Miia Kämppi

Smart Rollator

Designing a Desirable Product

Metropolia

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Ihmiset ikääntyvät kaikkialla maailmassa, noin 30% Suomen väestöstä on vuonna 2030 yli 65 vuotiaita. Tämä asettaa haasteita terveydenhoitokustannuksiin. Metropolian osaamiskiihdyttämön tarkoituksena on auttaa ikääntyneitä asumaan itsenäisesti kotona mahdollisimman pitkään robotiikan avulla. Tätä tavoitetta lähdettiin ratkomaan älykkäällä rollaattorilla.

Koska älykkään rollaattorin kehitysprojekti on alkuvaiheessa tämän opinnäyteyön tavoite oli selvittää millaisia käyttäjän tarpeita lähdetään ratkomaan sekä millaisilla ominaisuuksilla arjen haasteita pystytään ratkomaan. Koska Suomessa noin 85% rollaattorin käyttäjistä saa rollaattorin kunnan apuvälinekeskuksesta, on täten julkinen sektori yksi suurimmista asiakasryhmistä. Jotta rollaattorista saataisiin mahdollisimman haluttava sekä houkutteleva asiakkaiden näkökulmasta. Tässä opinnäytetyössä huomioitiin sekä käyttäjän että asiakkaan tarpeet.

Opinnäytteessä käytettiin menetelmänä toimintatutkimusta. Työssä toteutettiin kaksi sykliä; ensimmäisessä vaiheessa teemahaastattelun avulla selvitettiin vanhusten kohtaamia arjen haasteita ja toisessa vaiheessa innovaatiokeskustelun avulla haettiin rollaattorin ominaisuuksia, joilla vastataan näihin arjen haasteisiin.

Työn lopputulokseksi saatiin ehdotus rollaattorin sisältämistä ominaisuuksista, joilla saavutetaan mahdollisimman kattava vastaus sekä käyttäjän että asiakkaan näkökulmasta. Ehdotus sisältää 4 eri asiakasryhmälle ehdotelmaa, mutta suositelluin vaihtoehto on ehdotelma 1. Tässä ehdotelmassa keskityttäisiin luomaan ylösnousuavustus mekanisoinnin avulla. Älyrollaattori sisältäisi myös etälataus mahdollisuuden akuille sekä juomapullotelineen. Koska tavaroiden internet ja käyttäjädatan kerääminen mahdollistavat paremman jatkokehityksen ja tiedon hyödyntämisen opinnäytteessä katsottiin, että nämä ominaisuudet kannattaa ottaa käyttöön jo heti alkuvaiheessa, jotta jatkokehitys on helpompaa.

| Avainsanat | Rollaattori, älykäs rollaattori, apuväline, tuotesuunnittelu, terveysala, |

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Aging of population is a trend in every developed countries and it is estimated that in Finland nearly 30% of population is over 65 years old in 2030. Metropolia's Competence Hub is using service robotics to improve people's safety and wellbeing by making their lives easier. Metropolia's Competence Hub subscribes this thesis and the burden of aging population to health care expenditures are tried to solve by new smart rollator.

The approach used in thesis was action research. Two cycles of the action research was done; in first phase user's daily challenges were surveyed by theme interview. In second phase features for these daily challenges were innovated in innovation conversation. The aspect of public sector was at the center, because in Finland almost 85% of rollator users are getting the rollator from public Medical Aid Centers. Hence Public sector is huge customer segment for new smart rollator and in important role for smart rollator successful sales.

The result of the thesis was proposal for Metropolia's Competence Hub what features should be included into smart rollator to fulfill the needs both of user and the customer. There are four propositions, but the most recommended one is the proposition number one. It includes standing up assistance implemented by mechanization. There should be also remote charging possibility. Water bottle holder is one new feature rarely seen in rollators. Because internet of things and using customer data to improve businesses is raising trend, these aspects are recommended to be included in the early stages of product development. Hence it is easier to develop the smart rollator further.

Keywords	Smart rollator, designing process, health care, elderly, living home

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1   Introduction

This thesis is part of Metropolia's Competence Hub process to innovate new smart rollator to help elderly to live longer at home. The product development process is in its early stages and my interest in this thesis is to find out features that make this rollator as desirable as possible for buyers and users as well. There are reasons why elderly's living home longer is important topic and worth of research. First of all markets size will increase significantly. In the end of 2015 there was 1 123 103 over 65 years old in Finland. Population forecast shows that number of over 65 years old will increase instead of present 19,9% to 26% by 2030 (SVT a,b). The same trend is in European area and other developed countries. Other reason for research is smart rollators possible impact to public health expenditures. Solutions that help elderly live at home are of interest to health policymakers due to potential cost savings and these solutions can be achieved by innovative assistive technologies (Salminen 2003: 15; Gutman – Sixsmith 2013: 1,9). There are multiple smart assistive technologies prototyped and innovated, but they are not manufactured or bought for use, because especially commune's medical aid centers use them sluggishly (Rintala 2015: 1).

In this thesis, the customer is referred to as the chief of admission in medical aid center whereas the user is a person who is over 65 years old, using a rollator. This is because every citizen in Finland has rights to get assistive technology from municipal medical aid center for free. Almost 85% of the user's of rollator gets it from medical aid center so on medical aid center becoming the biggest customer segment in rollator markets (THL; Supporting the Functional Capacity of the Older Population and on Social and Health Services for Older Persons 980/2012; Lemmetyinen 2016).

The case company in this thesis is Metropolia University of Applied Science's (UAS) Competence Hub. Metropolia UAS is located in Helsinki, Espoo and Vantaa. Competence Hubs are part of research, development and innovation programs and they combine experts in various organizations and fields to solve future problems. Service robotics for enhancing health and wellbeing is one Competence Hub established in 2014-2015. Service robotics has four main objectives for enhancing health and wellbeing: they use robotics to improve people's safety and wellbeing by making their daily lives easier. They are specialized in combining service robotics with automation, design, and

business economics of those who use health care. (Metropolia 2015.) This thesis is part of the innovating process of smart rollator in Metropolia's Competence Hubs.

The business challenge is to innovate new smart rollator to resolve some new functional dimension. This means defining the consumer needs for increasing the purchase rates for smart rollator, so those consumers would by this product. These new functional dimensions can exceed competitor's supply and so give market advantage (Tuominen 2010: 18). I need to find out what are the features needed to gain this market advantage.

The two main objectives of this thesis is to research what functional dimensions smart rollator should resolve for it to awaken the interest of medical aid center who buy smart rollator and what should be the features in this smart rollator to achieve desirable functional dimensions. Before I can reach these two objectives I need to find out what are the user needs for smart rollator. That way I can make sure that the new smart rollator meets the real needs of user, the person who is in the center of every action when rollator is used. Because this thesis has innovative and designing aspect, we need to also know what kind of problems users have in their daily lives and how problems could be resolved with this new smart rollator. In this thesis I'm framing the users of smart rollator as elderly as mentioned earlier.

Thesis research is based on action research. First I collected data considering elderly's daily problems from relative of senior citizen and domiciliary care nurse. I collected this data from someone near of rollator user, because it might bring out challenges user doesn't recognize. There is another thesis in the process of surveying rollator user experience and needs, so I'm not focusing in that part in this thesis. When I had gathered background information, I held an innovation conversation session with chiefs of admissions of greater Helsinki. This session included workshop based on feature tree and brainstorming, so that we can innovate by conversation and perceive new product more clearly. After data collection phase, I analyzed and collected proposal of the best features to be included into smart rollator for Metropolia's Competence Hub.

2 Method and material

2.1   Research approach

Research can been seen as the search for knowledge, or any systematic investigation into and study of materials and sources with purpose to establish facts and new conclusions. Applied research is for developing methods and systems to achieve improvement of human knowledge relating to our world. (Milton – Rodgers 2013:11.)

The research approach was first difficult problem to solve in this thesis. The purpose of the research, ways to collect data and form the research questions are similar to vary research approach. I needed to consider different types of research approaches to find most suitable for this thesis. I present theoretical background for each of approaches and I try to justify my selection by this information.

I looked information about research approaches from literature and I selected the most suitable ones for my thesis: action research, producing innovation and qualitative research. Qualitative research is any research without statistic methods and data is in form of words and sentences. The purpose of the research is to understand, describe, and create model about phenomenon researched. Descriptive is the word to describe qualitative research and it's characteristic such as researcher is interested processes and meanings. (Kananen 2014: 21-22.)

Qualitative data analysis is a cyclical process without exact rules how to do it. Analysis is not an end stage in qualitative research process, but action in every stage. Analysis guides research process and data collection, where analysis and data collection alternate. (Kananen 2014:21.)

Research problems give guidelines which research approach is most appropriate choice. The operating situations, where qualitative research is good option to achieve research objectives, are the phenomenon is to be a profound vision, the phenomenon is to be a good description, the phenomenon is not researched before or the purpose is to make new theories and hypothesis. (Kananen 2014: 23.) Qualitative research is appropriate approach for me, because good and deep descriptions of phenomena are in the base of this thesis.

The second option is action research. This approach has many characteristics common with my thesis (see Table 2). The purpose is to make this research in co-operation with many partners to ensure reliable and useable information. In this research the focus is on how things should be, what kind of smart rollator should be and what it should include. Participants and I, as researcher, have an active role in this research and even if the characteristic 'done with organization' isn't fulfilled, the number of other matching characters supports the selection for this approach. Furthermore action research is part of qualitative research and hence we can see that both of them are included to this thesis (Kananen 2014: 21-22).

Other interesting research approach is producing innovation. Characters such as done in real life by real people, different professionals gathered to together and main method as brainstorming would be fulfilled. In the end of this whole product development process Metropolia's Competence Hub is doing, there will be something new produced. However, one important definition of this approach is that results of the research will be commercialized or taken into use. Within the framework of this research, there will be nothing commercialized yet. So this approach might not be the best option to use as research approach. (Ojasalo – Moilanen – Ritalahti 2014: 82-90.)

Table 1.　　　Research approach comparison (Kananen 2014: 11-17; Ojasalo – Moilanen – Ritalahti 2014: 58-64; 82-90)

	Action Research	Producing innovation	Qualitative research
Characteristic is fulfilled	• Participatory • Practical problem to be solved • Practice-oriented • How things should be • Problem centric • Examinee and examiner are active • Develop multiple answers for problem solving • Produce data about actions and change • Cyclic process • Done together with community	• Done in real life by real people • Different professionals gathered together • Main objective is producing new • Method: brainstorming	• Understand, interpret and create model to phenomenon researched • Multiple data resources and methods to collect them • Situation-specific and unique
Characteristic not fulfilled	• Done in organization	• Results have to commercialized or take in use	• From practical phenomena to empirical theory

After this evaluation of different research approaches I went forward with action research. Action research is considered to belong in qualitative research (Kananen 2014:20). I will use action research in this thesis, also combining collaborative trans disciplinary approach as intention to facilitate better end-user and stakeholder engagement for effective innovation (Gutman – Sixsmith 2013: 14). Action research combines praxis, participative manners, and diagnosis with reflection (Crouch – Pearce 2012:143; Cohen – Manion - Morrison 2000:227; Gray 2004:374). The main goal in action research is to find out solutions, which are practical and relevant to the problems identified. Action research is suitable and often-used tool in design processes. It is concentrating in human action, not in product analysis and so it is the good choice for a designer. Design problems require typically review, amendment, adaption and refinement and this process can be made visible by action research. (Crouch – Pearce 2012:144-146, 157.) Even though every aspect of action research is not met in the

framework of this thesis, there are sensible advantages and also arguments stated above support the decision to choose the approach.

Action research is not for generalizing the information. The result of research is a change between current and former situation. Kananen (2014:33) gives examples that action research results could be new concept for product, improved use of your time or improvement in workplace comfort. In this thesis result of research should be proposal of features and functions of new better selling smart rollator.

In action research, there is a main four-phase cycle that goes on over and over again. The first phase 'plan' is getting the focus right. In the phase 'act' designer gathers evidence. Third phase 'observe' means analyzing the impact and the last phase 'reflect' is for evaluating the impact of the project. (Gray 2004: 378-382.)

Crouch and Pearce (2012:148) gives example how to modify action research basic phases. I base my own thesis' research phases on this model, but modify it a little more to be more suitable for achieving my objectives. I started with observing phase, which includes problem identification, reflecting current practices and reading relevant literature (Crouch – Pearce 2012: 148-149). For this observing phase I needed to contact domiciliary care nurse and rollator user's relative, someone who can tell me what are daily challenges rollator user meet and also their activities during a day, because recognizing the customer needs was the most important stage in product development process (Milton – Rodgers 2011: 67). On the other hand, it was important to understand how the person is using the assistive technology and the focus was on the functional outcome (Cook – Polgar 2015:5) The data in this phase (*Observe*) was collected by theme interview, so that I could deepen my knowledge about problems elderly are facing in their daily living (Hirsjärvi – Hurme 2011: 35). Theme interview was a proper choice, because I knew beforehand that interview would produce complex answers that are suggestive in many directions (Hirsjärvi – Hurme 2011: 35). In analyzing this data (*phase reflect/plan*) I combined theme interview analysis by Hirsjärvi and Hurme (2011:143-151) and process presented by Milton and Rodgers (2011:67-69) of identifying customer need and wants. Process included collecting data, describing data, organizing data into hierarchy of primary and secondary, establishing relative importance of customer needs (Hirsjärvi – Hurme 2011: 143-151; Milton – Rodgers 2011: 67-69). I reflected the results to literature about elderly daily activities and this way increase the validity of my research. Result of this phase was a list of different issues. Phase two is

reflect/plan and in this phase I'm trying to come up with some possible ways forward and began to plan solution (Crouch – Pearce 2012: 149).

In phase three (*act*): innovative conversation session complemented with brainstorming aspect recorded by voice recorder. Brainstorming method is used in designing problems to generate ideas more rapidly and efficiently. Brainstorming method works best when group is using the method and it is the highly efficient method of generating surprising and innovative concepts. (Milton – Rodgers 2011: 79.) In innovation conversation there was also feature tree, which ensures that every topic from phases 1 and 2 was conversed. Feature tree has also the benefit of seeing and combining multiple features at the same time. (Moritz 2005: 215.)

In phase four (*Observe*) I was taking action to try out the solution and do what I had planned last phase (Crouch – Pearce 2012: 149). Phase four was monitoring and observing the outcomes to see what kind of new materials and opportunities experiment provides. In phase four the main tools was content analysis and benchmarking. Benchmarking was meant for comparing own mode of operation to other companies' solutions. Aim of benchmarking in generally is to identify the success factors, for example hospitals have implemented the technology used in aviation to allocate planes to allocate patients. (Jämsä – Manninen 2000: 37-38; Moritz 2005: 187.) Phase five (*reflect*) was about evaluating and reflecting on what happened and what was achieved. In phase six I was modifying practice, in other words gathering best proposals of features to include new smart rollator. (Crouch – Pearce 2012: 149-150). As evaluation I also discussed of validity and reliability; how these results are achieved and is the proposal relevant.

In table two I have collected objectives, which I was trying to reach and also tools, how I was going to reach the objectives. This is described in text above.
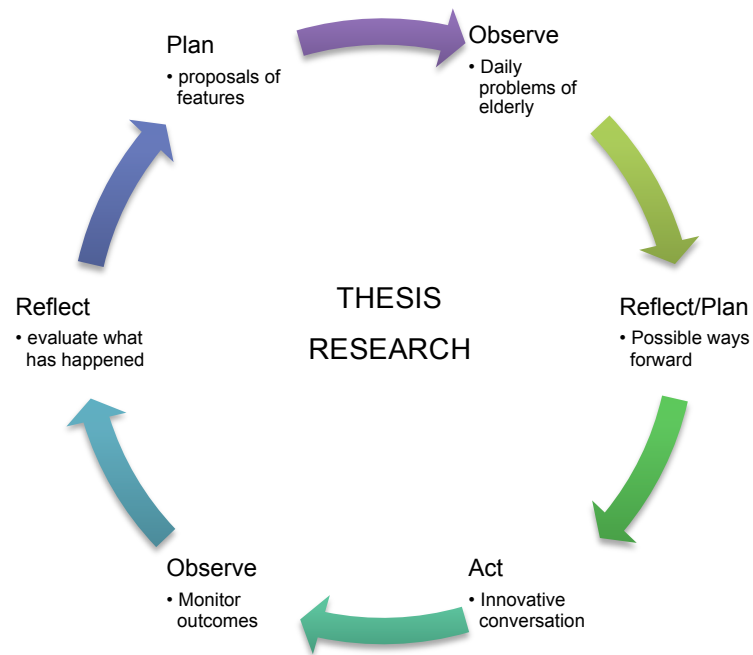
Picture 1 Action research phases in this thesis based on Crouch and Pearce (2012: 148) example.

Table 2. Objectives and tools used in every phase of the research

Action research phase	Objectives for action research phase	Tool used
1. Observe	Make knowledge-based understanding of the functions smart rollator should resolve	Literature Theme interview
2. Reflect/Plan	Analyze data from literature and theme interview, identifying user needs and wants	Theme interview analysis process combined to process Content analysis
3. Act	Find out features that could meet the user needs	Brainstorming Feature tree
5. Observe	Finding key elements and features are making smart rollator as attractive product	Content analysis Benchmarking
5. Reflect	Making proposal for functions and features that should include new smart rollator	

2.2   Research questions

The purpose of this research is to find out what are the features in smart rollator, that make it most attempting for buyer in this thesis admission of medical aid center. Because the buyer and the user are, in most cases, different people, I need to consider them both in finding appealing and selling features. Deep down, finding features appealing to buyer is making value for buyer; hence in this thesis I need to find value aspects for buyer and user at the same time.

First I'm going to gather information about what functional dimension smart rollator should resolve. I'm going to research this from view of daily activities elderly do everyday, what challenges they might have to trying to do these actions and what are the user needs for this smart rollator. When someone is trying to maximize value for customer, one needs to start up with recognizing activities both functional, social and emotional jobs or activities user is trying to cope with (Osterwalder – Smith – Bernarda - Pigneur 2014; 12-13).

In phase 3, based on functional dimensions emerged in previous phases, I'm finding out what are the features that meet the functional dimensions from the point of view of the buyer, considering also their willingness to pay for it. Sub questions, for resolving the main questions are: How we are resolving these daily challenges? What is needed to solve these challenges? Which solutions give most value?

When I combine these two main questions "What functional dimension smart rollator should resolve?" and "What should be the features in smart rollator?" I will end up a situation where smart rollator is so attempting that customer is willing to pay it (See picture 2)
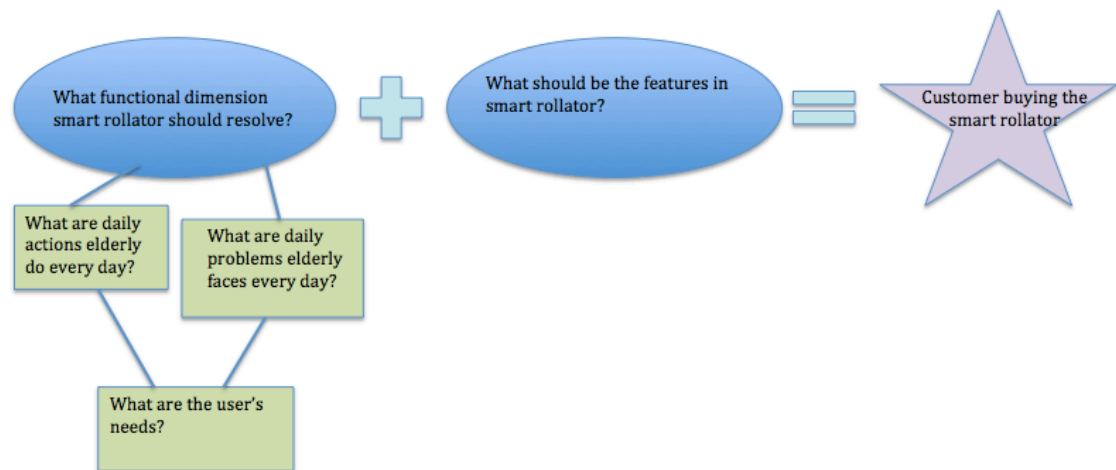
Picture 2 Research questions and their relationship to each other.

2.3   Participants in research

Innovation can be random, but mostly they follow a disciplined process to discover opportunities to do something different. Process will start with identifying target customer and the challenges the customer is struggling to solve today. (Anthony 2012: 87.) Participants in the first phase are either relatives of rollator user or domiciliary care nurse. The purpose of this phase is to survey daily actions of elderly and challenges they have, so that in the research phase I will have realistic understanding possible functional dimensions what might be solved and what are really wanted to be solved in nurse or relative point of view.

Samppa Lemmetyinen (2016) from Apuväline Avux company estimates that almost 85% of rollator users gets their rollator from medical aid center, though amount of rollator user buying rollator themselves is increasing. This makes medical aid centers as the biggest customer segment in rollator business. The initial idea beforehand was to get chiefs of acquisition of medical aid centers, but I couldn't invite any. They decide what kind of rollators they are going to buy and they would have had the knowledge what kind of rollators they are going to buy in future. Fortunately I was able to invite to join a prosthetist, who is along with buying rollators for municipal medical aid services and also evaluates and chooses the right rollator for the user's needs.

I also considered having a representative of Council of the elderly. Council of the elderly has to be established in every Finnish commune according to Act on Supporting the

Functional Capacity of the Older Population and on Social and Health Services for Older Persons (980/2012). According to Local Government Act (410/2015) the legal clause 27§ Council of the elderly has been given the opportunity to influence the planning, preparation and monitoring of the activities of the different municipal sectors in matters relevant to the welfare, health, inclusion, environment, housing, mobility and activities of daily living or services they need in terms of population aging. Hence it is reasonable, if they would have had a representative in this thesis research, but unfortunately I couldn't invite any of these either.

3   Theoretical background

3.1   Ability to do activities of daily living

Several factors and several diseases are involved in the performance of activities in daily living in elderly. Locomotion is a key factor in the quality of life for every elderly. Muscle strength and skeletal muscle mass is associated with physical fitness and disability and are important part of independence and quality of life in elderly. Loss of muscle mass is prevalent in elderly and causes mobility disabilities, increased risk of falls and impaired ability to perform activities of daily living. Yamada (2012: 640) researched that durability training among elderly increases significantly skeletal muscle mass and is effective way to improve and defragment an existing physical performance. (Yamada – Arai – Uemura – Mori – Nagai – Tanaka – Aoyama et al. 2011: 637, 640; Martins - Santos - Frizera-Neto - Ceres 2012; Lacey – MacNamara 2000:709.)

Socially active life has an important role for elderly. Tomioka et al. (2015:8) have researched that social participation lower significantly the risk of declined ability to perform activities of daily living. Higher level of social activity reduces the onset of need for long-term care and decrease risk of incident disability. (Tomioka – Kurumatani - Hosoi 2015:8.)

A major effect on well-being and health of elderly has declining cognitive ability. There are growing numbers of people with dementia and other mild cognitive impairment. There is an estimation that 20% of people over age 65 may experience mild cognitive impairment. Because there are no effective disease-modifying drugs, it is important to

find real opportunity for developing ICT-based solutions to enhance the cognitive health of elderly. (Gudman – Sixsmith 2013: 12-13.)

3.2   Assistive tools and devices

Cook and Polgar (2015:2) introduces WHO's definition for assistive technologies as "any product, instrument, equipment, or technology adapted or specially defined for improving functioning of a disabled person". Cook and Polgar (2015:2) tells that United States legislation has their own definition for assistive technologies which is " Any item, piece of equipment or product system whether acquired commercially off the shelf, modified, or customized that is used to increase, maintain or improve functional capabilities of individuals with disabilities".

Assistive tools and devices can be used to advance person's performance, when person's operation and participation is impaired, because of disease, trauma or aging. Devices can be used to replace, maintain, recover or empower locomotion capacities. The locomotion ability is important in individual's life faculties. Not only the locomotion will be better with assistive tools, but also mental health will be good, because individual is able to do certain things and affect daily routines. With assistive tools and devices self-help of elderly can be increased. Person aged 65-74 can get dressed and undressed, but after 85 years, only half can. Over 40% of 75-years-old and older has problems to go shopping. (Salminen et al 2002 : 15; Bastos-Filho 2014: 122-124.)

3.3   Robotics

Metropolia's Competence Hub is concentrating on helping living at home longer and aiming to do so with service robots. The assumption or supposition is that smart rollator would comprise robotic aspect.

Definition for robot is an automatically controlled, reprogrammable, multipurpose manipulator in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications. This definition includes assistive robots used for amelioration of physical sensory and cognitive limitations in children and adults with disabilities. Robots or robotic systems are intended to assist with manipulation. That is the reason why they are natural alternative manipulation devices for persons who have

disabilities. The purpose of new smart robot is not to replace the user, but the goal is to enhance the user's ability to manipulate objects and to function independently. Robots are often employed as personal assistant, so the goal is to provide manipulation aids to people with motor impairments. (Cook - Polgar 2015: 299-301.)

Because people need manipulation in different locations, mobile assistive robots have been developed. One disadvantage is that mobile robot needs user to add steering to the required control commands. User of the robot most likely has a restricted set of control signals available, so the addition of these kinds of commands may be impossible. (Cook – Polgar 2015: 302.)

There are growing markets in robotic health care industry, and now there is rising ethical issues, which should be considered before designing new smart rollator. Basically robots could be used in elder health care in three ways: to assist the elderly and their daily tasks, to monitor their health and behavior and to provide companionship. In the name of human rights, robots should be designed to benefit elderly themselves, and not just to reduce the care burden on the rest of society. The risks in mobile assistive robots are that, it may reduce amount of human contact or increase elderly's feeling of objectification and lack of control over their lives. (Sharkey – Sharkey 2012: 27-29.)

3.4   Product design

3.4.1   The design process

There cannot be drawn a one map or a model about design process. Some of the models describe what are the sequences of activities got through in designing process. Nigel Cross (2008) represents French's model of designing process, which is based on analysis of problem, conceptual design, embodiment of schemes and detailing. The process begins with need or problem to be solved. (Cross 2008: 29-31.)

Milton (2013:14) represents same kind of model for design research process. First is opportunity identification that desires needed to be sated and problems that need to be solved has to be identified. Phase brief and specification includes construction and analysis of a design brief, identifying the customer's needs and forming product design specification. In phase concept design designer create number of different viable con-

cepts. Design development refines the chosen concept into a product way that it satisfies the requirements enrolled to product design specifications. Detail design and production phases define fully detailed design and how the product is manufactured. Milton (2013:14) model includes seven research methods categorized essential phases: Looking, learning, asking, prototyping, testing, evaluating and communicating. (Milton – Rodgers 2013:14-15.) In this thesis I'm going to evolve with three or four first phases, because case company doesn't have the product designed yet and on the other hand limits of the thesis research doesn't contribute to go through whole product design process.

3.4.2   Idea collection implemented by innovative conversation

When development needs are defined, but solutions are missing the creative tools are used. In social and health care field brainstorming is applicable. This is meant for answering the question what kind of product answers the needs and expectations. (Jämsä – Manninen 2000: 35.)

When one is trying to set up innovative "brainstorm" or conversation event, framework has to be defined. Framework process should include the definition of context, "How to…?" question, the boundaries, the type of solution and the project charter. Leaders may think that they are limiting innovativeness if they give boundaries, but actually there are always limitations and if they are not brought out, the whole event may turn out to waste of time. Within clear boundaries and focus, innovative thinkers can identify solutions to the real issue and thereby maximize the value of the whole process. (Weiss - Legrand 2011: 80-81, 125; Miller – Wedell-Wedellsborg 2013: 35.)

Weiss and Legrand (2011: 126) announce that most great ideas and innovations are result of combining existing and unconnected facts in a new way to solve a clear problem or opportunity. I'm trying to use this as a guideline in my thesis process. I'm trying to find new solutions for elderly to survive by themselves at home as long as possible.

Idea generation is seen usually as a group activity. In a group, there will be greater sum of knowledge and experience than one individual will have and also combination of different thinking and problem-solving styles creates more value. Group innovation conversation session has few key elements to success: objectives has to be set out, participants has to be selected and arrange logistics for the session. Optimal number of

participants is four to seven. Less than four participants limits the broad range of ideas and more than seven might have challenges with group dynamics compromising successful outcome. Innovation conversation should include non-expertise participants, because they probably bring different perspective to complex issues. (Weiss - Legrand 2011: 126-129.)

4   Current state analysis

Innovation means a new idea, new service, and mode of operation or solution, which is taken into use. Innovation has to significantly improve previous product or service, so it can be called an innovation. (Inno-Vointi.) The purpose of Metropolia's Competence Hub is to innovate new smart rollator. It is important to know what is available in the rollator markets, so that I can avoid results similar to previous products. It is relevant to know what kind of rollators has been prototyped or developed. Who is the biggest customer? How big might be the rollator market? What is the scene in rollator markets? Under the circumstances I might find some new innovative idea during the thesis process.

4.1   Rollators in Finland

4.1.1   Conventional rollator versus smart rollator

Rollator is an assistive technology product, where is four wheels. Normally the user moves it with arms and body strength, by holding on to the grips and pushing the rollator forward. Rollator is usable choice in situation when user cannot gain enough support from crutches. Shape of the grip and brakes are customized features vary by model. Rollators are designed to improve user's mobility and help them maintain balance and in the long run user could avoid use of wheelchair. (Salminen 2003: 131-133; Martins – Santos - Frizera-Neto – Ceres 2012.)

Below you can see two examples of current rollators available in the markets. The brakes are located in different places, in the other rollator brakes are below handgrips directed to the user, but in the other one brakes directs away from user. There is a seat in the other rollator, but other rollator don't have them. Also the shape of basket is dif-

ferent and located in diverse positions. These rollators are designed to meet different needs of user and there is variation in rollators available in the markets.

Picture 3 Two examples of rollators available in the markets.

Smart rollator includes technical additional feature, possibly based on robotics. Smart rollator helps user by manipulation and enhance the ability to maintain activities in daily living. (Cook - Polgar 2015: 2,299.) The possibilities for features included in smart rollator are numerous, such as navigation, gait monitoring and partial body weight support. Martins et al. (2012) reminds that when designing a smart walker, it is needed to take account users disabilities and cognitive and sensory deficiencies, because there is a risk that device become too complex to use. The use of rollator requires adequate cognitive and attention resources from user to control rollator, which might be challenging for example user with dementia. Martins et al (2012) represents two reports that have pointed out rollators including many features actually increase the risk of falling not preventing them. (Martins – Santos - Frizera-Neto – Ceres 2012).

4.1.2   Usage of rollators in Finland

Finnish people lives longer, hence cost of health and social care will rise significantly. In European area health and social costs will be about 9% of EU GPD in 2050 and one of the three will be over 65 years old by 2060. Information and communication technology could be the most powerful ally to maintain cost efficient and high quality - patient centered - health and social care, where the key elements in ageing well is in preventive health care and inclusion of ICT-products and services. European Commission

sees that service and care robots are future and they could play a supportive role in the life of many chronic patients and older people who want to live independently at home. As it is European Commission supports and funds multiple research and innovation projects related on ICT for ageing well. (European Commission.)

In Finland, everyone, according to the law, has the right to receive medicinal assistive technology, if physician states the need for assistive technology because of illness or injury. When the need for assistive technology is stated, the services and products are free for the user. (THL) There are no statistics available of public funding invested in rollators, but in Finland for all assistive technologies the investment was 59 million euros in 2005. The amount of money invested in assistive technologies has almost doubled from 1993 to 2005. (Töytäri 2007: 28.) And the assumption is, that the increasing number of elderly will increase money invested in assistive technologies.

National Audit Office of Finland has published audit report considering technical assistive technologies used in Finnish domiciliary care. Currently the most common technical assistive technology is security telephone service for elderly. Technical assistive technologies are sluggishly used in private homes of elderly. However Act on Supporting the Functional Capacity of the Older Population and on Social and Health Services for Older Persons (980/2012) will tighten institutional conditions of the long-term care and oblige communities to find new service paths for elderly inter alia technological smart solutions. (Rintala 2015: 1.)

In Finland, there is no research data about cost savings made in elderly service, when technical assistive technology is used. The estimation of cost savings is based on the perspective it is looked at. Costs consist of buying the assistive technology, educating the personnel, application update and maintaining assistive technology. In the audit report is noticed that technological assistive technology has to be taken in private homes, otherwise Finnish welfare system cannot survive expenses resulting from an increasing number of elderly and disabilities because of ageing. Unfortunately, municipalities are not enthusiastic about technical assistive technology, because they see the investment as an expense, and investment does not give value in short term. (Rintala 2015: 2,6,18.)

People getting older might have declining cognitive ability. However there has not yet been ICT-related research specially addressed the needs of people with mild cognitive

impairments. However, elderly with mild cognitive impairment have more ability to adapt and more potential to learn to use new technologies than those whose illness has proceed to dementia and more severe levels of cognitive impairment. So, the crucial need is to develop innovative approaches that will help maintain or even improve cognitive status, extend independent living and enhance quality of life. (Gutman – Sixsmith 2013: 12-13.)

4.2 Usage of rollators in other countries

The rollator was invented in Sweden in 1978, and it has been taken into use in Scandinavian area quite well. There is estimation from the year 2000 that Swedish rollator manufacturers produced nearly 175 000 rollator unit. In Germany, about 500 000 units of insurance-covered rollators were sold in 2005. About 98% of German sales of rollators are partial covered by insurance. (Levsen 2015: 70-71.)

Still in some countries, like Spain and United States the emerging of rollators into the markets have been quite slow. However, in every country, it can be seen that usage of rollator will increase when people get older; a person older than 85 is 3,5 times more likely to be a user of rollator than younger ones. (Levsen 2015: 69,71,75.) I can make an assumption from this information that the markets for rollator will expand also in other countries as well as in Finland, based on the aging of population and huge unused potential of countries not using rollators yet.

4.3 Examples of smart rollators existing in the literature

Smart rollators already existing, offer different types of support: physical support, sensorial assistance, cognitive assistance and health monitoring. Almost every smart rollator gives some kind of features, mechanical or structural, for physical support to provide better gait stability. In turn, sensorial assistance can help user by navigational and security issues. This includes obstacle avoiding by using ultrasonic, vision or infrared sensors to detect static and dynamic obstacles. The control system can give guidance to user by sound or vibration alerts or device might be operating independently to secure user. (Martins – Santos - Frizera-Neto – Ceres 2012; Frizera – Ceres – Pons – Abellanas – Raya 2008:2.)

Cognitive assistance in smart rollators is based on for example GPS to follow prede-termined paths or reach a certain location. Also, the smart rollator with cognitive assis-tance included can two-way communicate enabling user to give direction or smart rolla-tor to alert about environment conditions. Health monitoring is used to keep medical history of the user through wireless communication network to improve emergency situation detection. (Martins – Santos - Frizera-Neto – Ceres 2012; Frizera – Ceres – Pons – Abellanas – Raya 2008:2-3.)

There have been multiple smart rollator development projects. One of these rollators has been prototyped in Finland. Älykkäitä liikumisen apuvälineitä ikääntyneille (Älli)-project in 2000-2003 was carried out in co-operation between Oulu University Infor-mation Technology: Work Science Laboratory and Lapland University industrial design. The purpose of this project was to develop independent mobility supporting assistive technologies for elderly. They designed rollator prototype that gives information about environment, services nearby and passage, taking advance of main unit called Koti-apuri. Rollator doesn't include any specific robotics or ICT systems, but Kotiapuri can be integrated to rollator, so it can give information about environment and hence give support user. Kotiapuri includes microphones, speakers and for use a touch screen. Kotiapuri provides Internet services and photo calls. (Nyyssönen 2003; Virta 2005: 42; Sotarauta – Ståhle 2003: 100-101; Alakärppä 2016.) The smart rollator did not end up in manufacturing, because the manufacturers/companies had no interest in the product (Alakärppä 2016).

DALi (Devices for Assisted Living) is a European Commission's Community Research and Development Information Service project (ICT-2011.5.4). The project group had expertise from multiple countries, but the coordinating of the project was handled from University of Trento in Italy. Product called c-Walker, was developed within this project and it was aimed at provide physical and cognitive support to adults to extend the au-tonomous life outside the home. The c-Walker is full of hi-tech solutions such as Radio Frequency Identification (RFID) tags, invisible QR codes and cameras (See picture 3). The c-Walker senses the environment and collects information from other systems and sensors. c-Walker can suggest user the way through wanted destination. C-Walker fuses information from walker using mechanical and visual odometer and tachometers combining it to information considering environment using radio frequency ID-tags, visual markers and environmental maps. User is always in control, but rollator con-stantly monitors risks and safety of user and makes suggestions to avoid anomalies,

crowded spaces or hazards. For example, in shopping mall user can choose destination from the preference list and c-Walker selects the shortest route and navigates user to arrive at destination by using 3D technology to build map from environment. C-Walker can uses surveillance cameras to identify queues in specific shop user is heading in and giving precious information to user about queuing time. (DALi; European Commission; CORDIS.)

C-Walker has also cognitive side. The cognitive engine is the brain of c-Walker and it can detect emotional situation of user and understand it. C-Walker can use this information to planning the course of actions to correct way and achieve desired destination. For example c-Walker can determine deviations in the motion of the user and hence avoid collisions and unsafe situations by planning alternative route. The user is not necessarily aware of hi-tech solutions, but user is guided nicely and safely by rollator to location user wants. (DALi; European Commission; CORDIS.)

Guido is a robotic walker that gives assistance for avoiding obstacles as well as navigation. It is developed at the Atlanta Department of Veterans Affairs Medical Center and participants of trials have been older adults with visual impairments. Guido has three control modes. In first mode user has control, but Guido gathers information from the environment by sensor and with auditory messages gives instructions. In second mode if any obstacles are detected Guido takes control and guides user safely pass the obstacle. Third mode is parking mode, where user can lock front wheels to prevent the Guido moving. (Rentschler – Cooper – Blasch – Boninger 2003: 1281,1285.)

In Guido, there are four different types of sensors. Sick laser is used to scanning and finding the obstacles and landmark detection. The Sick laser can give 180° horizontal view of environment, so everything above and below the lasers vertical location is invisible. Sonar sensor are positioned in the walker so that sensors can detect i.e. glass what Sick laser can't detect. Optical encoders are included to calculate the position and orientation of the walker. Potentiometer is on the steering wheel for receiving user input. In front of the walker there is control console. It consists of a key slot to turn on the walker, a volume knob for auditory messages and switch for selecting control mode. On the back of the walker, voltmeter, fuse and recharging port are positioned. (Rentschler – Cooper – Blasch – Boninger 2003: 1285-1286.)

In the research Rentschler, Cooper, Blasch and Boninger made, the Guido and current rollator were compared in aspects of completion time, obstacle/wall contacts and reorientations No significant differences were found between the devices for any tests, hence Guido didn't perform better than assistive medical device during the trials. (Rentschler – Cooper – Blasch – Boninger 2003: 1281.)

The Personal Adaptive Mobility AID (PAM-AID) was designed in Trinity College, Dublin, Ireland in 1994. PAM-AID aim is to provide both physical support and environmental information by voice messaging and hence maintain the ability to act independently and safely. PAM-AID has to control modes; in first one user is controlling the rollator and in second one is assistive mode in which the PAM-AID is controlling the front wheels to avoid obstacles. (Martins - Santos - Frizera-Neto - Ceres 2012; Lacey – MacNamara 2000:709.)

PAMM (Personal Aid for Mobility and Monitoring) is intended to assist the elderly living at home or in senior assisted living facilities. The PAMM is providing assistance in physical dimensions and guiding the user, but also monitoring the user's basic vital signs. In the PAMM is included six-axis force-torque sensor under the user's handle to predict user's intent. An admittance-based controller integrates these signals with schedule based planner information, the facility map and signals from the obstacle avoidance sensor intending to control system. Vital signs are monitored via on-board sensors e.g. electrocardiogram. The whole system communicates through wireless link to provide information on the health and location. Compared to other smart rollators presented, PAMM includes also medicine and other scheduling feature, to remind user important actions they have to perform. (Dubowsky – Genot – Godding – Kozono – Skwersky – Yu – Yu 2000:1)

VTT technical research center of Finland Ltd is the leading research and technology center in the Nordic countries. They offer research and knowledge expert services for domestic and international customers. VTT has developed a smart rollator prototype, which includes sensors and digital software to analyze user's physical condition and daily activities. These features enable the smart rollator to collect useful information on user's daily rhythm, walking distances, duration and speed of walking, in addition to handgrip strength. This information can be used to monitor wellbeing and physical condition of user. According to Kuusisto (2015) there are multiple options to further devel-

op the smart rollator such as include rollator a fall alarm or enabling information transfer to care personnel or relatives. (Kuusisto 2015.)

There are still other examples of smart rollators already prototyped. Most of them exploit technical systems to visualize and evaluate the area around and help navigating to direction wanted. Examples of these are VA-PAMAID and Simbiosis. (Rentschler – Simpson – Cooper – Boninger 2008: 1281; Frizera – Ceres – Pons – Abellanas – Raya 2008.) There are still some with robotic arms to help every day life such as MOVAID (Paolo – Eugenio – Cecilia – Giancarlo 1999:77).

I have gathered information about smart rollators existing in the table two to clarify features smart rollators include. As I earlier told there is different types of support smart rollator could give, hence features are categorized based on these types. The basic aim of the rollator is supporting physical locomotion and walking. However, none of the presented smart rollators have not been advertised, how they support physical needs. Frizera et al (2008:2) gives examples about physical assistance such as heavy elements are positioned at lower planes to increase stability, or walker has forearm platforms to support user's weight facilitating easy walking. Also, brake system is physical support to control rollator movement and prevent acceleration. (Frizera – Ceres – Pons – Abellanas – Raya 2008:2). The reports and articles considering these rollators presented above do not introduce these aspects, though physical support is noticed based on basic aim of rollator. As we can see (Table 3) environmental information, including the obstacle avoidance, and navigation has been popular in previous researches.

Table 3.   Features included smart rollators already existing.

Name of the smart rollator	Physical assistance	Cognitive assistance	Sensorial assistance	Health monitoring assistance
Älli-project	•	• Localizes services nearby	• Environmental information • Microphones, speakers, touch screen • Enables to make contact/ photo calls	•
C-Walker	•	• Navigation • Suggest safe way to destination	• Environmental information • Real time information about queuing time in shops	•
Guido	•	• Navigation • Suggest safe way to destination	• Environmental information	•
PAM-AID	•	•	• Environmental information	•
PAMM	•	• Navigation • Suggest safe way to destination • Medicine/other scheduling	• Environmental information	• Monitor vital signs
VTT-project	•	•	•	• Physical condition • Daily activities

4.4   Starting points for this research

This topic is very well researched, and a few smart rollator is already prototyped. I tried to several keywords on Google such as 'smart walker price', 'smart rollator price', 'where can I buy smart rollator', 'smart rollator manufacturer' and ' smart walker seller and many others, but I couldn't find any retailer actually selling these devices. There still is an interest for smart rollators, because so many has been prototyped and eventually need, because the aging of the population. Most prototyped smart rollators are concentrating on moving safely. Robotics could still offer much more opportunities to improve quality of life of elderly's, combining new aspects and dimensions to rollator. I

can see the potential in this, based on the earlier research and future possibilities; this topic is worth of exploring.

5   Data collection and analysis

5.1   Theme interview

Theme interview is a semi-structured interview, where form of questions is decided, but answers are not connected to given response options (Hirsjärvi – Hurme 2011:47). Interview as a data collection tool is good in situations as where person is seen as subject and person is creating meanings between things as a benefit of interview interviewer has possibility to ask to deepen the answer and find new aspects in interviewing situation. Interview as a tool, has disadvantages such as interviewer has to be educated for the mission, and multiple source of error, for example interviewee is giving socially appropriate answers. (Hirsjärvi – Hurme 2011:35.)

The purpose of interview is to collect data, so that researcher can make reliable conclusions about the phenomenon. This is the reason to prepare properly for the interview situation and the selection of themes is the priority. Sometimes it might be good to include narrow questionnaires in theme interview situation to gather compressed data. (Hirsjärvi – Hurme 2011:66.)

I have gathered themes based on first research question "What functional dimension smart rollator should resolve?", see appendix 2. I will seek the answer for this question based on daily activities elderly does and also evaluating current rollators on market. Even Hirsjärvi and Hurme (2011: 66-67) state that specific questions are unnecessary in theme interview, only themes are mandatory.

5.2   Preparing to theme interview

I started to prepare to theme interviews by contacting one rollator user's relative, who I knew already. She promised to join as an interviewee to my thesis process and she recommended to me that we would take practical nurse to join in our interview session. This practical nurse has also nursed, mom of the relative joining theme interview. Practical nurse has very long working history with helping elderly living at home, so she might give valuable insight to my thesis topics. Because both interviewees knew each

other and the themes were not personal, I assumed they would feel confortable together and increase the reliability of my research that way. Hyysalo (2009: 132-133) recommends interviewing two persons at the same time, when basic information is needed to gather. Interviewees can easily complement each other's sentences. Hyysalo (2009:133) tells also that he has very good experiences about a couple interviews, when interviewees have suggests itself the couple interview, hence I'm counting on it the good results too.

I prepared my themes for the interview based on research questions. I chose the themes carefully under surveillance my supervisor, so that they would give me the most appropriate and relevant answers to my research. I also made actual questions based on themes so that if I would freeze or loose my thought I would have backup.

I also needed to consider am I going to tell the current state analysis to interviewees. At the first I needed to gather information about elderly's daily activities and challenges as authentic as possible. These issues I would collect without any limitations. This way I could ensure that innovated smart rollator would really help elderly to live at home. After realizing what is innovation; something new or significantly improved (Inno-Vointi) I changed my plans so that precious interview time would not be used for coming up with similar functions that already exist. So I planned to start interview with Table 2 and going through functions and features from other rollators and pointing out that those are not what we are looking for.

5.3   Interview

I interviewed the participants on 27th May 2016. I recorded the interview by digital voice recorder. Interview started by telling features of previous smart rollators to interviewees, so interviewees could avoid coming up with similar and already existing features. Other interviewee was 68 years old women, whose mother is Helmi 88 years old rollator user suffering from Alzheimer's. Second interviewee was 61 years old home-helper and practical nurse from a company providing home help for elderly. She has work experience from this company for 8 years, but she has made work with elderly her whole career. Hence she has relevant information considering the challenges elderly face and also views how to fix these challenges. In addition to her professional background, her father is called Pelle (Per-Olof) 84 years old and he is also suffering from Alzheimer's.

Because interviewees knew each other, interviewees seemed to be relaxed and they had conversation with released atmosphere. The interviewees were supplementing each other's phrases that confirmed the status of a relaxed meeting.

5.4   Interview data processing

I started data processing by transcribing the interview. Transcribing is writing the interview dialog into words and there are no unambiguous guidelines how exact the transcribing should be. Data and research questions directed the accuracy of transcription. (Hirsjärvi – Hurme 2011: 138-140). Because my purpose is not to analyze the dialogue between interviewees, I don't need to record pauses in the conversation, volume and sighs. I decided to make verbatim transcribing, so that I wrote down who is speaking at the time. It would have been possible to collect only themes from interview, but if the data is needed later, it is available in written down format.

I read the data several times right after transcribing, so I would form understanding what the data includes. I noticed already in this stage that there are few topics, which are occurred in conversation several times for example elderly have lost their time perception.

After transcribing and understanding the big picture, I needed to choose coding system to arrange and analyze the data. Coding system can be done based on data alias inductive or based on theory alias deductive (Kananen 2014: 108). Inductive approach means making analyze from separate observation to generalization. Deductive approach is opposite to inductive; there exists common theory that is tested with research process. (KvaliMOTV.) In this research the main goal is to create new innovative smart rollator; hence data would lead to new information. Testing existing theories means that researcher would already know what might be the result. This is the reason why I selected inductive approach to be base for this analyzing process. Because pure inductive approach is not possible due to lack of presumption every human have, abductive approach is between inductive and deductive, data is the ground and theories are supporting blocks.

I started to collect every sentence or sentences if they related to each other on table, made with Microsoft Word software. I did this because I wanted to be sure that no de-

tail be missed from the analysis. After collecting the original words, I reduced the expressions to next column. In classified expression stage I reflected reduced expressions to research questions and tried to find code fitting on those questions. For example in table 4 interviewee says that "*sleeping, sleeping nothing is interesting in the stage I came along*", if the researched questions would be different than they are now, I would have made conclusion that elderly likes sleeping, that is what they just want to do. But when reflecting to research questions and also themes of theme interview in this thesis I coded the expression elderly is passivized. This same pattern I tried to use with every expression to increase the validity of this research.

Table 4.   An example of coding system.

The original words	Reduced expression	Classified expression	Categorized based on research question
nukku, nukku ei mikään siis kiinnostanu ja siis siinä vaiheessa kun mä tulin kuvioon	Elderly use time for sleeping and they are not showing any kind of interest.	Elderly are passivized.	Daily challenges
siinä se sitte istu (sohvalla). joo ku mä lähdin ni hän jäi sinne tota en tiedä koska sitte. joskus nukkukin ihan siinä.	Elderly spend their day sitting at the couch.		
mutta isäkin oli aika paljon olohuoneessa et sieltä se oli olohuoneessa ja istu sohvalla tuota et	Elderly is sitting on the couch.		
ja sitten palas istumaan olohuoneseen? joo ja television auki. ja istu loppuillan siinä	Elderly are sitting on the couch all evening watching TV.		

After classifying the data there was so many related topics messed up in the table, I rearranged the table collecting related classified expression one below the other, so I could combine similar issues for example elderly are passivized in Table 4. For realization of what theme of the interview I had used I made an extra column and rearranged the table once more.

It is not unusual that interview data processing emerge new themes (Kananen 2014: 111). While processing data there arouse new theme Well-fare of elderly, which was related to daily activities, but what elderly really enjoy and what makes them happy. For this reason, it has be drawn in to a new theme. Some of the themes I planned for theme interview blended to others or there was so less conversation about them, it wasn't reasonable to separate them. Under the circumstances the themes chosen are daily challenges of elderly, daily activities, welfare of elderly, wanted features for smart rollator and current rollators. Because every sentence was taken into the coding system, I made an unclassified section for sentences that were left over. For example interviewee says, "If the new smart rollator would talk, it might be a problem that the machine is talking, not real person" and this is classified as machine cannot replace real human. This classification couldn't fit in any themes and so it was gathered in unclassified section. In order to facilitate processing the data I made Table 5 based on themes and classified expressions included to theme

Table 5.   Classified expressions emerged in interview separated to themes

Daily problems of elderly	Daily actions	Well-fare of elderly	Wanted features for smart rollator	Current rollators
• Remember to take medication • Taking shower • Eating, drinking enough • Immobility • Choosing appropriate clothing • Time and time perception • Changes in personality • Violent behavior • Willingness to participate joint events • Lack of activity • The recognition of daily actions is deficient • Improper use of rollator • The courage to try things that are not familiar • Elderly is passivized • Elderly need stimulus to start doing actions • Assistance to go to toilet • Assistance is needed to take care of hygiene • Encouraging is needed to do activities • Making food • Someone has to make sure elderly eats • Sense of direction lost during walking	• Sitting • Jigsaw • Predetermined walking routes • Making coffee • Eating • Going to the toilet • Sleeping • Reading	• Singing • Listening music • Old domestic movies • Evening news • Physical training • Listening to a book • Events • Jigsaw • Reading	• Reminder for medication • Reminder for time perception • Advising to perform daily actions • Obstacle avoidance • Songs • Preventing of boredom • Physical training • Reminder for keys • Reminder for checking post • Steady chair • Easy use brakes • Winter wheels • Water bottle holder • Instructions what to do next	• Light weight and good adjustments • Locks • Basket • Seat • Too small elevators in houses • Shopping centers strips too steep • Home decoration is needed **Unclassified:** • Smart rollator would help living at home longer • Machine cannot replace real human • Elderly might feel pride owning new technologies. • Vocal stimulus might lead to actions. • Adoption of rollator use might be problem with some. • Rollator within arm's reach • Doing things without help is good • Performing daily actions depends on disease status • Disease progression can be slowed down by active life. • Feeling safety

Daily activities

There are only few daily activities among elderly, especially with those suffering from a cognitive disorder. In the interview, both interviewees told their experience to be that

the elderly are sitting on the couch most of the time. This issue emerged four times in interspersed with conversation.

> *"There she sat (on the couch). Yeah and when I left, she was there and I don't know when she…Sometimes she slept on the couch too."*

Interviewees described the typical day: first the elderly are getting up, they put on clothes, use toilet and if there is breakfast ready, they eat or then they have to make it themselves. After breakfast there is only few things to do. According to interviewees, most of them are sitting or sleeping. Doing a jigsaw, reading and listening to music or the news are enjoyed things to do. Elderly go for a walk if they are capable for it mentally and physically. Most of the elderly have same routes they are using, because of cognitive disabilities.

> *"So it is this predetermined route… so they learn some prescribed route and yeah they can manage with that until their cognitive ability decreases"*

What elderly are doing in the evenings is bit of a mystery for interviewees. Relatives are not spending every evening with elderly and home care has left and only critical nursing issues are solved in the evening shifts. The other interviewees said that when she once called to one elderly she was sleeping four o'clock afternoon, and other said that when she left elderly sitting on the couch in the afternoon, she found her in same place at the morning. The assumption of interviewees was that elderly use most of the evening on the couch watching television.

Daily Challenges of elderly

Interviewees discussed about elderly's time perception three times. They saw that it is real challenge if elderly does not perceive the time, because they lost their daily rhythm. Elderly sleeps in the daytime and hence they are awake at night. If elderly has some activities at a certain time for example watching domestic movie from the TV, they miss the activity, because of they don't recognize the time of the day. Challenges with time perception also burden the relatives, who have to be for example answering the phone when elderly is calling middle of the night.

> *"They are calling six times per night is it morning or evening --- I called once was it for or three o'clock when I needed to say something to her, so she was sleeping. And I said come on it is four o'clock. She taught it was night."*

The passivation of elderly is big challenge. It emerged in many different occasions during the interview. Both interviewees said that elderly do not have anything to do, lack of activities is challenge. Daily routines include a lot of sitting and lying in the bed. Elderly might even sleep on the same couch they spent their whole day. Interviewees thought that activation of elderly's daily life would slow down the progression of the diseases, both mental and physical.

> *"I think it would be good if they're not bored, so that they don't know what to do. And this leads to that they are going to certain condition and then they regress quicker. And that's why circadian rhythm is messed up, when you don't do anything else lying on bed or sitting and nobody is able to lie all the time…"*

Mental and physical weakening leads to problems to take care of personal hygiene. Showering isn't easy for elderly, but they might not see the importance of the hygiene anymore and even minimize it. The using toilet is also difficult. Sitting on the toilet seat might be hampered because of the high of the seat. If the toilet seat is low, elderly need extra aid for example handgrip located to near the seat. The toilets might be also too small to have rollator in it for extra help to descend and ascend from the seat.

> *"And the going to toilet… one thing she asked help for was to get up from the toilet seat, so that she doesn't fell down. And there was handgrips beyond the doorpost"*

If elderly has physical ability to walk, they might loose the sense of direction during the walk. They don't recognize the place they are in and know with direction leads to home. That is why the elderly with cognitive disabilities count on predetermined and learnt route they like to walk. It makes them feeling confident. Interviewees say that this predetermined route works for them until the cognitive disease progress.

One interviewee said that in medical aid centers they don't introduce well enough the use of rollator for the elderly. This leads to that the adjustments are wrong for person using the rollator and they misuse the rollator. They might push rollator too far from the body or lifting the rollator over the obstacles. As it is misusing rollator might cause physical problems such as back pain. Interviewees noted that even though medical aid centers would introduce the usage of the rollator properly; the fact is that the elderly might forget introduction right after they have been introduced.

Both interviewees agree that making food is difficult to elderly suffering decreased physical or mental abilities. During process of making meal, it is not unusual for the elderly lose their thought on what they are doing and for example recognize what is the kettle on their hand and what to do with it. The nurse told also example she had faced many times: elderly is watching in fridge, where the meal is, but they just can't see it. When nurse says that take meal out of the fridge, elderly is able to perform the task of getting the meal. Even if the elderly would get the lunch from food service or they would have home aid to help with making lunch, the evening meal is still managed some how. The most interviewees told that some kind of light snack was prepared to be ready for elderly or relatives has to come to make. One challenge related to making food is also that nobody can make sure are the elderly eating and are they eating enough.

> *"The sandwich was prepared at day and yoghurt was put in the cup, sometimes she ate, sometimes not"*

Other daily challenges emerged in the interview was elderly's changing personality and violence related to it. Relatives and nursing personnel might be even afraid of elderly behaving violently. One interviewee told example where elderly was tried to drive over the homecare nurse.

Well-fare of elderly

Even though the elderly are passivized physically; they still enjoy doing certain things. During the interview, these issues came up every now and then tand interviewees saw that these issues are making elderly's life enjoyable and increasing quality of life.

The most discussed issue was singing songs. Both interviewees said that it could be seen on elderly's face how they enjoy old domestic songs. Elderly might close their eyes and listen carefully to the song. Both interviewees were experience situations where elderly has lost their memory or even ability to talk and elderly still has inspired about the song that every word of the song has recalled to elderly. Everyday situations can stimulate some part of brains to remember songs also. One example talked about in interview was an old lady who saw postman outside the home; she started to sing an old Finnish postman song. Elderly enjoy both singing and listening songs.

> *"And I sing to him and he loves it so much. He quiet down and closes his eyes and smile. And after I have ended the song he opens his eyes."*

Elderly enjoy also physical training. Nurse especially told that they like it, when they have been training together. Training would be one activity for the day, if elderly would do it.

Evening news is both activities for day and also enjoyed entertainment. Especially news with plain language is preferred, because the ability to understand might be decreased. Other interviewee had noticed that in some point of progress of cognitive disability, elderly stops watching TV programs in different languages, because they are not able to read the translation text fast enough. Other programs elderly enjoy watching are old domestic movies. They might have to have post-it note or other reminder for when the movie begins, so they remember to watch the movie.

> *"And when we got TV fixed for Helmi, she really liked to watch old domestic movies."*

Wanted features

Even though the purpose of this theme interview was not to collect the wanted features for a smart rollator, the interviewees got so excited that they started to innovate, even though I tried to curb the enthusiasm. The interviewees hoped for new smart rollator multiple kinds of reminders. First of all interviewees would like to have reminder for time. Interviewees think this reminder should tell is it morning or evening, day or night to ease elderly's time perception. Reminder to take medication is seen very important too, because elderly miss the time to take medication or they hide those pills. In this same reminder category fits also reminder for keys. Interviewees think this when elderly are leaving the home reminder should remind for taking keys with them.

> *"It would be good that smart rollator would say the time of the day and would say 'hey, have you taken your medicine if not now go to take them'."*

Interviewees talked much about issues increasing well-being of elderly. These issues were hoped to be included into the smart rollator, such as songs, talking books and physical training. Boredom prevention, combined to instructions for daily activities was generally one wish from interviewees to help elderly live at home longer.

When talking about technical solutions, interviewees told that smart rollator should have steady chair and breaks that are easy to use. One interviewee also hoped that the rollator would have winter and summer wheels, because current rollator are slippery if used outside in the winter. Obstacle avoidance was also on the interviewees' wish list. In the end of interview, interviewees became excited about water bottle holder. One interviewee told that her mother does not drink enough, even if the relatives buy different kinds of drinks for her. She might walk into the kitchen and when arriving to kitchen she has already forgot that she became for drinking there. Helmi has dehydrated few times and this has lead to hospitalization and infusion into veins for recovering fluid balance. Interviewees hoped that smart rollator would include reminder for drinking enough fluids.

> *"These elderly people drink too rarely, so it would be good if smart rollator includes water bottle holder. Smart rollator could also remind in some point of day have you drunk and hence the bottle is located within arm's reach it is easy to drink"*

Current rollators

When interviewees were asked what are the good things in current rollators, they were giving answers such as good chair, good breaks and light weighted and good adjustments abilities. The basket in current rollators is a good asset, when elderly goes shopping. Interviewees had a view that buildings need bigger elevators, because too small elevator complicates the use of a rollator. Elderly has to fold up the rollator, hence they can't use the seat of rollator to sit and rest during the elevator ride. The use of rollator requires changes in decor of home. Carpets and some furniture might be needed to move away for possible and safe use of the rollator. One other problem in the usage of the current rollator is wheelchair ramps being too steep or even missing. The elderly needs these wheelchair ramps to access into the shopping malls, bureaus etc.

Daily rhythm

Interviewees described the daily rhythm such as incoherent and demented. Elderly wakes up and dress up. After this they go to bathroom to perform toilet actions. Breakfast might be ready if relatives have prepared it or elderly has to prepare it and after

preparing they eat the breakfast. Interviewees assumed that after this they sit and watch TV until lunch. After lunchtime, they sit down on the couch and might sit there until evening and in the worst case they even sleep on the couch. During the day, there might be few actions such as playing jigsaw or walk, if elderly have some aid from nurses or relatives for performing these actions.

5.5   Possible solutions to results of interview topics

There were many examples given during the theme interview how the elderly is passivized. They sit, they sleep, and they watch TV. Elderly might not have sense what to do. This can be expected to be a big challenge, because immobility and lack of activity leads in long-term period to decreasing of physical performance. Maintaining the daily activities and avoiding passivation are crucial in elderly to live home longer. (Haskell – Blair – Hill 2009: 280.)

In the interview, physical training was wished as a feature for a new smart rollator. Physical training is one good way to increase the amount of activities in elderly's day. These physical activities are important to maintain muscular and functional strength to cope with everyday life. Actually there are recommendations for older adults considering amounts of exercise to promote health and prevent disease formed by American College of Sports Medicine and the American Heart Association (ACSM/AHA). They have divided activity into three parts: aerobic activity, muscle-strengthening activity and flexibility activity. The recommendations include proposal of activity plan, which should have been done for each older adults to ensure exercises will be done. (Nelson – Rejeski – Blair – Duncan – Judge 2007: 1095, 1098- 1099.) Exercising is therefore important, but also easy way to help elderly live home longer.

Physical exercising could be arranged by automated video playing on a screen fitted in smart rollator. Nowadays exercises for elderly can be found in YouTube and it has been showed that seniors can understand and learn better with video (Liu – William 2014: 71). Hence videos are one way to implement training with low costs, because of existing mode of operation and already existing training programs.

So that elderly with cognitive disabilities really perform daily training session to gain physical improvement, Trainer has to be automated on the rollator. Every day should include some kind of exercise to perform. Because each elderly is a different person

and have their own habits, Trainer should be modifiable to personal needs. Elderly, relatives or nurses who knows the elderly might choose the time of the exercise. Even the exercises could be chosen according to the physical condition of elderly, be tailored to everyone. Tailored exercises could be used also in cases of recovery and rehabilitation from surgery and other operations. Many research support the idea of taking into account patient's physical condition and making personal exercising program to have significant impact to recovery (Giallauria – Lucci – Pietrosante - Gargiulo, G. et al. 2006: 716). This could lead to that therapist's could save time and efforts. Therapists could easily support customer to make needed actions to rehabilitate.

Mere reminding to do exercise might not be enough for the elderly. Acceleration sensors are very common technology used, for example in activity trackers; these could be used also in a rollator to ensure that elderly has done the exercise. On the other hand, there is ethical issue related to this, because every elderly has right to refuse doing the training if they are not willing and it has to be accepted. The information can be still important, for example considering new rehabilitation methods; if there is no progress in the healing process, the reason might be that elderly does not do the exercises, hence it is not reasonable to introduce even more challenging exercises.

New smart rollator helping in daily activities and reminding for these actions can be also seen as increasing physical condition. Interviewees wished that the new smart rollator would remind elderly to check mail. This means that if elderly is sitting on the couch and new smart rollator gives the command check the mail, the elderly has to move towards letter drop. Now they have to use their muscles and cognitive abilities to do the activity commanded. It has to be remembered that elderly have various degrees of cognitive disabilities and command 'check mail', might not be enough for the elderly to carry out the activity. More specific commands might be needed, for example 'check the mail from the hallway letter drop'. The reminder is functioning as a passivity reducer: reminders asking to do something and requiring to move around, the home can be seen as a place for maintaining physical and cognitive ability.

As told in current state section, the basic aim of the rollator is supporting physical locomotion and walking. These kinds of solutions told above; physical training, daily activities where rollator is needed to perform the activity, supports also the basic aim of the rollator in the point of view increasing the use of it. If the smart rollator inspires the

elderly to use more the rollator, the support for walking is needed more. Hence smart rollator can fulfill the basic need, the rollator is used for.

Songs, old domestic movies, news, voice books and physical jerks could remove lack of activity. Interviewees perceived singing songs a very entertaining for elderly. Interviewees had experience that elderly are enjoying it and even if they have problems with their memory, they probably know the words of old songs. They are enjoying singing so it can be seen from their face that is delighted and sometimes they are smiling with closed eyes. Wall and Duffy (2010: 108,113) have made literature review about music therapy effects on elderly with dementia and they have gathered many good impressions music and song have to elderly's life. These impressions are that music can enhance participation, social and emotional skills, decrease behavioral problems and help elderly to recall language skills. Among these benefits music can restore cognitive and motor functions and hence facilitate the survival of elderly at home. It has been shown that music improve patient's overall quality of life. Music therapists are no needed to achieve good impressions, music therapy can be provided by singing or playing background music. (Wall – Duffy 2010: 108,113.)

It is justified to say that because of good effects of listening to music, it should be included into smart rollator. It has to be discussed is the listening songs scheduled function for every day or is behind pushing a button, when elderly has their own choice when to listen. The deeper cognitive disability, more guided functions and buttons elderly might need. The buttons should be as easy as possible to use. For example, a smiling face button will continue and sad face button stops the music.

Burakoff and Haapala (2013: 8) tell that it is important to continue do activities elderly experience pleasing. The feeling of failure and anxiety is not allowed. So when these songs, old domestic movies, talking books and news are included into smart rollator, we need to know the user and what are their preferences. Adjustable features are the main issues when increasing the quality of life of the individual. If these features would be automated through calendar, different personalities and preferences would be easy to take into account; just schedule activities elderly likes.

One of the challenges interviewees presented was elderly's changing personality. Changing personality might include aggressive behavior towards other people. Lou (2001: 172) has researched impact of music to demented person's behavior. The re-

search result Lou made based on earlier studies is that music has potential to decrease violent behavior among elderly people. Lou also sees that when elderly can handle their violent behavior, it will increase their quality of life. Hence music and songs included somehow in new smart rollator might resolve several challenges with one solution.

Based on the interview, time perception is a challenge for the elderly and their relatives and possibly for home care nurses too. There is research data available that time orientation is related to whether the elderly experience their lives stressful or pleasant and how time is passed by. It guides the actions of the day and if there are problems in time orientation it might lead challenges in performing actions. Especially in the morning elderly have most problems with time orientation. (Iwamoto – Hoshiyama 2012: 202, 209.)

Smart rollator should tell the time by voice and possibly show it on a screen. Like interviewees said it is important to tell is the clock 4 a.m. or 4 p.m. to ensure elderly understand it. Because elderly might lose their sense of time at anytime, the clock should be easy to use as needed. This might design as a button for time elderly could push when needed.

Perception of the time is associated with performing daily routines. Dependent on degree of cognitive disability, telling the time of the day might give understanding what has to be done. For example clock is 7 a.m., now has to be dressed up. If the ability to understand the time has declined, the smart rollator could tell clock is now 7 a.m. and it is time to dress up. Elderly also might need a reminder for meetings, varied programs and activities during the day. Muistiliitto (2016) has paper version of calendar for elderly to mark up routines. Burakoff and Haapala (2013:4) recommend older people to keep calendar to make it easier for remembering. When elderly has decreasing of cognitive ability at an early stage, user would fill up the calendar included into smart rollator, but when the disease has progressed to severe stage relatives or home care could fill up the schedule. Burakoff and Haapala (2013:4) reminds that it is useful to maintain reading ability, but when the reading ability has lost the calendar is needed in vocal mode too. Hence new smart rollator should tell what to do in certain time.

There are also digital calendars, Outlook for example, where one can program meetings and schedules. An advantage of digital calendar is that one can copy paste the

routines easily based on one's needs. The repetition of events or actions can be set as daily, weekly, monthly or yearly, hence the daily routines are easily programmed. Digital version of calendar would be reasoned option for smart rollator.

Depended on who is using the calendar, it sets needs for the calendar system itself. The calendar should be easy to use, when elderly suffering mild cognitive disease is using it. There must not be many options and small text in the calendar, because too many options might complicate the use of calendar and too small letters cannot be seen. And when elderly's disease has progressed to severe stage, it might be reasonable that they are not able to change the schedule by themselves, because the ability to use system, even if it has been used before, might have been lost.

Helping with elderly's time perceptions eases the burden of relatives answering for inquiry of elderly. We can also assume providing aid for this issue could save time for elderly care givers. Some of the elderly have calling system for home care and elderly might contact fewer times, if they feel secure and know the time of the day.

Related to calendar and time perception there is also the issues of remembering to take the medication. According to interviewees, elderly might forget to take them or they try to hide and avoid taking medication. In the markets, there is different kind of medicine dispenser, where one can put medication ready to be taken daily and according the time of the day. Still there is challenge with remembering to take medication from dispenser and ensuring that the elderly really are taking the medication.

There are also available applications for remembering taking the medication. One example is Finnish Hyvinvointini- application for mobile phones from Orion Oyj. The application includes calendar and the user has to add batch number from medication packet to the system and insert the schedule of medication. After this, the application reminds every time that medication has to be taken. Only limit is that application is meant only for Orion's products, so other producers' products can't be reminded by the application. (Orion Oyj.) If a calendar was included in the smart rollator, a similar kind of system for taking medication would be easy to include in the calendar system. Presumably the costs would be minimum and not increasing the price of the smart rollator, because it would be only programmable addition feature for existing calendar system.

Beside the reminder for medication, there is still a challenge in ensuring that the elderly takes medicine and not hide it. There is for example Galantamine, which is medication for mild and moderate Alzheimer. The Galantamine can increase cognitive perfor- mance of Alzheimer patients at least half a year and increase or stabilize the general condition. The medication can slow down the deterioration of functional capacity of elderly in their daily life. (Erkinjuntti – Alhainen – Rinne – Soininen 2006: 488.) If elderly doesn't take this medication, the condition might decrease faster. That's why it is im- portant to figure out how to ensure medication taking.

Interviewees became inspired about water bottle holder. One interviewees told that Helmi does not drink even the relatives have bought lemonade for her. Relatives are also calling to ask if she has drunk enough. When the relative asks for her to drink, Helmi might go in to the kitchen, but after arriving she forgets why she came there. Elderly do not drink enough, partly because their reduced sensation of thirst. Several drugs used by elderly also dehydrate the body, which cause drop in blood pressure, which in turn increases the risk of falling. (Terveyskirjasto 2015.) Dehydration is a common condition among elderly causing hospitalization (Warren – Bacon - Harris – McBean – Foley – Phillips 1994: 1265). Dehydration in elderly is a serious, frequent and costly problem for society as research by Warren et al. (1994: 1268) has been shown. If the water bottle would be located on the rollator older person would have easier to drink more often to prevent dehydration condition. If someone calls by phone or the smart rollator would remind the person to drink, elderly does not have to go to retrieve the water from kitchen, risking in forgetting what she was to do. Warren et al. (1994: 1268) have the conclusion statement that dehydration in elderly is a significant cause of health care costs, which can be refrain by drinking enough.

If the smart rollator reminds to drink water, it might be that water bottle is not filled up. So, every morning the smart rollator should say a command to fill the water bottle. The water bottle should be easy to open and use, because of muscle stiffness, tremor and overall slowness in movement especially in Parkinson's decease (Terveyskirjasto 2016). The drinking must be made as easy as possible and the mouthpiece in such way, that the water is not springing between lips.

Sometimes it might be necessary to check out that the elderly has been drinking. Hid- rate Spark™ water bottle could be benchmarked for this need. Hidrate Spark™ con- nects via Bluetooth bottle and app that reminds to drink and also sensor inside bottle

tracks the water intake. In the Hidrate Spark™ app one can set an individual goal on how much to drink. In the USA markets this product costs 48,96$ so about 43,83€. (Hidrate Spark 2016.)

Preparing food is basic every day activity. Docent and a nutritionist Paula Hakala (Terveyskirjasto 2015) says nutrition has a considerable impact in elderly's health and performance in daily life. Sufficient level of nutrition prevents illnesses, prolongs the possibility to live longer at home, and increases the quality of life. Bad nutrition decreases mobility and ability to function, which in turn increases the risk of falling and fracture. (Terveyskirjasto 2015.) In conclusion, the support for preparing meals for elderly is an important issue.

People need food for living and the success of making food depends on visual, hearing, cognitive and mobility abilities of elderly. Some of the elderly need more support than others. Like interviewee said, his father had a phase when he could not see the read meal from fridge, except when someone asked to take the meal out and eat. Hence, if a smart rollator would help elderly to prepare meal and eat it, different users should be observed. The needs for this help differs based on the physical and cognitive condition of the user, others need more help others less.

FoodManager is an app for elderly people to give support for them when preparing meals. The recipes are easy to prepare and designed for elderly's nutrition needs. When elderly is ready to use the recipe, app will manage the oven. The app sends recipe name, oven function, temperature, time and preheat function and so it is easier for elderly to concentrate on preparing ingredients. FoodManager has feature to handle the food in the fridge and it can prepare list of needed ingredients for shopping. (Inglesias – Ibarguren – Gomez Ge Segura – Ugalde – Coello – Iturburu 2010:3.) It might not be possible to connect oven and fridge to function together with new smart rollator, but this could be used for designing food manager for smart rollator. For example ready to use shopping list probably makes easier to start trip to the grocery store and also reduces risk of forgot what to buy.

FoodManager can be used when cognitive abilities have been reduced mildly. Here in Finland elderly have the food service to deliver a meal to elderly's home once a day. In order that elderly eat the meal and hence gain good nutrition level, it has to be more researched. In the interview, arose this same issue that nobody knows if elderly eat or

not. If a smart rollator would tell, "now is time to eat", there should be at least approval button pushed when the meal is eaten to ensure meal was eaten, not put into garbage. However elderly's cognitive ability might not be good enough to use button in the way it is supposed to. They might push it without real purpose and hence the button loose it's meaning. At this moment, the button seems to be the only option to solve this issue, but in theme interview this idea can be brought forward.

Obstacle avoidance was discussed in the interview even though the features of current smart rollator were introduced at the beginning of the interview. Because the aim of the new smart rollator is to be innovative, it is obvious that copying existing rollators can't be done. Innovative product is new in matter of technical or other issue or significantly improved. If participants of innovation conversation would find new approach to this functional dimension, it could be used.

One challenge that emerged in the interview was elderly's problem to take care of their hygiene. Toilet actions might be difficult, because of physical capacity or even mental capacity; they don't remember what they are doing. Showering needs also physical capacity, because of the need to undress and dress up. Using body dimensions while stripping clothes might be tiring for elderly. Taking a shower include many risks, for example slipping. The options how a smart rollator would answer to this challenge are difficult to figure out. Quite often in the bathroom the air is humid, which might establish unspecified needs for rollator using. Other challenge, that needs to be considered when designing the rollator, arises from the fact that bathrooms vary greatly in size.

Supporting all kind of activities, that require cognitive abilities is important, because using of cognitive abilities help remain and maintain performances, which are effected by cognitive impairment. Cognitive practicing and mental activity might slow changes in cognitive impairment, elderly can learn new things and mood and performance are healed. (Hallikainen – Mönkäre - Nukari 2014; 97, 99-100.) If smart rollator has the ability to affect the issues mentioned before, it might have a positive impact in the progression of the decrease in cognitive ability.

Current rollators have many good features according to interviewees. Steady seat, easy to use brakes and basket were seen very important and user-friendly aspects. Also, lightweight is seen as an advantage when comparing rollators. These stated, good features should be included in the new smart rollator too. In order to innovate new

smart rollator it is not though justified to concentrate to improve these technical features, because in the markets there are so many different options for these already and technical issues are researched on several occasions (Bastos-Filho 2014: 125-126).

5.6   Conclusion of interview data

After collecting the results of the interview and processing the information, I needed to somehow delimit the results and ensure I develop the project toward the aim of the smart rollator to be innovative. In order that the new smart rollator would be something new, I based my criteria on existing smart rollators features in Table 1. There I have compared these existing smart rollator by the type of their features. The types of features are physical assistance, cognitive assistance, sensorial assistance and health monitoring assistance.

Some of the issues, emerged in the interview, are highly related to others for example these reminders. In the interview, the interviewees hoped that the smart rollator would have a reminder for time, for remembering keys when leaving home, reminder for checking post etc., hence these are combined under one headline all kind of "reminders for daily actions". The issues are collected based on the type of assistance needed and one additional group "technical improvement" for issues like steady seat.

Table 6.   Topics emerged in interview reorganized based on what kind of solution type it might be.

Technical improvement	Physical assistance	Cognitive assistance	Sensorial assistance	Health monitoring assistance
• Sturdy chair • Good brakes • Winter gears • Water bottle holder • Good weight and adjustment • Locks	• Assistance to go to toilet • Assistance to shower	• All kind of reminders for daily actions • Prevention of passivation • Time perception, calendar, medication • Preparing meal	• Choosing appropriate clothing • Predetermined walking routes • Obstacle avoidance • Drinking water enough	• Physical training • Music, news, other pleasing activity

The first phase research question was "What functional dimension smart rollator should resolve?". The issues emerged during interview are analyzed and collected in this table 6. Based on the amount of occurrence during the interview, prevention of passivation is the biggest functional dimension that should be resolved. Physical training and all kind of reminders would be also in the top according to interviewees' interest to discourse about these issues.

5.7   Preparing to innovation conversation

The first phase concentrated on rollator user's needs. Beyer and Holtzblatt (1998: 217) reminds that customers rarely can articulate their real needs and they have limited understanding how technology could help them. That's why innovators should observe challenges beforehand and after that, recognize the possibilities for use technology. (Beyer – Holtzblatt 1998: 217.) Challenges have been identified and now it is time to continue to innovation part.

I have gathered an estimated timetable for this innovation conversation in appendix 2 for clarification to keep up the time limitations. The timetable was functioning also as backup that we are debating all aspects that I have thought before hand.

The participants of innovation conversation were Prosthetist from Espoo city Apu-välinepalvelut, rehabilitation counselor and physiotherapist from Fysiogeriatria and emeritus professor of robotics from Gimltd. The specialists from Espoo city and Fysio-geriatria have the experience of the needs of the user, but also they know what kinds of rollators are bought. Specialist from Espoo city has experience about public sector, which is the main customer segment for rollators, but the Fysiogeriatria has also expe-rience of mediating medical aids to public sector. Specialist for robotics was chosen to participate in the innovation conversation to give insights how challenges could be solved by using robotics. This cross-functional team with diverse perspectives could ensure the creativity of the group.

The innovation conversation started with presenting the participants. I presented my previous work done for participants to get whole picture and position where we were at the moment. The current smart rollator (Table 3) was also presented, because we need to avoid similar features already existing to create something new and innovative.

The evaluation of the first action research cycle is done in the innovation conversation. The table 6 was presented for participants and also printed on paper, so that the main challenges were available all the time. We evaluated the needs of the user and challenges we want to resolve with the new smart rollator with questions like; can participants of innovation conversation see the importance of these issues? What else is important to resolve with smart rollator?

After evaluating the existing list of we were talking and innovating how we are solving these challenges and what are the functions that are included in the smart rollator to help elderly living home longer I drew a feature tree on the meeting room wall and include there these challenges to be resolved from table 6. For the innovation conversation I needed to translate challenges into Finnish to the language used in the conversation. We used post-it notes for filling the functions we wanted to include the new smart rollator. This kind of feature tree ensured that we processed the every challenge during innovation conversation and also it functioned as illustration of our ideas. Feature tree is presented below in Picture 3 as plain tree before we started the innovation conversation.
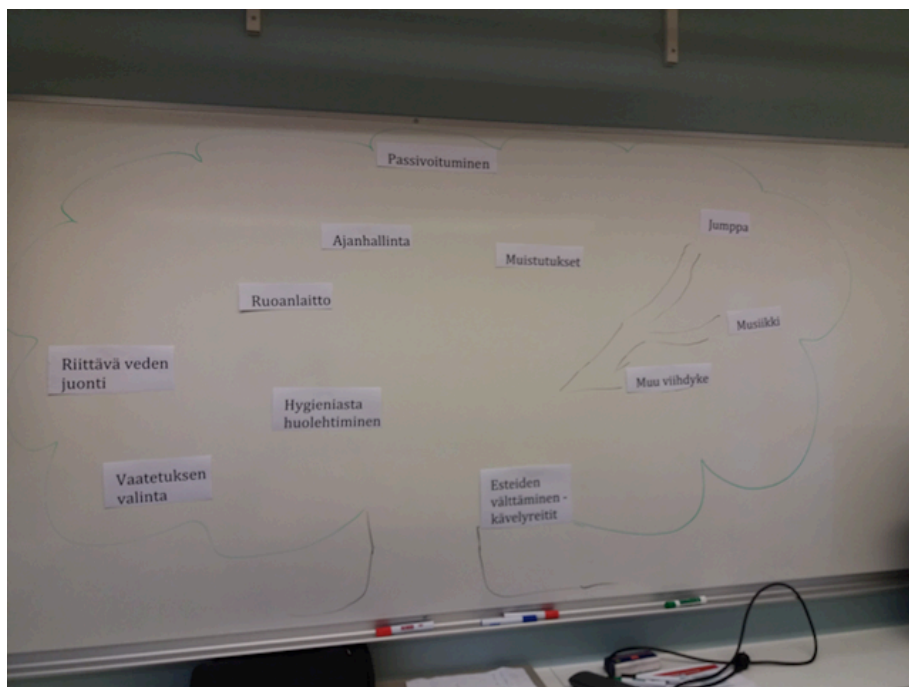
Picture 4 Feature tree before to be filled up.

In the end of innovation conversation session the participants decided the best solutions for the smart rollator. Innovation group also estimated how would elderly's daily

routines change with the new smart rollator. And the most important thing was to evaluate how much this smart rollator should cost, so that customers are willing to buy it. What other aspects than cost influences on the buying process of smart rollator? Can we offer enough value for customer to buy this product?

5.8   Innovation conversation data processing

Besides the feature tree we filled in together with innovators, I recorded the conversation. I started innovation conversation data processing with similar approach as theme interview phase. First I transcribed the conversation without pointing out pauses, volumes or sighs, only words were written down. After reading the data through several times strengthen the understanding of the content became clearer to me.

I chose the same coding system as in the theme interview phase. Abductive approach in the data processing was used. I tried to be open minded to my data, but still the process was guided by research aims and questions. I collected every phrase or phrases related into table, because I wanted to make sure every detail was considered. After collecting the original words, I reduced the expressions to next column. In classified expression stage I reflected reduced expressions to research questions and tried to find code fitting on those questions. The list of reduced expressions became great as 59 pages, here is presented only one sample related to motorization of smart rollator (Table 7).

Table 7.   Reducing the expressions and classifications in innovation conversation phase.

The original words	Reduced expression	Classified expression	Categorized based on research question
ja silti se ei sais lisätä sen pianoo	Adding the mechanics can't increase the weight of rollator	Mechanical parts can't increase the weight of rollator	Keeping the reasonable weight
se paino on varmaan ihan oikeesti iso asia siinä.	Weight is important aspect		
mut eiks se fysiikka kumminkin sanoo et jos se liike energia täytyy sille antaa jos ei sillä sitä ole mitä liikettä eli omaa kykyä, mutta sit jos tää robotti tulee niin sillonhan se voi esimerkiks avustaa	According to physical laws, object that is not self-energy, energy has to be given. Smart rollator could assist in the movement	Smart rollator assisting in the movement Example electric bikes as uphill aided product	Assisting movement as in electric bikes
niinku polkupyörät A: niin se sähkö-polkupyöräjuttu, ni sehän on tyypillinen tämmönen niin ni S: ylämäkiavusteinen	Electric bikes are a good example of this uphill aided product		
niin ni onks se mielekästä tämmönen et mä tarkotan sitä et sillonhan se oma energian antaminen siihen sit vähenee mut onks sillä merkitystä et sä liikut samalla et onks se liikun-taväline vai onks se peri-aatteessa vaan apuväline et se jalat liikkuu ni se on sulla… et tää on sitä fysioterapi juttua mitä mä niinku ajan vielä takaa	Does it matter is the rollator medical aid or exercise tool. Does it matter is the rollator producing the kinetic energy of the move-ment.	We can assist the movement of elderly and give kinetic energy for rollator	
tässä on just se et se on se asiakas et jos justiin et jos ihmiset on passivoituu tai on passivoituneita et sithän niille ei voi mitään motorist et se kannattais miettii et sithän niistä tulee vaan vielä laiskempia	If elderly is passivized, motorized rollator is not suitable for him, but passivizes even more	Motorized rollator could passivate the elderly	Motorization might have both positive and nega-tive impact
mut se on et eihän sitä voi ikäihmiselle antaa et sithän se ei tee enää mittään… et ne sitten kohtaa ne	Giving motorized rolla-tor to elderly passivizes him to use his muscles even less		
mutta se just jos asiakas ryhmä olis aktiivi tai ak-tivoitais rollaattorin avulla	Active elderly could gain benefit from motorized rollator	Active elderly could benefit from motorized rollator	

In the beginning of the conversation session, innovators stated the meaning of the rol-
lator and the related issues, so that everyone had the same understanding of the ba-
sics. As the result they stated that rollators are for balance, not for leaning on or to be
pushed, but for support. Innovators reminded that the right way to use rollator is to

stand between the back wheels and "*walk with*" it. Elderly doesn't have to have any kind of diagnosis to have rollator from medical aid center, only phone call for example from concerned relative is enough. After contacting the medical aid center, Prosthetist evaluate the needs and desires together with rollator user. Rollator user is taken into selection process and can affect to the choice what kind of rollator is most wanted one. When rollator is obtained from medical aid center, user can trust to that the rollator is maintained and brakes are working, as they should. The medical aid centers have several models of rollators for different kind of needs and they all are recyclable and maintained with propriety.

The first aim of the conversation was to confirm the challenges found in previous theme interview. The innovators saw the challenges as real life problems: "*And I think these are basic problems what you have collected here*". The innovators conversed that drinking enough water is a huge challenge among elderly, and if their fluid balance is poor, it affects their physical balance and absorption of drugs and metabolism. Also, hygiene of elderlies was seen an authentic challenge. For example

> "*Urine infections are very typical among elderly, who drinks too little and sit a lot. And there is not one or two, but several elderly who dries diapers on the radiator and uses them again. Elderly having different number of bacteria is challenge*".

Innovators pointed out the same issue as in the theme interview, that elevators are too small, but also the narrow doors, cobbled streets and thresholds are challenges for elderly.

Even though the innovators recognized the challenges found in the theme interview, they wanted to emphasize different types of challenges. They wanted to focus approaching the new smart rollator from its current purpose and meaning for user.

> "*These balance issues and to lean on or not are the questions we need to think about, these are the basic issues. What are the authentic needs for end user, what is the function smart rollator is made for? And now the current rollator has passive mechanics and we want to add mechanics, so why we would do that?*"

Innovators expressed more daily challenges that were not listed in the theme interview, such as getting up from chairs and sofas, walking in dirt road, muscular debility.

Getting up from chair was seen as a challenge among elderly.

> *"And if customer sits on chair, can rollator somehow ease the rising? I think this is important. And if we think current rollator, it won't help you at all if you don't go far enough on the rollator and push up when holding up handgrips, if customer slightly pull rollator might fall over".*

Innovators said that assistance for getting up for example to elderly suffering from muscular debility would be one aspect to support with smart rollator. This could be done with power steering.

One innovator reminded that mechanization and its aims should be framed before really starting the design process. Innovators thought that a tug assistance for example on a dirt road or crossing an obstacle would ease elderly's movement. Other example would be stepless high adjustment to adjust the support the different use situations and width changeable rollator for example to fit in tight elevator. Innovators thought that there might be positive and also negative affects if the smart rollator is mechanized; already passive persons might get more lazy, but active persons might be activated even more. Innovators paid attention to possible challenges in designing process for mechanized smart rollator. One was that the mechanics could not be located in the middle of the rollator, if we want to save the possibility to have a seat. Actually, it might be good, if the mechanics would be located as low as possible, so that rollator would gain more stability.

If the smart rollator is mechanized, it will need batteries. Innovators noted that batteries are heavy; hence they might hamper the use of rollator. Capacity of the battery has to be designed to meet the needs of the user. The ideal situation among innovators would be that there would be two types of batteries; one inside use and one efficient one for outside use.

Batteries need to be charged periodically. Innovators were concerned how the elderly would realize and remember to take rollator into a charger. They ended up in to a solution that charging the batteries would be during the nighttime. Most reliable version for elderly would be the rollator that can locate a charger itself, so that elderly doesn't have to do anything for charging.

The charging position could be some kind of dock system for rollator. Dock system was seen both as charging dock, but also as dock for example to connect a tablet in smart rollator. According to innovators, the dock could include the personalized data. For

example, if the smart rollator bole is taken into leasing maintenance, the replacement rollator for temporary use could be personalized for individual's needs by attaching the tablet to dock system. One innovator had opinion that this dock system could keep the price of smart rollator lower level.

One innovator noted that there are challenges in the hygiene of the elderly and if rollator is meant to use also in bathrooms for example assist to rising up from toilet bowl, the hygiene of rollator should be ensured. Disinfecting cleaning cloths might be included to supply of rollator. When speaking about elderly they might need some kind of reminder to use these cleaning cloths. Innovators suggested an option that cleaning would be combined to charging unit.

> *"Rollators are years and years in the use of one person and when time passes by brakes broke and rollator are in need of maintenance. Elderly themselves even recognize the defects. --- Then there is some relative with screwdriver fixing the brakes."*

Because of these issues the rollator should detect the need for maintenance, so that rollator would be safe to use. Innovators discussed about how nowadays responsibility for maintains rollators is on medical aid centers and how it would change if the rollator includes mechanics. Current rollators are washed in water, when they arrive from use to the medical aid center. Hence smart rollator needs to be waterproof. In the conversation, it was noted that it might be good to have leasing-product and service around it, because medical aid centers don't have knowledge base for maintaining mechanical products.

When innovators talked about using the smart rollator, they found several things to think through before proceeding with designing process. Innovators thought that smart rollator should be as attempting for use as possible, like smart phones. All the services should be available in one system, hence resistance to use the smart rollator would decline. In turn, in design should be estimated the elderly's ability to use smart systems. Innovators believed that some cognitive abilities are needed for using these mobile and smart solutions. Hence new generation of elderlies are aging and in ten years the knowledge level in technical and mobile solutions will increase, because people are used to utilize them. The timing of the introduction of the smart rollator is in crucial for elderly's ability to use the smart rollator;

> "*To ability to use technical and mobile solutions is pretty much related to individuals stage when they are taught to use solutions.*"

If the use of smart rollator needs more introductions and knowledge, it would be easiest to outsource the introduction to supplier of smart rollator. One of the innovators said that it is huge human resource consuming stages of process and medical aid centers have neither knowledge nor the human resources to do that. Leasing service arouse from the conversation again.

According to innovators there are multiple options for entertainment when frames of the smart rollator is defined, only "*the sky is the limit*". One option is dance mat. Youth people are playing with these kinds of activity games and elderly would enjoy it too. Other option one innovator gave, was the balance board. Rollators are given to elderly when they have balance problems and exercising with this would enhance their condition. There might be for example an order to come to balance board. Based on the elderly's situation it could be forced or volunteered. When innovators developed this idea to further, they saw that balance board could send information about elderly's physical condition to home care or relatives. Heart rate sensors might be included into rollators handgrips and they could send information about health also and caregivers could monitor the heart rate during the exercise. Innovators brought up also the community through playing games.

> "*In the elderly centers they are playing together a lot nowadays. For example in the sparsely populated area, when one come to elderly centers to play with others, they are paying 80€ for taxi. This is not cost-effective. Almost every fin has TV so combining it to these games and camera enables elderly to join to the game from home.*"

About prompts innovators thought that speaking is the best way to communicate. Voice of speaking can be added or it can be adjusted to hearing aid. One innovator said that especially time of the day should be spoken every now and then. Innovators proposed that even Menumat, meal delivery service, might be included into smart rollator. Smart rollator could say when it is time to eat and there could be button, where to start the Menumat to warm up the meal.

One innovator presented an option of wheelchair combined to rollator. One saw that the challenge of the rollator is that elderly who has lost their muscle strength has only

possibility is to sit and rest and then carry on their journey. But if rollator would be also wheelchair elderly could carry on the journey even the muscle strength in legs are lost.

Innovators touched on the designing process during the conversation several times. One innovator emphasized that reason why smart rollator is mechanized has to be clear before proceeding with the designing process. Other innovator reminded that there are already different types of solutions to elderly to manage their every day life. These solutions should be utilized, not re-invented and the possibilities should be found to combine these solutions to the smart rollator. All innovators agreed that data between these solutions should be easy to share and found.

> *"It could be the wristband, it is like safety wristband but it measures the activity too. So could these read each other or if there is mobile possibilities, so could relatives see that mom has not went to shopping, so that data would be shared. Or could home care nurses see that 'hey, she has no patience to go to elderly center to exercise or she has not gone to eat to elderly center."*

Innovators emphasized that difference between intended use of current rollator and smart rollator should be clarified. What kind of user this smart rollator is meant for? The whole concept should be written open. In this conversation innovators pondered the option to have leasing-service to respond to all needs and expectation for smart rollator. They considered that locating mechanical parts low as possible could increase balance of the smart rollator. They stated also, that smart rollator needs to be waterproof and recyclable.

In the conversation arose multiple issues that cannot be explicitly covered by any broader topic found in conversation. For example, the ability to be folded up has to retain in new smart rollator. It is important aspect, when elderly is moving around outdoors, in taxi's or busses. Innovators weight that reminder application is very useful and needed feature. Especially taking medicines is desired to be included into system, but also the drinking enough water could be one thing. Innovators predicted the future also and anticipated body fluid balance tracking without blood sample, possibly from breath detection. Innovators saw that smart rollator has to be safe and one product including everything.

In the end of the conversation the feature tree had been filled with post-it notes including the topics that arose during the conversation (See picture 4). When asking what are

the most valuable features innovators have presented during the conversation, the answer was clear: motorization. That was the feature everyone agreed. This was justified that motorization changes the use of rollator most compared to current rollator. Other features desired to be included were the reminders and also the compatibility of the different systems to smart rollator.
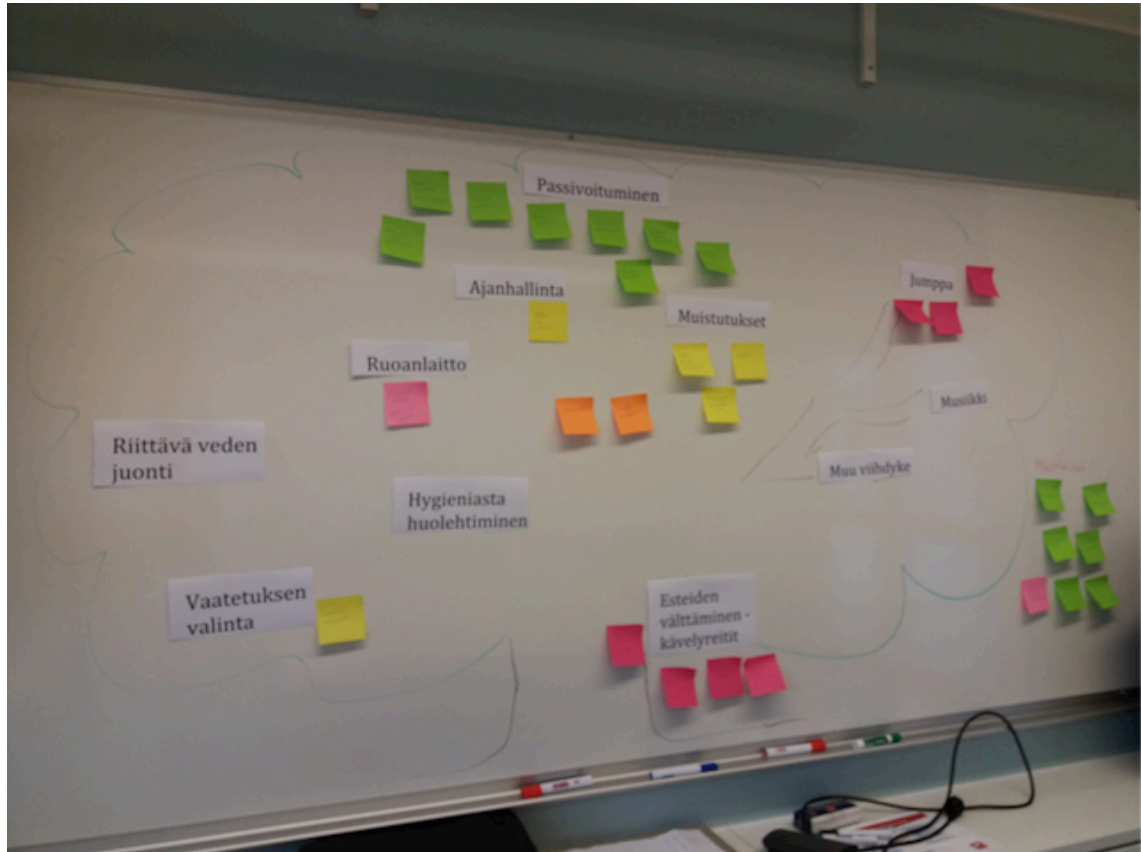
Picture 5 Filled feature tree

In the end of the conversation, innovators discussed about acquisition process of rollators and the predicted price of it. One innovator told that price is big aspect in public acquisition processes, but there are also safety issues and the possibility of recycling and also user's needs. At the moment, there are 5 models in prosthetist's unit to answer to different needs of the users. The estimation of price of current rollators in public health sector is 45€ to 160€. Innovator reminded that it has to be taken into notice that these prices are tax free and tendered prices. If these most wanted features would be included, the price would rise up to 2000€-5000€. One innovator pointed out, that price estimation is difficult to do before sketch design and knowing the components, but the estimation up to 6000€ is pretty much comprehensive.

After data process I collected the solutions for the challenges innovators brought into the table to more easily to manage and analyze the data collected (See table 8).

Table 8.   Possible solution for elderly's challenges by innovators.

Battery	Motorization	Call system	Playing	Usage
• Capacity of battery has to be designed • Batteries are heavy • Charging possibilities for batteries has to be designed • User needs for different types of batteries • Various batteries for inside and outside use • Responsibility to maintenance: commune or supplier • Charging in night time	• Clarification of purpose of mechanics • Motorization can't increase weight • Assistance in moving like in electronic bicycle • Motorized assistance when rollator is moved • Motorization might have positive and negative impacts to elderly's life • Pull assistance • Pull assistance is safe for elderly • Stepless height and width adjustment • Location of mechanics as low as possible to stabilization • Width changing	• To avoid falling injuries some calling button to call rollator near • Voice call is one option, but it probably won't work • Physical call button is most viable • Wristband could detect the moving and call rollator to be near • Wristband could detect the moving and light up lamp in rollator	• When frames of rollator is clear, enormous amount of possibilities for entertainment • Balance board • Dance mat • Call to come balance board • Balance board could send information about elderly's physical state • Playing with others from home • Heart rate sensors into hand grips of rollator to communicate with games	• Attractive to use • Elderly's ability to use technical solution • Some backup elderly don't leave the smart rollator home when going out • The timing of the introduction of smart rollator • Outsourcing of introduction • The division of responsibilities • Leasing- service • Medical aid centers have no competencies for mobile solutions
Maintenance	**Cleaning**	**Dock**	**Prompts**	**Wristband**
• Automated tracking for need of maintenance • Water cleaning proof • Outsourcing the maintenance	• Need for ensure hygiene of rollator • Cleaning clothes and reminder to use them • Different tyres for inside and outside use • Could cleaning and dock unified	• Includes personalized data • Can keep the price low • Need for maintenance tracking	• The most viable way to convey prompt • Could Menumaatti be combined to rollator • Time of day spoken	• Safety wristband combined to activity tracker • Elderly resist to use safety wristbands • Versatile features decreases the resistance to use them
Remote detection	**Rise up assistance**	**Wheelchair-rollator**	**Other issues**	
• HSL ticket remote detection • Electronic doors detect rollator and opens the doors	• Current rollator doesn't assistance in rising up from chair • Rise up assistance needed • Can be executed by power steering	• Combined wheelchair and rollator • If leg strength fails, elderly still is able to arrive home • Tukimet is one producer	• Data has to be able to be changed with different products • Safety • One product all services • Visually impaired is one user segment • Reminder for drinking enough • Surveillance of fluid balance • Parameters of breathing air • Challenge is not detecting the obstacle, but how to get over it • Reminder application • Reminding of taking medicines • Comprehensive health surveillance • Ability to fold up	

5.9   Analyses of data from innovation conversation

First noticeable difference between the theme interview and innovation conversation was that interviewees and innovators saw very differently the challenges of elderly's daily life. Those challenges interviewees presented, were agreed in the innovators conversation, but innovators did not emphasize these challenges. Their opinion was that basic movement should be in the center of this design process.

The innovators had the opinion that standing up from chair is the biggest daily challenge, which should be resolved. Importance of this challenge can be found also in the literature. The ability to stand up from a chair is crucial part for independent living. Standing up can demand more muscle strength than walking or climbing stairs. Standing up successfully requires comprehensive motor control but also dynamic stability. This is emphasized especially when chair seat is lower than knee height. (Hughes – Schenkman 1996:409; Scarborough – McGibbon – Krebs 2007:33-42; Alexander – Grunawalt – Carlos – Augustine 2000:633-634.) Bearing in mind that passivation was the biggest challenge according to the theme interview, mostly because elderly just sit day by day; I can make an assumption that standing up from the chair is the first step forward in active life. Hence this challenge and the innovators solution for it, motorization, have to be taken into consideration of final proposal of smart rollator.

If pull assistance for standing up is included in the smart rollator, battery is needed. Innovators proposed charging dock, so that elderly would not have to remember to charge the smart rollator. This is definitely important aspect especially for elderly, who has decreased cognitive ability. Robot vacuum cleaners contain this kind of technological solutions needed for smart rollator too. Robot vacuum cleaners can navigate to the docking station and they can detect the battery running low and estimate the time they need for arriving for dock station, so that they never shut down during the journey to the dock. (Vacuum cleaner buzz 2015).

There are also wireless chargers available. Chargers located on the table are pretty known, but now there is also charging furniture coming also in to the markets. For example Ikea has already lamps and bedside tables to charge smart phones. They have also charging plates, which can be located all over the apartment. (Ikea.) The question is how much smart rollators battery capacity will be, so that wireless charges has ability to charge them. However, I see that this could be also one technique to solve the

charging problem, so that elderly does not need to remember to put rollator in the charger. The difference in price between wireless charger and dock station has to be estimated before designing a prototype. The dock would be an extra product and increases the price of the smart rollator as do also wireless charger.

Innovators discussed about playing and it's benefits like community and interaction through playing. Innovators proposed dance mat and balance board to enhance the physical activity of elderly. Most of the dance mats available in the markets, needs some kind of game consoles, probably a kinetic sensor too. If this kind of activity product would be included into the smart rollator service package, it might increase the purchase price, because of these extra components needed.

Game playing among elderly has still a huge commercial potential. Elderlies are seen as wealthy generation, who can buy things and also their ability to use mobile solutions is increasing all the time. Business model is often difficult to form, because the buyer, user and payer are usually different persons. (Yle Uutiset 2014.)

There is Finnish research about digital games among the Finnish elderly. The result is that the elderly are willing to try digital games or they are already playing. The 66% of the answerers were either already playing or willing to play. The most popular game types were puzzle games and secondly they were interested about sports games. (Intosalmi – Nykänen – Stenberg 2013: 7, 10.) Similar kind of results have been obtained also in the research of Join-In project, which is project for elderly networking and social life activation funded by organizations from Germany, Finland, Hungary, Ireland and Norway. Hence the research result are obtained from more nationalities and reflects European elderly's wishes for digital solutions. Conclusion of the Join-In project was that the elderly especially liked functional games. They collected also the list of the features games should have to meet the requirements for elderly use. Games should be interactive as well as competitive and the rules should be easy to understand combined to visual and verbal explanations, speed of the game should allow an opportunity to correct bad moves and especially game has to be fun to play. Elderly poorly tolerate any incompleteness or waiting, they leave the game for good. That's why, before launching any game for elderly, it has to be tested and proven to work. (Yle uutiset 2014; Join-In 2014: 7-10.)

Pokémon Go is one example of succeeded digital activity game. Research shows that it increases the users amount of daily activity significantly and the researchers conclude that there is great opportunity for public health in having geocentric games like Pokémon Go (Althoff – White – Horvitz 2016:7). Could it be possible to design similar activity game also to elderly, yet take into notice the limitations and needs for digital solutions designed for elderly? I suggest that there could be walking game combined with other aspect, for example geocaching tailored for elderly, which might reward the user or user could proceed in the game based on their success. This could inspire the elderly to use the smart rollator more. Additional benefit would be healthier and more active life for elderly, which leads to ability to live home longer.

For the games, it is relatively easy to include the social aspect too. Many elderly live alone, both in Finland as well as elsewhere in the European area. That is one reason for the elderly being lonely and lacking for social contacts, which leads to physical diseases such as strokes and the onset of Alzheimer's diseases. (Join-In 2014: 3; SVT c 2016.) Adding social aspect to games for example chatting or calling within the game or sharing the results of the game on joint platform would enhance contacting other elderly and creating a new social network.

Playing these kind of activity games is relatively easy and also cheap. Games can be played with smart phones or tablets. In the markets, there are holders for tablets that can be attached to a rollator, so that games would be always with elderly. These are plastic products and the mass production would not increase the price of smart rollator disproportionately. The prices for tablets vary from 150€ to 600€, depended of the brand and features in the tablet. It can be assumed that relatively well functioning tablet costs around 300€ and if tablet would be acquisitioned, the price would decrease. The possibility of producing own tablet system designed for elderly use might be appropriate option, when I think about manufacturing costs and price for consumer.

Cognitive games are already available for elderly, for example Memoera offers gaming machine for those with decreased cognitive ability. It includes games that activates memory and gives daily activities. These gaming machines are already in elderly centers in experimental use, for example in Varkaus City. (Memoera.) Hence the cognitive games might be additional features in smart rollator, but in this point there is no reason to start build up new cognitive game sets, competing with the existing system and products.

Innovators expressed the need for different reminders, like taking medication or performing other activities. The same topic occurred in the theme interview phase, and as I already processed the topic there, the result could be based on for example Outlook calendar application. Even if the programming is done from scratch or used already existing base system; this can be included in the tablet or smart phone too. Reminder will not need an additional element into the smart rollator, so the price can be retained more easily. The costs of this calendar system comes from developing and updating the application, more specifically these costs would be personnel expenses.

Reminder should say the prompts to elderly, since the innovators considered that speaking is the best way to urge them in to action. This because of the elderly might have a bad vision and also bad hearing, but speaking can be adjusted to hearing aid. Speech functions are commonly used in smart phones and tablets. One can even add the speech function in to Microsoft Word software and it will read the written text. Therefore I can assume that using prompts with speaking functions costs only programming expenses, mainly personnel expenses.

Remote detection was one solution to daily challenges of the elderly according to innovators. They wanted to have remote detection to public transport, but also to opening doors in public places. This solution places demands on both, the smart rollator and also to public transport and doors. The installation of the needed technology to different places might lead to increasing costs. Cost-benefit ratio might stay low, because of these issues; hence at this point it might be better to leave it out from design of the smart rollator.

Innovators presented an idea to also have a combined wheelchair-rollator, so that if elderly gets tired out of walking, they could continue the journey in and with the help of the wheelchair. Idea and the problem are real, but there is already Tukimet Oy, who has solved this problem. They have a product called Wheellator, which is exactly combined rollator and wheelchair. Because aim of this project is to be innovative and create something new, this idea as only solution has to be left out from smart rollator or it can be only additional feature for something new.

Safety wristbands are common equipment elderlies have and wear. Wristbands are used for example elderly falling situations, so they can push a button in safety wrist-

band to call help. The problem is that they are not willing to use them, especially when they have cognitive disorders. Innovators thought that if the wristband would offer some other features like activity tracker, it would increase the acceptability of the equipment. One example of an activity wristband tracker is Fitbit. It has succeeded quite well and offers a lot for the user; it measures different data such as number of steps walked, heart rate, quality of sleep, steps climbed and other metrics. Few reasons for their success are that they combine data to drive business, they take advantage of Internet of Things (IoT) and they have created their own ecosystem around the Fitbit. (Fitbit 2016: 2-3.)

Innovators recommended that data should be transferred easily between different stakeholders. Fitbit has showed great opportunity for this by using Application Programming Interfaces (APIs). Through these kinds of interfaces, information can be transferred easily (Kivekäs 2014; Cenno Software). Fitbit's broad mobile compatibility combined to open API has created an enormous ecosystem, where any other service provider can join in. This ecosystem has enabled Fitbit to reach potential customers in extended areas. (Fitbit 2016: 3.)

Internet of Things and robotisation is identified as megatrend (Kataja 2016:9). These will drive the businesses on new blue oceans in future, new business models can be found. Hence IoT cannot be over looked, but must be taken into consideration. In businesses there is not possibility to live in present, you have to take future and future's trends into account, to make business profitable (Villanen 2016:126; Sonera n.d.). Turning to yet activity tracker wished by innovators, there is available so many activity trackers, probably is not profitable to start design new one, but we can offer open API to connect smart rollator to existing activity trackers.

Attaching a smart rollator to the Internet enables collection of data from users and rollator itself. This data will be crucial for optimization of smart rollator, for example innovators talked about automatic maintenance recognition. IoT can make this possible and useless maintenance visits could be avoided. User can also be served better, when the behavior of the user is known. (Sonera n.d.) The data rises to an important role when proving to public sector, that the smart rollator will bring savings. As an example from Pokémon Go, the researchers could show how many steps Pokémon Go players have taken more than before using Pokémon Go application. The data collection enables selling and marketing more on scientific grounds. Even though the smart rollator will

not use the Internet in its ordinary way, the option for the connection should be built already, so that in the future the collected data can be retrieved easily.

Creating an ecosystem around the smart rollator by using social aspect, as presented in game playing, and adding APIs, so that data and services could be altered, might prove the success of the smart rollator. In the innovation conversation, there was talk about multiple solutions that are available to facilitate living at home, but the systems and solutions are not connected to each other. The synergy benefit would be huge for every solution, as shown in Fitbit case, if they could share the data and provide the solutions through one platform. Building the platform around the smart rollator, might improve success and the desirability of the product.

The innovators said that leasing would be one option to answer the needs of the users and the customers. The idea of the innovators was that leasing service would include the smart rollator, but also maintenance services and induction for use of the smart rollator. Leasing has its pros and cons. Usually leasing is used when user needs the product for a limited time. For the lessees the value of the leasing the product has to be carefully considered, because real costs of leasing might easily increase over the bank loan costs of buying the product. There are many variables involved into leasing processes, which complicate the evaluating of whether to lease or not. (Contino 2002:1, 12.). Hence the public sector might have prejudice for leasing the smart rollator. The leasing option needs more research about; how it would be the best way to implement, what to include to the agreement, how much to charged? Thus, I could be sure that public sector would accept the agreement and the leasing system could benefit both customer and also the manufacturer of the smart rollator.

6 Proposal for smart rollator

During the research process, multiple features were found to solve different kinds of daily challenges of the elderly. I have collected these features into table 9.

Table 9.   Features assembled during research process.

Possible features for smart rollator
Food preparing instructions
Training videos
Music
Time management
Reminder, especially for medication
Water bottle holder, detector for liquid volume
Cognitive practicing
Standing up assistance/pull assistance
Remote Charging
Sports/ activity games
Co-operation with activity trackers
Combining Internet to smart rollator
APIs
Service platform
Ecosystem

Before I can give a proposal for a smart rollator, I need to do some segmentation. In product development process, it is important to know the customer or the user who is served. Even though, in the theme interview and innovation conversation we were talking about elderly in general, it is not possible to concentrate on all the people over 65 years old, because the needs of user differ so much. If trying to meet the needs too many at the same time, it would probably lead in big compromises and none of the elderly would be served properly in the end. This in turn would lead into situation that the product is unappealing and no one is willing to pay for product. (Villanen 2016: 181; Dibb – Simkin 2013: 4-5). I can assume elderly who is not suffering from cognitive disorder may not need the reminder, and also elderly having cognitive disorder, but having good muscle strengths don't need pull assistance.

The segmentation process is usually challenging and time consuming for the organizations. There might be problems to recognize the current segmentations and all kind of barriers will make the process challenging. (Dibb – Simkin 2013: 27.) Because some kind of segmentation is needed before proceeding to the proposal of the features, I try to do it as logical as possible. As told earlier, the reason for elderly to have a rollator is muscle weakness and problems in balance. The biggest challenge, according to my

research, was passivation of elderly. Still there are active elderlies and they do not need similar features as the passive ones. Other major problem among elderly is cognitive disorders. It is estimated that in relation to the aging population, Alzheimer and other dementias might even triple by 2050 (Alzheimer Association 2015: 21-22). Daily challenges related to these were also presented in theme interview, so it is relevant to segment elderly according from this aspect too.

Most obvious and easiest segmentation groups to me are:

1. Active elderly suffering from muscle weakness
2. Passive elderly suffering from muscle weakness
3. Active elderly suffering from muscle weakness and cognitive disorder
4. Passive elderly suffering from muscle weakness and cognitive disorder

Villanen (2016: 106-107) tells about Fazer product development process. Fazer has developed their Premium-chocolate by first analyzing what they could do differently than before. After this they have established four different product models and after this tested these models with customers by asking "is there anything missing from the model". I use this process as model for this research too. I will group up the most fitting features into these four segments (from table 9) and after my research process the Metropolia's Competence Hub can continue with these product models and find out what is the most wanted and suitable for them.

The first user segment is targeted for elderly that active, but suffering from muscle weakness (See table 10). They may not be interested about food preparing instructions or a machine to tell the time of the day. Water bottle holder is needed also in cars and bicycles, so why not in rollators. If we are thinking about summer time and walking in the sun, this might be really needed feature for those who do not need a reminder to drink. IoT, APIs, service platform and building ecosystem around the smart rollator are really closely connected to each other and I will include these for every proposal, because of their proven ability to increase and intensify businesses, create new ways to service and lean the service and product processes.

Table 10.   Features for first user segment.

Active elderly suffering from muscle weakness
Standing up assistance/pull assistance
Remote charging
Water bottle holder
IoT
APIs
Service platform
Ecosystem

Second user segment is targeted for passive elderly suffering from muscle weakness (Table 11). It is obvious that this user segment needs something that inspires them to move and take care of their personal life. This user segment benefits from sporty games for example geocaching tailored for elderly. They may need automatically appearing training videos to have some exercise every day. Co-operation with activity tracker provider would be beneficial for especially for home care nurses and relatives, who could use the information of exercising to motivate elderly to move more. Like I stated before, body movement and good physical condition enables the person to live at home. For the producer and the service provider of the smart rollator would receive data about the users movements and also about rollator, Internet connection will be included to rollator in this user segment too.

Table 11.   Features for second user segment.

Passive elderly suffering from muscle weakness
Standing up assistance/pull assistance
Remote charging
Water bottle holder
Training videos
Sports games
Co-operation with activity trackers
IoT
APIs
Service platform
Ecosystem

The third user segment I have formed for active elderly suffering from muscle weakness and cognitive disorder (See table 12). Because they suffer from muscle weakness and balance problems, they will gain benefit from standing up assistance. In addition for this mechanical help, they need also many features to support and maintain their cognitive ability to perform independently at home. For example, some cognitive exercises based on using memory, time management to ease perception of time and reminders for daily routines. Songs has been proved to have refreshing effect on memory and songs calms down person who has cognitive disorder. This user segment might benefit also for water bottle holder, but they need detector for liquid volume, so relatives or home care could ensure the elderly drinking enough, hence preventing unnecessary hospitalization related to dehydration. Bearing in mind that public sector is the major buyer of the rollators the price shouldn't increase too much, the IoT and APIs, ecosystem and service platform could be left out from smart rollator to handle moderate price increase, even I don't see it preferable, because of the future's product development and success in business.

Table 12.   Features for third user segment.

Active elderly suffering from muscle weakness and cognitive disorder
Standing up assistance/pull assistance
Remote charging
Water bottle holder/ detector for liquid volume
Cognitive practicing
Time manager
Reminder/ especially for medication
Songs
Food preparing instructions
IoT
APIs
Service platform
Ecosystem

The last and fourth user segment is passive elderly suffering from muscle weakness and cognitive disorder (table 13). In my opinion, they would need everything the third user segment needs (see table 12), but because they are passivized they would need the motivation and support for physical training and getting up from sitting position. That is reason for that addition for cognitive aspects they would need training videos, sports game and activity trackers. This segment's needs and requirements for the smart rollator might affect the price in a way that is not reasonable to try them, at least in the first launch. And it has to be remembered that falling down is more likely when there are many features in the rollator (Martins – Santos – Frizera-Neto – Ceres 2012).

Table 13.   Features for fourth user segment.

Active elderly suffering from muscle weakness and cognitive disorder
Standing up assistance/pull assistance
Remote charging
Water bottle holder/ detector for liquid volume
Cognitive practicing
Time manager
Reminder/ especially for medication
Songs
Food preparing instructions
Training videos
Sports games
Co-operation with activity trackers
IoT
APIs
Service platform
Ecosystem

In table 14 I have gathered the proposition in one table and included also the features witch are common in every proposal. There is need for these common features regardless of the user segments. These features are picked up to carry on the development process, based on the earlier evaluation presented in this research report.

Tablet or other kind of central processing unit for games and IoT is definitely needed. I suggest that this processing unit would also be a screen, so that number of components attached to smart rollator would not increase. Also, good aspects of the current rollators such as steady seat, easy- to-use brakes and basket have to be noted in further design process. Water resistance and recyclability are not the user needs, but customer needs, the public sector. If we want to sell for public sector, we have to take these wishes and needs into account too.

Modular design has become a developmental strategy to create products and systems in recent years. Modularity means units that are part of larger system. These units are structurally independent of one another, but they are able to work together. Modularity enables manufacturing, upgrading and maintaining easily. (Baldwin – Baldwin - Chan-

dler – Clark 1999:63; Hölttä-Otto – Chiriac – Lysy – Suk Suh 2012: 787.) I recommend Metropolia's Competence Hub to research and evaluate this aspect more. I see that this modularity provides opportunity for a smart rollator to grow along with elderly's life situation. For example, if an elderly receives a smart rollator initially when he has muscle weakness, but after some years Alzheimer's or dementia onset, there could be added features targeted for cognitive disorders. Like the innovators noted, it is important elderly have products early enough before cognitive disorders progression to ensure the proper use of the medical aids. Modularity provide for the familiarity of the product and elderly has internalize the use of the smart rollator. I can also predict that this modularity would increase the desirability of this smart rollator and would give more value to the user. Also, public sector as a customer might see this valuable, because modularity expand the intended use, hence might be bring savings when no other product is needed to meet user's needs.

In the table 14, I also gathered the features presented in this report earlier. These features are evaluated based on the present research information and also compared to what innovators and interviewees opinions. These features might be valuable for user and success of smart rollator, but more research is needed.

For the successful business to make the idea work, it easier to concentrate one customer segment and serve it as well as possible. Because here in Finland, public sector is biggest buyer segment for rollator, it will be also the biggest customer. We know that public sector has poor financial situation and they try to save money everywhere they can. This is reason why I do not recommend including too much features that would increase the manufacturing costs of the first prototype of the product family. Thus, the first and second user segments would be the choices for Metropolia's Competence Hub to go forward with the development process.

Table 14.   Proposal for smart rollator.

Segment group	Active elderly suffering from muscle weakness	Passive elderly suffering from muscle weakness	Active elderly suffering from muscle weakness and cognitive disorder	Active elderly suffering from muscle weakness and cognitive disorder
Features proposed to be included	Standing up assistance/pull assistance Remote charging Water bottle holder IoT APIs Service platform Ecosystem	Standing up assistance/pull assistance Remote charging Water bottle holder Training videos Sports games Co-operation with activity trackers IoT APIs Service platform Ecosystem	Standing up assistance/pull assistance Remote charging Water bottle holder/ detector for liquid volume Cognitive practicing Time manager Reminder/ especially for medication Songs Food preparing instructions IoT APIs Service platform Ecosystem	Standing up assistance/pull assistance Remote charging Water bottle holder/ detector for liquid volume Cognitive practicing Time manager Reminder/ especially for medication Songs Food preparing instructions Training videos Sports games Co-operation with activity trackers IoT APIs Service platform Ecosystem
Common features	Tablet or screen, recyclability, water resistance, modularity, steady seat, basket, easy to use brakes, light weight, fold up option			
Features needing more evaluation and research	Activity tracker to monitor exercising Songs, old domestic movies, news, voice books Recipes and instructions for preparing meal, Connecting Menumat to smart rollator Balance board, dance mat Heart rate sensors Dock system Disinfection Leasing service Maintenance service Call system for rollator to come closer Body fluid balance tracking without blood sample Remote detection Stepless height and width adjustments			

7 Validity and reliability

The validity and reliability can be considered from two perspectives: First in the point of view of scientific research. In scientific research, validity means that the research is done comprehensively and the conclusions are the right ones. In the qualitative research this means more credibility and plausibility. Reliability means that used methods are reliable and analyzing of the data is done with arguments and it is seen in the text how it is done. (KvaliMOTV.)

Other perspective is to consider this research's validity and reliability in comparison to what is known about good products and product development practices. This might be seen as sub category in the validity, are these research proposals for smart rollator the right ones. But I will consider this aspect separately too.

7.1 Scientific aspect for validity and reliability

I have executed this research by honestly, accurately and carefully and in accordance with the good scientific practice. In spite of good intention there can be found for and against issues, when analyzing validity and reliability and they has to be evaluated.

Theme interview was done only once. This means that interview data might have not been saturated, hence it decreases the validity and reliability of this research. Saturation of interview data means that new interview does not provide any new information to the matter (KvaliMOTV 2002). A few more interviews might have brought up more topics to solution of the research questions, but I complemented the information by theoretical knowledge and tried this way increase the reliability.

Hirsjärvi and Hurme (2011: 184-185) have told issues influencing on quality of research. These are for example quality of recordings, can interviewer hear all the statements, transcribing soon as possible, so interviewer can remember the conversation and educated interviewers. I was able to meet first two of these issues. Quality of the recordings was good and I could make precise transcription and I made it right next day of the interview. Transcription was easy to make, because conversation was fresh in my mind and I could empathize to it. Some kind of tutoring might have given me the know-how in asking further questions during the interview. Though I was relaxed in the

situation, because I already new other interviewee, conversation slipped few times in issues not related to themes. With experience this might have been avoided.

Objectivity of the researcher is part of good quality research. Kananen (2014: 136-137, 154) says that understanding and findings of the research data has to arise from data itself, not include researcher opinion. I was very exited about the topic of the research at early stages. This lead to that I had many expectations and features of new smart rollator in mind that it might have had influence on procedure of thesis. Fortunately, I observed this situation before theme interview and could make some changes on own attitude to ensure objective and also free conversation beyond opinion influencing on the way of discussion.

I tried to increase the reliability of the research by recording both theme interview and innovation conversation. By doing this, the same material is available for any other researcher for them to use, if seen necessary. I have also tried to write open how I have done the data processing and coding. I have examples of both theme interview and innovation conversation data processing and coding system. The coded material is so big, that it cannot be included in this written report as a whole.

In the innovation conversation, the feature tree was one tool to innovate and brainstorm the ways solving challenges found out in theme interview. I tried to facilitate it as much as possible, but still the feature tree was not the best option for this group to use. We filled it during conversation, so that it fulfilled its purpose as ensuring all the topics were conversed, but still there could have been some relations to mark beyond the features implemented in the tree and take more advantage of it. This might decrease the reliability of the research.

Despite of deficiency of the feature tree, the recording of the innovation conversation increases the reliability. Even the cause-effect links were missing in the feature tree, from the recording these could be found. Recording was the saving standpoint in view of validity and reliability, because I had access to every discussed topic afterwards and I could check over every detail.

7.2 Product development validity

Anne Burdick (Laurel 2003: 82.) says, "Research is only as good as its interpretations". The product designed giving most value is related to that data collected is rich and relevant. This would be achieved by risk-taking, speculation and discovery. In this research the data could have been richer. The theme interview was done only once and if there would been time for others, it would increase the product development validity. The data were relevant and I tried to increase the relevance by comparing daily challenges and issues into the earlier research done before my thesis.

This research includes the risk-taking and speculations too. In the written report, I have tried to give possible solutions and new aspects and tried to rationalize them as much as I could. Anne Burdick (Laurel 2003: 82.) reminds also that the value of design research is advance the scholarship of the disciplines that are related to design. The success of this combination in this research is seen, combination of robotics, mechanics, physiotherapy, business, and much more, but it could have been be more obvious and emphasized more.

Product development process has its own characteristic done in social and health care field. Ability to utilize research information and justify by using scientific research information is emphasized in social and health care. Arguments can be seen as clarification of information suitability. (Jämsä – Manninen 2000: 23-24.) I have tried to use research information especially in the analyzing phase of the theme interview. I collected the data and after recognizing the biggest challenges of elderly's daily life I seek the backup for accuracy and relevance of the challenges found. Though previously done research results is used also during the whole process of my research.

In product design the user-centric design process is emphasized in many literature resources (Laurel 2013: 39-40; Villanen 2016: 181). In this research I didn't have resources to contact and take elderly to participate this research. Still I have tried to figure out the challenges of elderly's daily life with the help of relative and home care nurse. Their view of challenges may differ from elderly's view, but views are still authentic and may give aspects that are not thought before for my research. The validity of the views, which are real observations of the interviewees, I have justified according to previous research information. Hence I can say that user-centric aspect has been noted as well as possible and can be seen throughout the whole process.

Customer, public health care, I have taken into consideration also. In health care field, there can be multiple customers, which might have different needs and they have to be fulfilled besides user's needs. (Jämsä – Manninen 2000: 24). I fortunately got one innovator from this sector to tell what kind of products they approve. These were that besides money, recyclability and water-resistance are the aspects they value.

I can comment on the research approach selection, which was hard stage for me: it seems that it went well after all. Main goal of action research is to find solution practical and relevant to identified problems and this goal was reached at least satisfactorily.

As a closure of validity and reliability I can state that I have tried to process smart rollator in different angles and take into reflection as variable topics as possible. I have obeyed good manners of academic research and have studied process of product development and chosen the best possible option for this research. Because of the limitations stated above I cannot say that this product would be enormous success, but it still is good start to further development.

8   What to do next – way forward?

In this research, I approached the subject with action research. According to action research process more cycles are needed to end up for real manufactured in the market being smart rollator. This research was start for some bigger development process.

The product development process has multistage character. I have examined several books about this process and have made a conclusion that there are several ongoing stages possibly at the same time. At the simplest process model of product development is defining problems and recognizing the need for development, gathering ideas, sketching, product development and after all finishing for the product (Jämsä – Manninen 2000: 28). Beyond these stages multiple tasks have to be done, before there is a real manufactured product available. I present here some important aspects for future research projects and how to proceed so that smart rollator would become an existing real product and service.

The problem of the product development processes is that developers become excited to new ideas over and over again. Before one can produce the ideas has to become in conclusion. (Villanen 2016: 116.) That's why it is important to proceed with proposal and figure out are they really good ones. The very first thing in successful product development is to combine users to evaluate the results and giving opinions to smart rollator features. I described Fazer's product development process, where they start with product models and after these Fazer is asking for consumers what is missing and what they wanted to add there. Metropolia's Competence Hub should do the same thing with smart rollator, and hand it over to the elderly. After checking from users that the product is desirable and the elderly would use it, the prototype should be designed and created. After this prototyping the final price estimation can be done.

If Metropolia's Competence Hub will proceed with this smart rollator, during the prototyping, when features are decided, business students could create brand image and research how to market this product easiest, cheapest and most efficient way.

9   Conclusions

In this research, I tried to find out what kind of features in smart rollator could help the elderly live longer at home. The research approach I used was action research and most used tools were theme interview, innovation conversation, benchmarking and content analysis.

The results of this research were a proposal of features, which should be included into smart rollator to give most value for users and customers as well. The features that change the most the usage of a rollator are standing up assistance and sporty games. These gives new angles not seen in the rollators before and are answering the challenge of passivation by inspiring and encouraging moving more. This probably leads to better health and living longer at home, which was the ultimate aim on a national level in the current and future circumstances.

Also, other features are proposed to support this aim to move and exercise more, such as training videos. There are also huge challenges with elderly having cognitive disorders and for that I have presented proposals as time manager, cognitive practices, songs, reminder and food preparing instructions. These activities, when reminded to elderly easier the surviving from daily activities, but also when for example reminder

says that time to go check post, elderly might really go and use his muscles and little by little the amount of moving might increase.

To make this smart rollator as desirable product as possible, the perspective of customer is taken into consideration too. Beyond the price of smart rollator, medical aid centers value the recyclability and water resistance of rollators. These aspects have to be thought and noted in design process in future.

For the future, the digitalization of smart rollator has to be considered already at this stage, because data and information are going to be base of successful business in every field, also in health care and home care. That is why my recommendation is to include IoT aspect right in the beginning of the product development, but also think about platform service system, open application programming interfaces to increase the possibility to other service providers to join and serve their services, which lead to unique ecosystem of smart rollator.

In the end I targeted proposals for four user segments and collected the features best answering to every user segments needs. This is presented to Metropolia's Competence Hub.

The research has its strengths and weaknesses considering validity and reliability; nonetheless the strengths overcome the weaknesses. There is still need for more testing and researching such as how elderly themselves see these presented proposals and outline the brand and search for best possible ways to market a smart rollator.

I can say, after finding information for current state analysis, that there will be users for rollators in the future. The number of elderly will significantly increase and likewise the occurrence of cognitive disorders. The European Commission is supporting projects that are helping ageing well and also here in Finland legislator is enforcing by law the adoption of smart technology solutions. The possibilities for business success are underlying there in the markets.

As conclusion, I can state that this proposal is good start for Metropolia's Competence Hub to proceed with to prototyping phase.

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Theme interview frame

1. Background information
- Professional, work experience/ experience among elderly

2. Activities of daily living
- Physical, social
- Challenges doing activities
- Assistive technology, also others than rollator

3. Current rollator in the markets
- The reason and purpose of use
- Advantages
- Disadvantages
- Accessories
- Needs for rollator

4. Summary
- Order of importance

Timetable for innovation conversation (estimated)

1. Presenting the participants for the conversation   *5 min*
2. Introduction of what has been done before this conversation   *10 min*
   - Method of the research
   - The current smart rollators (Table 3)
   - The results of the first action research cycle (Table 6)
3. Filling up feature tree   *60 min*
   - Evaluation of interview results
   - How we respond to these challenges?
   - What is needed to solve these challenges?
   - When smart rollator is used to resolve these challenges?
4. What are the best solutions?   *20 min*
   - Which solutions give most value?
   - How elderly's day changes?
   - How daily routines changes?
5. The price of new smart rollator   *20 min*
   - How much this smart rollator can cost, so that customer is willing to buy it?
   - What other aspects than cost influences on the buying process of smart rollator?
   - Can we offer enough value for customer to buy this product?
6. Closing up the innovation conversation   *5 min*