Discovering different Personas (User Groups) for ICT- based Fall Prevention Systems

Master Thesis

For attainment of the academic degree of
Master of Science in Engineering (MSc)

in the Master Programme Digital Healthcare
at St. Pölten University of Applied Sciences

by
Sophie-Catherine Schilling, Bakk. rer. nat.
1710756824

First advisor: Dipl.-Sporting. Dr. Mario Heller

St.Pölten, 13.05.2019

Declaration

I declare that I have developed and written the enclosed Master Thesis completely by myself, and have not used sources or means without declaration in the text. Any thoughts from others or literal quotations are clearly marked. This work was not used in the same or in a similar version to achieve an academic grading or is being published elsewhere.

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Abstract

Purpose: To identify different user groups for information and communication technology (ICT)- based fall prevention systems. An aging population and the fact that at least a third of people aged 65 or older fall once a year build the need to increase the opportunities for older adults to attend fall prevention programs. ICT -based Fall Prevention Systems permit older people to attend exercise programs at home and without employing a trainer or physiotherapist. To create not only programs that help prevent falls but also programs that the target group desires to take part, it is important to take a closer look on the user's and potential user's needs.

Participants: 14 Older adults participated in the study. Inclusion criteria are an age of 65+ and a lifestyle independent from third parties help.

Methodology: A qualitative study was conducted to create "personas" to represent different user types for ICT- based Fall Prevention Systems. The data collection contains the conduction of semi-structured interviews and the implementation of four questionnaires. Based on a combination of deductive and inductive evaluation approaches an autonomous evaluation strategy was created. It includes the generation of a coding system and the development of Evaluation Sheets to systematically analyse all captured data.

Results: Four different behavioural patterns were identified, which form the basis for the development of personas. The outcomes confirm, that older adult's pose different requirements to be incorporated when designing ICT-based Fall Prevention Systems.

Limitations: Due to limited resources the amount of collected data is confined. The validation of the presented personas is pending.

Keywords: Information- and communication technologies (ICT), fall prevention, ICT-based fall prevention systems, development of personas

Kurzfassung

Forschungsziel: Identifizierung von verschiedenen Gruppierungen, die IKT Systeme zur Sturzprävention anwenden. Eine alternde Population und die Tatsache, dass zumindest ein Drittel der Bevölkerung über 65 Jahre oder älter einmal pro Jahr stürzt, bestätigen den steigenden Bedarf an Möglichkeiten zur Teilnahme an Sturzprävention Trainings. IKT Systeme zur Sturzprävention ermöglichen der älteren Bevölkerung entsprechende Trainingsprogramme zu Hause ohne Involvierung eines externen Trainers oder Physiotherapeuten zu absolvieren. Um Programme zu entwickeln, die Stürze vorbeugen und auch gleichzeitig die Zielgruppe zur Teilnahme an diesem Programm motiviert, ist es erforderlich, die Bedürfnisse der Teilnehmer und potentiellen Teilnehmer genauer zu untersuchen.

Teilnehmer: 14 ältere Personen nahmen an der Studie teil. Teilnahmekriterien sind ein Alter über 65 und eine von Dritten unabhängige Lebensführung.

Methode: Es wurde eine qualitative Studie durchgeführt, um „Personas“ zu entwickeln, die verschiedene Typologien für IKT Systeme zur Sturzprävention darstellen. Die Datenerfassung basiert auf halb standardisierten Interviews und dem Einsatz von vier Fragebögen pro Interview. Basierend auf einer Kombination von deduktiver und induktiver Auswertungsmethoden wurde eine eigenständige Auswertungsstrategie entwickelt. Diese beinhaltet eine Erstellung eines Kodierungssystems und die Erstellung von Auswertungsbögen, um das gesamte erfasste Datenvolumen systematisch zu analysieren.

Resultate: Vier unterschiedliche Verhaltenstypologien wurden identifiziert, die als Basis für die Ableitung der „Personas“ dienen. Das Ergebnis bestätigt, dass ältere Personen sehr unterschiedliche Anforderungen an IKT Systeme zur Sturzprävention vorweisen.

Limitationen: Aufgrund limitierter Ressourcen ist das erfasste Datenvolumen begrenzt. Eine Validierung der erarbeiteten „Personas“ ist nicht erfolgt.

Schlüsselwörter: Informations- und Kommunikationstechnologie (IKT), Sturzprävention, IKT Systeme zur Sturzprävention, Entwicklung von „Personas“

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1 Introduction

Society is currently facing two impactful trends. First, a high life expectancy is experienced in many developed countries which leads to an aging population, especially having declining birth rates in mind. Second, an advanced technology is determining and facilitating daily life in many aspects. Following these impressions one of the main challenges today poses the confluence of these two trends in order to offer an aging population the benefits of technology based services (Charness & Boot, 2009).

According to Statistik Austria there were 1.583.928 humans, with residence in Austria, who were 65 years old or older in the beginning of the year 2015 that equals 18, 5 % of Austria's Population. In 2030, 23,4 % of the population will be over 64 years old and the amount of over 84 years old will double (Winkler, Pochbradsky& Wirl, 2012). Furthermore, a projection of the United Nations also shows that globally the part of people older than 60 years will more than double until 2050, which means that there will be over 2 billion people older than 60 (United Nations, 2013). The growing trend of an aging population harbors a variety of difficulties today's society and in particular health care systems need to face. One of the major burdens health care systems are facing are expenditures caused by falls and their consequences (Farshchian & Dahl, 2015). At least a third of the people aged 65 or older fall once a year (Sherrington & Tiedemann, 2015). About 15% of those even fall two or more times a year (Freiberger & Schöne, 2009). Within the population of 80 year old adults and older, nearly 50 percent of the mentioned target group have a fall every year (World Health Organization, 2008). Falls and theirs consequences belong to the most common causes of death among people aged 65 or older (Tideiksaar, 2000).

In this context Barelle et al. (2010) mention, "The World Health Organization, faced with the rapid ageing of the population, insists on the necessity to have an integrated answer to the ageing process and to adopt continuity of care in order to enable elderly to remain healthy, independent and active in their community as long as possible (Barelle et al., 2010,p.1)."

Fall prevention interventions have the aim to address the mentioned problem. Fall prevention includes prevention, the avoidance of falls and the rehabilitation. The

goal is to avoid falls as good as possible and to minimize the risk of severe injuries. Furthermore, fall prevention can lead to a better and faster rehabilitation after an injury (Ziganek-Soehlke, 2008). Therefore, the main purpose of fall prevention is to create programs and activities for those, who are at a high risk of falling (Ziganek-Soehlke, 2008). However, the implementation of regular physical activity is often difficult for older adults due to transport problems, a lack of motivation and adequate offers in their environment (Baez, Ibarra, Far, Ferron, & Casati, 2016; Ferraresi, 2015). Furthermore, older people often struggle to keep social contacts with their friends and other people in general (Baez et al., 2016).

In the rising world of eHealth devices, fall prevention solutions based on Information and Communication Technologies (ICT), might have an answer to the mentioned problems. There has already been positive acceptance for including virtual reality exercise programs and so-called exergames (Combination of video exercise and video games) into the rehabilitation process for older adults at special institutions (Ogonowski et al., 2016). Vaziri et al. (2017) assume that, ICT- based fall prevention systems do not only rely on their video game character, but also include other important tools to increase the number of older adults implementing fall prevention into their daily lives.

There are different approaches and projects based on information and communication technologies which are dealing with fall prevention. They are offering older adults to attend fall prevention training sessions at home and outside special institutions (Baez et al., 2016; Barelle et al., 2010; Ganesan & Anthony, 2012). The overall goal of ICT- based systems is to give older adults the possibility to train their musculoskeletal system to maintain their independency and reduce the risk of falling as well as the opportunity to communicate with other people through the system. The virtual environment is presented through the televisions in the homes of the target group (Baez et al., 2016; Barelle et al., 2010). Recent studies elucidate that there are four major components that have to be considered when creating ICT- based fall prevention programs. First of all, designers need to know what kind of *training interventions* should be provided. Secondly*, persuasion strategies*, that work for older adults have to be discussed. The relationship between *older adults and technology* pose the third aspect. At last, the *heterogeneity of older adults* regarding those three aspects has to be faced to reach user acceptance (Charness & Boot, 2009; Ogonowski et al., 2016; Pericie, 2012; Vaziri et al., 2017).

Whereas it is well documented what kind of training interventions should be provided in fall prevention programs, there is a lack of information on data about what motivates elderly to participate on a regular basis and which requirements do

they pose for technology-based programs. Those findings long for the approach of directly including stakeholders into the process of developing ICT-based fall prevention systems.

The aim of the study is to detect different user types for information and communication based fall prevention programs in older adults (65* years). Following research questions are formed: "*How can the target group be divided?" "Which requirements do elderly (age 65+) have of technologies that provide fall prevention programs?"*

To get an insight about the different characteristics and needs of older adults, qualitative research methods were chosen. To present different user types for ICT-based fall prevention personas (user groups) were created. Research shows that the development of personas out of semi-structured interviews are a good approach to capture different behavioral patterns of a target group (Vaughn, DeJonckheere, & Pratap, 2017; Vaziri et al., 2017). Therefore, semi- standard Interviews with older 14 adults have been conducted. Inclusion criteria are the age of 65 or older, ability to take self-determined actions, independent mobility with or without walking aid. Since a core component of semi-structured interviews is the development of a meaningful interview guideline to capture all relevant information, an in-depth literature research was conduct in advance to the data acquisition (McIntosh & Morse, 2015).

Therefore, chapter 2 of the present thesis guides through in chapter 3 the Methodology, including study design data, the steps taken towards creating the interview guideline, how data collection and its analysis were performed. The results of the individual interviews are presented in chapter 4, as well as the process of clustering those results to detect similar user types. The final outcome of the present thesis, the Personas, are illustrated in chapter 5. A reflection of the ongoing study and its findings, as well as the basis for potential future research on the topic of ICT- based Fall prevention as an answer to the challenges of raising falls in an aging population are discussed in the very end of the underlying thesis.

2 Background and Related Work

The following chapter is to give an overview on the background and related work to ICT- based fall prevention systems. Figure 1 represents the sequence of the chosen topics leading up to the methodology of the study.

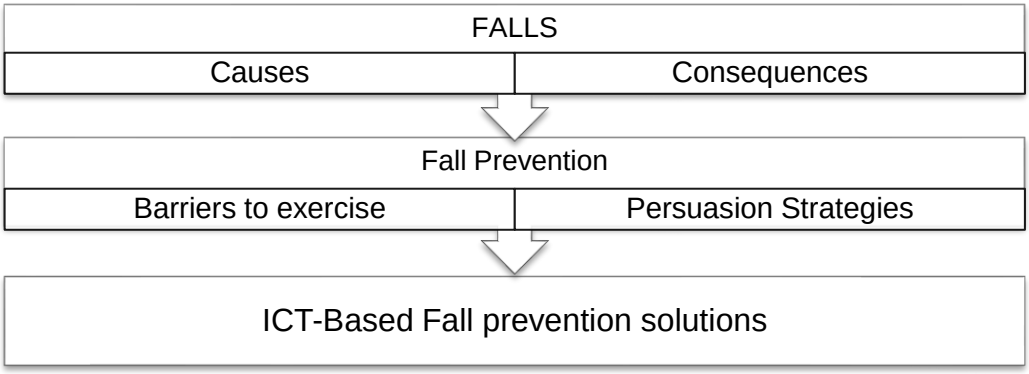


Figure 1: Overview Background and Related Work

2.1 Falls- Causes and Consequences

„A fall is defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level. Fall-related injuries may be fatal or non-fatal, though most are non-fatal (WHO, Fact sheet N°344).“

As indicated above, falls are one of the major burdens society is currently facing, due to an aging population (World Health Organization, 2008). Twenty to Sixty percent of falls engender an injury. The consequences are often severe, ranging from simple injuries to the death of the fallen victims. Especially, femoral and hip fractures pose major challenges. They not only cause the victim mature pain, but also enormous costs for health care systems (Freiberger & Schöne, 2009). In 2011, about 1.2 percent of the total health expenditures in Germany were used for hip fracture treatments (Bundesvereinigung Prävention und Gesundheitsförderung e.V, 2011). In addition, it also has to be considered that 50 % of the fallers do not regain their full mobility back. The immobility after fall entail severe loss of strength and muscle mass in older adults, which not unfrequently leads to premature death. In fact, fatal falls raise exponentially with the persons' age (World Health Organization, 2008). Those facts lead to the need of getting to the roots of the

problem. In the following, the major causes and consequences of falls will be further discussed.

The causes of falls are subdivided into two categories- primary or intrinsic factors and secondary or extrinsic factors. The primary factors include functional limitations, sensory deficits, cognitive impairment and psychological strains. All factors, that lead to unsuitable environmental conditions, like tripping hazards belong to the extrinsic group of causes (Barelle et al., 2010; Ziganek-Soehlke, 2008). The most common ones will be shortly touched in the following paragraphs.

The intrinsic factors can be further divided into physical and mental factors. Above all, the most common physical cause of falls is pain. As a consequence a blockade of movement sequences can arise, which can lead to severe vestibular disorders and poor balance (Ziganek-Soehlke, 2008). As a matter of fact, a decrease in general activity is often inevitable and reinforces the risk of falling among older adults. Furthermore, the sensory organs have a vital influence on a person's gait security. Within the aging process a lot of people have to face issues concerning the visual and the auditive system. They often lead to a lack of orientation ability and general uncertainty, which both increase the risk of falling (Pericie, 2012). Strength- and physical condition deficits probably represent the main intrinsic factors that cause falls in older adults. Geirsdottir et al.(2012) emphasize the important role of muscle strength and lean muscle mass when executing activities of daily living and maintaining quality of life (Geirsdottir et al., 2012). As a common consequence falls caused by so-called „leg- weakness" during activities of daily living can frequently occur. Joint immobility and chronic insomnia are further predictors for an increased risk of falling (Ziganek-Soehlke, 2008).

Beside those physical factors, the most prevalent mental factors that cause falls are feelings of anxiety. They often have a negative effect on one's ability to concentrate, which in turn can negatively affect the coordination skills, that are required to maintain stability (Pericie, 2012). Scare events, regardless of whether they are negatively or positively experienced, pose another potential danger for falling, especially for older adults, who are often easily unbalanced by outside influences (Ziganek-Soehlke, 2008).

Pericie (2012) state that most falls are caused by internal factors or a combination of internal and external interferences. Nonetheless, it is important to pay attention to all possible extrinsic factors that can cause falls in the environment of an older adult (Pericie, 2012). Among older adults, it appears that most falls happen in their own homes, especially bathrooms contain multiple sources of hazards (slippery tiles, entry and climbing out of the bathtub, etc.) (Ziganek-Soehlke, 2008). Ill-fitting

shoes, or wrong footwear according to the environment, pose another extrinsic factor that often lead older people to take falls (Ziganek-Soehlke, 2008).

Moreover, fall consequences are partitioned in three different categories (Pericie, 2012; Ziganek-Soehlke, 2008). *Physical consequences* are often fractures, particularly in the area of the hips, which can lead to immobility and significant limitations in the activities of daily living (Pericie, 2012).

The second category describes *mental issues*, mental and physical consequences often correlate with each other. Due to anxiety to fall again older people often avoid physical activity even more than before the fall (Pericie, 2012; Ziganek-Soehlke, 2008). It is well known that within aging there is a loss of skeletal muscle mass, strength, functionality and power (McGregor, Cameron-Smith, & Poppitt, 2014). As a matter of facts, the musculoskeletal system is no longer trained and the risk of falling again and the risk of injuries raise, which often ends up in a vicious circle if no adequate interventions are taken.

Economic consequences due to the number of falls represent the third category, especially the enormous costs for the health care systems (Pericie, 2012). There are various components that need to be taken into consideration in order to capture the whole repercussion falls have on the economic systems, in particular the emerging costs (Carroll, Slattum, & Cox, 2005). In the course of research on “The Cost of Falls Among the Community- Dwelling Elderly” Carroll et al. (2005) divide those tangible costs in three different categories, that showcase their far-reaching implications. First of all, there are “direct medical costs”, the health care systems have to deal with, that arise due to injuries and fractures. They often followed by “direct nonmedical costs”, which include costs for services concerning personal care services, transports and other supportive measures. The third category represent indirect costs addressing the loss of productivity due to injuries. Although this might seem negligible since most adults, aged 65 or older are retired from their professional carriers, it need to be borne in mind that they often undertake significant tasks in society, above all, volunteer work, childcare and caring for sick friends and relatives (Carroll et al., 2005).

Beyond doubt there is the need to find an integrated answer to the problems arising due to falls among older adults. There are a lot of different interventions, that have the goal to avoid falls among elderly, notably those which try to lead older adults to be more physically active. However, in order to successfully provide such interventions, there a variety of factors that need to be considered (Barelle et al., 2010). The following chapters will give a profound insight on what fall prevention is all about and which interventions are predicted to be embraced by the target group.

2.2 Fall prevention

Prevention (Latin "praevenire" zuvorkommen) includes preventive measures to prevent, delay or to avoid disease consequences. Accordingly, fall prevention includes the primary prevention, the avoidance of falls and the rehabilitation from injuries caused by a fall (Kannus, Sievänen, Palvanen, Järvinen, & Parkkari, 2005; Ziganek-Soehlke, 2008).

Focusing on interventions, that aim to prevent falls, studies show, that there are different strategies that contribute to successfully prevent falls among older adults. Kannus et al. (2005) list the most common ones as follows. Strength and balance training are an evidence-based intervention to prevent falls. They further state that supplementation of vitamin D and calcium, who have an impact on bone health as well as on musculoskeletal performance can play a supportive role. Apart from interventions that concern the affected persons themselves, fall prevention also earmarks eliminating or minimizing external interferences (Kannus et al., 2005; Stevens, Holman, Bennett, & Klerk, 2001; Ziganek-Soehlke, 2008). Especially the environment in the homes of older adults should be free of hazards, such as carpets, shallow stairs or any other potential tripping hazards (Stevens et al., 2001).

Literature reveals that there are single-intervention strategies as well as multifactorial- preventive programs (Kannus et al., 2005). Although a multidimensional approach, by means including different kinds of fall prevention strategies into intervention programs, seems to be the most effective way to successfully prevent falls among older adults, it has to be considered that resources are often limited. A meta-analysis conducted by Sherrington, Tiedemann, Fairhall, Close and Lord (2011) reveals that the effect of exercise as a single-intervention strategy is comparable to multifaceted intervention program. They describe that up to 42 percent of falls can be prevented by executing a well-designed exercise program (Sherrington et al., 2011). This incident emphasizes once more the importance of introducing exercise into the lives of older adults. Furthermore, fall prevention interventions that include physical activity can lead to a better and faster rehabilitation after an injury. Stating that the individual physical condition of a person has in advance to a fall occurring with severe injuries, significantly influences the success of the subsequent rehabilitation (Ziganek-Soehlke, 2008).

A further task of fall prevention should be to create tailored exercise programs for older adults with the objective of preventing falls (Ziganek-Soehlke, 2008).

Literature reveals that those exercise programs should mainly include strength training, training of coordination skills and mobility training (Jansenberger, 2011, p. 65). First of all, the positive impact of *resistance training* on the risk of falling or injuries caused by a fall, has been demonstrated in numerous studies. The main benefits are an increase of bone mineral density, bone strength, muscle strength and muscle mass. Those components have a high preventive impact on preventing falls, fractures and other injuries (Karinkanta, Kannus, Uusi-Rasi, Heinonen, & Sievänen, 2015; Teixeira et al., 2010). Secondly, the *coordinative abilities* have high significance in the life of every human being. Especially for older people, remaining well-defined coordination skills as long as possible is crucial for managing activities of daily living. Maintaining balance is a complex process that depends on vision, vestibular and peripheral stimulus processes, central coordination, and neuromuscular response. Therefore, particular attention should be paid to exercises that train the sense of equilibrium, considering that the functionality of these systems decreases with age (Jansenberger, 2011, p. 71). The third component *mobility training* plays a complementary, but still important role in training the musculoskeletal system to prevent falls (Jansenberger, 2011, p. 69). In addition, it needs to be emphasized, that any kind of exercise intervention needs to be done regularly in order to effectively minimize the risk of falling. Thus, adherence to physical activity and the awareness of its importance play an important role in exercise-based fall prevention interventions (Sherrington et al., 2008).

Even though older people have access to information about the importance of physical activity and the massive impact it can have on their quality of life the majority miss to implement exercise into their everyday life (Justine, Azizan, Hassan, Salleh, & Manaf, 2013; Stutts, 2002). Those facts lead to the question, “Why do older adults struggle to stay physically active?” Research on the mentioned topic shows that in order to pursue the idea of an active aging population, it is vital to detect factors that increase exercise adherence in older adults on the one hand, and decrease major barriers to participation in exercise that occur on the other (Justine et al., 2013; Miller et al., 2014). In the following major barriers and meaningful persuasion strategies are discussed, leading up to the main focus of the present thesis, the ICT- based Fall Prevention solutions.

2.2.1 Barriers to physical activity in older adults

According to Stutts (2002) the factors, that keep older adults from implementing exercise into their everyday life, can be divided into internal and external barriers. The outcome of two different studies shows, that “not having enough time”, is one of the most mentioned reasons to not being able to attend exercise classes. The

lack of motivation, as well as boredom and feeling too tired are further components that cause older adults to mainly remain inactive (Justine et al., 2013; Stutts, 2002). Bad childhood experiences in sports can also lead to a dismissive attitude towards exercise. Physical limitations and health in general are other common internal barriers to physical activity among older adults, even though those limitations often do not demand total exercise avoidance. In addition, older adults often consider exercise only available for young people, since the majority links physical activity only to sports like playing football or going for a run (Schutzer & Graves, 2004). This assumptions are often built out of a lack of knowledge and/ or a self-perception of not being healthy or fit enough to perform any type of physical activity (Ferraresi, 2015). Furthermore, the mental aspects must not be disregarded, as the anxiety to fall again can have a huge impact on person's willingness to attend physical activities (Whitehead, Wundke, & Crotty, 2006).

Nonetheless it has to be considered, that the overall mobility decreases with age, which directly leads to the external barriers older people perceive to attend exercise classes (Chao, Foy, & Farmer, 2000). The most frequent external barriers that occurred are a lack of exercise facilities, as well as "not being able or having the motivation to leave the house" (Justine et al., 2013; Stutts, 2002). Followed by bad weather conditions and the absence of support by significant others, who often have a huge influence on the lives of older adults (Stutts, 2002).

Complementary to those revealed internal and external barriers McInnes & Askie (2004) assume that there occurs to be a general resistive attitude towards preventive recommendations among older adults, especially if those include physical activity (McInnes & Askie, 2004). In line with this statement, Whithead et al. (2006) express the assumption that older adults often miss the immediate impact of preventive interventions and are therefore often unaware, that they pose a crucial factor for healthy aging. As a matter of fact, the results of their study show that only 28 percent of the subjects accepted to undertake exercise as treatment to prevent falls, whereas 72 percent of the subjects decided to receive medication for osteoporosis (Whitehead et al., 2006). Those numbers affirm the lack of acceptance of physical activity as a fall prevention strategy among older adults, explained by the aforementioned barriers to exercise (no time, no available locations to exercise, etc.). That directly leads to the need of finding strategies and solutions that enable older adults to implement exercise into their everyday lives. Key components that can evoke such behavioral changes are discussed below.

2.2.2 Motivators and Persuasion strategies to physical activity

The review/analysis of different studies, that dealt with motivators to physical activity and strategies for behavioral changes in older adults revealed that there are a variety of approaches leading older adults to remain active as long as possible. However, all of them emphasize the key role of self-efficacy in exercise adherence (Baez et al., 2016; Chao et al., 2000; Schutzer & Graves, 2004; Stutts, 2002; Whitehead et al., 2006). In the article "Physical Activity Determinants in Adults: Perceived Benefits, Barriers and Self Efficacy" Stutts (2002) describes that "self-efficacy has been shown to be a strong predictor of health behaviors, including physical activity behaviors (Stutts, 2002, p. 500)." For this purpose, it needs to be considered that there certainly is no "one size fit all" strategy to increase a person' self-efficacy, since everyone responds to different cues. This makes clear, that changing a person's attitude towards physical activity, takes a lot more than just informing the target group about its benefits (Schutzer & Graves, 2004; Whitehead et al., 2006). Particularly in the context of fall prevention researchers emphasize the importance of finding ways to enshrine regular physical activity into the life of elderly. To reach this kind of attitude change towards preventive interventions on a mature level it occurs the need of really getting to know behavioral patterns of older adults.

However, a group of authors found out, that persuasion strategies for fall prevention can be roughly divided into two groups (Baez et al., 2016). The first one contains all kind of ways that target the individual person, such as positive reinforcement or self-monitoring. The use of prompts, received via email or telephone have also shown to be an expedient way to increase exercise adherence in older adults (King, Haskell, Taylor, Kraemer, & DeBusk, 1991; Schutzer & Graves, 2004).

The second group, outlined by Baez et al. (2016), includes all kind of persuasion strategies that are based on social interactions. Stating that the support of family members, as well as the social contact with peers can motivate elderly to attend preventive interventions. Especially, exercise classes in group settings, which allow to incorporate small competitions and collaborations seem to have a motivating influence on the target group (Baez et al., 2016). So whether exercise is attended in a group setting or executed alone Chao et al. (2000) point out the relationship between self-regulatory skills and exercise adherence (Chao et al., 2000). Giving the action a purpose by setting a specific goal and having the possibility to monitor one's own progress seems to be one of the biggest motivators to include regular physical activity in the day-to-day life (Schutzer & Graves, 2004).

The consideration of all those different aspects should lead elderly to not only become more active but also to stick to a certain amount of exercise in a long-term perspective to maintain their independency as long as possible (Baez et al., 2016; Chao et al., 2000). However, the variety of the barriers and motivators in combination with the target group's heterogeneity and diverse needs continues to be a major challenge, when designing fall prevention programs. The following chapters will provide information on how ICT-based Fall Prevention solutions approach to the mentioned difficulties as well as the problems its developers and companies are currently facing.

2.3 ICT- based fall prevention

> eHealth is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology (Eysenbach, 2001, p. 1).

There are different eHealth applications: Information, Communication, Interaction, transaction and integration (Boogerd, Arts, Engelen, & van de Belt, 2015). Since ICT- based Fall prevention solutions should include information and communication as well as interaction, it can be seen as an eHealth device, that should help to improve not only the user's individual health and reduce their risk of falling, but also make its contribution to change health care systems for the better (Baez et al., 2016; Ganesan & Anthony, 2012).

As stated previously, fall prevention includes prevention, the avoidance of falls and the rehabilitation (Ziganek-Soehlke, 2008). Accordingly, ICT- based Fall Prevention solutions can be separated into two system: Those, which mainly focus on fall detection and those who provide exercise programs to increase the person's overall health status to prevent falls. In fact, there are a lot of sensors and techniques on the market to detect falls and for example automatically send messages to relatives if the person, who wears the sensor has taken a fall (Barelle et al., 2010). Detecting falls is extremely important, especially for older adults, who live alone, nonetheless any fall detection system does not address the cause of the problem (Farshchian & Dahl, 2015). The main focus is to avoid falls, not only through adapting the environment, but through enabling older adults to include more physical activity in their everyday life (Stutts, 2002). Physical activity, especially coordination and strength exercises and their positive effect on the medical condition also provides a better prognosis for potential rehabilitation from injuries (Geirsdottir et al., 2012). The present thesis focus on ICT- based Fall prevention systems that should help elderly to minimize their risk of falling through physical activity and goal-oriented exercises that help them remain and regain step security, strength and balance.

All different kind of video games are becoming more and more popular. So-called Exergames are computer games, which urge its players to physical movements

and reactions. A well-known example poses the Wii[1], a videogame console, which first appeared in 2006. Such videogames alone give the possibility to make people more physically active through entertainment. However, Vaziri et al. 2017 claim that exergames are not designed for older adults' unique and varying needs, nor for the purpose of fall prevention. Considering that exergames do not allow any professional motion monitoring or personalization, which is crucial to reach actual health benefits (Vaziri et al., 2017). The goal of developing ICT-based fall prevention solutions is to provide programs that allow personalization and motion monitoring as well as social interactions and communications, factors which have a proven impact on exercise adherence among older adults (Baez et al., 2016). Moreover, the communication application gives the possibility to directly involve professional physio therapists or sport scientists to ensure tailored exercise programs, feedback and the opportunity for the users to pose questions (Ogonowski et al., 2016). Smith et al. (2011) declare those ICT-based sytems as "novel "exergames", which suggest a low-cost method by which older adults can be engaged in exercises that challenge balance and which can be conducted in their own homes; (Smith, Sherrington, Studenski, Schoene, & Lord, 2011, p. 1)"

As persuasion strategies, ICT- based fall prevention systems are not only taking advantage of the entertaining characteristics of video based exergames, but also fortify self- regulatory skills and social interactions (Schutzer & Graves, 2004; Vaziri et al., 2017). Further they address the problem of group exercise classes among elderly. Different abilities and fitness conditions often make it difficult to include older adults in a group training setting. Further, it is quite common that older adults feel uncomfortable or even ashamed to attend group classes, due to their decreased physical condition (Vaziri et al., 2017). The virtual environment of a gym, that ICT-based fall prevention programs provide, give elderly the possibility to be part of a group, while maintaining their privacy at home and following a personalized exercise program (Baez et al., 2016; Vaziri et al., 2017).

Revisiting the main barriers to physical activity older adults have, which are presented in chapter, ICT- based fall prevention systems have the ability to rebut quite a few of them. The main advantage those systems engender is probably that problems concerning mobility or not having access to attend exercise classes are no longer relevant (Barelle et al., 2010). Instead of planning how to get to an exercise class, or in more rural areas facing the difficulties to even find appropriate offers and facilities, elderly have the possibility to do it at home. Another major barrier to exercise older adults assume is time constraints, referring to this ICT-

[1] /www.nintendo.at/Wii-U/Wii-U-344102.html

based fall prevention systems hope to give elderly the possibility to do exercise during a short period of time, which is enough, when performed regularly (Jansenberger, 2011; Justine et al., 2013).

Another application field to which ICT based fall prevention systems strongly contribute is the opportunity for older adults to maintain a certain amount of exercise after leaving special institutions, like rehab centers. Leading older adults to do tailored exercise programs, which are easy to implement into their everyday life, poses a promising intervention against the common loss of and thus the increasing number of falls among elderly (Ogonowski et al., 2016).

Despite the fact there are a lot of aspects, that contribute to make ICT-based fall prevention a perfect solution to persuade more older adults to lower their risk of falling through improving their coordination balance and overall physical condition, there are some components that need to be considered in order for the target group to really accept those systems. Since those programs require interaction with technical devices, IT-literacy is a major affordance they pose. It is well known that persons aged 65 or older often have troubles using technical applications and /or are not interested in learning how to incorporate more information and communication-based technologies into their daily lives (Charness & Boot, 2009). In this context Vaziri et al. (2017) emphasize that those systems need to have high fault tolerance, operating options, that are easy to understand, as well as the integration of an IT-service organization.

Reflecting on all the mentioned parameters that contribute to make ICT-based Fall prevention solutions suitable for older adults, there are main aspects that need to be considered. First, *older adults represent a vulnerable group*, who demands special and individualized persuasion strategies to implement exercise into their daily lives. Secondly, the *affinity towards technology appears to be quite poor among older adults*. Those facts lead to the realization that elderly cannot be lumped together in one group of persons aged 65 or older (Farshchian & Dahl, 2015; Schutzer & Graves, 2004). There are already some projects on ICT-based fall prevention solutions which try to conquer those challenges. To get an overview on those systems and their strengths and weaknesses, the outcome of studies that dealt with ICT- based Fall prevention systems are discussed below.

2.3.1 ICT-based fall prevention systems

There is a variety of studies that deal with the acceptance of information and communication technology (ICT) based fall prevention among older adults. Different projects and analysis on ICT- based fall prevention systems face the same difficulties. The heterogeneity of older adults and the lack of their IT-literacy such systems demand (Farshchian & Dahl, 2015; Gschwind et al., 2015; Ogonowski et al., 2016; Vaziri et al., 2017).

Gschwind et al. (2015) present an ICT- based fall prevention system (iStoppFalls[2]) to predict and prevent falls, which can be used in older adult's homes. One goal of the iStoppFalls[2] is developed to give older adults the possibility to be physically active while staying at home. The research team conducted an international multicenter randomized controlled trial to examine the feasibility of the system, focusing on exercise adherence and user acceptance. One of the major limitations of the study, was the relatively low adherence to the program. In the mentioned study, the authors draw this limitation back to the low technology affinity among older adults (Gschwind et al., 2015). In this context, Baez et al. (2016) elicit the importance of addressing the technology acceptance among older adults to increase the adherence to ICT-based fall prevention systems.

Farshchian and Dahl (2015) conducted a systematic mapping on studies dealing with ICT- based fall prevention systems. The results show that previous studies predominantly deal with the technical properties, paying too little attention to the user acceptance and ease of use. The authors further state, that data about the target users are often missing, which might be important to increase user acceptance (Farshchian & Dahl, 2015). In this context, Ogonowski et al. (2016) address: "Older people as a sensible group ICT-based fall prevention systems, we suggest, should be designed to allow for integrating the training activities into the daily routines of older adult and should address specific lifestyles, which are nowadays very diverse among older adults (Ogonowski et al., 2016, p. 27)." Further research points out that the majority of studies only use quantitative research methods to measure acceptance indicators, which can imply a lack of content and richness (Mesgari, Okoli, & Ortiz de Guinea, 2018; Vaziri et al., 2017).

Those findings emphasize the necessity of acknowledging the different needs, habits and affordances elderly have and to incorporate them into the development process of ICT- based fall prevention systems (Eissens van der Laan, van Offenbeek, Broekhuis, & Slaets, 2014; Rejeski, Brawley, McAuley, & Rapp, 2000).

[2] www.iStoppFalls.eu

Studies show that person-centered segmentation is a great tool to get a better understanding about a specific group (Eissens van der Laan et al., 2014; Mesgari et al., 2018; Wild et al., 2011).

Regarding the fact that older adults are not a homogenous group, it is necessary to find out what exactly are those distinct groups and which different segments have to be analyzed to pursue meaningful segmentations and Personas. Mesgari et al. (2014) describe a persona with the following words," A persona is a precise description of a user's characteristics and what he/she wants to accomplish (Mesgari et al., 2018, p. 1)." In the published paper "Creating rich and representative Personas by discovering Affordances" the authors flag the importance of examining the user's behavior and their preferences in the process of developing or enhancing a product (Mesgari et al., 2018). The objective of creating personas is to design one or multiple characters representing different types of users within a defined demographic group. The needs of those defined characters can be used as design and functional guideline for the design of new technical devices (Buß, 2009). Based on those findings the methodological strategy of the present study is explained in detail in the following chapter.

3 Methodology

The outcome of the preceding literature research, that there is a lack of subjective data led to the aim of the present thesis to pursue a qualitative approach to detect different user types for ICT- based fall prevention systems. Figure 2 represents a schematic view of the whole course of the study. Starting with the selection of the study design and research methods, followed by data collection and data analysis and finally leads to the development of Personas as a final outcome. This specific procedure was created based on a whit spread literature research on qualitative research methods.

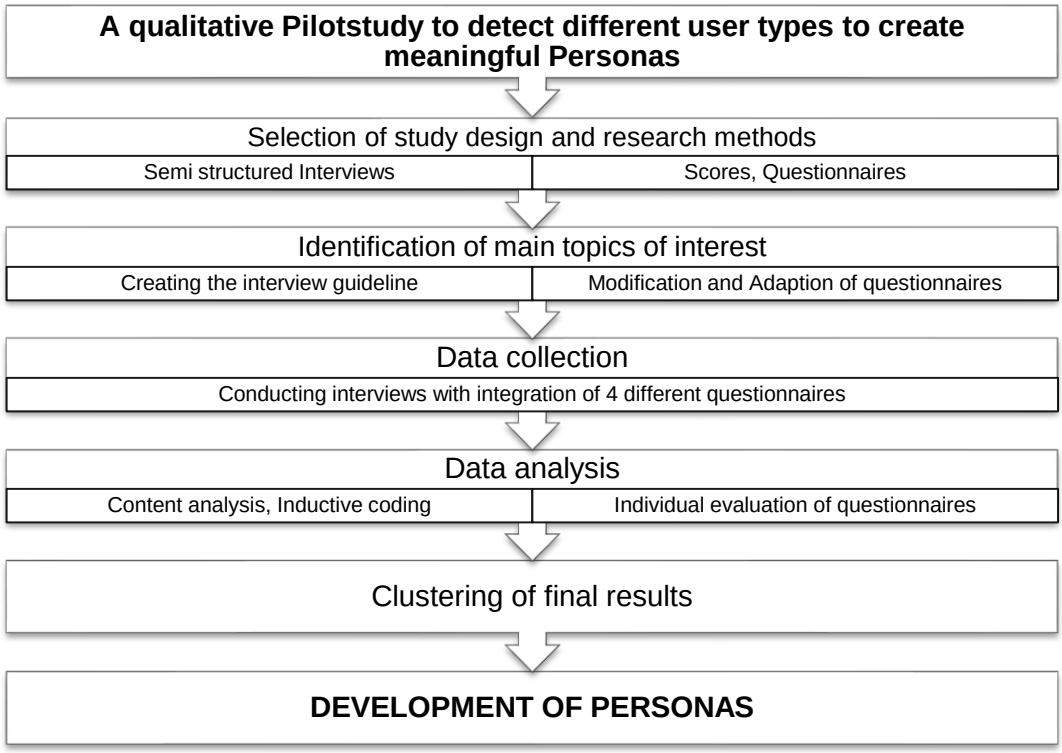


Figure 2: Methodology procedure

The final choice was made in line with the methodic design of two published studies, which dealt with similar interrogations (Vaughn et al., 2017; Vaziri et al., 2017). The methodological strategy of the present study can be further referred to the conference paper “Towards Reusable Personas in Everyday Design” published by O’Leary et al. in 2016. Detailed information on the whole research process of the underlying study is presented throughout the following chapters.

3.1 Study design

In total, 14 older adults, defined as 65 years or older, participated in this qualitative pilot study. Semi-structured interviews and four individual scores were chosen to capture relevant information for a representative and valuable outcome. The data collection took place in different places in Vienna, during a period of four weeks, directly followed by its analysis. Full and accurate information on the choice of research methods, the procedure and the final analysis are presented below.

3.1.1 Participants

According to Helfferich (2009), who published a manual for qualitative research, a total number of 6-30 interviewees as a sample size for medium-sized studies is recommended, depending on the available resources and the desired outcome (Helfferich, 2009). In line with this numbers, Vaziri et al. (2017) conducted 12 semi-structured interviews in the study “Analysis of effects and usage for ICT- based fall prevention”. Another research group recruited 21 interviewees to develop representative Personas out of semi-structured interviews (Vaughn et al., 2017). Considering those best practice models and the available resources for the present thesis, it was decided to interview 14 older adults. Inclusion criteria were the age of 65 years or older and complete independency when performing activities of daily living. Exclusion criteria were immobility and significant visual disturbances or hearing impairments. The terms participants and interviewees are used synonymously throughout the whole thesis.

During the process of recruitment, it was reached out to a total of 19 older adults who live in Vienna or Lower Austria. The recruitment took place as a form of opportunity sampling in the circle of acquaintances of the researcher. They all were contacted via phone. The first 10 persons called, offered to participate in the study. Two of the potential participants did not reply, one dropped out due to health issues and another two persons were not available during the desired time period. As a result, another four participants were recruited, while the first interviews have been already conducted.

A total of 14 older adults were included in the underlying study. There were 11 female and 3 male participants, who all have their current place of residence in Vienna. Their age varied from 67 to 82. Those two variables were the only person-centered data captured throughout the whole interview process. Therefore, absolute anonymity could be provided. All collected data, including questionnaires, records and transcripts were labeled according to the interview sequence from P1 to P14.

Throughout the whole process of data collection, there was no potential danger or risk for the participants from a medical point of view. The ethics committee of the Federal State Lower Austria stated that there is no obligation for this study to be submitted to an ethics committee. In addition, all participants were asked to sign a consent form, that they allow the researcher to use their given information. This formulary also informed them that data acquisition and processing is done by means of commercial software, all data is stored in computer files, and that only the study team has access to this data. In order to ensure the anonymization of the data, the name is replaced by a code when collecting personal data. Apart from the interview guideline, the implemented questionnaires and a recording device no additional resources were needed to conduct the study. The process of developing the interview guideline for the semi-structured interviews is documented in detail in the following passages of the underlying thesis.

3.1.2 Semi-Structured Interview

In view of the purpose of the underlying thesis it can be emphasized, that there are several studies, in which semi structured interviews were used to detect different user types (O'Leary et al., 2016; Vaughn et al., 2017; Vaziri et al., 2017). However, the following paragraphs give an overview how qualitative research methods, in particular the Semi- structured Interview, have reached their eligibility to serve as a stand-alone method.

From 1990 onwards the semi-structured interview has been accepted as an independent research method. Almost 30 years later, it is common use to resort to semi- structured interviews, especially if the main purpose of a study is to get subjective knowledge on a topic (McIntosh & Morse, 2015). However, it is crucial to do an in-depth literature research beforehand to provide sufficient objective knowledge on which the guideline for a semi-structured interview can be built.

Within time different types of Interview strategies were enabled, depending on the purpose, the epistemological privilege, the role of the participant and the outcome of the research. Table 1 shows the four different typologies used in different research areas.

Interview Type	Purpose	Epistemological Privilege	Role of Participant	Outcome
Descriptive/ interpretative	Discovery	Knower	Informant	Understanding
Descriptive/ confirmative	Assessment	Known	Respondent	Confirmation to fit
Descriptive/ corrective	Evaluation	Knower and the known	Collaborator	Refutation, elaboration, correction
Descriptive/ divergent	Contrast	Groups of knowers	Informants	Discernment

Table 1: Interview typologies modified after (McIntosh & Morse, 2015)

McIntosh and Morse (2015) describe the descriptive/ divergent topology as follows: “The purpose of this type of interview is to contrast the perspectives of different groups of knowers (McIntosh & Morse, 2015, p. 4)”, which fits perfectly with the aim of the underlying thesis. Thus, as the anticipated outcome is to detect or more specifically to discern different user groups for ICT-based Fall prevention systems among older adults the descriptive/ divergent typology is chosen. Further considering that the needed information (synonym for epistemological privilege) to create representative personas comes directly from the target group (synonym for groups of knowers) and stating that the interviewees have the exclusive role of “Informants” for the presented study (compare Table1).

McIntosh and Morse (2015) ascertain that using this type first demands researchers to employ an interview guideline and a set of questions to make data comparable and measurable. They recommend creating a meaningful guideline in three major steps. First of all, there is the need to take a closer look on the outcome of the *preliminary literature research* (see. chapter 2) to identify the main topics to focus on in the interview. Secondly, the researcher has to filter out i*ndividual categories* to define different areas. The third and final step contains the *creation of questions* for individual categories (McIntosh & Morse, 2015). In addition, approved interview techniques and recommendations were taken into consideration, such as the importance of choosing a simple language, always having in mind that the respondents do not have any difficulties to understand (Adams, 2015; Leech, 2002).

Figure 3 shows a simplified visualization of the process of creating the interview guideline. Those major steps towards creating an interview guideline are explained in detail throughout the following passages.

Figure 3: Major steps towards the interview guideline

3.1.3 Creating the interview guideline

With the aim of creating meaningful Personas out of semi- structured interviews, inspired by the aforementioned studies from Vaughn et al. (2017) and Vaziri et al. (2017), the election of the main topics is based on a profound research. Revisiting the second Chapter of the underlying thesis the research included fall Prevention, ICT-based fall prevention, including the technical affordances those programs pose, and the Persona methodology. Main areas that contribute to ICT- based Fall prevention are adherence to exercise and physical activity, self-perception as well as openness towards technology and IT -literacy (Vaziri et al., 2017; Wulf, Rohde, Pipek, & Stevens, 2011). In addition, leaning on the concept of affordances by Mesgari et al. (2018), it seems crucial to include questions that evoke answers, out of which the requirements older adults pose, in order to include ICT- based fall prevention systems into their everyday life, can be filtered.

As a result, the conjunction of research on ICT-based Fall prevention and on the chosen methodology led to collect user information about following topics to create representative Personas.

- Subjective mental and physical well being
- Physical activity
- Openness towards technologies
- The requirements and affordances the target group has towards ICT-based Fall Prevention Programs

Those also represent the baseline balance and the first step of the overall process to develop a meaningful interview guideline, visualized in Figure 3. Based on those four identified main topics of interest, the four main categories for the guideline are built. Accordingly, the first category deals with the *subjective mental and physical health condition*, the second category is named "*Physical activity*" and the objective of the third category is to collect information about the target group's technology

acceptance and is entitled as *"Openness towards technology".* To really conquer the aim of the underlying thesis of getting an in- depth understanding of the requirements and affordances older adults have towards ICT- based Fall prevention the fourth and final category explicitly addresses those components, declared as "*ICT-based Fall Prevention Systems*".

After having set the main construct for the guideline, including the four main categories the research moved on to find an appropriate way to capture the desired information. The process of polishing subcategories and question stems, documented as the final out of the three major steps towards the interview guideline (Figure 3), follows. In addition to a review of published papers, that used similar methodologies and had similar goals, one participant was asked to remain responsive throughout the whole process of developing the interview guideline. This instance made it possible to directly involve the target group (older adults) from the outset of the present study. Table 2 shows the final choice of categories, subcategories and additional instruments to capture valuable information. In the following four subchapters (3.1.3.1 to 3.1.3.4) the development of the individual subcategories and the choice of implementing scores and questionnaires will be further elucidated.

Category	Subcategories	Additional instruments
1. Subjective mental and physical condition	1.1 Overall subjective well being 1.2 Perceived state of physical condition	Groningen Frailty Index[4] WKV Adjektivliste[5]
2. Physical activity	2.1 Sporthistory 2.2 Current state 2.3 Motive 2.4 Fall prevention	Open questions BMZI- HEA[6]
3. Openness towards technology	2.1 Use of technical devices in everyday life 2.2 Technology Affinity	Open questions ATI[7]
4. ICT based Fall prevention		Open questions Closed Questions modified after PU and PEOU

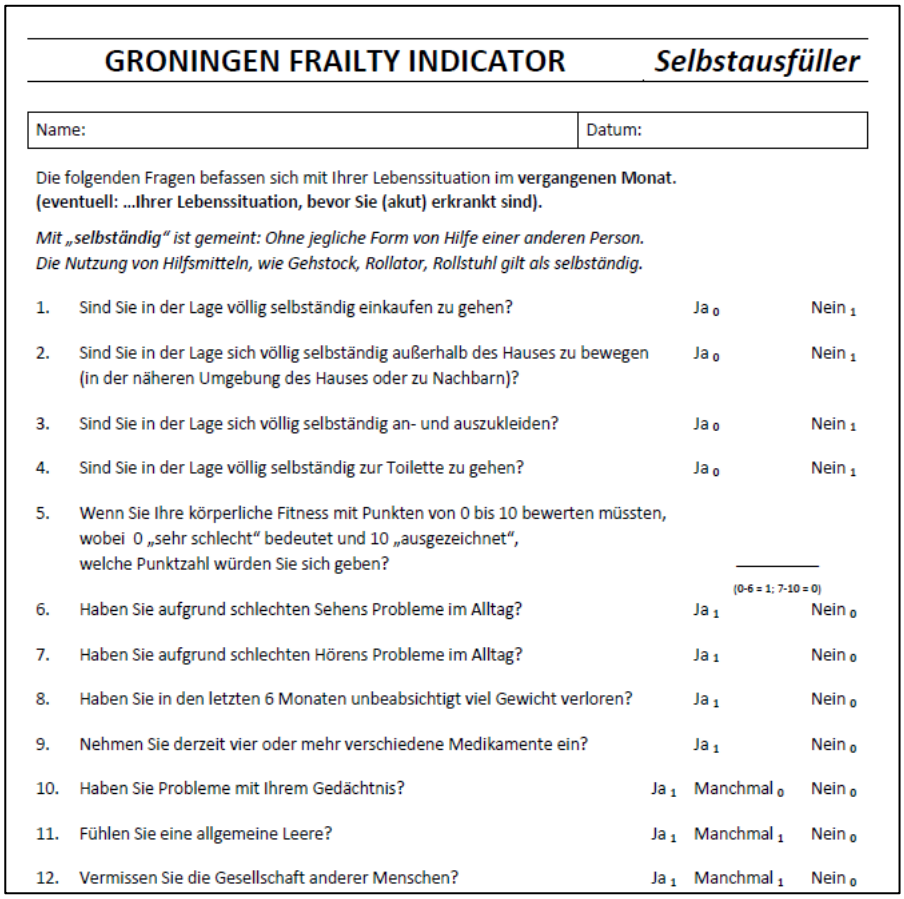
Table 2: Declaration of the interview guideline

3.1.3.1 Subjective mental and physical well being

A study published by Eissens van der Laan et al. (2004) used person-centered segmentation to group elderly according to their unfulfilled bio-psychological needs (Eissens van der Laan et al., 2014). They used parts of the Groningen Frailty Indicator and Intermed[3] to get information about five different areas (biological, psychological, social, mobility and cognitive state). Since the desired outcome of this category is to capture the subjective physical and mental well- being of the participants the GFI[4] is included into the guideline. Further research revealed that the GFI[4] is a stable instrument to capture an overview of the overall health condition of older adults (Peters, Boter, Buskens, & Slaets, 2012). Given the fact, that all of the interviews were conducted in Austria, the German version of the Groningen Frailty Index Formulary is used (Braun, Grüneberg, & Thiel, 2018). Figure 4 shows a snapshot of the GFI[4], as it was implemented into the interview setting (Braun et al., 2018).

[3] Intermed (Wild et al., 2011)

[4] Groningen Frailty Index (Braun, Grüneberg, & Thiel, 2018)



GRONINGEN FRAILTY INDICATOR ***Selbstausfüller***

Name:	Datum:

Die folgenden Fragen befassen sich mit Ihrer Lebenssituation im **vergangenen Monat.**
(eventuell: ...Ihrer Lebenssituation, bevor Sie (akut) erkrankt sind).

*Mit „**selbständig**" ist gemeint: Ohne jegliche Form von Hilfe einer anderen Person.*
Die Nutzung von Hilfsmitteln, wie Gehstock, Rollator, Rollstuhl gilt als selbständig.

1.	Sind Sie in der Lage völlig selbständig einkaufen zu gehen?		Ja 0	Nein 1
2.	Sind Sie in der Lage sich völlig selbständig außerhalb des Hauses zu bewegen (in der näheren Umgebung des Hauses oder zu Nachbarn)?		Ja 0	Nein 1
3.	Sind Sie in der Lage sich völlig selbständig an- und auszukleiden?		Ja 0	Nein 1
4.	Sind Sie in der Lage völlig selbständig zur Toilette zu gehen?		Ja 0	Nein 1
5.	Wenn Sie Ihre körperliche Fitness mit Punkten von 0 bis 10 bewerten müssten, wobei 0 „sehr schlecht" bedeutet und 10 „ausgezeichnet", welche Punktzahl würden Sie sich geben?			(0-6 = 1; 7-10 = 0)
6.	Haben Sie aufgrund schlechten Sehens Probleme im Alltag?		Ja 1	Nein 0
7.	Haben Sie aufgrund schlechten Hörens Probleme im Alltag?		Ja 1	Nein 0
8.	Haben Sie in den letzten 6 Monaten unbeabsichtigt viel Gewicht verloren?		Ja 1	Nein 0
9.	Nehmen Sie derzeit vier oder mehr verschiedene Medikamente ein?		Ja 1	Nein 0
10.	Haben Sie Probleme mit Ihrem Gedächtnis?	Ja 1	Manchmal 0	Nein 0
11.	Fühlen Sie eine allgemeine Leere?	Ja 1	Manchmal 1	Nein 0
12.	Vermissen Sie die Gesellschaft anderer Menschen?	Ja 1	Manchmal 1	Nein 0

Figure 4: German Version of the Groningen Frailty Indicator[4]

In contrast, the Intermed[3] is not included into the final interview guideline, as the referenced study by Eissens van der Laan et al (2014) provides. In the course of developing and testing the guideline, it turned out that this questionnaire does not gather relevant information for the underlying study, since Intermed[3] deals more with the mental than the physical well-being of older adults (Wild et al., 2011). As a result, another instrument was chosen to measure the target group's perceived physical well-being in more detail. The "WKV- Adjektivliste zur Erfassung der wahrgenommenen körperlichen Verfassung", that was constructed, validated and published by Jens Kleinert in a German peer-reviewed journal for Psychology (Kleinert, 2006). The WKV- Adjektivliste is composed of 20 different items measuring people's perceived physical state assessing four dimensions: perceived Alertness, perceived fitness level, perceived health status, perceived flexibility. For each dimension there are five different adjectives that describe a physical state. The participants task is to rate those items depending on their own perception. Since this scale gives the opportunity to collect data, that can be quantified and

compared the WKV-Adjektivliste[5] was modified and included into the guideline for the underlying study. Figure 5 shows an extract of how the mentioned scale was implemented into the interview setting.

WKV Adjektivliste zur Erfassung der wahrgenommenen körperlichen Verfassung (modifiziert nach (Kleinert, 2006)

„Bitte schätzen Sie spontan, ohne viel zu überlegen, ein, inwieweit die folgenden Aussagen zu Ihrer körperlichen Verfassung für Sie im Augenblick zutreffen. Machen Sie ein Kreuz an der entsprechenden Stelle: Im Augenblick fühle ich mich körperlich ...“

Item	trifft sehr zu	trifft eher zu	mittel	trifft eher nicht zu	trifft gar nicht zu
kräftig					
energielos					
unbeweglich					
platt					
lädiert					
gelenkig					
ausgelaugt					
	trifft sehr zu	trifft eher zu	mittel	trifft eher nicht zu	trifft gar nicht zu
krank					
abgeschlafft					
stark					
steif					
fit					

Figure 5: WKV- Adjektivliste modified after Kleinert (2006)

The combination of the Groningen Frailty Indicator and the WKV-Adjektivliste to assess the perceived physical state provides a valuable insight into the participants physical and mental well-being, that is expected to have an impact on their willingness to increase their level of physical activity, which directly leads to the following category of the interview guideline.

3.1.3.2 Physical activity

Since physical activity plays a key role in the process of fall prevention the goal of this category is to get an in- depth understanding about the participants relationship with sports and physical activity in general (Sherrington & Tiedemann, 2015). What motivates them and what are theirs boundaries to involve exercise into their daily

[5] WKV- Adjektivliste zur Erfassung der wahrgenommenen körperlichen Verfassung (Kleinert, 2006)

routines, is a key component to know when designing exercise programs for older adults (Stutts, 2002). Therefore, four subcategories were constructed to capture all aspects, which enclose information about the target groups' experiences and attitudes towards physical activity. Table 3 shows the classification of those four subcategories, the opening question to each new area and the used references.

Subcategory	Opening question	References
Sporthistorie	Erzählen Sie mir etwas über Ihre sportlichen Aktivitäten im Laufe ihres Lebens?	(Schutzer & Graves, 2004)
Aktuelles Sporttreiben	Wie körperlich aktiv sind Sie derzeit? Gehen Sie derzeit einer sportlichen Aktivität nach?	
Motive	Was motiviert Sie mehr Bewegung zu machen/ generell Bewegung zu machen? Was hält Sie davon ab? BMZI- HEA[6]	(Schmid, Molinari, Lehnert, Sudeck, & Conzelmann, 2014) (Lehnert, Sudeck, & Conzelmann, 2011)
Sturzprävention	Machen Sie gezielt Übungen zur Sturzprävention?	

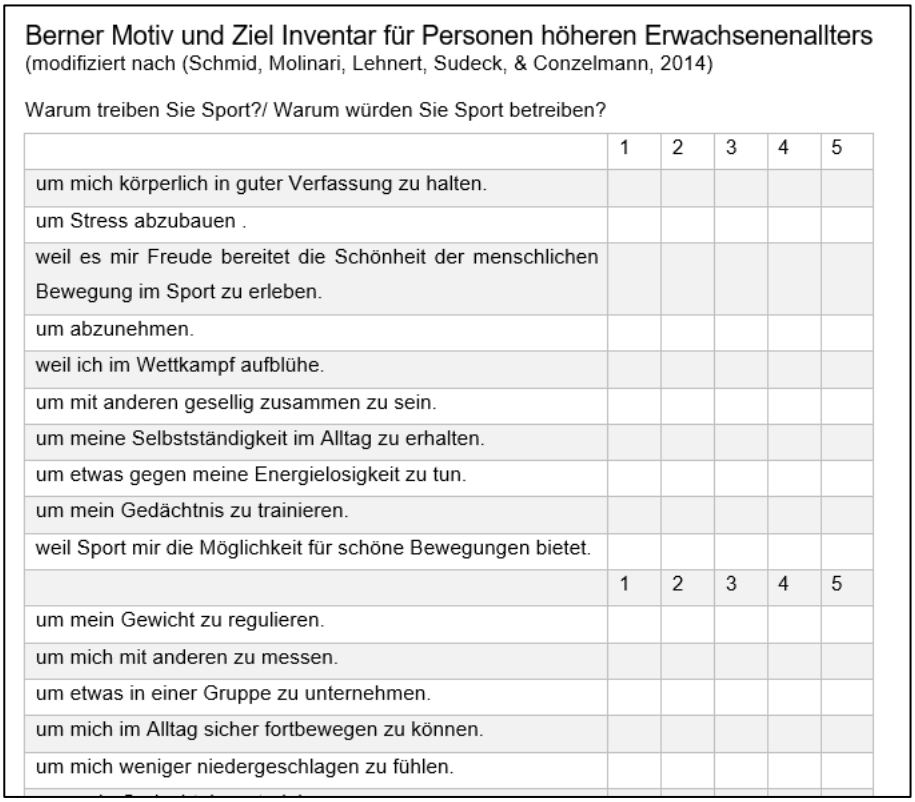
Table 3: Interview Guideline for Category "Physical Activtiy"

The goal of the first subcategory is to learn about the history of sports and physical activity of the interviewees, since those experiences are likely to have an influence on the activity level throughout a person's life (Schutzer & Graves, 2004). An example for some of the questions are: "Which sports activities have they done in their childhood and youth? Have they remained physically active throughout their professional carriers?" The second subcategory addresses all kind of physical activity and exercise the participants are doing at the present state. In consultation with the participant who was available to test the guideline throughout the whole developing process, it became clear that the interviewer needs to give additional advice to the participants that physical activity not only means to take specific sport classes but also going for a walk or cleaning the house. Therefore the opening question: "How active are you during the day?", was chosen in advance to questions directly addressing if the participants follow any kinds of sports activities.

As the preliminary literature review revealed that scrutinizing the motives of older adults to physical activity is crucial to increase their exercise adherence, the third subcategory deals with motives and barriers to include or to include more exercise into the theirs daily lives (Sherrington et al., 2011). In addition to the open questions, an alteration of the "Berner Motiv und Zielinventar für Personen des höheren Alters (BMZI-HEA)" is also included into the interview guideline (Lehnert et al., 2011; Schmid et al., 2014). The BMZI-HEA[6] is based on the BMZI ("Berner Motiv und Ziel Inventar"), an inventory which is suitable for the screening of multidimensional motivational profiles in recreational and health sports (Lehnert et al., 2011). The BMZI- HEA is an adaption and extension to the original BMZI, specifically created to enable the individual diagnosis of motives and goals towards exercise for persons of higher age.

The BMZI- HEA includes 27 items belonging to seven different dimensions: contact ("Kontakt"), activites of daily living and health ("Alltagskompetenz und Gesundheit"), positive movement experience ("positive Bewegungserfahrung"), mood regulation ("Stimmungsregulation"), cognitive functioning ("Kognitive Funktionsfähigkeit"), gugur/aesthetics ("Figur/ Aussehen"), performance and competition ("Wettkampf und Leistung") (Schmid et al., 2014). The aim of this inventory is to find out about person's main motives to attend exercise. Figure 6 shows a cutout of the modified BMZI-HEA, which was used in the interviews. On the left side the original verbalizations of the items, provided by Schmid et al. (2014) are listed. Unlike the original Inventory which includes a rating scale from one to seven, the modified version for the present study only contains a scale from 1 to 5. This decision was made to keep the rating scales nearly the same in all used questionnaires throughout the interview, to prevent confusion and excessive demand among the participants. The outcome of the BMZI-HEA is only meant to be used to compare the participants within the underlying study, so the modification of the scale does not cause any problems in the evaluation.

[6] BMZI-HEA Berner Motiv und Zielinventar für Personen des höheren Alters (Schmid, Molinari, Lehnert, Sudeck, & Conzelmann, 2014).



Berner Motiv und Ziel Inventar für Personen höheren Erwachsenenallters
(modifiziert nach (Schmid, Molinari, Lehnert, Sudeck, & Conzelmann, 2014)

Warum treiben Sie Sport?/ Warum würden Sie Sport betreiben?

	1	2	3	4	5
um mich körperlich in guter Verfassung zu halten.					
um Stress abzubauen .					
weil es mir Freude bereitet die Schönheit der menschlichen Bewegung im Sport zu erleben.					
um abzunehmen.					
weil ich im Wettkampf aufblühe.					
um mit anderen gesellig zusammen zu sein.					
um meine Selbstständigkeit im Alltag zu erhalten.					
um etwas gegen meine Energielosigkeit zu tun.					
um mein Gedächtnis zu trainieren.					
weil Sport mir die Möglichkeit für schöne Bewegungen bietet.					
	1	2	3	4	5
um mein Gewicht zu regulieren.					
um mich mit anderen zu messen.					
um etwas in einer Gruppe zu unternehmen.					
um mich im Alltag sicher fortbewegen zu können.					
um mich weniger niedergeschlagen zu fühlen.					

Figure 6: BMZI-HEA modified after Schmid et al. (2014) and Lehnert et al. (2011)

To complete the category „Physical Activity" there are questions about the participant's previous experiences with fall prevention. The purpose of this fourth subcategory is not only to find out whether the participants have already taken any kind of intervention to prevent falls, but also if they need to be clarified on the topic in general. Is that the case, the interviewer should be able to give a short explanation on fall prevention, so the participant will not have any troubles staying on track, especially with the upcoming questions on ICT- based Fall prevention.

3.1.3.3 Openness towards technology

Beyond doubt, openness towards technology and IT-literacy poses, alongside exercise adherence, an indispensable presupposition to use ICT- based fall prevention systems (Obi, Ishmatova, & Iwasaki, 2013; Vaziri et al., 2017). To embrace those components within the interview three subcategories for the interview guideline were chosen. According to Liu and Yang (2014) information around the use of technical devices in a person's everyday life has informative value about a person's openness towards new technologies (Liu & Yang, 2014). Therefore, "What kind of technical devices do you use regularly?", is chosen as an opening question in the interview guideline to the present category. Follow up

questions to find out about the participants motives behind using or avoiding certain devices are chosen accordingly to each individual interview situation. Facilitating conditions and the social environment play another important role regarding the relationship between older adults and technical devices (Thompson, Higgins, & Howell, 1991). In the publication "Personal Computing: Toward a Cenceptual Model of utilization" Thompson, Higgings and Howell (1991) formulate four statements that should help to find out about a person's so-called facilitating conditions for technical devices. They were translated into German and implemented into the interview guideline as the main part of the second subcategory, which is presented in Table 4.

Subcategory	Opening questions	References
Nutzung von technischen Geräten im Alltag	Welche technische Geräte nutzen Sie regelmäßig?	(Liu & Yang, 2014)
Facilitating Conditions	FC1: Bei der Auswahl von Hard- und Software steht mir eine Anleitung zur Verfügung FC2: Eine bestimmte Person oder Gruppe steht für Hilfe bei Softwareproblemen zur Verfügung. FC3: Spezielle Anleitungen zur gängigen Software stehen mir zur Verfügung FC4: Eine bestimmte Person oder Gruppe steht zur Verfügung.	(Thompson et al., 1991)
Technikaffinität	ATI Fragebogen	(Franke, Attig, & Wessel, 2019)

Table 4: Interview guideline for category "Openness towards technology"

With the implementation of the Scale for measuring the Affinity for technology interaction (ATI) by Franke et al.(2019) the third category of the interview guideline "Openness towards technology" is completed. The German version of the ATI[7] illustrates a stable instrument to get an overview of a person's technology affinity, which fits perfectly into the research field of the present thesis. Figure 7 shows a cutout of the ATI Formulary (Franke et al., 2019). In fact, there are nine statements concerning the interaction with technical systems. By technical systems are meant

[7] ATI Affinity for Technology Interaction Scale (Franke, Attig, & Wessel, 2019)

apps and other software applications, as well as complete digital devices (e.g., cell phone, computer, television, car navigation). The participant's task is to rate their personal degree of approval for each of those 9 Statements from "completely correct ("stimmt völlig") to "not at all" (stimmt gar nicht") in 6 ranges.

Fragebogen zur interaktionsbezogenen Technikaffinität (ATI)

(Affinity for Technology Interaction (ATI) Scale, Deutsche Version)
Franke, Attig, & Wessel (2018)

Im Folgenden geht es um Ihre Interaktion mit technischen Systemen. Mit ‚technischen Systemen' sind sowohl Apps und andere Software-Anwendungen als auch komplette digitale Geräte (z.B. Handy, Computer, Fernseher, Auto-Navigation) gemeint.

Bitte geben Sie den Grad Ihrer **Zustimmung** zu folgenden Aussagen an.		stimmt gar nicht	stimmt weitgehend nicht	stimmt eher nicht	stimmt eher	stimmt weitgehend	stimmt völlig
01	Ich beschäftige mich gern genauer mit technischen Systemen.	☐	☐	☐	☐	☐	☐
02	Ich probiere gern die Funktionen neuer technischer Systeme aus.	☐	☐	☐	☐	☐	☐
03	In erster Linie beschäftige ich mich mit technischen Systemen, weil ich muss.	☐	☐	☐	☐	☐	☐
04	Wenn ich ein neues technisches System vor mir habe, probiere ich es intensiv aus.	☐	☐	☐	☐	☐	☐
05	Ich verbringe sehr gern Zeit mit dem Kennenlernen eines neuen technischen Systems.	☐	☐	☐	☐	☐	☐
06	Es genügt mir, dass ein technisches System funktioniert, mir ist es egal, wie oder warum.	☐	☐	☐	☐	☐	☐
07	Ich versuche zu verstehen, wie ein technisches System genau funktioniert.	☐	☐	☐	☐	☐	☐
08	Es genügt mir, die Grundfunktionen eines technischen Systems zu kennen.	☐	☐	☐	☐	☐	☐
09	Ich versuche, die Möglichkeiten eines technischen Systems vollständig auszunutzen.	☐	☐	☐	☐	☐	☐

Figure 7: Affinity towards technology Interaction Scale (Franke et al., 2019)

As a result, the conjunction of those three areas, which are outlined in Table 4, is expected to give valuable information about the target group's attitude towards technology.

3.1.3.4 ICT based Fall prevention

The intention behind implementing the category “ICT-based Fall prevention” into the interview guideline, is to directly address the participants opinions on ICT-based Fall prevention systems. Based on the literature research on ICT-based Fall prevention solutions (s. chapter 2.3 p. 12) the interviewer needs to give the participants a description that is easily understandable by all participants.

Subcategory	Opening question	References
Vorstellung von ICT basierenden Sturzpräventionsprogrammen	Können Sie sich vorstellen wie so ein Programm funktionieren würde?	(Gschwind et al., 2015)
	Würden Sie es regelmäßig nützen? Warum schon /Warum nicht?	
Erforderliche Kompetenzen / Voraussetzungen (persönliche Meinungen)	Welche Kompetenzen sind Ihrer Meinung nach für diese Tätigkeit wichtig?	
Perceived Usefulness Perceived ease of use	Perceived Usefulness (Wahrgenommene /Angenommene Nützlichkeit) Perceived Ease of Use (Wahrgenommene/ angenommene Nutzerfreundlichkeit)	(Davis, 1989)

Table 5: Interview guideline for Category “ICT-based Fall prevention”

The opening questions to this last category where, whether the participants can imagine how an ICT-based fall prevention system could work in their own homes and whether they think they would use it. Follow up questions should engage with the participant’s reasons of its usage or non-usage. In addition, the interviewees are asked to think of requirements or the environment that a person would need in order to use an ICT- based fall prevention systems.

As the very last part of the interview guideline the perceived usefulness (PU) and the perceived ease of use (PEOU) of an ICT-based fall prevention system is implemented. Liu and Yang (2014) state that measuring the PU and PEOU can

help to capture a systems overall usefulness for the target group. Perceived Use (PU) “refers to a user’s subjective belief that a certain technology will benefit his or her work performance in the future (Liu & Yang, 2014)” and Perceived ease of use “refers to the extent to which a user perceives that a technology is easy to use” (Liu & Yang, 2014).” The authors refer to Fred D. Davis, who published respectively six statements to measure PU and PEOU as the outcome of a study that deals with technology acceptance (Davis, 1989). Those 12 statements were adapted to the present topic, translated into German and implemented into the guideline.

Wahrgenommene Nützlichkeit **modifiziert nach Perceived Usefulness (Davis, 1989)**	**1**	**2**	**3**	**4**	**5**
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde mir ermöglichen in kurzer Zeit zielgerichtet Bewegung zur Sturzprävention zu machen.					
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde es mir einfacher machen Bewegungen korrekt auszuführen.					
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde dazu beitragen, dass ich mehr Bewegung zur Sturzprävention mache.					
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde es mir leichter machen gezielte Bewegung zur Sturzprävention in meinen Alltag zu integrieren/ einzuplanen.					
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde ich nützlich finden, um aktiv Bewegung zur Sturzprävention zu machen.					
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde mein alltägliches Leben vereinfachen.					

Table 6: Perceived Usefulness modified after Davis 1989

Wahrgenommene Nutzerfreundlichkeit **(modifiziert nach Perceived Ease of Use (Davis, 1989))**	**1**	**2**	**3**	**4**	**5**
Es wäre für mich einfach zu lernen mit einem IKT-basierenden Sturzpräventionsprogrammen umzugehen.					
Ich würde es leicht finden das Programm so einzustellen, dass es so funktioniert, wie ich es möchte.					
Für mich wäre der Umgang mit IKT- basierenden Sturzpräventionsprogrammen einfach und verständlich.					
Ich würde das Programm als leicht zu bedienen empfinden.					
Es wäre leicht für mich, mich gut mit dem Programm auszukennen und es zu bedienen.					
Ich würde ein IBSP als leicht zu nützen empfinden.					

Table 7: Perceived Ease of Use modified after Davis, 1989

Within the scope of the interview setting, the interviewer read the statements to the participant and asked them to rate those statements from 1 to 5. This gave the interviewer the possibility to further explain any statement, if the participant has troubles understanding.

All of the stated Tables, which include the distinction of subcategories, opening questions and/ or follow up questions were printed out and taken to every interview to provide that none of the mentioned topics were left out. Since the interviews were conducted as semi-structured interviews, apart from the implemented questionnaires, the structure and order of the questions can vary from one interview to another. How the actual data collection of the underlying study with the goal to detect different user types for ICT-based fall prevention systems took place is documented in the following chapter.

3.2 Data Collection

All 14 interviews were conducted throughout a period of four weeks on different days and different times of the day, depending on the individual availability of the participants. There was no specific order in which the participants were interviewed, thus the chronology was determined by the availability of the interviewees. According to the sequence of the meetings the participants were given numbers from P1 to P14. All of the used questionnaires as well as the records were only marked with this code, to provide full anonymity.

3.2.1 Interview Setting

All fourteen participants were interviewed by the same person in their native language German. Twelve out of the fourteen participants were visited at their homes. Out of those twelve participants there were six persons living alone and three married couples, of whom every person was interviewed separately. Two participants agreed to visit another participant to take part in the interview process.

All of the questionnaires were printed out in advance. The guidelines for each category (Table 3, Table 4 and Table 5) were printed out as well. They also contained some additional space for the interviewer to eventually take notes. As a recorder the recording application on the interviewer's smartphone was used. An additional memory card was used to save all recorded data.

Since the recruitment of the interviewees was executed by different persons, the information the participants had in advance to the interview differed. Thus, to make sure, that the participants feel comfortable and informed, they were given a brief overview of what they can expect before the actual interview started. Further, they were clarified about the use of the information they would provide during the interview and that no personal data would be gathered, except their age, which could link to their identity. In addition, they were asked to sign the statement of agreement, that the provided data is allowed to be used for the purpose of research in the underlying thesis. Specifically, the participants were also informed that the whole interview would approximately take 20 to 25 minutes and that are four different questionnaires to complete as well as open questions concerning the mentioned categories physical activity, openness towards technology and ICT-based fall prevention systems. During the whole interview process the interviewer made sure to lead the participant through the topics, so they would always know what to expect next.

3.2.2 Interview Procedere

The actual data acquisition started with two of the presented questionnaires in chapter 3.1.3.1 the Groningen Frailty Indicator[4] and the WKV-Adjektivliste[5] to file the subjective mental and physical well-being of the interviewees. The first questionnaire, the participants were asked to complete was the Groningen Frailty Indicator. In addition, the interviewer added their age and their gender on the top of that question sheet. Following this, the older adults were shortly introduced that the goal of the "WKV- Adjektivliste" is to capture their subjective physical well-being at that moment. After the completion of those two questionnaires the participants were informed, that the recording would start at that moment, but that there is no need to pay any attention to this occurrence. Then the recording was started by the interviewer on a smartphone.

As soon as the recording started, the participants were once again encouraged to always interrupt the interviewer or ask any question if something was not clear to them. Initially the participants were invited to talk about their sports activities in the course of their lifetime, starting with the experiences they had in their youth, through their working life up to now.

As an extension to their information they have already given on what motivates them to be physically active, the participants were asked to complete the BMZI-HEA[6]. This questionnaire required the interviewees to rate given reasons, why they are or would be physical active from 1 to 5 (1= "I totally agree", 5= "I do not agree at all). "I do physical activity, because I want to remain independent," poses one example of the 27 items the BMZI- HEA[6] contains. While the participant was filling out the questionnaire, the recording remained active, since the test interview showed, that the target group is often thinking out loud in the process of answering questionnaires. Those thoughts often provided significant information about their motives and barriers to physical activity, which they did not think about when the participants were asked in advance.

Moving on to the third category of the interview guideline, concerning the target group's openness towards technology, the participants were initially asked to array their technical components of use during the day. After completing the open questions, the interviewer provided the last of the four questionnaires, the German version of the "Affinity Towards Technology Interaction Scale (ATI[7])" (Figure 7). The participant's task was to read the nine provided statements and rate them in 6 ranges from "completely correct ("stimmt völlig") to "not at all" (stimmt gar nicht"). The recording also lasts while the participants filled out this questionnaire. Further, they were always allowed to ask for an explanation, if there was anything unclear to them concerning this or any other questionnaire.

The last part of the interview started with an explanation of what ICT- based Fall prevention is all about. After a short repetition of the importance of regular physical activity and staying as mobile and healthy as possible to prevent falls, the interviewer explained how an ICT- based Fall prevention System works and how it would be implanted in the participants' homes. Once the interviewer was sure, that the participant has completely understood how he/ she could use an ICT- based Fall Prevention Program, the prepared questions according to the interview guidline (Table 5) were asked. To complete the interview 12 scheduled questions regarding the perceived usefulness and the perceived ease of use according to Davis, 1989 were posed (Table 6, Table 7).

Throughout the period of conducting the interviews, all questionnaires, which were completed in pencil and paper form, as well as the signed approvals were stored in separate folders. The records were saved as an audio file on a memory card on the smartphone of the interviewer. All interviews were fully transcribed, coded, printed out and added to the questionnaires of the individual participants. The evaluation of the questionnaires and the analysis of the transcripts did not start until all 14 interviews were conducted.

3.3 Data Analysis

The goal of the preliminary data analysis is to extract all relevant information of each individual interview, including questionnaires and the transcript, according to the four main topics of interest. Table 8 revives those topics and the additional instruments, which were used to capture that information within the scope of data collection.

Category	Subcategories	Additional instruments
1. Subjective mental and physical condition	1.1 Overall subjective well being 1.2 Perceived state of physical condition	Groningen Frailty Index[4] WKV Adjektivliste[5]
2. Physical activity	2.1 Sporthistory 2.2 Current state 2.3 Motive 2.4 Fall prevention	BMZI- HEA[6]
3. Openness towards technology	2.1 Use of technical devices in everyday life 2.2 Technology Affinity	ATI[7]
4. ICT based Fall prevention	Measuring Perceived Usefulness and Perceived Ease of Use	

Table 8: Declaration of the interview guideline

With regard to the purpose of the present thesis to create meaningful Personas, data from all 14 interviews has to be processed to be measurable and comparable. This includes two major steps, the evaluation of all used scores and questionnaires (s. Table 8, column 3) and the interpretation of the interview transcripts. The questionnaires (GFI[4], "WKV-Adjektivliste"[5], BMZI-HEA[6], ATI[7]) are evaluated exact or slightly modified to their original sources. A combination of the content analysis according to Mayring (2000) and an inductive coding approach according to Thomas (2003) are the tools chosen to evaluate the interviews. The basis to use those tools is the creation of a coding system relying on the categories and subcategories of the interview guideline (Table 8). The coding system is outlined in chapter 3.3.2.

Microsoft Excel was used to list and operationalize data and calculate scores. To provide complete traceability for each participant a separate Excel file, named from P1 to P14 was created, in which all data were entered. In the following two subchapters the systematic procedure will be described in detail. In terms of

readability chapter 3.3.1 outlines the analysis of the questionnaires and in chapter 3.3.2 the coding system will be further explained.

3.3.1 Individual Analysis of scores and questionnaires

In advance to the explicit description of the analysis it needs to be clarified, that some of the questionnaires and/ or their evaluations slightly differ from the original sources and are adapted to the affordances of the present study. The outcomes of any of the questionnaires only serve for comparison within the study and are only meant to be used within the 14 participants. Further details are documented below.

3.3.1.1 Groningen Frailty Index[4]

According to the original GFI[4] scoring System, the Groningen Frailty Indicator was calculated for every individual participant (Braun et al., 2018). Since the original aim of the Groningen Frailty Indicator is to get an overall statement on a person's health condition the recommended presentation of the outcome only includes the total score, not paying attention to the outcome of the individual subcategories. In contrast, to capture as a much and as detailed information as possible a separate Excel chart for each participant was created to also have an overview on the outcomes of the individual subcategories.

Groningen Frailty Index											
Mobility		Vision &Hearing & Nutrition		Nutrition		Co-morbitdiy &cognition		Psychological		Physical Fitness	
Question	Score	Question	Score	Question	Score	Question	Score	Question	Score	Question	Score
1	0	6	0	8	0	9	1	11	0	5	1
2	0	7	0		0	10	1	12	0		1
3	0		0				2	13	0		
4	0							14	0		
	0							15	1		
									1		
Total Score						4					

Figure 8: Evaluation sheet GFI

Figure 8 shows one example of the mentioned charts, which make it easy to compare the scores of the 14 participants.

3.3.1.2 WKV-Adjektivliste[5]

The second questionnaire, the participants of the underlying study completed was the "WKV- Adjektiv Liste[5]", with the aim to capture more measurable information on their subjective physical well-being. Figure 5, which is presented in chapter 3.3.1.2 shows how this questionnaire was presented to the participants with the task to rate 20 different adjectives from "totally agree" to "not agree at all" according

to their own subjective perception. Consequently, to assess the perceived physical condition of the participants, the adjectives were assigned to one of the four dimensions according to Kleinert (2006). The author of the WKV-Adjektivliste[5] states that the items for every dimension have to be summed up, further it is defined which items have to be inverted (Kleinert, 2006). Figure 9, which presents the Excel chart, that was created for the underlying study, those inverted items are highlighted in grey.

Auswertung: WKV-Adjektivliste zur Erfassung der Wahrgenommenen Körperlichen Verfassung							
Aktiviertheit		**Trainiertheit**		**Gesundheit**		**Beweglichkeit**	
Items	Score	Items	Score	Items	Score	Items	Score
energielos	4	kräftig	3	lädiert	4	unbeweglich	2
platt	5	stark	4	krank	5	gelenkig	2
ausgelaugt	4	fit	1	angeschlagen	5	steif	5
abgeschlafft	5	durchtrainiert	1	gesund	3	dehnfähig	4
schlapp	4	kraftvoll	2	verletzt	5	beweglich	1
	22		11		22		14

Figure 9: Evaluation sheet_WKV-Adjektivliste

Since the maximum score for each dimension is 25 (5 items, possible score from 1 to 5), the displayed example shows high scores of 22 for both “Aktiviertheit” and “Gesundheit” lower scores for “Trainiertheit” and “Beweglichkeit”. Therefore, those outcomes assume that this participant feels active and healthy but would not consider himself/herself as well trained or extremely flexible. The individual outcomes are presented in chapter 4.1.

3.3.1.3 BMZI-HEA[6]

A modification of the BMZI-HEA[6] was included as part of the second category “Physical Activity” into the interview guideline (Figure 6). Figure 10 shows how the modified BMZI-HEA[6] was evaluated, on the basis of one randomly chosen evaluation sheet of one of the 14 participants. According to Schmid et al. (2014) all 27 items were allocated to their motives.

BMZI-HEA					
Sportbezogene Motive und Ziele	**Items**	**Itemformulierung**	**Score**	**Total Score**	**Relatvie Score**
Kontakt	kon1	um durch den Sport neue Freunde zu gewinnen.	3	15	**60,0%**
	kon2	um dabei Freunde/Bekannte zu treffen.	3		
	kon3	um mit anderen gesellig zusammen zu sein.	5		
	kon4	um dadurch Menschen kennen zu lernen.	3		
	kon5	um etwas in einer Gruppe zu unternehmen.	1		
Alltagskompetenz und Gesundheit	allges1	um im Alltag körperlich mobil zu bleiben.	5	25	**100,0%**
	allges2	um körperlichen Bewschwerden entgegen zu wirken.	5		
	allges3	um meine Selbstständigkeit im Alltag zu erhalten.	5		
	allges4	um mich im Alltag sicher fortbewegen zu können.	5		
	allges5	um mich in körperlich guter Verfassung zu halten.	5		
Positive Bewegungserfahrung	bewerf1	weil es mir Freude bereitet,die Schönheit der menschlichen Bewegung im Sport zu erleben.	2	9	**45,0%**
	bewerf2	weil Sport mir die Möglichkeit für schöne Bewegungen bietet.	3		
	bewerf3	vor allem aus Freude an der Bewegung.	3		
	bewerf4	um angenehme körperliche Erfahrungen zu machen.	1		
Stimmungsregulation	stimm1	um etwas gegen meine Energielosigkeit zu tun.	1	8	**40,0%**
	stimm2	um mich weniger niedergeschlagen zu fühlen.	3		
	stimm3	um Stress abzubauen.	1		
	stimm4	um mich weniger angespannt zu fühlen.	3		
Kognitive Funktionsfähigkeit	kogn1	um meine Denkfähigkeit zu erhalten.	1	3	**20,0%**
	kogn2	um geistig fit zu bleiben.	1		
	kogn3	um mein Gedächtnis zu trainieren.	1		
Figur/Aussehen	figaus1	wegen meiner Figur.	1	3	**20,0%**
	figaus2	um mein Gewicht zu regulieren.	1		
	figaus3	um abzunehmen.	1		
Wettkampf und Leistung	wetlei1	um mich mit anderen zu messen.	1	3	**20,0%**
	wetlei2	um sportliche Ziele zu erreichen.	1		
	wetlei3	weil ich im Wettkampf aufblühe.	1		

Figure 10: Evaluation sheet_BMZI-HEA

The numbers in the column “score” represent the answers of the participant, meaning that 5 equals they “totally agree” with the statement on the left and 1 “they do not agree”. Those figures were added up for each individual motive and termed “Total Score”. As a last step the relative scores for every motive was calculated to compare the different outcomes. The participant, represented in Figure 10, for instance has a relative score of 100% for the motive activities of daily living and health (“Alltagskompetenz und Gesundheit“) and a relative score of 20% for the motive. This can be further interpreted as this participant is or tries to be physically active primarily due to health benefits. The remaining 5 motives were analyzed accordingly. Conjoined with the outcome of the open questions of the interviews the outcome of each individual participant is presented in chapter 4.

3.3.1.4 Affinity towards technology score (ATI)[7]

ATI		
Statement	**Score**	**Mean**
1	6	
2	2	
3	1	
4	1	
5	1	2,2
6	1	
7	2	
8	1	
9	5	

Figure 11: Evaluation sheet_ATI

The ATI[7] Score was calculated and interpreted according to the original terms of reference (Franke et al., 2019). Figure 11 illustrates how data from the original questionnaires, which were completed by the participants, were transferred to an Excel chart. For each of the 9 statements the score was put down into the chart. Statement 3, 6 and 8 had to be inverted (Figure 7). At last the mean of those nine different figures was calculated and used to interpret the participants affinity towards technology interaction. On a scale of 1 to 6, it is assumed that the higher the average, the higher the affinity for the technological interaction In the overall analysis of the underlying study, alongside with the outcome of the open questions concerning the openness towards technology, the ATI[7] score was used to assess the participants' attitude towards technology (see chapter 3.3.1.4).

3.3.2 Coding System

The second part of the data analysis is the evaluation of the semi-structured interviews. A coding system to identify similar behavioral patterns within the participants was created. The goal was to create representative codes to operationalize the answers of the participants of the present study. The whole process from the raw interview data to the final codes included four steps, which are outlined in Figure 12. A combination of deductive and inductive approaches to evaluate the interviews lead to the final coding system (Bowen, 2008; Mayring, 2000; Thomas, 2003).

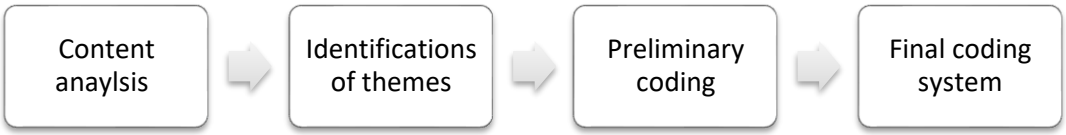


Figure 12: Process from raw interview data to final codes

At first data was analyzed according to *the qualitative content analysis* after Mayring (2000). The information of each interview was allocated to the different categories and subcategories (physical activity, openness towards technology, ICT-based fall prevention systems), which were defined in the course of creating the interview guideline (Table 8).

The second step included *the identification of 1 to 5 themes* within each subcategory. Therefore, an inductive approach to analyze qualitative data according to Thomas (2003) was chosen. The author recommends discerning different themes out of the interviews following the principle of saturation[8]. This method demands close reading of the individual interview transcripts and adding themes to the subcategories as long as no new themes occur. “Saturating data ensures replication in categories; replication verifies and ensures comprehension and completeness (Bowen, 2008, p. 4)”.

Once the themes were specified, *the preliminary coding* was conducted. In line with the study by Vaughn et al (2017) each theme was assigned with different

[8] Bowen, G. A. (2008). Naturalistic inquiry and the saturation concept: a research note. Qualitative Research, 8(1), 137–152. https://doi.org/10.1177/1468794107085301

codes according to the different answers of the interviewees. This coding process was also conducted in reference to the principle of saturation[8], in other words codes were defined until data recurred. Saturation was reached within two to six different codes per theme.

Since the interviews were conducted and transcript in German, the final step contained not only a revision and reduction of the preliminary codes but also their translation. The result of this process was a *final coding system*, which allowed to systematically analyze the interviews.

The coding charts for the individual categories are outlined below (Table 9, Table 10,Table 11). The columns represent the four steps, which are explained above. For example, “Current level of physical activity” (First Column) is a subcategory to the category “Physical activity”. The identified themes within this subcategory are: Form of exercise, Frequency, Setting, Importance of Feedback and Overall activity (second Column). In the third column of the coding charts the Preliminary codes to each theme are documented. The final codes are outlined in the fourth column (Table 9).

Physical Activity			
Sub categories	Themes	Preliminary Coding	Final codes
Sort History	Youth/ Adulthood	• Turnverein • Schwimmen/ Radfahren • Skifahren • Tennis • Kein Sport	• Gymnastics club • Skiing, Hiking, Swimming, Running, Cycling • Team sport • No sport
Current level of activity	Form of exercise	• Turnen • Wandern • KISA Training • Kein Sport • Selbstständige Übungen • Hometrainer Ergometer • Tanzkurs	• Gymnastics/ Dance class • Hiking • Resistance Training • Exercise bike • At home exercise • No exercise
	Frequency	• 1-2x/Woche • 2x/ Woche • Täglich	• 1/Week • 2-4/Week • Daily
	Setting	• Gruppe • Alleine, aber in Gesellschaft • Alleine • Nicht konkurrenzorientiert	• Group • Alone, but in company • Alone • Team
	Importance of Feedback	• Sehr wichtig • Regelmäßige Erstellung von neuen Programmen • Nicht wichtig, • muss es nicht so genau wissen /will es nicht so genau wissen	• Very important (every session) • Periodic feedback • Indifferent • Not necessary/ not required
	Overall activity	• 1/Tag 1 Stunde Spazieren • Stiegen Zweiter Stock • Wandern in einer Senioren Gruppe • Stadtleben ohne Auto • Seltenes Spazieren Gehen • Viel unterwegs sein	• Going for a walk every day on purpose • Active lifestyle (no car, no elevator etc.) • Very inactive lifestyle
Motives and Barriers	Motives	• Gesellschaft • Gesundheit • Solange wie möglich fit sein • Wahrgenommenes Wohlbefinden gesteigert • Spaß	• Sociability • Health & staying fit as long as possible • Increased overall well-being • It's fun.
	Barriers	• Schlechtwetter • Schmerzen durch Verletzung • Nebenwirkung Medikamente • Chronische gesundheitliche Einschränkungen • Zu alt	• Bad weather conditions • Pain/ restrictions due to present or previous injuries • Side effects from medications • Chronic health related restrictions • "being too old" • Lack of motivation

Fall prevention	Knowledge	• Muskulatur Erschlaffung im Alter • Bewegung hält fit • Umgebungsanpassung • Keine Gefahr für sich selbst • Kein Wissen	• Physical activity keeps the muscles strong • Environmental adaptions • No knowledge • Not considering him/herself at risk of falling
	Intervention past	• Aufenthalt im Rehazentrum/ Krankenhaus • Keine Intervention	• During a stay at a rehab center or hospital • No intervention
	Intervention current	• Ja, aber nicht bewusst • Keine Intervention • Gleichgewichtsübungen	• Regular balance training • Yes, but not on purpose • No intervention

Table 9: Coding Chart_ Category Physical Activity

Openness towards technology			
Sub categories	Themes	Preliminary Coding	Final codes
Use of technical	Devices	• Fernseher • Handy (normal) • Smartphone • Radio • Computer	• Television • Mobile Phone • Smartphone • Computer
	Use	• Internet • Telefonieren und SMS	• Internet (e-mail, News, etc.) • Calls, Text messages
Faciliating conditions	Instructions	• Nein, von vorherein • Ungern • Schwer zu verstehen • Keine Geduld • Gibt es oft nicht • Nur englische Anleitungen	• No, not even trying to understand • Hard to understand • No patience
	Who to ask/ Where to inform	• Servicekraft, per Telefon • Katalog • Fachgeschäft • Kinder • Kinder • Bekannte • Fachgeschäft ▪	• Serviceman • Catalogues • Specialist store • Family members • Instructions
	Problems	• Zuerst selbst probieren • Gleich jemanden Kontaktieren • Solange probieren bis es wieder geht	• Trying until it works again • First try alone, then contacting someone • Directly contacting someone for help

Table 10: Coding Chart_ Category Openness towards technology

Category ICT-based Fall prevention			
Sub categories	Themes	Preliminary Coding	Final codes
USAGE	Frequency	• Nicht regelmäßig • 1/ Tag • 3/Woche	• Not on a regular basis • 3/ week • More often than 4 times /week
	Duration	• 20 Minuten	• 10 Minutes • 20 Minutes
	Feedback	• Ja ist sehr wichtig • Nicht so wichtig	• Very important • Not too important • Cannot imagine
	Group component	• Kein Motivationsfaktor • Nein kein wettkampfgeist • Ja, ein Ansporn	• No motivational factor • Yes, because it gives it a competitive character
PROS/CONS	PROS	• Um fit zu bleiben • Selbst einstellen was man machen kann (z.B.: Gesunder Rücken) • Mehr Möglichkeit etwas zuhause zu machen	• Personalized programs • Possibility to be more active at home • To stay in shape
	CONS	• Zu laut für Nachbarn • Schwere Übungen • Angst vor falschen Bewegungen • Zu viel Überwachung	• Too noisy for neighbors • Fear of incorrect movements • Exercises too difficult • No, to many technical components • No, don't like to be controlled • Not fit enough
Required comptences	Environment	• Räumlichkeiten • Keine Störungsfaktor für Nachbarn • Wenn man schon im Berufsleben mit technischen Geräten zu tun gehabt hat • Fernseher	• Suitable premises • Curiosity in discovering new technical devices • Fitness level • Time
	Exercises	• Keine Übungen am Boden • Kein Hüpfen • Man muss sicher sein können, dass sie angepasst sind	• No exercises on the ground • No Jumping around • Need to personalize exercise program
	Technik	• System einfach zu bedienen • Zu jeder Zeit abrufbar • Beschreibung ist wichtig	• Easy to handle • Instructions that are easy to understand

Table 11: Coding Chart_ Category ICT-based Fall Prevention

In combination with the analysis of the different scores (see chapter 3.3.1), those three coding charts provide the basis for creating Personas for ICT- based Fall Prevention Systems. The last chapter dealing with the methodology of the underlying thesis illustrates the final procedure how to detect different behavioral patterns out of the collected data.

3.4 Development of Personas

The conduction of 14 semi-structured interviews and the use of four individual questionnaires provide the basis for the development of personas (Table 8). The way of proceeding is modified in reference to the study by Vaughn et al.(2017). The researchers of the mentioned study resorted to develop Personas out of semi-structured interviews and a preceding generation of a coding system. Accordingly, a coding system for the underlying study was created (see chapter 3.3.2.). In addition to the interviews the results of the four questionnaires, which were used for data acquisition, have to be incorporated (see chapter 3.3.1). The final step towards creating Personas is the organization of all analyzed data to identify similar behavioral patterns.

At *first* all interviews were analyzed and coded according to the presented coding system to identify similar behaviors. The paraphrases in every individual interview were marked with different colors. The outcome of the preliminary coding were 4 different behavioral patterns. Each of the discovered patterns is represented by three or four interviewees of the present study. One of the fourteen transcripts could not be allocated to any of the patterns and was excluded from the evaluation.

Secondly, the results from the scores and questionnaires (see chapter 3.3.1) were consulted. The results of the individual questionnaires of all participants within one of the four identified behavioral patterns were averaged. Table 12 illustrates an example of the strategy. Pattern 3 includes the results of participant 3, 1, 12, and 14. To identify the GFI[4] Score, which represents pattern 3, the individual scores of those 4 participants were averaged. The scores for the WKV- Adjektiveliste[5], The BMZI-HEA[6] and the ATI[7] were calculated accordingly.

PATTERN 3	**Individual GFI[4] Score**	**Mean**
Participant 3	3	GFI for Pattern 3 = 4
Participant 7	4	
Participant 12	4	
Participant 14	5	

Table 12 Example: identification of different behavioral patterns

The *third* step implies the inspection if the identified patterns out of the interviews and the results of the scores are coherent.

In order to combine all results (questionnaires and interviews) in one picture a separate evaluation sheet was created. Figure 13 and Figure 14 illustrate the evaluation sheet. In terms of readability the evaluation sheet is separated into to figures.

Pattern:

Physical and mental Well being

Groningen Frailty Indicator		WKV-Adjektivliste	
Total Score		Activation	
		Fitness Level	
		Health condition	
		Mobility	

Physical Activity

Subcategory	Codes for different themes
History	•
Current exercise	•
Activity in daily life	•
Motives	•
Barriers	•
Fall prevention: Knowledge	•
Fall prevention intervention (current & past)	•

BMZI-HEA			
Motives and Goals	Relative Score	Motives and Goals	Relative Scores
Contact		cognitive functioning	
ADL and heath		figure/aesthetics	
positive movement exp.		performance/ competition	
mood regulation			

Figure 13: Evaluation Sheet for development of Personas Part1

Openness Towards Technology

Subcategory	Codes for different themes
Use of technical devices	•
New devices	•
Facilitating Conditions	•
Instructions	•
Problems with technical devices	•
ATI SCORE	

ICT-based Fall prevention

Patterns	Codes for different themes
Usage	•
PROS /CONS	•
Communication /interactions	•
Required competences	•
Perceived Usefulness (PU)	

Figure 14: Evaluation sheet for development of Personas Part 2

According to the four main topics of interest (see chapter Creating the interview guideline3.1.3) the sheet is separated into four different sections. In the *first* one the results from the GFI[4] and the WKV -Adjektivliste[5] are outlined, to illustrate the *subjective and physical well- being*. The *second* section represents all results contributing to the topic *physical activity,* including outcomes of the interviews and the BMZI-HEA[6]. The ATI-Score[7] in combination with the identified codes of the open questions demonstrate the *third* section *Openness towards technology.* The *fourth* section provides all relevant data for the topic *ICT based Fall Prevention Systems.* For each topic the most relevant themes were implemented into the charts. The most common codes within one pattern were chosen to represent the answers of the participants of the underlying study.

The outcome of the data analysis, including the evaluation of the questionnaires and the interviews revealed four different behavioral patterns, which are presented in the following chapter.

4 Results

Data from 13 different older adults were conducted and analyzed to detect different user types for ICT- based fall prevention systems. Four behavioral patterns were discerned, which are presented successively in the present chapter. As documented in chapter 3.4 the results of the participants were combined in one evaluation sheet. In the following they are titled *Evaluation Sheet Pattern 1*, *Evaluation Sheet Pattern 2, Evaluation Sheet Pattern 3 and Evaluation Sheet Pattern 4.*

Subsequent to the presentation of the Evaluation Sheets, practice model of the interpretation of the results is documented. Those findings form the fundamentals for the 4 Personas, which are presented in chapter 5 of the underling thesis.

4.1 Presentation of the Evaluation Sheets

In each case, data from three different participants were adduced to define the characteristics of *Pattern 1, Pattern 2 and Pattern 4. Pattern 3* derived from data from four different participants.

4.1.1 Evaluation Sheet Pattern 1

Pattern 1 Part 1

Subjective Physical and mental Well being

GFI		WKV-Adjektivliste	
Total Score	3	Activation	15,6
		Fitness Level	14,6
		Health condition	16,3
		Mobility	15,3

Physical Activity

Subcategory	Codes for different themes
History	• Team Sport • Gymnastics
Current exercise	• Exercise bike • At home exercises • 2-4/ week • Alone • Periodic feedback
Activity in daily life	• Active Lifestyle • Inactive lifestyle
Motives	
Barriers	• Pain/ restrictions due to present or previous injuries
Fall prevention: Knowledge	• Environmental adaptions to prevent falls • Physical activity keeps the muscle strong
Fall prevention intervention (current & past)	• Regular balance training

BMZI HEA			
Motives and Goals	Relative Score	Motives and Goals	Relative Scores
Contact	63,7%	cognitive functioning	82,3%
ADL and heath	86,3%	figure/aesthetics	55,3%
positive movement exp.	86,7%	performance/ competition	38%

Figure 15: Evaluation Sheet Pattern 1, Part 1

Pattern 1 Part 2

Openness Towards Technology

Subcategory	Codes for different themes
Use of technical devices	• Smartphone • Television • Computer
Facilitating Conditions	• Serviceman • Catalogues • Instructions
Instructions	• Hard to understand
Problems with technical devices	• Serviceman • Trying until it works again
ATI SCORE	3,3/6

ICT-based Fall Prevention Systems

Patterns	Codes for different themes
Usage	• 3/week • 20 Minutes
PROS /CONS	• Possibility to be more active at home • Fear of incorrect movements
Communication /interactions	• Yes, because you can compare
Required competences	• Suitable premises • Need to personalize programs
Perceived Usefulness (PU)	5/5

Figure 16: Evaluation Sheet Pattern 1, Part 2

4.1.2 Evaluation Sheet Pattern 2

Pattern 2

Physical and mental Well being

GFI		WKV-Adjektivliste	
Total Score	1,3	Activation	21,7
		Fitness Level	19,6
		Health condition	23
		Mobility	16,3

Physical Activity

Subcategory	Codes for different themes
History	• Gymnastics Club
Current exercise	• Gymnastics/Dance class • 1-2/Week • Group setting
Activity in daily life	• Going for a walk every day on purpose • Active Lifestyle
Motives	• Sociability • Health &staying fit as long as possible
Barriers	• Bad weather conditions • Lack motivation (sometimes)
Fall prevention: Knowledge	• No knowledge
Fall prevention intervention (current & past)	• No intervention in the past or currently

BMZI HEA			
Motives and Goals	Relative Score	Motives and Goals	Relative Scores
Contact	82,6%	cognitive functioning	80%
ADL and heath	100%	figure/aesthetics	37,6%
positive movement exp.	85%	performance/ competition	26,6%
mood regulation	65,3%		

Figure 17: Evaluation Sheet Pattern 2, Part 1

Pattern 2

Openness Towards Technology

Subcategory	Codes for different themes
Use of technical devices	• Television • Mobile phone
Facilitating Conditions	• Serviceman • Family members
Instructions	• No, not even trying to understand
Problems with technical devices	• Directly contacting someone for help
ATI SCORE	2,6/6

ICT-based Fall prevention

Patterns	Codes for different themes
Usage	• 3/week • 20 Minutes
PROS /CONS	• Personalized programs • Too noisy for neighbors
Communication /interactions	• Group: motivational factor • Feedback: very important
Required competences	• Suitable Remises • No exercises on the ground
Perceived Usefulness (PU)	4,5/5

Figure 18: Evaluation Sheet Pattern 2, Part 2

4.1.3 Evaluation Sheet Pattern 3

Pattern 3

Physical and mental Well being

GFI		WKV-Adjektivliste	
Total Score	4	Activation	15,3
		Fitness Level	9
		Health condition	17,25
		Mobility	13,5

Physical Activity

Subcategory	Codes for different themes
History	• No Sport • Skiing, Running, Hiking, Cycling
Current exercise	• At Home exercise • No exercise • Feedback: indifferent
Activity in daily life	• Active lifestyle • Non-active lifestyle
Motives	
Barriers	• Pain/restrictions due to present or previous injuries • Chronic health related restrictions • “Being too old “
Fall prevention: Knowledge	• Physical activity keeps the muscles strong
Fall prevention intervention (current & past)	• No intervention • During the stay in a hospital

BMZI HEA			
Motives and Goals	Relative Score	Motives and Goals	Relative Scores
Contact	33%	cognitive functioning	68,3%
ADL and heath	76%	figure/aesthetics	43,25%
positive movement exp.	56,3%	performance/ competition	23,25%

Figure 19: Evaluation Sheet Pattern 3, Part 1

Pattern 3

Openness Towards Technology

Subcategory	Codes for different themes
Use of technical devices	• Television • Smartphone
Facilitating Conditions	• Serviceman • Family members
Instructions	• Hard to understand
Problems with technical devices	• First try alone, then contacting someone
ATI SCORE	• 3,1/6

ICT-based Fall prevention

Patterns	Codes for different themes
Usage	• No not on a regular basis • 10 Minutes
PROS /CONS	• Not fit enough
Communication /interactions	• Not important
Required competences	• Fitness level
Perceived Usefulness (PU)	5/5

Figure 20: Evaluation Sheet Pattern 3, Part 2

4.1.4 Evaluation Sheet Pattern 4

Pattern: 4

Physical and mental Well being

GFI		WKV-Adjektivliste	
Total Score	2	Activation	24
		Fitness Level	13
		Health condition	22,3
		Mobility	18

Physical Activity

Subcategory	Codes for different themes
History	• No Sport • Skiing, Hiking, Swimming, Running, Cycling
Current exercise	• No exercise • 1/Week • Feedback: not necessary/ not required
Activity in daily life	• Active lifestyle
Motives	
Barriers	• Lack of motivation
Fall prevention: Knowledge	• Physical activity keeps muscles strong • Not considering him/herself at risk of falling
Fall prevention intervention (current & past)	• No intervention

BMZI HEA			
Motives and Goals	Relative Score	Motives and Goals	Relative Scores
Contact	56%	cognitive functioning	46,7%
ADL and heath	98,6%	figure/aesthetics	24,3%
positive movement exp.	53%	performance/ competition	20%
mood regulation	46,7%		

Figure 21: Evaluation Sheet Pattern 4, Part 1

Pattern 4

Openness Towards Technology

Subcategory	Codes for different themes
Use of technical devices	• Television • Mobile Phone
Facilitating Conditions	• Family Members
Instructions	• No, not even trying to understand
Problems with technical devices	• Directly contacting someone for help
ATI SCORE	• 1,7/6

ICT-based Fall prevention

Patterns	Codes for different themes
Usage	• Not on a regular basis
PROS /CONS	• No, don't like to be controlled • No, to many technical components
Communication /interactions	• Cannot imagine
Required competences	• Time • Curiosity in discovering new technical devices
Perceived Usefulness (PU)	2/5

Figure 22: Evaluation Sheet Pattern 4, Part 2

4.2 Interpretation

To showcase the process of interpretation of the four different Evaluation Sheets, the interpretation of *Pattern 1* (Figure 15 and Figure 16) is documented below. The remaining patterns were interpreted accordingly.

Figure 15 shows the first part of the Evaluation Sheet, which contains the results concerning the *Subjective physical and mental well-being* and *Physical activity*. The findings for *Openness towards technology* and *ICT-based Fall Prevention Systems* are outlined in Figure 16. In addition, the results will be described, using the term Collective One to represent the attitudes and characteristics persons, who contribute to this behavioral pattern, are assumed to have.

Subjective Mental and Physical Well-being

The outcome of the GFI[4] Score and the WKV- Adjektivliste[5] show that Collective One assumes to feel healthy appropriate to their age. The scores for “Activation”, “Fitness Level”, “Health condition” and “Mobility” are all allocated between 14,5 and 15,6 out of a maximum score of 25. This leads to the assumption that Collective One feels a moderate level of activation and fitness. It doesn’t not declare to be healthy without constraints, but there are no severe illnesses.

Physical Activity

Collective One participated in different kind of exercise activities during their youth and early adulthood. Currently members of Collective One use an exercise bike or execute “at home exercises” two to four times per week. Feedback on the execution is important, but it can only be received periodically from doctors and therapists, since the exercise is performed at home. The major barrier to maintain a high activity level is pain or restrictions due to previous injuries. According to the outcomes of the BMZI-HEA[6] there are three main components, that motivate collective one to be physically active. “Positive Movement experiences” earned the score of 86,7%, “Activities of Daily Living and Health” reached 86,3% and “Cognitive Functioning” 82,3%.

Collective One is aware of fall prevention interventions. “Physical activity keeps the muscles strong” and “Environmental adaptions can help to prevent falls” represent the knowledge on fall prevention. “Ja Sturzprävention habe ich gehört und finde ich sehr gut. Wir machen sehr viel einbeinig auf solchen Brettern (Interview 9, row 51; row 54).”, is a quote from one of the participants representing Collective One.

Openness Towards Technology

The most common technical devices Collective One uses are the television, a smartphone and a computer. If there is a problem with any of the devices, members of Collective One prefer to read the instructions and try to solve the problem on their own. If their knowledge is not sufficient or the instructions are too hard to understand a service man is contacted. As a last component to capture the *Openness Towards Technology* the ATI[7] Score for Collective One was calculated. Although the score of 3,3 out of 6 seems to be low, in comparison to the other 3 patterns this one was the highest score.

Those facts illustrate that members of Collective One are used to implement new technical devices into their every-day life and are interested in new technologies and are encouraged to learn how to use them. Following quotes from the interviews underline this assumption: “Ich nutze den Computer, um viel nachzuschauen, im Internet und auch um manche Sachen zu schrieben (Interview 6,R57).” „Wenn es ein technisches Problem gibt, probiere ich eigentlich gern, ob ich selbst was zusammenbring (Interview 9,R89).“

ICT-based Fall Prevention Systems

Collective One would be curios to use an ICT-based Fall Prevention System, because it gives them “the possibility to be more active at home”. Members of Collective One state to use such systems up two three times per week for approximately 20 minutes. Collective One appreciates the communication and interaction tools, because those components allow them “to compare their exercise level” with others”. Collective One emphasizes the need to personalize the programs by expressing “fear of executing incorrect movements”. A Score of 5/5 representing the perceived usefulness (PU) of ICT-based Fall Prevention Systems show that Collective One would be open to implement those systems into their daily lives.

All four identified patterns and their interpretations are neutral in terms of gender and age, since there were not a balanced number of male and female participants nor a sufficient age distribution among the interviewees. For that reason, the names and genders for the subsequent Personas were chosen randomly.

5 Presentation of Personas

Each of the four personas incorporates data from one of the behavioral patterns (Vaughn et al., 2017). The names of the personas were chosen to represent their personal characteristics.

Four segments were chosen to represent the traits of the personas (LeRouge, Ma, Sneha, & Tolle, 2013). The first segment describes the *Personal Characteristics,* including the perceived well-being, their attitude towards physical activity and technology. The second segment provides a list of the persona's *Motives and Goals* to implement physical activity into their daily lives. The listing of *Challenges* the persona might face when using an ICT-based Fall Prevention System build the third part. The major *Requirements* the persona pose for ICT -based Fall Prevention Systems are documented in the fourth segment.

Curious Angelina

Personal Characteristics

Angelina is a healthy woman of higher age, who is always curious to learn new things. She does not consider herself as sportive, but it is aware that physical activity is important to stay healthy and prevent falls and willing to take necessary interventions.

She likes to implement technical devices into her daily life. She often uses her smartphone or her computer to inform herself on the latest news.

Motives and Goals

- Learning new things
- Staying healthy and fit
- Having positive movement experiences

Challenges

- Fear of wrong movements to harm herself
- Staying on track with the latest technical devices

Requirements

- Tailored exercise programs
- Exact feedback, comparison and rewards
- Good instructions
- Nice virtual environment

Persona 1: Curious Angelina

Healthy Peter

Personal Characteristics

Peter's highest priority is to stay fit and healthy as long as possible. Most of the time he feels activated and strong. His level of fitness is high according to his age. Peter participates in an exercise class at least once a week and likes to take long walks with friends.

Peter is not comfortable with using any technical devices. He owns a television and a mobile phone, which he refuses to trade for a smartphone. If any technical problem in his environment occurs, he immediately contacts his children for help.

Motives and Goals

- Staying healthy and fit as long as possible
- Sociability
- Not interested in any comparison

Challenges

- Fear of too difficult exercise programs and not appropriate to his age
- Concerns to distract neighbors
- Fear of dealing with a new technical system

Requirements

- Tailored exercise programs
- Exercise programs, that are not longer than 15 min
- A technical System, which is very easy to handle
- Excellent customer service

Persona 2: Healthy Peter

Old Martha

Personal Characteristics

Martha had to deal with several injuries and health issues in the past. She often feels weak and traces her low level of fitness to her age. She knows about the benefits of fall prevention interventions but does not attend any.

Martha owns a television and a smartphone. She primarily uses her smartphone to communicate with friends and family. Currently she is discovering all the different application a smartphone can provide.

Motives and Goals

- Keeping an independent lifestyle
- Pain reduction

Challenges

- Health issues
- Lack of motivation to exercise
- Poor adherence to recommended exercise interventions

Requirements

- Exercise programs, that provide easy movements
- Engagement of family and friends
- Nice virtual environment

Persona 3: Old Martha

Uninterested Brad

Personal Characteristics

Brad is a man of higher age who feels physically fit and healthy. He has heard of fall prevention, but he does not see himself at risk of falling or the need to take interventions. Brad does not think, that an increased activity level would benefit his well-being.

Brad is not interested in new technologies, because he assumes, that he would not know how to use them anyway. He owns a smartphone, because his family gave it to him, but he does not like to use it.

Goals

- Maintaining his present lifestyle
- Health

Challenges

- Lack of awareness of fall prevention
- Lack of openness towards new innovations
- Poor adherence to recommended exercise interventions

Requirements

- Tools to increase motivation
- A technical System, which is very easy to handle
- Short exercise programs

Persona 4: Uninterested Brad

6 Discussion

Following the results of the present study four different user types for ICT- based fall prevention systems has been discovered. In reference to a study by Vaughn et al. (2017) the persona methodology was chosen to present the final results. This method permits to display the key components of each pattern in one picture. Based on 14 semi-structured interviews four different user type patterns could be developed for information and communication based fall prevention systems for older adults (age 65+). A preliminary in- depth literature research revealed the main topics, which need to be considered when designing tailored programs for ICT- based fall prevention systems: *Subjective physical and mental well-being, Physical activity, Openness towards technology, ICT- based fall prevention* (see chapter 3.1.3). They also served as the basis for the interview guideline. *Curious Angelina", "Healthy Peter", "Old Martha"* and *"Uninterested Brad*" represent the four identified user type patterns.

Pattern 1	**Pattern 2**	**Pattern 3**	**Pattern 4**
Curious Angelina	Healthy Peter	Old Martha	Uninterested Brad

Table 13: Patterns and Personas

Table 13 shows the personas, categorized according to the initial results of the present study and labelled from *Pattern 1* to *Pattern4*. Each persona includes information on the *Personal Characteristics, Motives and Goals, Challenges Requirements.* All aspects refer to the use/ the potential use of ICT-based fall prevention systems. The comparison of the findings with previous studies on the acceptance of ICT-based fall prevention systems revealed similarities as well as discrepancies to the outcomes of the present thesis (Barelle et al., 2010; Farshchian & Dahl, 2015; Whitehead et al., 2006). The main aspects of each user type pattern are discussed below.

Curious Angelina- Pattern 1

The persona of "Curious Angelina" represents an ambitious group of older adults, that are willing to take interventions to remain a healthy and independent lifestyle. Further, the characteristics of this audience reveal a high interest in implementing technical devices into their daily routine (see chapter 5 and in chapter 4.1.1). The

scores of the WKV- Adjektivliste[5] to measure the perceived physical condition, show that elderly allocated to *Pattern 1* feel activated, fit and healthy on a moderate level (Figure 15: Evaluation Sheet Pattern 1, Part 1Figure 15). The analysis of the interviews also revealed that "Curious Angelina" welcomes programs that monitor her success on fall prevention exercises. Those findings are in line with a previous study on ICT-based fall prevention systems, which outlines that self- monitoring, rewards and the visualization are great tools to increase exercise adherence among older adults (Vaziri et al., 2017). According to Ogonowski et al. (2016) the combination of cognitive tasks and physical exercise has a positive effect on exercise adherence among older adults. This supposition can also be found in the results of the behavioral pattern of *"Curious Angelina".* As an outcome of the BMZI-HEA[6] , an instrument which was to measure the participants' motives and goals towards physical activity, the dimension "cognitive functioning" was rated high (82,4%).

In terms of technology acceptance this group of older adults require to have good instructions, which permit them to cope with technical problems without additional help. In this context, some interviewees stated, that they would like to solve problems with technical devices on their own, but the accompanying instructions are often confusing and/or only available in a foreign language.

Healthy Peter- Pattern 2

The key aspects of the second identified behavioral pattern is shown in the persona of "Healthy Peter". This group of elderly has one main goal when executing physical activity. *"Wenn man keine Bewegung macht, dann erschlaffen die Muskeln ja im Alter schneller und dann kann ich vielleicht einmal nicht mehr gehen und man will ja so lange wie möglich fit sein (Interview 1, R60-62)."* This group of elderly wants to stay healthy, fit and independent as long as possible. The outcome of the BMZI-HEA[6] highlights this attitude, stating a score of 100% for the dimension "Activities of Daily Living and Health". According to Rodríguez, Roa, Morán and Nava-Muñoz (2012) so called abstractions can have a high impact

Another key component for elderly are existing Facilitating Conditions- meaning the support of family or a developed customer help desk, offering easy and quick support in case of any technical/handling problems can decrease the fear of dealing with technical devices in older adults (Charness & Boot, 2009; Lee, Chaysinh, Basapur, Metcalf, & Mandalia, 2012). The participants of the present study confirmed this assumption, stating that they often don't know how to cope with technical problems, but they know they can rely on their family members for help. In addition, previous studies revealed that ICT-based Fall prevention systems are better accepted by the target group, when additional technical equipment is

kept to a minimum (Gschwind et al., 2015). Knowing that the provided exercise lead to a better health condition, and the security to have a support system to rely on for the technical system are assumed to be two major components to increase the acceptance of ICT-based fall prevention system.

Old Martha- Pattern 3

"Ja das kann man alles machen wenn man jung ist. Wenn man nicht nach einer falschen Bewegung gleich wieder 14 Tage außer Betrieb ist (Interview14, R71-72)." "Being too old" for any kind of exercise is a belief, which older adults often share (Whitehead et al., 2006). The third behavioral pattern describes older adults, that have a poor health condition and do not see themselves capable to participate in any fall prevention interventions (Figure 19: Evaluation Sheet Pattern 3, Part 1Figure 19;Figure 20). The outcome of the WKV- Adjektivliste[5] within this pattern reveals only a score of 9 out of 25 for the perceived level of fitness. According to Whitehead et al. (2006) the poor initial health condition of higher aged adults has an negative impact on his/her adherence exercise. Matching this supposition, the results of the BMZI-HEA[6] for "*Old Martha"* reveal low scores in comparison to *"Curious Angelina (Pattern1)"* and *"Healthy Peter (Pattern2)".* According to the results, *"Old Martha"* is still open to technical systems and new technologies but needs sufficient support- either by family or servicemen- to use it.

Uninterested Brad – Pattern 4

In comparison to the other three identified usage patterns the persona of "Uninterested Brad" shows the lowest results for both exercise adherence and the openness towards technology. The results of *Pattern 4* indicate that "a lack of motivation to exercise" as well as the assumption of "not being at risk of falling" are the main barriers to implement exercise.

Low exercise adherence in combination with missing interest in new technologies give few links to designers of ICT-based fall prevention systems. In case of "*Uninterested Brad"* a change in mind set behavior needs to be focused to reach higher exercise adherence. Additionally, the relationship between *"Uninterested Brad"* and technology has to be significantly improved in order to be more open to new technologies and thus ICT- based fall prevention systems.

General findings across all for behavioral patterns

There are some findings that has been noticed across all four behavioral patterns, which reflect major requirements elderly may pose of ICT- based fall prevention systems.

There is one motive that was mentioned by all 14 participants: The desire to remain an independent mobility as long as possible. *Man hat schon Angst, dass man dann nicht mehr so kann und jemanden braucht wenn es alleine nicht mehr geht. Darum schau ich schon, dass ich beweglich bleibe (Interview 5,R 29-31).“* The analysis of the BMZI-HEA[6] revealed that within every behavioral pattern, the dimension “activities of daily living and health” were rated above 75% out of 100%.*“* Those figures highlight the power of the desire ”to stay independent as long as possible”. This finding is in line with previous studies and emphasizes the desire of older adults to remain healthy, which is one of the main motives to remain physically active (Schutzer & Graves, 2004; Whitehead et al., 2006).

Studies state that the inclusion of a competitive character in exercise interventions is a big motivator for elderly to regularly participate in exercise classes (Barelle et al., 2010; Gschwind et al., 2015). In contrary, within the present study only three out of the fourteen interviewees declared any kind of competition would motivate them.

Another aspect that previous studies on the relationship between older adults and ICT address is the fear of being observed at home by any technical device (Charness & Boot, 2009). Some of the participants of the present study uttered feelings of discomfort imagining being monitored while exercising at home. *“Weil mir jede Art von Kontrolle meiner Person zu wider ist (Interview11, R77)“.* Since ICT- based fall prevention systems need to implement motion capturing to provide feedback, this is an aspect that might be considered.

Those findings show the requirements for different user types for ICT- based fall prevention systems among older adults. In this context, Barelle et al. (2010) address the necessity of a holistic approach, when designing ICT- based programs for older adults. It needs to be acknowledged, that different lifestyles and past experiences on physical activity and the usage of technical devices evoke diverse requirements within the target group of older adults (Vaziri et al., 2017).

The different requirements for user types are in line with the results of the present study discovering the four different user types for ICT- based fall prevention systems. These personas could build an interface between older adults and the designers of ICT- based fall prevention systems to help them meeting the range of

different requirements of older adults. This contributes to the aim of ICT- based solutions to be used frequently and thus to increase physical activity and prevent falls among older adults.

Limitations

There are limitations, which may have an effect on the presented results of the study. According to Mesgari et al. (2018) any qualitative research methods are "limited to the cognitive to the cognitive capabilities of the development team." The coding of the interviews according to the coding system (see chapter 3.3.2) was not reviewed by a second researcher.

There has been no prototype of an ICT- based fall prevention system available to be demonstrated during the interviews. Thus the results of the interviews are based on the explanations of the tool by the interviewer.

7 Conclusion

“In order to support and achieve this goal of supporting active ageing it is important to recognize the heterogeneity of older adults (Vaziri et al., 2017, p. 11).“ Understanding the individual needs, capabilities and practices of older adults are important to arrive a better acceptance of ICT- based fall prevention systems among older adults (Barelle et al., 2010; Farshchian & Dahl, 2015; Whitehead et al., 2006). Accordingly, the aim of the present thesis is to discover different user types for ICT- based fall prevention systems. In this regard two research questions were formed: *“Which requirements do elderly (age 65+) have to technologies that provide fall prevention programs?”* “*How can the target group be divided?”*

Four different user type patterns were identified, which confirm that ICT- based fall prevention systems have to meet a variety of requirements to reach user acceptance. The diverse outcomes on exercise adherence and the diverse openness towards technology emphasize the need for different persuasion strategies to use ICT- based fall prevention systems. Designers of ICT-based fall prevention systems have to make sure users are able to cope with the technical components of system. The four personas, ”*Curious Angelina”, “Healthy Peter”, “Old Martha” and “Uninterested Brad”* have been created. The needs of those defined characters have the potential to serve as a guideline for the design of new ICT-based fall prevention systems.

A full validation of the presented personas is still required to ensure that *“Curious Angelina”, “Healthy Peter”, “Old Martha” and “Uninterested Brad”* are useful and reliable reflections of user types for ICT-based fall prevention systems among older adults.

In conclusion, displaying usage patterns in form of personas might be a valuable approach to discern the different requirements older adults may pose to implement ICT-based fall prevention systems into their daily routines. Accordingly, the results of the present study are assumed to contribute to a better acceptance of ICT-based fall prevention systems and thus, to the goal to decrease falls and their consequences in a globally aging population.

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Appendix

A. Questionnaire WKV-Adjektivliste

ProbandIn:__

WKV Adjektivliste zur Erfassung der wahrgenommenen körperlichen Verfassung (modifiziert nach (Kleinert, 2006)

„Bitte schätzen Sie spontan, ohne viel zu überlegen, ein, inwieweit die folgenden Aussagen zu Ihrer körperlichen Verfassung für Sie im Augenblick zutreffen. Machen Sie ein Kreuz an der entsprechenden Stelle: Im Augenblick fühle ich mich körperlich ...“

Item	trifft sehr zu	trifft eher zu	mittel	trifft eher nicht zu	trifft gar nicht zu
kräftig					
energielos					
unbeweglich					
platt					
lädiert					
gelenkig					
ausgelaugt					
	trifft sehr zu	**trifft eher zu**	**mittel**	**trifft eher nicht zu**	**trifft gar nicht zu**
krank					
abgeschlafft					
stark					
steif					
fit					
schlapp					
	trifft sehr zu	**trifft eher zu**	**mittel**	**trifft eher nicht zu**	**trifft gar nicht zu**
durchtrainiert					
angeschlagen					
gesund					
dehnfähig					
kraftvoll					
verletzt					
beweglich					

B. Questionnaire BMZI-HEA

Berner Motiv und Ziel Inventar für Personen höheren Erwachsenenallters
(modifiziert nach (Schmid, Molinari, Lehnert, Sudeck, & Conzelmann, 2014)

Warum treiben Sie Sport?/ Warum würden Sie Sport betreiben?

	1	2	3	4	5
um mich körperlich in guter Verfassung zu halten.					
um Stress abzubauen .					
weil es mir Freude bereitet die Schönheit der menschlichen Bewegung im Sport zu erleben.					
um abzunehmen.					
weil ich im Wettkampf aufblühe.					
um mit anderen gesellig zusammen zu sein.					
um meine Selbstständigkeit im Alltag zu erhalten.					
um etwas gegen meine Energielosigkeit zu tun.					
um mein Gedächtnis zu trainieren.					
weil Sport mir die Möglichkeit für schöne Bewegungen bietet.					
	1	2	3	4	5
um mein Gewicht zu regulieren.					
um mich mit anderen zu messen.					
um etwas in einer Gruppe zu unternehmen.					
um mich im Alltag sicher fortbewegen zu können.					
um mich weniger niedergeschlagen zu fühlen.					
um meine Denkfähigkeit zu erhalten					
vor allem aus Freude an der Bewegung.					
wegen meiner Figur.					
um sportliche Ziele zu erreichen					
	1	2	3	4	5
um dabei Freunde/Bekannte zu treffen.					
um körperlichen Beschwerden entgegenzuwirken.					
um mich weniger angespannt zu fühlen.					
um angenehme körperliche Erfahrungen zu machen.					
um dadurch Menschen kennen zu lernen.					
um im Alltag körperlich mobil zu bleiben.					
um durch den Sport neue Freunde zu gewinnen.					
um geistig fit zu bleiben					

Schmid, J., Molinari, V., Lehnert, K., Sudeck, G., & Conzelmann, A. (2014). BMZI-HEA: Adaption des Berner Motiv- und Zielinventars im Freizeit- und Gesundheitssport für Menschen im höheren Erwachsenenalter. *Zeitschrift für Gesundheitspsychologie*, *22*(3), 104–117. https://doi.org/10.1026/0943-8149/a000119

C. Questionnaire PU, PEOU

Fragebogen: Wahrgenommene Nützlichkeit und wahrgenommene Nutzerfreundlichkeit

Wahrgenommene Nützlichkeit **modifiziert nach Perceived Usefulness (Davis, 1989)**	**1**	**2**	**3**	**4**	**5**
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde mir ermöglichen in kurzer Zeit zielgerichtet Bewegung zur Sturzprävention zu machen.					
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde es mir einfacher machen Bewegungen korrekt auszuführen.					
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde dazu beitragen, dass ich mehr Bewegung zur Sturzprävention mache.					
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde es mir leichter machen gezielte Bewegung zur Sturzprävention in meinen Alltag zu integrieren/ einzuplanen.					
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde ich nützlich finden, um aktiv Bewegung zur Sturzprävention zu machen.					
Die Nutzung von IKT- basierenden Sturzpräventionsprogrammen würde mein alltägliches Leben vereinfachen.					

Wahrgenommene Nutzerfreundlichkeit **(modifiziert nach Perceived Ease of Use (Davis, 1989))**	**1**	**2**	**3**	**4**	**5**
Es wäre für mich einfach zu lernen mit einem IKT- basierenden Sturzpräventionsprogrammen umzugehen.					
Ich würde es leicht finden das Programm so einzustellen, dass es so funktioniert, wie ich es möchte.					
Für mich wäre der Umgang mit IKT- basierenden Sturzpräventionsprogrammen einfach und verständlich.					
Ich würde das Programm als leicht zu bedienen empfinden.					
Es wäre leicht für mich, mich gut mit dem Programm auszukennen und es zu bedienen.					
Ich würde ein IBSP als leicht zu nützen empfinden.					

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease Of Use, And User Accep. *MIS Quarterly; Minneapolis*, *13*(3), 319.

D. Declaration of consent

Einwilligungserklärung zur Teilnahme an einem wissenschaftlichen Interview

Verwendung der Daten
Die verantwortliche Person wird sicherstellen, dass alle Daten vertraulich behandelt werden und nur für den hier festgelegten Zweck verwendet werden:

- Der Proband bzw. die Probandin erklärt sich damit einverstanden, dass das Interview aufgezeichnet und wissenschaftlich ausgewertet wird. Nachdem die Aufzeichnung abgeschlossen ist, können auf Verlangen, bestimmte Abschnitte von der Aufzeichnung entfernt werden.
- Der Proband bzw. die Probandin erklärt sich damit einverstanden, dass die aus den Interviews gewonnen Erkenntnisse im Rahmen der Masterarbeit verwendet werden dürfen.

Aufnahme

1. Die Aufnahme des Interviews wird auf einem Passwort geschützten Speichermedium gespeichert und sicher aufbewahrt. Nach Abschluss der Studie wird die Aufnahme noch ein Jahr gespeichert und anschließend gelöscht.
2. Nur die Verantwortliche wird Zugriff auf die Aufnahme haben, um diese zu transkribieren.
3. Sollte ihr Betreuer der FH St.Pölten Fragen zu den Transkripten haben, darf die Verantwortliche ihm die Aufnahme vorspielen.

Auswertung der Daten

1. Damit das Interview wissenschaftlich ausgewertet werden kann, wird die Aufnahme transkribiert. Hierbei werden alle personenbezogenen Daten wie Name, Geburtsdatum, Wohnort etc. pseudonymisiert d.h. alle Daten die direkten Rückschluss auf Ihre Identität zulassen werden durch einen Code ersetzt (z.B. wird dein Name durch T1 ersetzt). Ohne Zugang zu der Code-Liste wird es einem Außenstehenden schwerfallen, Ihre Identität herauszufinden. Lediglich die Verantwortliche hat Zugang zu der Code-Liste.
2. Die Transkripte dürfen in den Anhang der Masterarbeit. Hierbei sind alle personenbezogen Daten pseudonymisiert!

Widerruf

1. Sie können die Einwilligung zur Erhebung und Verarbeitung Ihrer Daten jederzeit widerrufen. Nach deinem Widerruf werden keine weiteren Daten mehr über dich erhoben. Die bis zum Widerruf erhobenen Daten können allerdings weiter im Rahmen dieser Masterarbeit verwendet werden.
2. Aufgrund der gesetzlichen Vorgaben haben Sie außerdem, das Recht auf Einsicht in das Transkript von dem mit Ihnen geführten Interview und die Möglichkeit der Berichtigung, falls Sie Fehler feststellst.
3. Sie haben auch das Recht, bei der österreichischen Datenschutzbehörde eine Beschwerde über den Umgang mit Ihren Daten einzubringen (www.dsb.gv.at).

Einwilligung
Hiermit erkläre ich mich mit den vorherig aufgeführten Punkten einverstanden. Zusätzlich bestätige ich, die eine Seite gelesen und verstanden zu haben. Mit folgenden Punkten bin ich nicht einverstanden:_____
_____

Ort, Datum: _____

ProbandIn:_____ Interviewer:
_____