall interest on technology- question, if one person gives five times the same answer.

The separate ethical permission was not needed because this study was conducted in cooperation with SAMK's own BaltSe@nioR project. Therefore, the study did not either involve costs for the researcher. Responding to the questionnaire was voluntary, as was attending the event. The ethical issues in the observation method are that it should consider that the purpose and methods of the research are clarified for the subjects, and to obtain their consent for the research (Dudovskiy 2020). One ethical issue was that will the seniors stay anonymous. In the questionnaire form there was asked gender, age, and work status as a background information. The places where seniors came from were told, but they were not connected with information directly. In the case of sensitive groups of people, the actions have been ethical and the authorization forms for participating in the study and for using the answers anonymously for study has been completed. The observation results cannot be combined with the questionnaire data to identify person, since most of the seniors filled their questionnaires afterwards. The answers are published anonymously, and the collected data will be destroyed properly.

6.3 Applicability of results

The seniors were mainly interested in these prototypes, which is good news to the developers. A large proportion of seniors saw that prototypes have the potential to add content and benefits to their lives, such as entertainment or a sense of security. In general, the meaningfulness of a prototype seemed to be easier to identify when the prototype was more tangible, and its functionalities could be tested.

Testing prototypes with target group provides realistic information, for example, on what may become a barrier to the use of the product. By doing so, development resources can be allocated correctly, and the meaningfulness and benefits from the use of the product can be maximized. This study provides valuable insights for the smart

furniture prototype producers. This information can also be used by others that work with welfare technology.

6.4 Limitations of results

This study involved only people who were willing and able to come to Mewet house, so this provides only a limited picture of the user experiences and insights of the seniors. Only a small sample of Finnish seniors was included in the study, thus this study is not able to describe the user experience of all seniors. Generalizability of results can be difficult, as the sample group was rather small (Bhandari 2020). The transferability and the reproducibility of the study is limited as it was done in the research environment provided by the BaltSe@nioR project. The results are likely to change if the subjects change. No list of names was collected from event visitors, so it would be difficult to re-examine the exact same group with the same line-up.

The results are as valid as can be obtained with these methods. However, observation is always ultimately the researcher's own interpretation of the situation and events, so another person could get different results in the same situation. In this combination of methods, the researcher had a big role in analyzing and interpreting the results, so the results can be challenging to replicate and may vary by interpreter (Bhandari 2020).

If I were to do this study again, I would carefully select the target group before making the observations, as it would help to focus more on monitoring the activities of the target group. Observations could have been collected, for example, by using the Feedback Capture Grid, which would have clearly sorted out the likes, criticisms, questions, and ideas into four quadrants (Dam & Siang 2020). Other option could have been taking parts of the Elo-D Observation Form used in the Virtuaalikymppi project (Lind 2013, 41). It contained various things in human activity to be noticed in the observation situation. On the other hand, there were only one researcher doing the observation of many seniors. It was not possible to concentrate on one person at a time, and the seniors attended according to their own interest. More comprehensive results would probably have been obtained if the test situation had been more structured. But,

on the other hand, it could have influenced seniors' behaviour. Otherwise, I found the data collection methods used to be suitable for such an event.

6.5 Future studies

For the development of smart furniture based on this study, it would be useful to involve seniors in the early stages of product development, as they are best able to tell about their own needs and wishes. For example, they wish that the brand of the prototype would be for all, not only for seniors or disabled people. This type of early prototype testing was good, so that the user experience comes along on the early stages of the design process. This way resources would not be wasted unnecessarily.

Privacy pondered seniors, who manages the user's information and can see it. In this context, it could be useful to find out in further research what seniors think about information security and how they think it should be implemented.

It might be worthwhile to create an association involving seniors, product developers and nursing staff. The association could bring each party's views on the development stage, and to create, for example, user reviews of different products. This group could be consulted at different stages of the development process. It could also be beneficial for smart furniture product marketing if it could be mentioned when marketing the product that there were also seniors on the development team. This could lower the threshold for skeptical seniors to buy technical products that could make their daily lives easier.

Nordlund (et al. 2014, 61–62) stated that many companies leave older age groups completely excluded from product design. This is indeed a challenge, of how to get user experience from the oldest users. To this event came a limited number of seniors from the nursing homes, and probably the eldest in those nursing homes were in a condition of not to be able to move far. Therefore, the events or projects should be taken to them. When doing similar study, it is worth considering the environment in which the demonstration of prototypes will take place; what would be the results if prototypes were presented in a nursing home, for example. There, the target group

could be more diverse, and it could be interesting to observe how physically disabled people would react when they see other seniors play. The Smart Chair and its games could be especially useful in seniors ’communities, where they could bring joy and a sense of community to residents.

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THE QUESTIONNAIRE

Background information

Gender:

Age:

Profession/industry:

Prototype:

Generic interest in advanced technologies		Not interested ☹	Some intrest 😐	Very interested ☺	can't tell
Visual design					
1.	The design of the prototype was…	Poor ☹	Sufficient 😐	Good ☺	can't tell
2.	The outlook clearly indicated the use of the prototype	not at all ☹	Somewhat 😐	well ☺	can't tell
3.	The visual appearance of the prototype was good	disagree ☹	somewhat agree 😐	totally agree ☺	can't tell
Information design and interaction design					
4.	In my opinion the prototype was easy to use	disagree ☹	somewhat agree 😐	totally agree ☺	?
5.	I understood the purpose of the prototype…	disagree ☹	somewhat agree 😐	totally agree ☺	?
Functional specifications & content requirements					
6.	Did the prototype function as expected	insufficiently ☹	OK 😐	well ☺	?
7.	The functionalities of the prototype were…	insufficient ☹	Ok 😐	Brilliant ☺	?
User needs and site objectives					
8.	If available, would you use the prototype?	Not at all ☹	Possibly 😐	for sure ☺	?
9.	How meaningful is the prototype	Not at all ☹	To some extent 😐	Very ☺	?

-Rate the prototype (from 1-5 stars)

-How would you improve the prototype?

-How/ to which purposes would you use the prototype?

-How did you experience the demo situation?

-Any other comments