Empathy-led Service Design

Imagining Future Health Smart Homes through Co-Design with Older Adults

Azadeh Mokhberi

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Imagining Future Health Smart Homes through Co-Design with Older Adults

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A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Design in Visual Communication Design

Department of Art & Design
University of Alberta, 2019

To my loving parents,
Mina and Saeed

Acknowledgements

I would like to express my deepest appreciation for my supervisor, Aidan Rowe, for his constant support of my Master's study and thesis research, for his patience, openness, motivation, and outstanding advice. His guidance helped me throughout the research and writing of this thesis. He consistently allowed this work to be my own work, but steered me in the right direction whenever he thought I needed it. I have been very fortunate to work under Aidan's supervision to be a better designer.

Moreover, I would like to thank all the faculty, staff and students of the Department of Art & Design for their support and advice, which I owe them for my growth as a person and designer. My sincere thanks go to one of the best professors and the coordinator of the program, Sue Colberg, whose support, knowledge and wisdom helped me during the whole journey of my master's research. Thanks to all my educators for giving me the chance to be in their classes or work under their supervision, particularly Gillian Harvey, Carlos Fiorentino, and Justin Pritchard, and especially Judy Armstrong, whose kind support was with me throughout the program. I would like to acknowledge former and current members of the group for creating a pleasant working atmosphere, particularly Mischa Patel for her kind openness to discussion and constructive feedback.

I would like to acknowledge Cezary Gajewski for agreeing to be the chair of the master's examination, Carla Hilario for kindly agreeing to be the external examiner, and Tim Antoniuk to be the internal examiner.

Special thanks to my Department advisor, Lydia Hunter. The door to Lydia's office was always open whenever I ran into trouble or had a question, and her kind support and advice sustained me for the whole two years. I would like to warmly acknowledge Louise Asselstine and Cindy Couldwell for their excellent technical support, and Cindy Chopoidalo for careful reading and excellent proofreading of the manuscript of this thesis.

This project would not have been possible without the help of my participants. It provided me with a unique opportunity as a designer to contribute to other disciplines. It was my absolute pleasure to have the chance to interview Elizabeth B. N. Sanders, Lili Liu, Eleni Stroulia, Alex Mihailidis, and Antonio Miguel. This study would not have been successful without all the knowledge and experiences in their careers which they shared with me. I would like to acknowledge the valuable opportunity Alex Mihailidis gave me to visit Zero Effort Lab, a Health Smart Home laboratory at the University of Toronto, and also Lili Liu for helping me to visit the Smart Condo, a Health Smart Home laboratory at the University of Alberta, and also

for her constant and warm support throughout my work on new technology and the aging problem. I am particularly grateful to all nine Baby Boomer participants who allowed me to visit their homes and interview them, did the homework assignments, participated in the co-design workshop, provided feedback, and most importantly, shared their life experiences. Although I cannot name them in order to preserve anonymity, I am thankful for their resilience, their collaboration, and their giving time and effort to ensure the success of this project. Without doubt, this study would have been meaningless without the consistent participation of all nine people.

I would like to thank Professor Wendy Duggleby, Research Chair in Aging and Quality of Life, Director of Innovations in Seniors' Care Research Unit; Adriana Rios Rincon, Assisstant Professor in Rehabilitation Medicine Occupational Therapy; PhD computer scientists Farnoosh Fatemi Pour and Shadan Golestan; Dr. Ehsan Dorri, Department of Psychiatry; and Dr. Fraser Armstrong, Devaki Joshi, designer; Carrie Demmans Epp, Assistant Professor in Computer Science, for an informal interview at the beginning of the project; and Shabnam Haghzare, PhD student at the University of Toronto, who kindly showed me the Zero Lab and explained its functions with details for support and helpful discussions. I would like to acknowledge the support of Connecting Edmonton Seniors and Edmonton Senior Centre, for helping me publish flyers to find participants.

Last but not least, I would like to wholeheartedly thank my family, especially my parents, Mina and Saeed, for their kind and endless support, allowing me to give my best to this work. Also, I would like to thank my kind sisters Adele and Arezoo for their support.

Contents

"It is an exciting time for health technology, but it's important that we get it right. Intelligent and intuitive design plays a crucial part in this. By putting patients at the heart of decision-making, we can not only relieve the pressure in the health industry, but also make taking care of ourselves much easier."

— Mager.B et al., 2017, p. 26

1. Introduction

1.1 Abstract

This project investigates the development of a service for Health Smart Homes (HSHs) from the perspective of Baby Boomers (people born between 1946 and 1964) living in Edmonton, Canada. A Health Smart Home is a home that has been designed for people with special needs employing technology for monitoring and assistance purposes through mobile or networked devices. In order to help people to better manage their healthcare, improve their health, and provide access to health support at home, this project explores the convergence between strategic design and design for services as a way to imagine and identify key factors for the development of future HSHs.

Baby Boomers are the group, within the larger spectrum of older adults, that were selected for this study. These are people who were born between 1946 and 1964, currently aged 55–73. The baby boomer generation makes up a substantial portion of the world's population, especially in developed nations such as Canada, with 29% (Martel & Ménard, 2011). Baby Boomers have different experiences with new technology, and different expectations than previous generations of older adults (Ontario Association of Community Care Access Centres, 2013). As such, service and product designs must be designed to their needs and expectations.

More extensive collaboration with all stakeholders is required in the design of smart home solutions focused on health support at home (Vacha & Kandusova, 2018). This human-centered design project, therefore, investigates such opportunities in order to gain a better understanding of future users of HSHs. It takes a participatory research approach that includes expert interviews, contextual interviews and a co-design workshop with Baby Boomers. Employing a mixed qualitative method approach provides insight into Baby Boomers' perceptions, interests, and satisfaction with regard to future living scenarios. These activities helped to facilitate user engagement, better explain their experiences, and generate service concepts.

The broad aim of this study is to illustrate the capacity of design to better understand users' experiences through more empathic collaboration, and to articulate the role of designers in helping researchers and organizations to imagine future HSH scenarios.

The study provides two sets of design recommendations. Apart from providing guidance for conducting interdisciplinary research working on HSH projects, my findings and recommendations for design of HSHs may be used to inform the design of future HSH to be more helpful, effective and appealing for future older adults. This

work should be of interest to researchers, designers, industry, and decision-makers, especially smart home service providers, with regards to technology adoption.

1.2 Background

The World Health Organization predicts that by 2050, there will be approximately 2 billion people aged 60 years and over, and the proportion of adults over 80 will quadruple (UN: World Population Prospects, 2019). Europe and North America have the highest percentage of older adults, with 18 percent aged 65 or over (UN: World Population Prospects: Highlights, 2019). Aging of individuals and populations presents challenges for individuals and families, and for the healthcare system (Kima, Gollamudi, & Steinhubland, 2016; Fry, 2019). Some significant concerns related to aging and health support are shortages of healthcare workers, financial support, available caregivers, and the costs to healthcare systems resulting from older adults reaching the peak years for possible chronic diseases (Mshali, Lemlouma, Moloney, & Magoni, 2018; Orlov, 2019; Coughlin, Pope, & Leedle, 2006). By 2050, it is expected that there will be less support for older adults in North America due to an aging labour market population and the fiscal pressures of continuing to build and maintain public systems of healthcare, pensions and social protection for senior citizens (UN: World Population Prospects, 2019).

Among the problems that can arise in older adults are limitations of physical activity, which may affect all aspects of life; reduced ability to live independently; economic challenges; and the breakdown of family support that may hinder older adults from living independently in their own homes (Yusif, Soar, Hafeez-Baig, 2016; Vacha & Kandusova, 2018; Fitzpatrick & Stringer, 2007)

Not only is the population aging at an increasing rate, but the challenges that population faces are also more complex, dynamic, interconnected, and interdependent. Such challenges are often called wicked problems (Hazelton, Gillin, Kerr, Kitson, & Lindsay, 2019). In an interview, Dr. David Hogue, applied psychologist and interaction/UX design lead at Google, suggested that designing for Aging in Place (AiP) with the help of smart technology should be considered a wicked problem, particularly when health, humans, and technology are all involved (personal communication, Wicked Problem Workshop, 2019). Design can play an important role in addressing these challenges. Aging in Place (AiP) refers to adults continuing to live independently as they age in their own homes with proper support, the ability to control daily activities, and greater independence, autonomy, and involvement in their social network. Wiles and colleagues (2012) have noted that AiP is the preferable option for most older adults (Wiles, Leibing, Guberman, Reeve, &

Allen, 2012). The ability to perform autonomous health management and everyday activities is key to the elderly's well-being and self-esteem (European Commission, 2007). Many older people spend much of their time trying to cope with increasing levels of disability, requiring innovative strategies such as smart technology (Bright & Coventry, 2013; Hazelton et al., 2019; Ontario Association of Community Care Access Centres, 2013). Homes that are equipped with such technology are known as Health Smart Homes (HSHs), and the technologies that may be used in HSHs include Telemedicine, eHealth, Assistive Technology, Smart Homes, Movement Tracking and Fall Detection (MTFD), Physiological Health Monitoring (PHM), Ambient Assisted Living (AAL) , Home-based Consumer Health (HCH), Internet of Things (IoT) systems and Health Monitoring Systems (HMS) (Vacha & Kandusova, 2018; Sernani, Claudi, Palazzo, Dolcini, & Dragoni, 2011; Agoulmine, Deen, Lee, & Meyyappan, 2011). Ambient Assisted Living (AAL), Movement Tracking and Fall Detection (MTFD), and Physiological Health Monitoring (PHM) are the main features of HSHs (Mshali et al., 2018).

As the area of HSHs is very broad, for the purposes of this study, the focus is on Ambient Assisted Living (AAL) technologies. These technologies relating to Aging in Place can be grouped into three areas: assisted movement, rehabilitation, and monitoring (National Science & Technology Council, 2019). Due to the growing complexity in design projects, we are witnessing a further shift toward a Human Centered Design approach (HCD), a framework that considers all aspects of human life and experiences. In this context, service design can serve as a useful and valuable model (Meroni & Sangiorgi, 2011). As Stickdorn and collegues noted there is no single defenition for service design yet; for the purpose of this research service design is the activity of planning and organizing of a service for individuals, facilities, communication and products to enhance its performance, usability, efficiency, and desirability for its users (Stickdorn et al., 2011; Wikipedia contributors, 2019). Design as a discipline and profession has experienced shifts and reframings for two main reasons (Sanders & Stappers, 2014). First, the types of problems we are facing have changed, which require greater contributions from both design and designer, and this becomes more noticeable in addressing wicked problems (Irwin, 2015). Second, designers are increasingly participating at the beginning of the design process (Sanders & Stappers, 2014). Considering new roles and tools has led to designers helping to address complex social and economic problems (Burns, Cottam, Vanstone, & Winhall, 2006). The relatively new field of HSHs has seen a need to think and design systematically in order to facilitate contributions between users, designers, computer scientists, gerontologists, smart technology providers, home planners, and healthcare services. Service design tools, techniques, and approaches can thus provide a holistic overview of the project.

Research through design, for the purposes of this study, means applying design methods and processes in an interdisciplinary project holistically to address this wicked problem over iterative stages while engaging stakeholders in determining the preferred state of the outcome (Zimmerman, Stolterman, & Forlizzi, 2010). The methodology for this project is participatory. Sanders and Stappers (2008) define co-design as the "creativity of designers and people not trained in design working together in the design development process" (p. 6). Co-design takes an open-ended approach to framing key problem areas in complex service systems. These complex problems require openness to define the area of the project, and co-design can help us better understand people's lived reality in this open area (Lee et al., 2018).

1.3 Statement of the Problem

With an aging population and a shortage of caregivers and healthcare facilities, strategies for alternatives such as HSH are necessary, and design processes and technology use can help us develop and promote these alternatives. However, the process faces three significant problems: a lack of collaboration between designers and researchers at the front stage; a lack of participatory research processes (e.g. co-design); and a tendency not to view HSH projects as service design projects.

From my review of literature, it is apparent that the front stage of research is a determining factor for complex projects like designing a viable and appropriate HSH. However, studies have shown that at this stage, collaboration between designers and scholars in other disciplines is uncommon, and newer way of practices such as service design is needed to employ a more holistic, user-centred approach, with a focus on individual behaviour (Stickdorn, Schneider, Andrews, & Lawrence, 2011; Burns et al., 2006).

Aging in Place with the help of technology is a complex field because of its incomplete, contradictory, changing, and often difficult-to-recognize requirements. Moreover, due to complex interdependence, the effort to address one aspect of such issues may reveal or create other problems (Rittel & Webber, 1973). Designing for HSHs is not just related to the home itself; many other factors are involved that must be addressed in the beginning phases of design. This study indicates a lack of holistic attention to the use of technology at home to assist Aging in Place, and recommends a larger more holistic approach for designing a system to better address the problem.

1.4 Rationale

Health Smart Homes can add value to the healthcare continuum by improving the quality of care and reducing the pressures on a healthcare system that, in many

ways, is over capacity. Experts agree that many health conditions, especially chronic diseases, could be monitored and treated in a home equipped with necessary smart home products (Agoulmine et al., 2011). These homes empower patients and their families, directly connect to caregivers, and personalize services based on needs, preferences, and values (Coughlin et al., 2006). New technology at home can provide help to users by monitoring health status, detecting emergencies, and notifying healthcare providers (Rantz et al., 2013).

Another significant point of this project is the potential of HSH design to reduce the costs of healthcare. It has been proven that "effective prevention of diseases and early detection of health problems help to significantly reduce the cost of healthcare" (Agoulmine et al., 2011, p. 7) and can also help decrease healthcare costs "associated with institutionalization or unnecessary hospital visits" (Kima et al., 2016, p. 30).

A better understanding of the human experience in healthcare systems is essential to providing more effective services and increasing the satisfaction of users (Duncan & Breslin, 2009). Relatively few studies have considered the integration of the primary end user's perspectives in the design of health technology (Vaziri, 2018). A participatory approach enables closer collaboration between designers and future users.

The technical feasibility of devices and sensors in HSH systems is not the only factor in the success of such services; their integration into the routine lives of users is also crucial (Demiris, Oliver, Dickey, Skubic, & Rantz, 2008). There is a lack of qualitative user-centred research in this area (Liu, Stroulia, Nikolaidis, Miguel-Cruz, & Rincon, 2016). Some approaches, such as participatory design, offer methods, tools, and techniques which have been little used in healthcare quality improvement until very recently (Robert, 2017). Currently, the development of HSHs takes place primarily in the lab, with little involvement of the range of actors that are required. It seems fruitful to involve future users in the front stage of the design process before development and commercialization so as to reduce cost and adverse outcomes.

From the point of view of design, "several authors have pointed out that for a deep understanding of the user, designers should ideally be involved in user research activities" (Sleeswijk Visser, 2009, p. 29). The involvement of designers can be beneficial in the process beyond the later conceptualization phase. It is especially crucial in planning for health systems, due to their complexity (Sleeswijk Visser, 2009; Robert, 2017). Also, a designer's frame of mind, often termed design thinking offers new perspectives fo improving the quality of healthcare by 'making sense' of experiences and finding solutions (Sangiorgi, Prendiville, & Ricketts, 2014). Previous

literature on the subject and personal interviews have demonstrated a lack of contributions by designers in the front stage of designing HSHs.

This project not only helps to provide a better understanding of users' perspectives on the design of smart homes, but also provides a holistic view of the problem through examining design for services. It considers various factors that contribute to HSH design, such as stakeholders' needs and human-centred products, services, and relations.

Finally, this project is an example of how designeres can be involved in the front stage of a HSH research, what they can bring to the table and the possible outcome of such collaboration.

1.5 Research Questions

The project began with a pre-defined and tight brief, but one not limited by borders. Over the course of the study, it was re-framed to be more open-ended. Based on the identified problems and the chosen methods, tools, and concepts, this project seeks to answer the following questions:

- What are the essential factors that influence the design for Health Smart Home services from the perspective of Baby Boomers?
- What is the role of design in an interdisciplinary project such as the creation of Health Smart Homes?

1.6 Research Aim and Scope

This study seeks to investigate the effectiveness of design practice, its benefits and recommendations in providing care for older adults in order to enable them to live more independently and comfortably in their own homes with the help of smart technologies. This thesis adds to the field by exploring the use of co-design to develop HSHs. The project used a participatory approach and developed a model to encourage Baby Boomer users to share ideas and experiences through participatory research. The goal of this project was to develop design suggestions to improve the quality of design for HSH systems to help the elderly maintain healthy lifestyles and continue independent living in place.

In order to define the scope of this project and determine my research questions, I engaged in preliminary research on aging, independence, and problems concerning technology. During pre-research activities, I conducted interviews with general

practitioners, psychologists, computer scientists, an occupational therapist, two PhD computer scientists working on Smart Condo projects (a Health Smart Home), and nursing research chair in aging and quality of life, all in Edmonton, and then I attended the 47th Canadian Association on Gerontology Conference in Vancouver to meet scholars from different disciplines related to aging. I was able to narrow down the focus of my work to smart technology to support care at home for older adults and found new opportunities for design contributions in this area.

1.7 Method

This thesis is intended to answer the research questions introduced above and consider the growing scale and complexity of design problems that are forcing a move towards more open and collective design activity in which multiple stakeholders — particularly the end users, but also professionals from other fields — are included as equal partners in the design process (Pirinen, 2016). These approaches can provide high-level design guidance for developers of complex systems such as HSHs. In my approach to designing for service innovation, I integrate several activities across a service development process that includes exploratory, generative, and evaluative research. Different levels of knowledge are necessary to gain a better understanding of users. Froukje Sleeswijk Visser, Assistant Professor Design Conceptualization and Communication, University of TU Delft, and her colleagues developed a model of the various techniques for accessing different levels of knowledge (Figure 1).

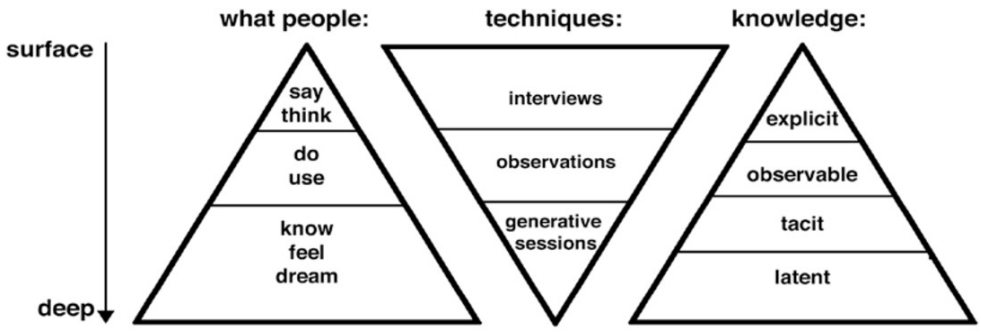

Figure 1. Different levels of knowledge (from Sleeswijk Visser, Stappers, Lugt, & Sanders, 2005)

Based on this model, I selected a participatory approach, which is human-centred. Participatory research enables different modes and levels of stakeholder participation in the design process. Co-design, a qualitative practice-based approach, is one method of participatory design. The co-design process in this study involved contextual interviews with nine Baby Boomers; interviews with five experts from different fields related to the design of HSHs; visiting two HSH labs; and, most importantly, a co-design workshop with all nine Baby Boomers as partners in

designing. Co-design partners in this study play a considerable role in knowledge development, idea generation and concept development.

A review of the literature relating to qualitative research revealed that no single method could be defined as the best approach for data analysis. The data analysis strategies used in this study included scanning for words and phrases, repetitions, primary and secondary data comparisons, searching for missing information, comparing primary research findings to phenomena in different areas, and discussing similarities and differences.I then mapped the concepts out of gathered materials, and noted patterns using affinity diagrams, identifying themes, patterns, and relationships.

1.8 Outcomes of the Project

The outcome of this study was not meant to completely change the path of HSH research, but rather to provide a more holistic view of the subject by providing sets of design recommendations related to the main areas of environment, equipment, interactions, services, and strategies that must be considered in the design of future HSHs. The project's suggestions are evidence to show the role of design in the front end of the development process; that is, the many activities that inform and inspire exploration. The front end is often referred to as 'fuzzy' because of its ambiguity and chaotic nature (Sanders & Stappers, 2012).

An associated outcome from this study is a suggested model for conducting HSH projects related to people, mindsets, methods, and research processes.

1.9 Overview of the Process

Some tools have been used throughout the whole process of research and presented visually in most of the diagram in this study (Figure 2a). The diagram below (Figure 2b) documents the process of this research from beginning to the end. It will be explained further in Chapter 3.

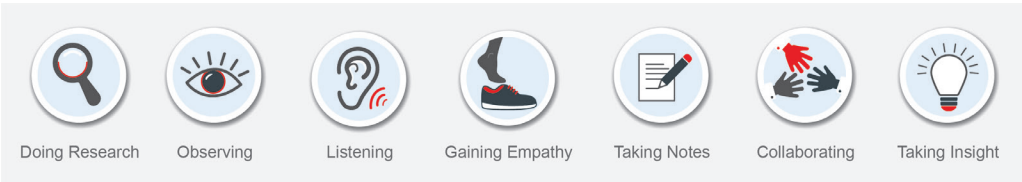

Figure 2a. Essencial tools used throughout the whole process of this study

Figure 2b. Research process of this study

"The negative view of old age with its outworn stereotypes must be changed if the elderly are to have more opportunities for successful aging. It is time for a more balanced attitude. Health in old age involves mental and social as well as physical well-being."

— Robert Neil Butler, scholar, psychiatrist, and prize-winning author
(*Journal of the American Geriatrics Society*, 1974, p. 529)

2. Literature Review

This chapter serves as the foundation on which my study is built. It summarizes articles and book reviews related to healthy aging, independence, and Aging in Place with the help of technology. The literature review is followed by a review of smart technologies for AiP and health support at home. The chapter concludes with an examination of challenges and expectations related to future HSH technologies. As discussed in Chapter 1, this project focuses on the design of services for older adults; therefore, this chapter discusses service design principles and the use of those principles and designs in health-related projects. The chapter describes the co-design method, including its benefits and risks; and the research process for this project, including the participants, tools, and techniques used in the study. Related to design practice it discusses the need for designers to update their approaches to problems; the changes in design over time; and its application in interdisciplinary projects such as this study.

2.1 Healthy Aging and Independent Living

The increase in the aging population has various consequences for society and for individuals, and as noted in the previous chapter, these consequences must be dealt with urgently. One such concern for both individuals and governments is healthy aging. The World Health Organization (WHO) defines health as a "State of complete physical, mental, and social well being, and not merely the absence of disease or infirmity"(n.d.).

The physical, mental, and social components of health must be considered in relation to healthy aging in order "to locate the conditions which enable humans to thrive and not merely survive" (Butler, 1974, p. 531). In this regard, new health smart technologies could be beneficial to an improved quality of life for older people and could also help them to remain independent. Mshali and colleagues (2018) define independence as a person's ability to achieve the primary tasks of daily living without the help of a third party.

In older age, people are more likely to face physical, mental, and social problems that could reduce living independently. Additionally, they may encounter psychological issues such as loneliness, which can be caused by the loss of immediate relatives or children leaving home. However, Butler (1974) points out that the physiological, chronological, psychological, and social effects of aging are different for each person (p. 531).

For healthy aging and independancy it is required to consider all aspects of seniors' lives, especially a balanced view of aging and an awareness of existing stereotypes, some of which include the perception of older adults as unproductive, disengaged, or inflexible (Butler, 1974).

Aging is associated with a range of health issues including chronic illnesses, falls and injuries (Mshali et al., 2018; Elixhauser, Steiner, Harris, & Coffey, 1998). Vacha and Kandusova (2018) note that falls, which can cause serious injury and reduced mobility and can increase the risk of social isolation and lower levels of physical activity, are a significant threat to the elderly (Bright & Coventry, 2013). The loss or reduction of the ability to walk or manage everyday activities also reduces self-management and results in a greater dependency on others (Vacha & Kandusova, 2018).

Attitudes toward aging that regard older adults as passive consumers of social services rather than active creators can lead to decreased self-esteem (Sun, Florio, Gui, & Blondia, 2009). Moreover, socioeconomic factors such as poverty, the death of a partner, family pressure, or lack of social support become more critical in older age groups, and their ability to live independently may be jeopardized (Vacha & Kandusova, 2018). Additionally, common diseases may cause decline in physical and cognitive skills, and may hinder older adults from living independently (Mshali et al., 2018). The aim of technology at home is to address obstacles such as these, and help keep older adults in their homes longer than they might otherwise.

2.1.1 Aging in Place (AiP) with the Help of Technology

Many older adults are forced to relocate in order to attain higher levels of care (Vacha & Kandusova, 2018). Based on previous studies, the biggest difference between independent housing and institutional housing, from the perspective of older adults, are privacy and choices concerning daily life (Vacha & Kandusova, 2018). Living in one's own home is part of one's self-image, social status, and key memories (Vacha & Kandusova, 2018).

The idea of Aging in Place is an alternative service that enables people to stay at home (Rantz et al., 2013). The American Planning Association defined Aging in Place as "the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level" (Centres for Disease Control and Prevention, 2009).

Kim, Gollamudi, and Steinhubl (2016) argue that Aging in Place with the use of technology can improve quality of life, increase cost efficiency for older adults and provide more social support. Moreover, they argued that keeping autonomy and

independence for longer periods decreases healthcare use by reducing unnecessary hospital visits, optimizes health outcomes, enhances individual choice, and reduces caregiver stress (Kim et al., 2016; National Science and Technology Council, 2019). The National Science and Technology Council (NSTC) is the principle means within the USA to coordinate science and technology policy. The council suggests consideration of the following criteria to guide the development of technology or technology usage in AiP:

1. Ability to perform daily activities;
2. Cognitive changes that are common in older people;
3. Communication and social connectivity;
4. Personal mobility, which refers to all movement,
5. Ability to use transportation;
6. Access to healthcare (National Science and Technology Council, 2019).

2.2 Smart Technologies for Health Support at Home

The idea of monitoring technologies is relatively new. The concept of a Health Smart Home (HSH), defined as an attempt to provide an independent life through various technical supports for people in their own homes, is a possible solution to some of the concerns faced by an aging population (Mshali et al., 2018). HSHs monitor and evaluate health conditions and employ Ambient Assistive Living (AAL) technologies to provide universal design approaches to accessibility, usability, and acceptability of interactive technologies (Mshali et al., 2018; Blackman et al., 2016).

According to a scoping review by Blackman and colleagues (2016) on AAL technologies three generations of technology designed for supporting independent living for older adults are available. The first and second generations of AAL products are already established within the marketplace, while third generation technologies are still in the research and development phase and would benefit from further development (Blackman et al., 2016). These three generations are described below.

1. Wearables: The first generation of Ambient Assistive Living (AAL) is a wearable alarm. The user presses a button, which activates an alarm, in the case of an emergency such as a fall. Once alerted, the call centre contacts the older person to determine what level of support is needed and the possible need for emergency services. LifeAlert is one well-known example of this type of

assistive-living technology. Benefits related to security and safety include reduced stress among older adults, families, and caregivers, reduced hospital admissions, earlier hospital discharge, and delayed entry into long-term care facilities. If the person is incapacitated either physically or mentally or is not wearing the device, it is impossible to trigger the alarm. The alarm may also prove useless in high-risk situations.

2. Home Sensors: The second generation of technology for assisted living is characterized by the integration of electronic components that helped to address the limitations of the first generation. These devices respond to and detect potential emergencies, such as falls or environmental hazards, by using sensors. For example, if there is a gas leak within the home and the older adult is incapacitated or unaware, the sensor monitoring system automatically raises the alarm and contacts the appropriate authorities. Despite the potential benefits of home sensors, some users regard them as unnecessarily intrusive.

3. Home Sensors and Wearable Devices Integration: The most recent wave of AAL technology has emerged alongside advancements in information and communication technologies (ICT). One example of this technology that detects, reports, and prevents problems is a home monitoring system that uses non-intrusive methods, negating the need for manual activation of alarms while reducing reliance upon active supervision. These systems integrate computing systems and assistive devices into everyday living contexts to monitor activities and detect patterns in the person's behaviour and home environment. Embedded devices are currently in development and a benefit is the reduction of stigma associated with monitoring and assistance devices by embedding the technology invisibly within everyday objects (Blackman et al., 2016).

Based on the Mshali et al. study, current Health Smart Homes use sensors, which may either be stationary or wearable, in order to collect the subject's contextual information and analyze the data. The HSH system evaluates the subject's health conditions and notifies caregivers in the case of an abnormality or an emergency based on the data gathered. Collected information includes data from the environment such as temperature, humidity, and sound detection; movement and location tracking such as gestures and pressure; and vital signs such as heart rate, oxygen saturation, and blood pressure. These data provide a low-level view of the person's health status, their surroundings, and their living environment. In a higher-level view, the data are used to classify diseases, predict health conditions, and detect patterns in human behaviour. Health monitoring systems can recognize behaviour patterns and activities in real-life settings, detect abnormalities, predict

behaviour and health based on these data and proactively make necessary arrangements (Mshali, Lemlouma, Moloney & Magoni, 2018).

2.2.1 Systematic Review of Smart Technologies for AiP

The results of a systematic review conducted by Liu and colleagues at the University of Alberta of 48 studies between 2010 and 2014 show that smart homes and home health-monitoring technologies have been used to address several medical conditions and disabilities.

The evidence supports that home health-monitoring technologies for cognitive decline and mental health reduce symptoms of depression and visits to the emergency department in older adults with chronic illness. There is evidence to support that technologies for monitoring heart conditions improve patients' sharing data with clinicians and their blood pressure control. There is no evidence that smart homes or home health-monitoring technologies help to address the conditions of disease or disability prediction, health-related quality of life or fall prevention (Liu et al., 2016, p.55).

Additionally, they found that the level of technology readiness for smart homes and home health-monitoring technologies is still low. Results have shown that, although a large number of papers mentioned "older adults," many of these studies included younger adults as research subjects. Important factors required from technology use include allowing older adults to remain in their own homes, helping to improve their quality of life, and perceived usefulness. On the other hand, the main factors hindering adoption are security and privacy of the occupant and the collected data, particularly when cameras are used. Therefore, many home health technologies should consider this issue in their design of data-capture methods (Liu et al., 2016).

In another review related to Assistive Technologies (AT) by scholars in Australia, Yusif and colleagues (2016) documented that a lack of information and support from formal health and social care services concerning how to access AT, where to source it, and when and how it can be used, caused concerns. Other issues that impede use of AT include negative cultural stigma, the difficulty of using the devices and concerns about privacy, trust, functionality/added value, cost, and fear of dependence (Yusif et al., 2016).

In 2010, Mitzner and collegues in the United States conducted a smart home participatory research project and surveyed 113 older adults on their use of and attitudes about technology in their homes, work, and healthcare. Participants reported using a wide variety of devices, particularly in their homes. Positive attitudes

outnumbered negative opinions, suggesting that older adults perceive the benefits of technology use. Positive attitudes were related to support of activities, convenience, and useful features. Negative attitudes were associated with inconveniences created by the devices, unhelpful features, and security and reliability concerns. This study suggested that education and training programs might increase future technology adoption (Mitzner et al, 2010).

2.2.2 Challenges in Designing HSHs

There are a variety of challenges affecting the design of HSHs, the most significant of which are listed below.

Based on Mshali and colleagues, technical factors include the reliability of data transmission in real time, the processing of data, and the making of relevant decisions. The definition of "normal" human behaviour is challenging because it is different for everyone. Data accuracy and the collection of highly relevant contextual data are also important for HSH design. Monitoring must also be accurate, as behavior is subjective, context-awareness is required to correctly interpret data and events, in order to extract a coherent high-level abstraction of contextual data. Emergencies and deterioration in health conditions should be reliably detected as early as possible (Mshali et al., 2018). Healthcare monitoring systems rely heavily on technology that can pose security threats or be used in attacks such as location and activity tracking, forging medical data, denial of service, physical tampering of devices, and jamming attacks. Moreover, using wireless technology in healthcare systems without considering security requirements often makes subjects vulnerable to privacy issues. Some smart technology requires subjects to wear and carry sensors constantly, and this can be cumbersome (Mshali et al., 2018). Other issues related to technology include power consumption, data transmission, heterogeneity system maintenance, interoperability, loss of control and apathy, cost, and lack of data standards, (Mshali et al., 2018; Balta-Ozkan, Davidson, Bicket, & Whitmarsh, 2013; Kim et al., 2016).

Another important issue is the consideration of human factors such as human acceptability, ergonomics, and human-computer interaction (HCI) and how these help to optimize human well-being, safety, and overall system performance (Mshali et al., 2018). From a design perspective, these factors help us better understand the interactions between the subject and the system components. This relates both to caregivers (occupational ergonomics) and to care receivers (subjects). Specifically, factors that aim to achieve effectiveness, efficiency, and subject satisfaction in the design of a health monitoring system must be considered (Hossain, 2014). Added to this, age-related health issues such as decline of cognitive abilities may prevent

elderly people from easily adopting and learning new technological solutions (Lemlouma & Chalouf, 2013; Hossain, 2014; Holden, 2013). Affordability is also an important factor as are concerns such as social isolation, lack of direct contact, and information flow from users to caregivers (Mshali et al., 2018; Kim et al., 2016).

Many scholars have suggested that usability, acceptability, and safety are the most important factors to be considered for both monitored subjects and caregivers in HMS (Lemlouma & Chalouf, 2013; Hossain, 2014; Gurses, Ozok & Pronovost, 2012; Ahlan & Ahmad, 2014). "Unfortunately, these factors have been ignored by the majority of works we have examined to date and are, thus, worthy of future attention" (Mshali et al., 2018, p50) and the importance of social connections and social activities is less noticed (Sun et al., 2009).

Making appropriate health data accessible on time is another critical issue for health monitoring systems for HSHs. (Mshali et al., 2018).

2.2.3 Expectations for Future HSH Technology

As scholars suggested technology has the capacity to empover people to live and age well in the following ways related to health monitoring and AAL:

- Supporting individuals to keep up with similar activities at home and in the community (Blackman et al., 2016);
- Providing self-management-style health, self-monitoring of health, and medical self-measurements (Agoulmine et al., 2011);
- Continuously informing doctors about smart home inhabitants' conditions (Agoulmine et al., 2011);
- Providing intelligent, unobtrusive, and ubiquitous assistance (Blackman et al., 2016);
- Increasing self-confidence and mobility;
- Promoting a better and healthier lifestyle for individuals at risk;
- Enhancing security, preventing social isolation and supporting the multifunctional network around the individual;
- Supporting carers, families, and care organizations (Sernani et al., 2011);
- Increasing the efficiency and productivity of resources in aging societies

(Sernani et al., 2011; Blackman et al., 2016);

- Avoiding hospitalizations, improved overall function, better chronic illness management, and better overall quality of life for older adults (AgingMO, 2018);
- Making healthcare services more sustainable by reducing the pressure placed on the overall health system (Mshali et al., 2018);
- Manageing of chronic conditions, frailty, social isolation, and fall prevention and detection (Kim et al., 2016).

2.3 Approach to Design

We are witnessing shifts, connections, and reframing in many aspects of the design discipline (Sanders & Stappers, 2014). Traditionally, problems were seen as complicated challenges, but they could be solved by breaking them down into smaller pieces (Burns et al., 2006). Today, however, designers increasingly face more complex and ambiguous issues, which Horst Rittel, a design theorist and professor at the University of Stuttgart labelled "wicked problems". Irwin (2015), Head of the School of Design at Carnegie Mellon University (USA), suggested that these wicked problems require new approaches. Moreover, Buchanan in his article related to wicked problems noted:

> As described in the first published report of Rittel's idea, wicked problems are a "class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing." (Buchanan, 1992, p. 15).

As the number of wicked problems is expected to continue to grow, developing human-centred and holistic solutions is one potential response (Plattner, Meinel, & Leifer, 2014). Considering the new roles and tools, designers are increasingly in demand to help address complex social and economic problems (Burns et al., 2006). Services such as Health Smart Homes can benefit from knowing how design contributes to better understanding people's tangible and intangible needs.

Understanding the needs of users becomes an indispensable part of design for services, and users of services have never been as highly regarded as they are today. Service designers have tools to identify and map these needs and facilitate the process of improving current services and innovating new ideas (Larson & Berg, 2017).

2.3.1 Landscape of Design: How Design has Changed

Jon Kolko, a partner at Modernist Studio and the founder of Austin Center for Design, noted in his article for *Harvard Business Review* that design has been traditionally considered in terms of aesthetics and craft, and designers have been celebrated as artistic professionals (2015). Today, although many people still view design in this way, it has changed significantly as designers are playing a larger role in bringing ideas to life. Liz Sanders, professor in the Design Department of Ohio State University (USA), editor of the journal *Co-Design*, states that changes in the complexity of the problem caused a move from "the designing of things to interactions to systems," and from "designing for people to designing with people and by people" (Sanders & Stappers, 2014, p. 2). The turn of the century has seen two dominant shifts: "in where design skills are being applied" and "who is doing the design" (Burns et al., 2006, p. 10). User-centred design and participatory design are two human-centred approaches that have emerged in response. The user-centred approach, originating in the US, has had the most impact in industrial and user interface design as users of the product are now increasingly being seen not just as customers and consumers, but as end users (Sanders & Stappers, 2014). By contrast, in the participatory design approach, popular in the Scandinavian countries, users are seen as partners. These two approaches are now beginning to influence one another, as demonstrated in Figure 3:

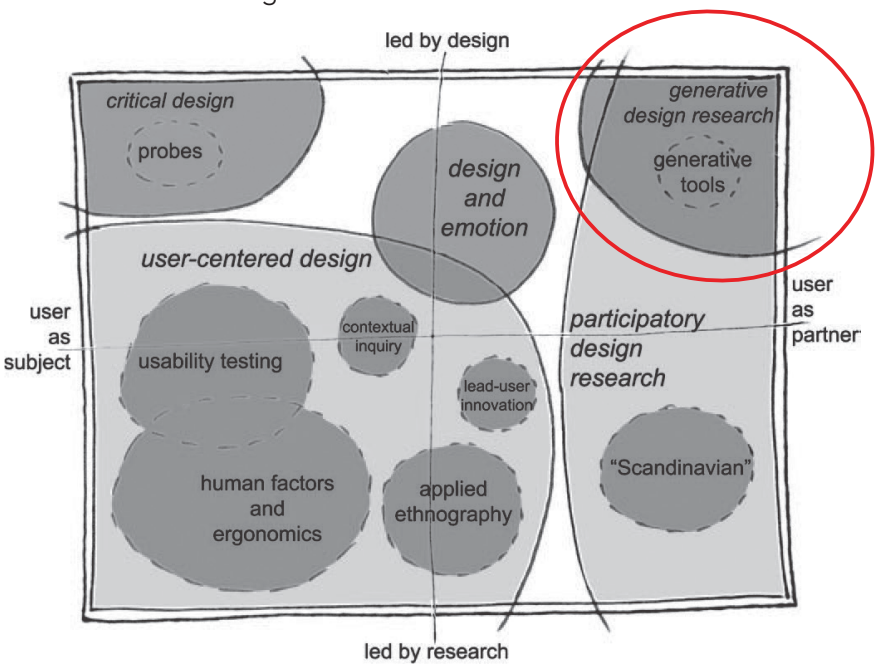

Figure 3. The current landscape of human-centred design research as practiced in the design and development of products and services (from Sanders & Stappers, 2008)

The approach of this study, which will be explained in the next section, focuses on participatory design, and in particular generative design research, as shown in the image above.

2.3.2 Design for Services and its Benefits for Health Related Research

This section focuses on understanding the application of design for services, and also outlines a case study that will help to clarify the meaning of design for services in this project. As Figure 4 demonstrates, Meroni and Sangiorgi depict the relationships between service design, design for service and co-creation, which are the main components of this study (Meroni & Sangiorgi, 2011).

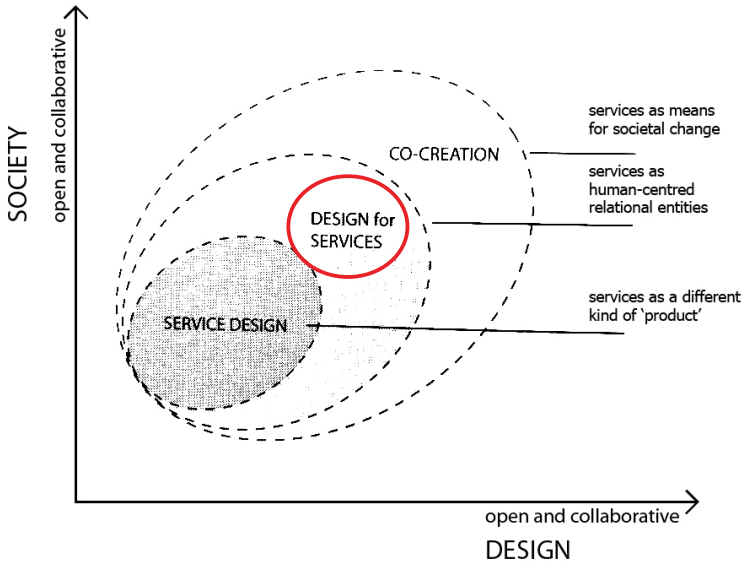

Figure 4. Ongoing transformation in design and society (Meroni & Sangiorgi, 2011, p. 226)

Birgit Mager, president of Global Service Design Network and Service Design Professor at Köln International School of Design in Germany, states:

> Service design choreographs processes, technologies and interactions within complex systems in order to co-create value for relevant stakeholders ... service design uses design processes and methodologies in order to create services that are useful, usable and desirable from the user perspective and valuable and different from the provider perspective (Mager, 2015).

Service design is interdisciplinary, human-centred, and holistic, with a focus on users' journeys and their experience of services (Fry, 2018). Stickdorn the co-outher of *This*

is Service Design Thinking noted that service design provides a common language for projects such as HSHs that involve interdisciplinary collaborations between researchers with their own specific knowledge areas and languages (TCDCThailand, 2014).

Services have four main characteristics:

- Intangibility: services cannot be seen, felt, touched or tested like products;
- Inseparability: companionship of users is needed in most services;
- Heterogeneity: each service is unique due to situations and participants;
- Perishability: they are not storable (Meroni & Sangiorgi, 2011).

The role of the service designer in the research team is a facilitator of the whole process (Stickdorn et al., 2011). Stickdorn and colleagues, listed five keywords that describe the service designer's mindset when generating successful projects:

1. Human-centric: put the users in the centre of the whole service, try to slip into their shoes, and try to understand the experiences of people in depth.
2. Holistic: understand the problem from all possible perspectives to generate knowledge for the foundation of the design process (Larson & Berg, 2017).
3. Co-creating: the people using and working with the service know the solution and goals the best (Larson & Berg, 2017). Co-creating is vital for successful results, as it facilitates trust, motivation, engagement and creates ownership.
4. Sequencing: a service is a sequence of touch points for users.
5. Evidencing: because services are not tangible products, providing evidence is part of the service.

The service design approach to problem-solving has been used frequently by the National Health Service (NHS) the publicly funded national healthcare system in the UK (Freire & Sangiorgi, 2010). Some of the benefits of applying service design to health-related research in the NHS, include:

- Developing new services based on higher value with the availability of resources;
- Changing organizational culture and providing better connections between organizations and clients (Freire, Sangiorgi, 2010; Moritz, 2005);

- Bringing new perspectives for future development and innovation (Freire, Sangiorgi, 2010; Moritz, 2005);
- Increasing service effectiveness with a better user understanding (Moritz, 2005);
- Increasing efficiency by improving user experiences (Moritz, 2005);
- Gaining insight through patient involvement (Fry, 2018).
- Increased patient satisfaction is less tangible, harder to measure, and more difficult for managers to quantify and visualize than the other goals listed above (Fry, 2018).

Based on the map of design for services developed by Meroni and Sangiorgi (Figure 5), this project focuses on imagining future directions for service systems. The main design contributions in this area are in generating and sharing a vision for the future, visualizing future scenarios through stories and service ideas, and working with stakeholders to create long-term transformation processes (Meroni & Sangiorgi, 2011).

Figure 5. Map of design for services (from Meroni & Sangiorgi, 2011, p. 204)

In another literature review, results from an online survey conducted by the Service Design Network (2017) to better understand the effects of service design on healthcare showed that 54 percent of the project outcomes focused on improving existing experiences, while 47 percent developed new offers for healthcare (Figure 6).

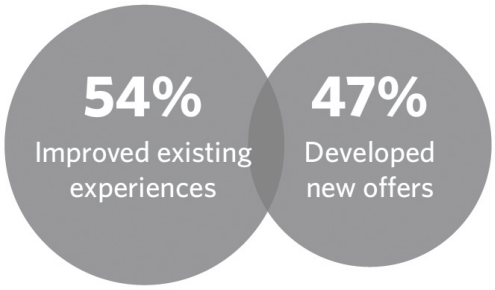

Figure 6. Service design innovation focus (Service Design Network, 2017, p.7)

Additionally, the report demonstrated several effects of the project's outcomes:

- organizational process and/or structural changes, such as new networks between previously-unconnected stakeholders, new partnership opportunities, and co-creating;
- organizational culture changes, such as establishing user centred values;
- citizen/patient engagement, such as community building for volunteer engagement;
- capability building and education such as offering service design training within an organization;
- policy and regulation design and development, such as using design research to inform policy decision-making (Service Design Network, 2017, p. 8).

A significant example of a participatory approach to service design in Canada is the MyHealth project. In 2015, the MaRS Discovery District's in Ontario partnered with the Bridgeable team to address the follwing problem "How to make clear to government and potential funders the benefits of giving citizens control over their electronic medical records." They engaged with Bridgeable to tackle this problem by applying citizen-centric design and prototyping techniques to comprehend and achieve better infrastructure, business models, and policies. The team used a service design approach that focused on the needs of citizens in relation to standardizing the implementation of electronic health records (EHRs). The project team found that

most of the thinking on EHR implementation was driven by healthcare administrators and clinicians, rather than by users. The design team concentrated on maternal and pediatric health in the first 24 months. New mothers, who had multiple interactions with the healthcare system, were invited as collaborators. They invited 15 mothers to share their needs and desires, and collaborated to design prototypes with them. The mothers, healthcare professionals, and innovators met in a room in which they could listen to each other, and the design team reported that they found the experience inspiring and energetic. Through co-creation, the team recognized that the design solutions had to centralize data, be extensible, and provide actionable messages. They made prototypes iteratively and tested designs (Mager et al., 2017).

The final design solution was BabyBundle, as explained in their website:

> A simple, holistic view of a child's health, from latest milestones to feeding to immunizations—on a mobile device. Key information appears all in one place, with new information presented in the larger context of a child's current health and development. Because BabyBundle is a flexible ecosystem of tracking apps, parents can download different features as they need them. This creates a dashboard that is always relevant and that grows with the child. (Bridgeable, n.d.)

Using service design allowed the design team to propose something that was compelling and that would address important unseen needs. The designers thus achieved greater momentum to drive system-level changes across the province. It is well understood that co-designing with users throughout the service design process is critical to the creation and adoption of meaningful service experiences (Service Design Network, 2017).

2.3.3 The Participatory Approach of the Study

There is a growing movement among designers toward the futures of users, especially around new technologies (Sanders & Stappers, 2008). New approaches in design, as discussed previously, put users at the centre of the process.

This study involves a participatory design approach. Participatory design uses social-science methods to involve the main stakeholders in the design process and the user is seen as a partner in the entire creative process (Zhang et al., 2015; Tschimmel, 2012). The participatory method used in this study is known as co-design, an approach that recognizes that all people are creative and that end-users are the "experts of their experience" (Sleeswijk Visser, Stappers, Van der Lugt, & Sanders, 2005). The aim of the co-design approach used in this study is to bring future users

directly into the design process to make sure that we can meet their needs and dreams in relation to Health Smart Homes.

In reference to smart technology for health support, Demiris and colleagues (2008) used a participatory evaluation approach in a residential care facility to evaluate the potential of smart homes and the usefulness of this method of evaluation. Krafft and Coskun (2009) used photography to examine the homes of stroke survivors. The results of qualitative interviews conducted in this study helped provide a better understanding of the perceptions of older adults, an important factor related to the design of HSHs from the perspective of the users (Krafft & Coskun, 2009).

2.3.3.1 Co-Design and the Role of People

In the past, users were seen as consumers of products: "Any customer can have a car painted any color that he wants so long as it is black," Henry Ford stated in 1909. Today, people play various roles in knowledge development, idea generation, and concept development through co-creation approaches. Co-design, the method used in this project, is part of the co-creation approach. The term *co-creation* refers to

> Any act of collective creativity, i.e. creativity that is shared by two or more people. Co-creation is a very broad term with applications ranging from the physical to the metaphysical and from the material to the spiritual, as can be seen by the output of search engines (Sanders & Stappers, 2008, p. 6).

Co-design is more focused, and as Sanders and Stappers (2008) use the term,

> Co-design refers, for some people, to the collective creativity of collaborating designers. We use co-design in a broader sense to refer to the creativity of designers and people not trained in design working together in the design development process (p. 6).

Thus, co-design is a specific instance of co-creation (Sanders & Stappers, 2008); this project uses both. I further conducted secondary research related to co-creation and co-design together. In co-design, diverse experts, such as researchers, designers, or developers, come together with (potential) customers and users to cooperate creatively. Co-creating activity dates back to the 1980s, when the participatory design (PD) movement emerged in the Scandinavian countries (Lee et al., 2018).

In the 1990s, Elizabeth Sanders introduced the notion of "collective creativity," which holds that each person is the expert with regard to his/her own life, and is thus able to contribute to the design process (Sanders & Stappers, 2008). In

collective creativity, the designer is a facilitator who scaffolds a process. The designer should be aware of the environment of hierarchy and take responsibility for leading discussions (Fry, 2018). Sanders introduced a set of generative tools with which users, or non-designers, can express their experiences and generate new ideas (Sanders & Stappers, 2008). These approaches have now been adopted in emerging fields such as service design (Lee et al., 2018).

Through co-design, I engaged in an ongoing dialogue with the people who participated, which enabled me to jointly develop and create ideas and identify themes, and this further helped me to generate valuable and validated suggestions.

In this project, I have worked with two types of partners: experts in the areas of computer science, occupational therapy, and co-design; and older adults as experts in their own lives. They have valuable experiences to share and, more importantly, provide more in-depth understanding.

2.3.3.2 Benefits of Having Different Stakeholders Around a Co-Design Table

Based on the literature review, identified benefits of using co-design in research include:

- Enhanced resulting value-in-use (Witell, Kristensson, Gustafsson, & Löfgren, 2011);
- Reduced costs of production and development time (Steen et al., 2011; Alam, 2002);
- Increased satisfaction and well-being of people (Steen, Manschot, & Koning, 2011; Tschimmel, 2012);
- Organized innovation processes more effectively and helped to organize joint creativity (Steen, Manschot, & Koning, 2011);and generate more ideas (Sanders & Stappers, 2012);
- Higher quality of system requirements (Kujala, 2003);
- Provided a better fit between the system and users' needs (Kujala, 2003);
- Developed differentiated new services with unique benefits (Alam, 2002);
- Provided education of users on the use, attributes, and specifications of a new service (Alam, 2002);
- Rapid diffusion and better market acceptance (Alam, 2002);
- Improved public relations, and better long-term relationships between the

service provider and users (Alam, 2002).

2.3.3.3 Risks of Having Different Stakeholders Around a Co-Design Table

There are a variety of risks associated with co-design, some of which are listed below:

- Diminished control over a project (Voorberg, Bekkers & Tummers, 2015);
- Possible increased project complexity, as the objectives and interests of diverse people and managing the situation can require extra coordination (Voorberg, Bekkers & Tummers, 2015);
- Discussion of additional co-ordinating costs;
- Need for new management skills and different management styles (Voorberg, Bekkers & Tummers, 2015).

2.3.4 Empathy and Design

Empathy, the ability to understand and share the feelings of another person, is an important factor in this project. The adjective *empathic* in relation to design was introduced in the late 1990s, when companies started to realize that customers' responses to questionnaires were not enough to develop successful products (Battarbee & Koskinen, 2005; Devecchi & Guerrini, 2017). Therefore, designers often focus on their empathic abilities to help interpret what people think, feel, and dream, and to envision the experiences triggered by products or services (Devecchi & Guerrini, 2017).

The role of empathy is particularly recognized in design practices such as user-centred design (UCD), human-centred design (HCD), participatory design (PD), and co-design (Co-D) (Devecchi & Guerrini, 2017). Empathy with participants in co-design attempts to establish a dialogic design culture that results first and foremost in relationships (Manzini, 2016). In this respect, the focus is transferred from the designer's ability to step into the other's shoes, to the capacity of establishing a qualitative human relationship with other people (Devecchi & Guerrini, 2017).

Psychological literature characterizes two components for empathy. Affective empathy refers to the immediate emotional response of the empathizer, such as smiling back at a person who smiles at you. Cognitive empathy refers to the understanding of the other person's feelings by the observer. For designers, being aware of both is essential (Sleeswijk Visser, 2009).

In design practice, it is not the aim of the designer to fully understand the user, as all people are different, but it is valuable as an attempt to gain awareness, expand imagination, and increase sensitivity to other people's worlds (Sleeswijk Visser, 2009).

2.3.5 Role of Design in this Interdisciplinary Project

Designers can bring tools, techniques, and specific mindsets to an interdisciplinary team. Various scholars have noted that designers are concerned about how things should be, whereas traditionally, scientists are trying to define the parts of current how things are (Alexander, 1964; Simon, 1969; Cross, 2001). Computer scientists have been one of the main researchers in HSH research; however, their way of thinking about, approaches toward, and tools for design are different from designers. One recent method of addressing a wicked problem such as Aging in Place with the help of technology is the design thinking approach. Tim Brown, head of IDEO and author of *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, defined design thinking as "a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" (Brown, 2008, p. 2). In 1992, Richard Buchanan, professor of design, management, and information systems at the Carnegie Mellon School of Design (USA), editor of *Design Issues*, published the paper "Wicked Problems in Design Thinking," which inspired a shift in design theory from its legacy in craft and industrial production to a more generalized design thinking approach. He argued that this method could be applied to nearly anything, whether a tangible object or intangible system, because designers bring a unique way of looking at problems and finding solutions (Kimbell, 2011).

Design thinking approaches offer new process models and toolkits to foster and visualize creative processes (Tschimmel, 2012). The aim is to create innovative solutions to complex and wicked problems, though not everyone who is trained in this approach will become professional designers (Thoring, Müller, 2011; Tschimmel, 2012). According to Brown (2008), a successful design outcome exists at the intersection of three concerns: description from the users' point of view, technical feasibility, and commercial viability for the organization. David Kelley, founder of IDEO, lecturer at Stanford University, and author of *Creative Confidence*, declared that design thinking "allows people to build on the ideas of each other instead of just having their own which provide a chain of ideas built on top of each other from different disciplines and expertise" (TheRosePedals, 2013). The benefits of design thinking in interdisciplinary research projects are its use of the designer mindset,

prototyping tools, and techniques in order to address complex problems.

Stanford University lecturer Dave Evans noted that engineers' methods of thinking and solving problems are useful in addressing tame problems, which have clear repeatable solutions, but not wicked problems. In terms of making and prototyping, Evans provided a comparison between engineers and designers by commenting that an engineering prototype is to try to understand whether a solution to a tame problem correctly proves that the idea works correctly, while a design prototype is meant to find out what we want to do in the first place. An engineering prototype starts with a conclusion, while a design prototype begins with curiosity (Big Think, 2016).

Design thinking has become increasingly popular among businesses worldwide and is component of many engineering and business schools' curricula (Dunne & Martin, 2006). Over the past decade, we have seen a growing number of publications about design thinking, and design thinking ideas have been adopted by management educators, consultancies, businesses and organisations (Brown, 2008; Martin, 2009; Lockwood, 2010; Cross, 2011; Liedtka & Ogilvie, 2011; Kolko, 2015).

Many design thinking models have been developed around the world. Four of these are outlined here:

1) HCD Model (Brown & Wyatt, 2010), by the design agency IDEO

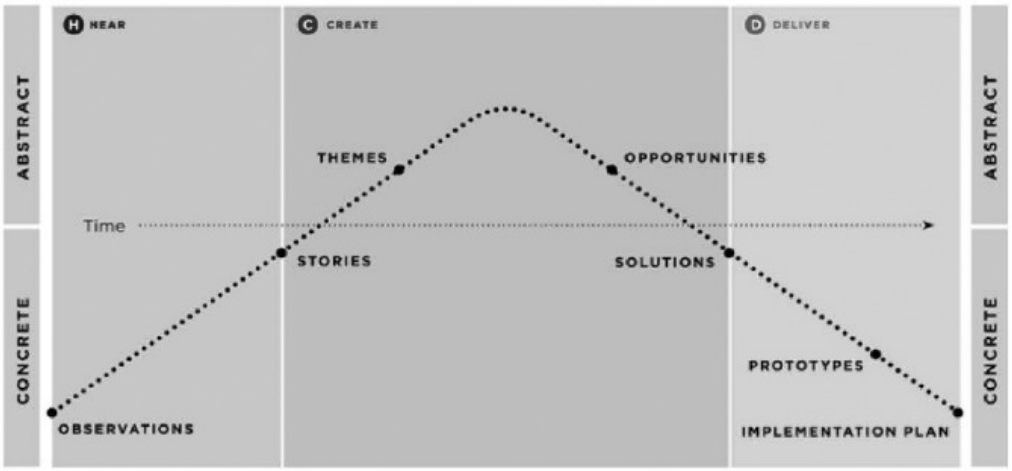

Figure 7. IDEO, 2010

IDEO developed a design thinking model as a toolkit for NGOs and social enterprises that work in the developing world (Brown & Wyatt 2010). The kit is based on HCD, which stands for Hear, Create, and Deliver. In this process, the user is led through a participatory design process, for supporting operations such as constructing listening abilities, running workshops and putting thoughts into practice (IDEO, 2010).

2) The Design Thinking Model of the Hasso-Plattner-Institute

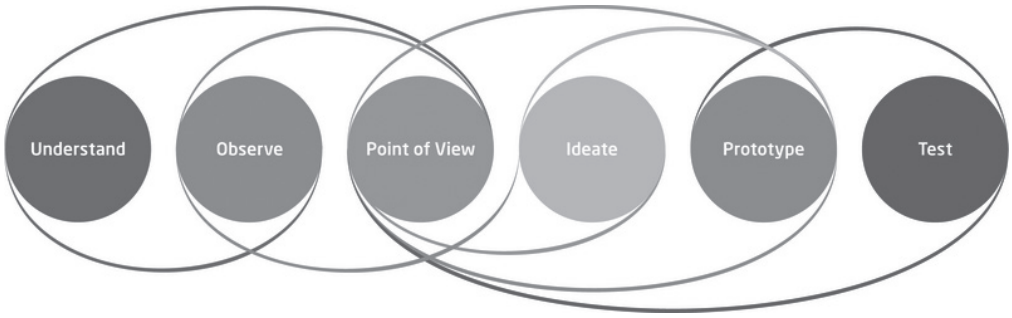

Figure 8. Hasso-Plattner-Institut

This model was developed at the Hasso-Plattner-Institute at the University of Potsdam (Germany). The design thinking process is visualized in six steps linked by curved lines indicating that each step is carried out in iterative loops (Thoring & Müller, 2011). In comparison with the IDEO model, this model shows that the stages of a design process are not always undertaken sequentially, because projects may loop back to earlier phases.

3) The Double Diamond Model by the British Design Council

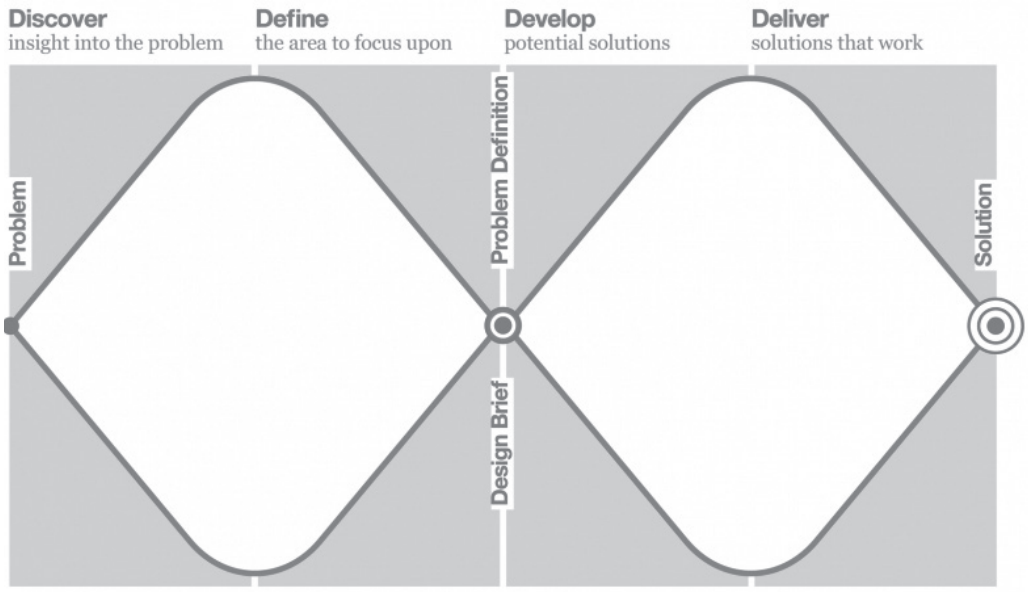

Figure 9. Design Council

The Double Diamond is a straightforward visual map of the design process divided into four separate stages – Discover, Define, Develop and Deliver. A number of feasible concepts are developed in all creative procedures (divergent thinking) before being refined and narrowed down to the best idea (convergent thinking), and this

process can be represented in a diamond shape. This occurs twice: once the issue definition is confirmed and once the solution is created (Design Council, 2019). The process of research for this study is based on this model.

4) The Service Design model proposed by Stickdorn and colleagues (Figure10)

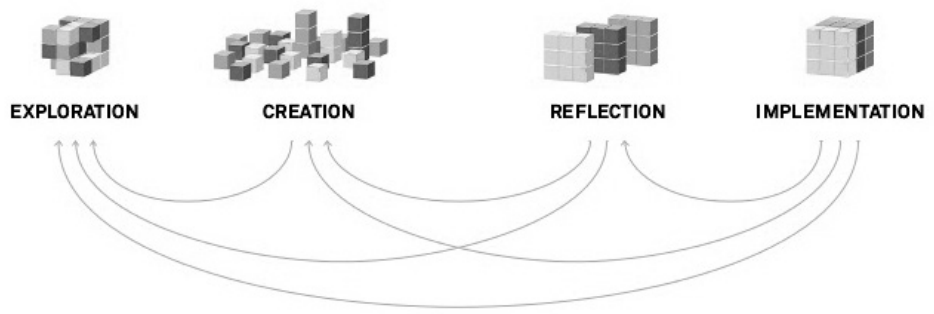

Figure 10. Stickdorn & colleagues, 2011

The Service Design Thinking (SDT) model is an iterative process composed of four phases: Exploration (understanding the culture of the customer and the real service problem, and visualising the context); Creation (generating, testing and retesting ideas and concepts); Reflection (building on ideas and concepts, prototyping; and Implementation (communicating and testing the new concept, improving the prototype). Stickdorn and colleagues emphasize that the first step of any SDT process is to design the process itself, and thus this stage is different from project to project. Tschimmel believes that this model is the most appropriate method for innovation managers working in the service area. However, it is not detailed enough to enable non-designers to work with these tools in creative processes without a professional facilitator. This method is relevant to the study of wicked problems, as such problems are dynamic and never-ending. (Tschimmel, 2012)

2.4 Chapter Summary

This chapter reviewed existing research related to aging, smart technologies and design. The important areas of concerns related to Aging in Place with the help of new technologies, challenges HSHs designers faced and expectations for future are the main ingrediants of this chapter related to older adults and Health Smart Homes. In addition, this chapter discussed the need for new approaches to design, new opportunities for designers, and service design as an emerging discipline. It investigated the role of co-design in related projects, the role of people in this process, and the use of design thinking in interdisciplinary projects.

"Designers bring multiple talents to the solutions of complex issues, but first and foremost in my mind is the incorporation of empathy, of incorporating the needs of the people who must work within the system, the people who must approve it, and the people who are to benefit from the resulting system."

—Don Norman, Director of The Design Lab at the University of California, San Diego, (Norman, 2014).

3. Design Methodology

This chapter documents the methodology of this research which is a combination of qualitative methods. The process itself is explained with more details about who participated, what they have done and the process of collaborations.

3.1 Research Process

The methodology of this project began with an examination of a variety of participatory research methods, particularly co-creation, co-design and generative techniques in design, and the service design and design thinking processes used by scholars, organizations, and designers. Generally, we cannot put a specific point for the start or end of phases of activities and there are many back and forths throughout the whole process. However, the overall process is shown schematically in Figure 11:

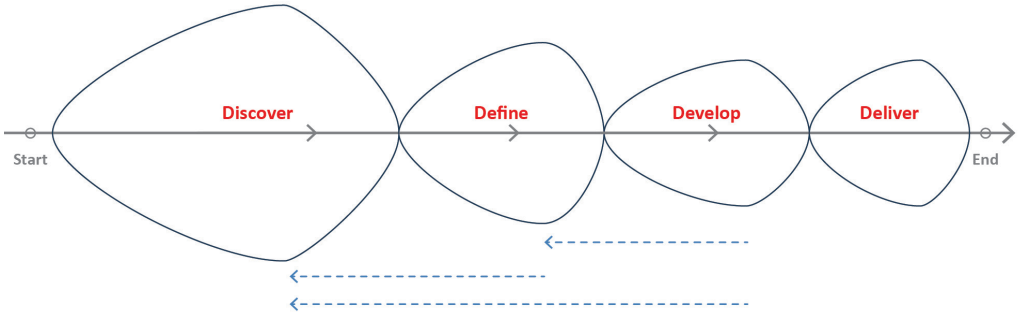

Figure 11. Design thinking model modified for this study from the Design Council's Double Diamond model

As mentioned previously, Figure 12a here is a legend to use throughout the document. Figure 12b shows the design thinking model in more detail adopted for this research. It includes four main steps: discover, define, develop, and deliver. Each level diverges and converges and more importantly, is iterative. The process of conducting this study is represented below:

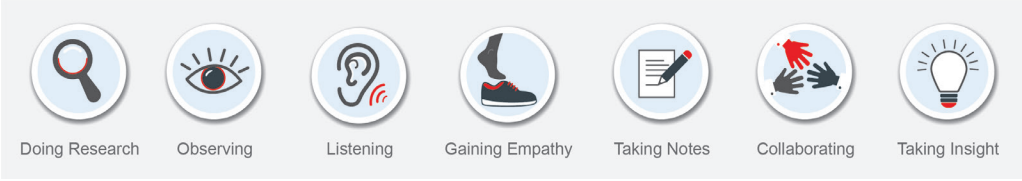

Figure 12a. Essencial tools used throughout the whole process and stage of this study

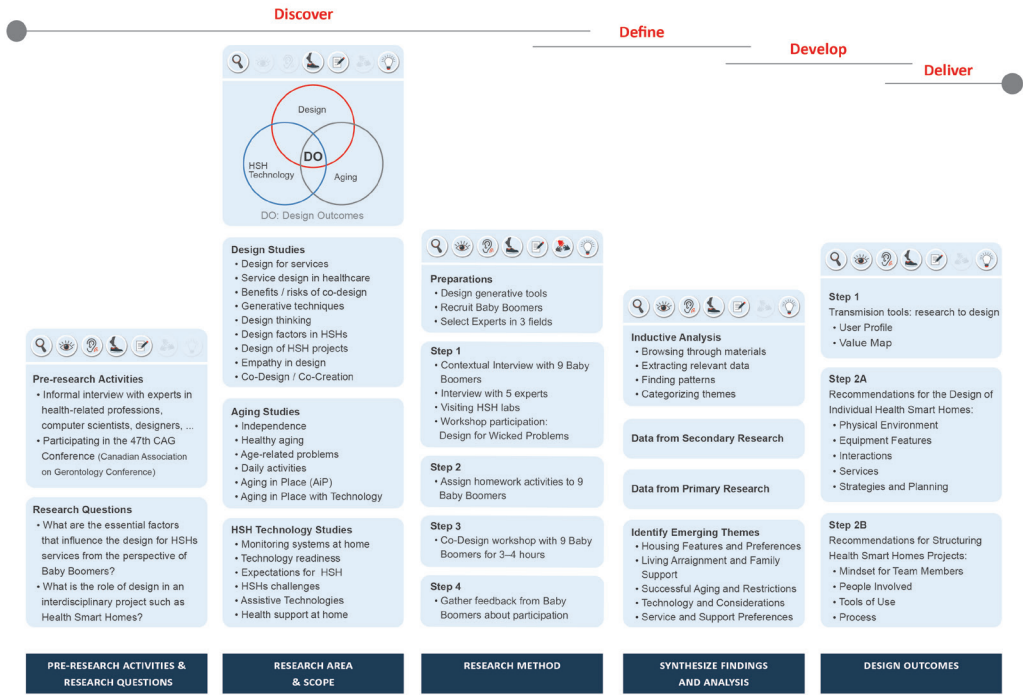

Figure 12b. Design thinking model for this study

The research process was broken into four steps, which are outlined below.

Stage 1: Discover

The aims of the first stage of the project were to better understand the latent needs of future users, gain empathy, and gather insights. In this exploratory part, I tried to better understand the current scenario of Aging in Place and living situations, the development of health-smart technologies, the factors considered by developers, and the problems and barriers related to HSHs both for older adults and for experts. This stage, as the biggest part of this study, started with informal interviews with a psychologist, a general practitioner, PhD students working on a project related to an HSH lab, computer scientists, occupational therapists, etc. These investigations allowed me to narrow the scope of my research into the current project. I studied possible methodologies, tools, and techniques in design, including background reviews, participant observations, HSH lab visits, interviews with experts, and semi-structured contextual interviews with Baby Boomers as part of the exploratory stage of this project which was divergent.

I then tried to determine what matters most both for HSH researchers and users, what is feasible, and what is meaningful for future possibilities of services. The aim of this stage of the project was to develop a clear brief that frames the fundamental challenge in designing HSHs, and the opinions, needs, concerns, and expectations

of older adults for HSHs. Moreover, discovering possibilities by running a co-design workshop offered the opportunity to collaborate closely. The workshop helped to explore future possibilities by better understanding the older adults' prospective needs, desires, and futures relating to HSHs.

Stage 2: Define

Based on the qualitative and in-depth primary and secondary research in the previous phases of the project, analysis of all the material helped to provide a clearer picture of the current situation and desires of future users of HSHs. In this phase, I tried to find patterns and concepts based on the previous stage. It started with putting all raw data, transcripts, and notes together. This was hugely divergent. The more I reviewed materials, the more notes and insights revealed themselves. Then I started to converge all gained information by grouping ideas and notes, I found patterns and distinguished key categories and organized information under these specific groups. This stage was repeated to optimize the findings.

Stage 3: Develop

To transition from research to design, I developed a User Profile and a Value Map. Intense observation and empathy during the research process was fundamental and will be discussed later in this chapter. At this stage I tried to develop relevant suggestions based on primary findings out of interpretations of materials, and direct ideas, as well as secondry research and literature reviewe

Stage 4: Deliver

Two sets of design suggestions were developed as deliverables and documented in this thesis work. Design suggestions originated from co-design activities or my insights which will be explained more fully in Chapter 5.

In the following section, I explain who participated in the study, the tools created for them to collaborate in the design part and I describe the activities that participants undertook in the study.

3.1.1 Participants

The study involves two groups of stakeholders. The first group was made up of Baby Boomers (nine older adults aged 61-77) , and the second group involved five experts.

Baby Boomer participants were involved in one-on-one contextual interviews at their

home, homework activities, and a co-design workshop. These helped to engage the participants as co-creators in a longer research process, and not just as short-term participants in the study. The method of research was designed to support this collaboration and engage with stakeholders by gathering their feedback after each step of collaboration and design. The participants were recruited by email platform and distribution by two centres of aging: Connecting Edmonton Seniors and Edmonton Senior Centre, which posted information about the study on its Facebook page and advertised the study in their weekly newsletter. 15 people responded to the first advertisement, out of whom 9 participants were selected based on their expertise and life situations. The aim of this stage of the project was to choose participants with a variety of expertise and life experiences. Sampling with partners should be done with care, as a co-design session can be dependent on the attitudes and personalities of the participants (Fry, 2018).

The Baby Boomer volunteers were a group of nine voluntary participants, ranging in age from 61-77 years, both male and female, immigrants and native Canadians, some of whom have children and grandchildren, in different states of marriage, and coming from a variety of cultural and socioeconomic backgrounds living in Edmonton, Canada. Participants in interviews and workshops had to understand and communicate in English. The diagram below (Figure 13) documents general information about the participants.

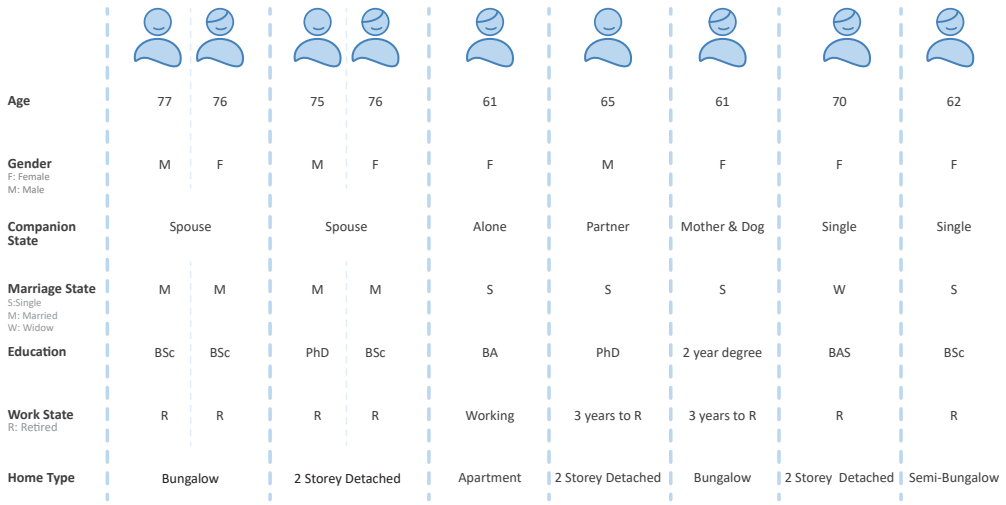

Figure 13. Baby Boomer participants

The experts in related fields were selected from specialists who worked in the field of designing HSH labs. This diverse group of experts would also be stakeholders in the project.

Experts interviewed included the following:

- Occupational Therapist with expertise in user adoption of technology for rehabilitation assessments and interventions and co-leader of Smart Condo project
- Occupational Therapist with expertise in technological interventions for older adults
- Research Chair in Rehabilitation Technology at the University of Toronto and Toronto Rehab Institute, an internationally recognized scholar in the field of technology and aging
- Computing Scientist researching the area of healthcare technologies and co-leads the Smart Condo project
- Co-Design scholar whose work in co-creation is recognised internationally

This diverse group of experts gave me an expanded opportunity to understand, on different levels, how HSH homes are developed, designed, and tested for older adults and how we can benefit from collaboration and co-creation with stakeholders during the research process for designing.

3.1.2 Research Through Design by Generative Tools

In order to support stakeholders' collaboration, ideation, and communication, and to gain empathy with future users at the beginning of the project, I employed generative research tools. In generative research projects such as this study, design skills play an essential role in developing tools for ideation sessions and in collaboration with users (Sanders & Stappers, 2012). This is especially true when working with non-designers such as Baby Boomers, who must be given appropriate tools for expressing themselves (Sanders & Stappers, 2012).

I used the path of expression model to evoke and organize the data and design activities during the research process developed by Sanders & Stappers (2012). This model consists of the following steps:

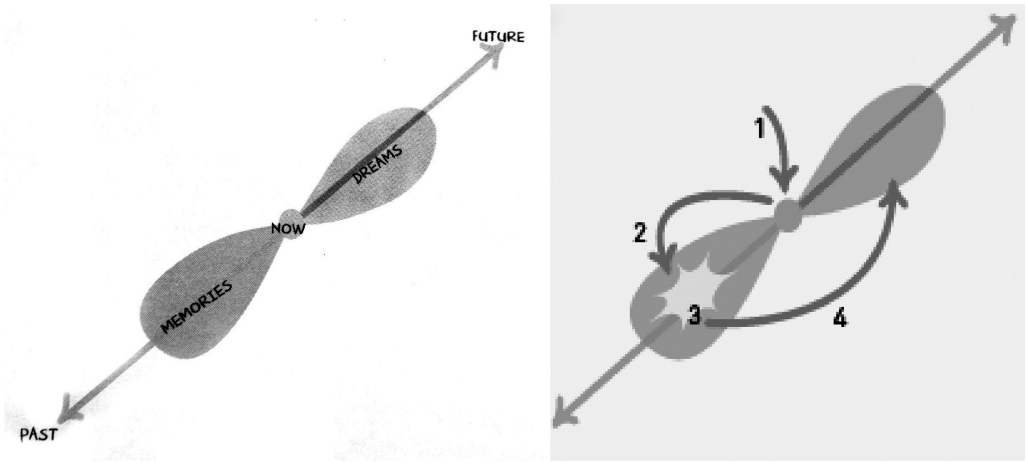

Figure 14. The experience of the moment (now) is connected to past and future memories and dreams. The path of expression (right) shows that a person's awareness can be guided in steps by thinking first of the present, then of the past, then looking for underlying layers, in order to move toward the future (Sanders & Stappers, 2012, p. 55).

1. Start with observing and documenting participant current activities around the study topic. I did this at contextual interviews and the first part of the workshop.
2. Recall memories from earlier through a making exercise that includes photography and other evocative triggers. I did this during homework activities.
3. Reflect on those memories and responsibilities for the future with a making exercise that allows for abstract and/or experiential expression. This was completed by all participants up to the middle of the workshop.
4. Express in a making activity to create artifacts for future experiences. The second part of the workshop was focused on design for future HSHs.

In planning the methodology, I used the framework of *Say, Do, Make* to gain knowledge about the users (Figure 15). I applied this framework both to the kind of information I was collecting and to the methods I used to collect the data. In interviews, one can listen to what other people *say* and interpret what they express. Through observation, one can watch what other people *do* and how they use products or services. Where *making* is associated with co-design, in a creative workshop people can jointly explore, articulate their needs and make solutions (Sanders & Stappers, 2012).

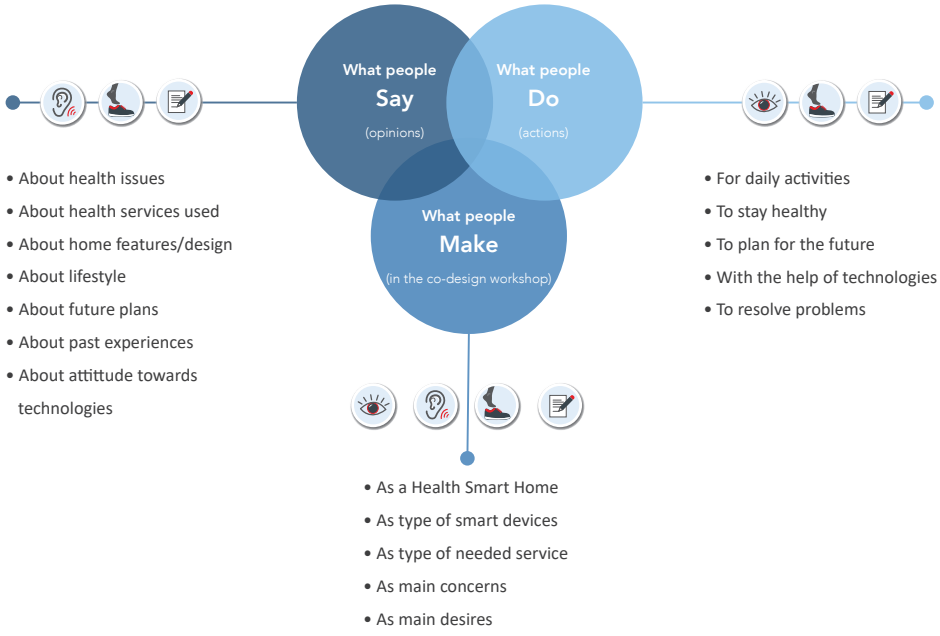

Figure 15. Say, Do, Make process in this study

3.1.3 Materials Used for Methodology

Various research methods were used as generative tools for inspiration, ideation, and information. These tools provided a space in which participants could imagine and express their ideas and dreams for future experiences (Sanders & Stappers, 2012; Fry, 2018).

3.1.3.1 Observation

Observations related to older adults involved recording by photography, taking notes about behavior patterns, home settings, and interactions with technological devices during contextual interviews at individuals' homes, and workshop days. These observations were documented in notes, photographs, and audio and video recordings. Observations of Health Smart Home labs included the recording of system processes, design functions, and communications with users, as well as equipment used. Documentation for this part of the project included notes taken at both institutions and photographs taken at the HSH lab at the University of Alberta.

3.1.3.2 Interviews

The involved two different sets of interviews, each taking approximately one hour. First, I conducted contextual interviews with nine older adults. Each session was audio recorded and then transcribed.

In the interviews, I asked the participants about management of their health on a daily basis in and outside of their home, interactions with caregivers and families, and overall lifestyles. These questions also covered personal health, health services they are using, their interactions with health centres, and smart technologies. At the start of the interview, the participants were asked to talk about the activities they performed during the past week. The interviewees discussed their experiences relating to healthcare. The focus of this part of the study was mostly in gaining knowledge about the past and present living situations of the interviewees. During these interviews, I asked for clarification whenever necessary.

The second set of interviews were conducted with academics at the University of Alberta (Canada), University of Toronto (Canada) both in-person, and the University of Ohio (USA) via Skype.

After the interviews with the Baby Boomers were completed, the next steps of the collaboration involved a homework assignment and then a co-design workshop, while the expert interviews were being conducted.

3.1.3.3 Homework Activities for Older Adult Participants

It was necessary to prepare the participants before the generative design workshop (see e.g. Binder & Brandt, 2008; Sanders & Stappers, 2014; Vaajakallio & Mattelmäki, 2014). Therefore, they were given a homework assignment that would prepare them for the workshop, elicit knowledge, and create new ideas. Each participant was provided a package of homework activities including three assignments (Figure 16). This step was inspired by my previous experience designing a Cultural Probe kit for older adults in Iran for an investigation about ATMs.

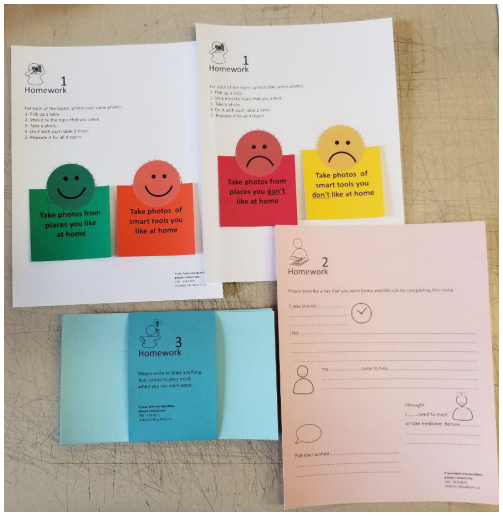

Figure 16. Homework activities assigned to older adults

The homework included the following activities:

Photography: the participants were asked to take some specific photos around their home environment and from daily objects (Figure 17 documents selected results). The aim of this activity was to make them think about their environments and the objects within. These photos were also needed for designing their future home on the day of the workshop.

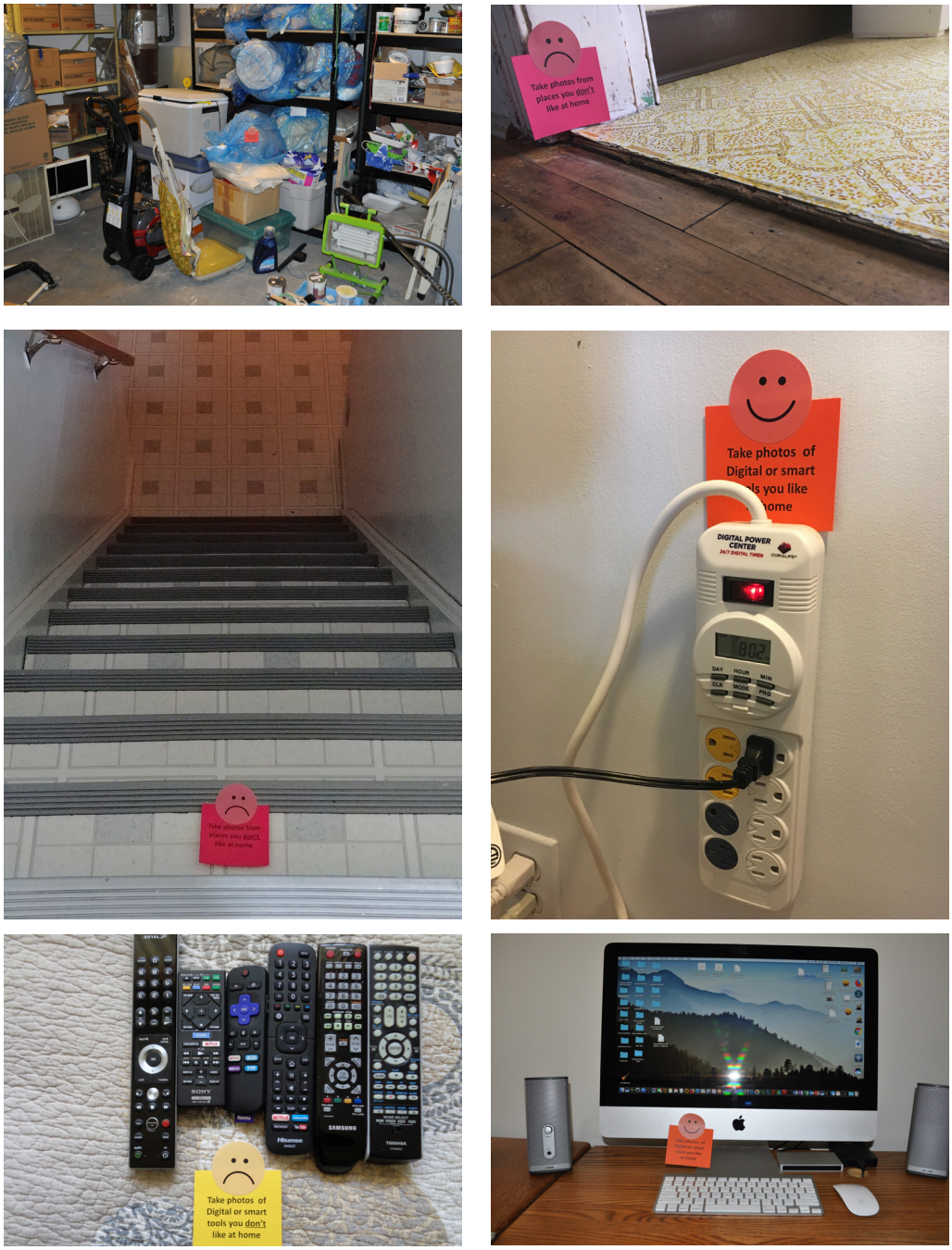

Figure 17. Photography activitiy by participants

Storytelling: Participants were asked to tell a story about one of their previous experiences of illness. One goal of this practice was to learn about an experience the participants had faced, how they tackled it, and who helped them. Another was to allow the participants to practice evoking memories of experiences, which would further help them express their thoughts and ideas about a similar situation when they design their future home at the workshop. I used a storyboard-series of illustrations to visualize a process of experience and to help them recognize important points. This process of visual thinking and planning promotes dialogue and communicates between the participants and designer (Tschimmel, 2012).

Word Game: This activity involved specific topics on a piece of paper, mainly related to health, technology, and distance health supports (Figure 18). Participants were asked to note any word or drawing that came to their minds. This activity enabled brainstorming practice before the day of the workshop for ideation and expression, and also demonstrated which words connected to this topic in their minds.

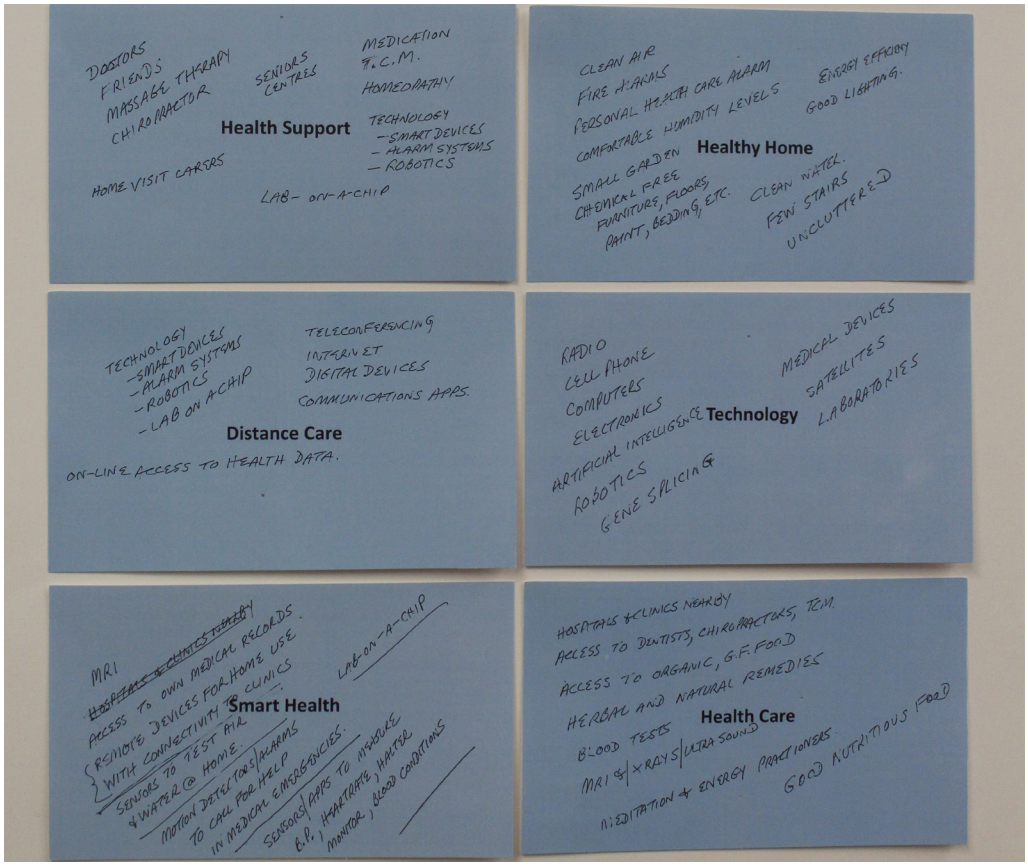

Figure 18. Word game activity

All the activities were explained thoroughly to the participants, and they were given approximately 7–10 days to complete the homework exercises. They were asked to send photos with short explanations via email, so I could print them for the workshop day. They were asked to bring the rest of the homework on the day of the workshop.

3.1.3.4 Co-Design Workshop with Baby Boomers

In the third phase, the Baby Boomer participants were invited to participate in a co-design workshop. Through co-design, the participants and I engaged in a dialogue, which enabled us to develop ideas and themes jointly and helped to generate valuable concepts. This process yielded narratives, insights, and discussion into interests, beliefs, feelings, and wishes about their future homes. I gave participants the tools to design and develop their health smart home in a "perfect world" scenario while also asking them to explain why they built their perfect smart home in that particular way. From observing their building process and listening to their explanations, I learned many things that I would not otherwise have understood through interviews or questionnaires with users. The making tools used during the co-design workshop helped to facilitate support and provoke creative thinking (Figure 19): The workshop activities were held in three parts with refreshments in between. Each section lasted approximately 30–45 minutes, and the workshop took 3 hours and a half in total.

Figure 19. Materials for workshop day including participants photos, emoji, post it,...

The following is a list of workshop activities in the three stages.

1. Preparation for Design

Presentation: I showed several videos and images to help familiarize the participants

with smart health technologies and applications.

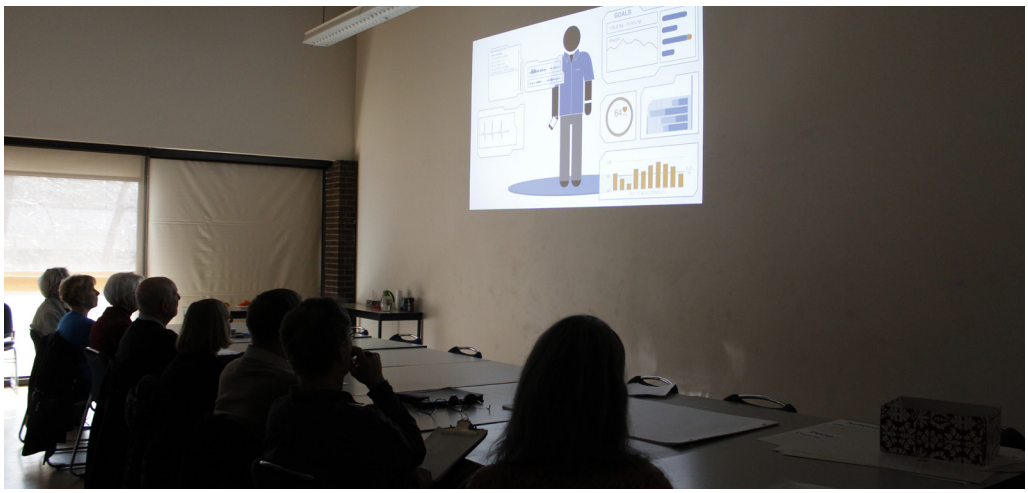

Figure 20. Showing examples of smart health technologies

Drawing: Each participant was given a big sheet of paper and a marker to start drawing the floor plan of their existing home. Then they were given the photos they took around their house to add. The purpose of this task was to help them to visualize the problems and current scenarios of their living situations. Additionally, they used pre-prepared emojis to map their feelings related to their living environments.

Experience Explaining: The participants were given sticky notes on which they could list the advantages and disadvantages of their current homes and devices.

Figure 21. Participants drawing the home

Figure 22. Participants make the current scenario with photos, description and emojis

2. Designing for Future HSHs

Make the Home Smart: Participants added stickers of specific smart technologies to their designs and noted their thoughts on factors such as functionality and aesthetics.

Expectation Designing: The participants were given sticky notes of smart technologies (Figure 23) to add to their designs. They were free to choose any type, and they were asked to define a function. After doing so, they were given other sticky notes in different colours to add their thoughts about this design. During this part of the investigation, and even during the break, participants discussed all issues with each other.

Figure 23. Making homes smart

3. Presentation and Discussion

Presentation: Each participant presented his/her work and explained the design, which was followed by a short discussion among all group members.

Brainstorming About Future Opportunities: The participants were divided into two groups to discuss preparations, services they were seeking, benefits, and possible adverse outcomes.

Figure 24. Co-designers explain their design of HSH

Figure 25. Group activity

3.2 Chapter Summary

This chapter presented the process of primary research, including two main groups of participants involved during the study. The process of this research was grouped in a modeling of Discovery, Define, Develop, and Deliver. Each part incorporated activities which were explained with more detail in this chapter. Following the model (Discovery, Define, Develop and Deliver), I worked with nine Baby Boomers and five experts in the field. The participation of Baby Boomers was throughout the whole project with participation in a contextual interview, homework activities, co-design workshop, and feedback about collaboration. Experts were selected from the three main areas of research in this study: aging-related fields, computer science, and design. Further discussion of findings from interview with experts is provided in the next chapter. All activities were designed based on generative techniques inspired from the literature review. The purpose of adopting tools and activities was to facilitate the collaboration of non-designers, Baby Boomers, in the research process in particular in the design stage of future Health Smart Homes (HSHs)

"Empathy is at the heart of design. Without the understanding of what others see, feel, and experience, design is a pointless task."

—Tim Brown (Interaction Design Foundation, 2019)

4. Analysis and Findings

This chapter starts with a review of the literature related to data analysis to develop a methodology for this project, and an explanation of the process of data analysis. It reports the results of the qualitative research undertaken as part of this thesis with Baby Boomer participants, and documents the findings of investigating what Health Smart Homes (HSHs) might look like from their perspective. Next, the chapter summarizes my interviews with experts in relevant fields and two visits to HSH laboratories.

4.1 Analysis Process

The word analysis here refers to the process of extracting findings from interviews, observations, homework, and the co-design workshop. The final results of qualitative analysis are unique for each researcher, and due to the nature of generative research, there is no specific formula for rich data analysis (Patton, 2002; Visser, 2009). Although the analysis process has no fixed procedures, some patterns do help designers from other similar research areas (Sanders & Stappers, 2012). The process documented in this chapter includes my insights and interpretations of all materials based on the qualitative analysis methods that were used in the study.

4.1.1 Theoretical Background for Analysis

An essential part of this project involved gaining empathy with my research participants. The process of documenting data from observations, interviews, and other activities is very important in the assessment of those data. The data collected in this study includes audio and video recordings, interview transcripts, photos, participant design work, email conversations, and notes of personal observations, questions raised, insights, and reflections. I evaluated existing literature in order to analyze the material, and in this chapter I have documented the works that most influenced my methodology and analysis.

Most of the data gathered in this study consist of life experience information gathered from communication with users. Froukje Sleeswijk Visser, Assistant Professor at the University of TU Delft, evaluates these communications as successful if they provide an in-depth understanding of the user's information and the ability to apply this knowledge to create new ideas. According to Sleeswijk Visser (2009), information should aim to enhance empathy with users, provide inspiration for idea generation, and support engagement with rich experience information.

In her 2009 PhD dissertation, Sleeswijk Visser documented a comprehensive analysis process involving a team of designers and researchers studying users. The analysis process, which involved observation, interpretation, and iteration, consists of browsing data such as notes, interview transcripts, videos, or photos; selecting data; finding and discussing patterns in the data; categorizing those patterns and determining findings; and comparing findings with those of earlier studies.

One such method that fit with the aim and type of materials in this study, is known as *analysis on the wall*, The analysis on the wall process is valuable for its simultaneous provision of information and inspiration (Sanders & Stappers, 2012). It is based on the Data, Information, Knowledge and Wisdom (DIKW) model developed in 1989 by Russell Lincoln Ackoff, Anheuser-Busch Professor Emeritus of Management Science at the University of Pennsylvania. In Ackoff's hierarchy, raw data gathered from users is the lowest basic level. As Sanders and Stappers noted, raw data can be interpreted into information (the next level) in many ways. Lower levels are filled with details and discuss individuals, whereas the higher levels are more abstract and comprise insights which are expected to be valid for other people besides the participants. The level of abstraction depends on the researcher, purpose of the research, and interpretation level (Sanders & Stappers, 2012).

This model has guided my process of developing raw data to the knowledge level. In the analysis on the wall process, all the materials are gathered together on a large wall, from which the researcher compares levels of abstractions and interpretations by moving up and down through the hierarchy (Sanders & Stappers, 2012).

4.1.2 Analysis Process Model

The process of analyzing the material for this project is summarized in Figure 26 and will be explained in more detail in the following paragraphs.

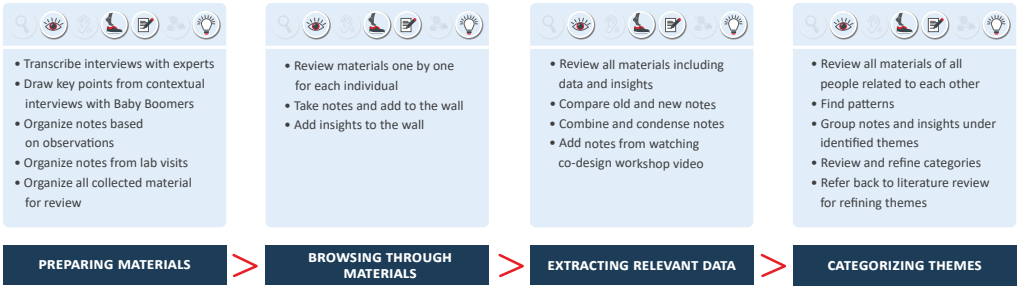

Figure 26. Data analysis process in this study

The process of analyzing data on the wall included the following steps.

- **Preparing Materials:** All relevant keywords, sentences, and quotes were written down. These comments were arranged into groups, named after the different interviewees. Material from interviews and workshop transcripts, including data from interviews, homework, and design work, were pasted on a pinboard for each participant, which provided an overview of each participant and his/her material, both individually and as a group (Figures 27, 28)

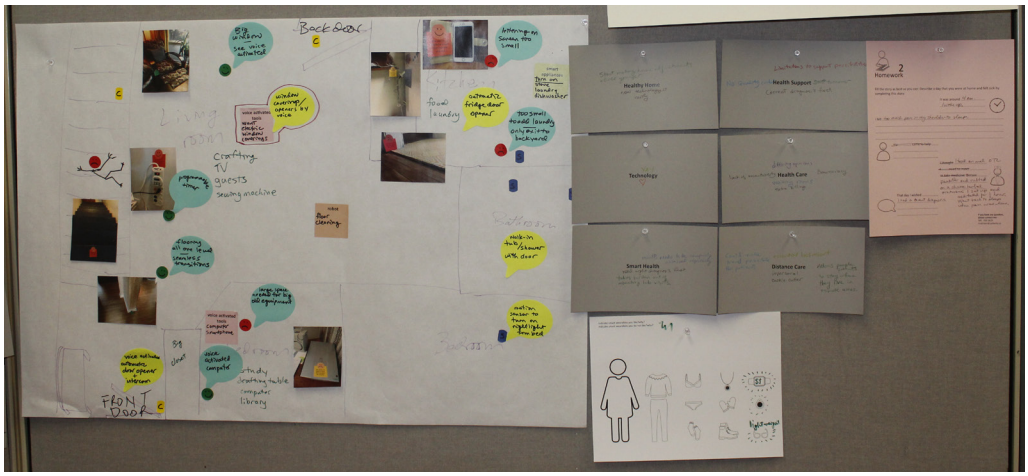

Figure 27. Putting up all materials gathered from individuals

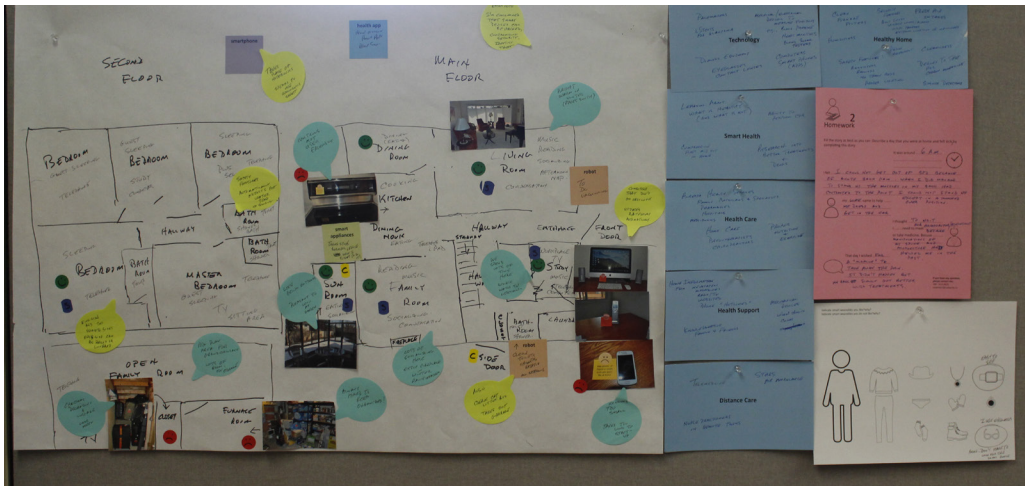

Figure 28. Putting up all materials gathered from individuals

- **Browsing Through Materials:** Looking through all the material gathered from individuals helped me to know the participants better and identify common points with them in order to develop empathy. I took notes from each participant's material on colour-coded Post-it notes: green for insights and orange for raw data (Figure 29). This was the first round of reviewing materials focusing on individuals.

Figure 29. Browsing through data and making notes and insights on colour coded Post-it notes

- **Extracting Relevant Data:** In the second round review, I again browsed and took notes on Post-its. Later, I returned to my notes from the first insight, comparing them with my new notes in order to add, combine, or condense those notes. These Post-its were all put on the walls with the related participant material. (Figure 30). It should be noted that not all data received are helpful; therefore, selecting relevant data is important. This process was highly divergent up to here.

Figure 30. All materials together

- **Categorizing Themes:** Throughout the process, empathy played an important role. In the third browsing, I reviewed all of the participants' material with the intent of locating the notes that received support across all participants' data. I wrote these notes on Post-its and added them to the wall. After the

supported notes were gathered, I tried to extract the ideas available within the materials. These could be direct ideas that the participants had mentioned themselves, or my interpretations of what they had written or said (Figure 31). This stage was converging. At each reviewing stage, certain themes gradually became apparent. By the time of the last reviewing stage, in which I read all the material to find relations, connections, and common themes. All the data were organized under relevant themes (Figures 32, 33). This process was repeated as necessary. The interpretation of this model was iterative, with different levels of interpretation, systematic organization of information, pattern recognition, and extraction of meaning and ideas from the quantity of collected information. Secondary research readings helped in this process. The process of data analysis for interview with experts was similar and simultaneous.

Figure 31. Review of materials provided abstraction to identify categories and themes

Figure 32. Theme recognizing

Figure 33. Theme recognizing

4.2 Findings

As discussed in previous chapters, the activities and interactions with Baby Boomer participants were designed to provide detailed information about those participants' past, present and future. Contextual interviews, field research, observation, homework activities, and co-design workshops were complementary activities that had to be considered in connection to one another. In the analysis process, these materials were put together and reviewed with each other. All the findings from the raw data were gradually moved to the knowledge level and were presented in the first part of this section. The findings are grouped into five categories: Housing Features and Preferences, Living Arrangement and Family Support, Successful Aging and Restrictions, Technology and Considerations, and Service and Support Preferences.

The recordings of all interviews with experts were then transcribed into text and summarized. This portion of the process is a deconstruction of HSH labs as observed and recorded in field notes, supported by a summary of the interviews, in order to speculate on the future commercialization and conducting research of HSHs projects. The main lessons for the future of Health Smart Home design learned from this qualitative research process are presented below.

4.2.1 Findings from Co-Design Participants

This part contains all finding from participants including contextual interviews, homework activities, and the co-design workshop with Baby Boomers participants.In order to maintain the anonymity of my participants, they are identified by the letters A, B, C, D, E, F, G, H, and I. I do not always cite the interview quotations according to the specific participant, if more than one person made the same reference, or if the identity of the speaker is not important, or if the quotation was from the workshop. All quotes below are from the interactions with Baby Boomer participants throughout the whole process of research.

4.2.1.1 Housing Features and Preferences

Home features, such as indoor and outdoor spaces, environmental concerns, accessibility, organization, and personalization, become even more critical in older age: several of the participants noted that when one is retired, one has more time to spend at home.

- **Indoor Spaces:** Based on the participants' responses, spacious rooms and kitchens are highly preferable for a variety of reasons. Interviewee C stated that home "should be a place for socializing"; while Interviewee F liked "having

open spaces in kitchen"; and Interviewee G noted that "in my office room everything is too packed together…it is just fine for someone who can stand, but I had to modify everything to move" and assistive tools such as wheelchairs need more space for movement. Many of the interviewees expressed difficulty with stairs, a common problem among older adults, but attitudes were varied: those participants with restricted mobility preferred to have a one level house, mentioning that they found it hard to go up and down. Interestingly, other participants, aged about 70 years and up, considered stairs a source of good exercise to stay active. Two participants who were older than 70 years said that having stairs helped them do activities and would prefer to have stairs as long as they were able to use them. Most of the participants insisted on zero steps and no edges on the floor in all places around the house, such as the hall, entrance, bathroom, and rooms, in which falls were probable. They also referred to challenging movement with or without assistive tools, and difficulties in household work. All participants agreed on the need for brighter homes with bigger windows and more light. Also, the photography task made it obvious that darkness in the basement was a problem. Another major problem was entrances: Interviewee G stated that "entrances are not wide enough… those who do not have a permanent disability cannot ask for the Widening Doors program." This program provides grants to help lower income Albertans with mobility challenges modify their homes (Residential Access Modification Program, 2018)

- **Outdoor Space:** One common preference among all participants was a view of the outside. The participants had individual preferences regarding gardens. Interviewee B noted that "having a balcony on the same level [allowed them] to have accessibility of spaces to the deck and yard easily"; although many liked having a garden, the interviewees raised concerns about related tasks such as snow cleaning or grass cutting. The location of their home was another concern, as they might be isolated or their access to other places may be restricted. The neighborhood environment and its safety, easy community access, walkability, cycling possibilities, and easy access to classes, hospitals, and clinics are key factors in choosing a place for a home for older adults.

- **Environmental Issues:** noise, water, and air pollution were the main concerns related to quality of the home environment. Most of the participants mentioned wanting fresh air. In terms of energy consumption, using clean energy sources was important for five participants out of nine.

- **Accessibility:** One particular difficulty related to accessibility was the height

of kitchen cabinets. For example, Interviewee F noted, "high cupboards are annoying; they are hard to reach … there is a possibility to face hazard." Moving heavy materials is more difficult when one's physical ability is reduced.

- **Organizing the Environment:** Storage areas were the most disliked place at home due to "messiness", "always attention for keep[ing] clean" and "always [being] hard to keep organized," as several participants pointed out. Storage places that are not well designed for organizing different materials in different sizes were problematic for most of the participants.

- **Personalizing the Environment:** Participants would prefer to make individual choices to personalize their spaces. One participant suggested adjustments for individuals living together, such as couples forced to sleep in separate beds due to physical problems even though they would prefer to sleep in one bed.

4.2.1.2 Living Arrangements and Family Support

The data in this section, which deals with the area of daily life, can help HSH designers develop more empathy with the participants. It includes information on daily activities, preferred places for health-related activities, companions and their roles, habits and preferences related to a healthy lifestyle, and process of emergencies happening at home.

- **Daily Activities:** Common daily activities among all nine participants included cooking, reading, resting, sleeping and shopping. Spare-time activities for entertainment and health included swimming, attending social events, gardening, dancing, sewing, knitting, fitness and yoga classes, and cycling. Participant A noted that "playing with kids has great joy!" Other such activities include singing in a choir, visiting friends, volunteer charity work and making art pieces. Participant C, who is 77 years old and enjoys mountain biking, stated that "some activities such as cycling need some preparation, and it's a good motivation in life for staying healthy."

- **Preferred Places for Health-Related Activities:** The participants found outdoor health related-activities preferable when the weather is good. They also preferred activities in the fresh air outside rather than staying in and doing stationary or video exercises. The preference for indoor activities depended on the location, the season of the year, and the cost.

- **The Role of Companions:** Companionship becomes more important in older age as they can encourage older adults to participate in activities, help/

accompany with shopping or visiting the doctor. Most relationships are based on connections with family, friends, neighbors, faith organizations, senior centres, and community. Participant D noted that "company with other older adults is pleasant." Those participants who were lonely were more interested in smart technologies and had more barriers than those who have partners or relatives at home. One participant said having a caregiver at home would be beneficial, especially if anything unusual or traumatic happens. The participants expressed different opinions about animals: Participant B said "they are good companions and good motivation for outdoor walking … they provide protection … or for lonely time at home," while others mentioned that although animals are good companions, taking care of them is time-consuming, and physical limitations may also hinder some people from having pets. Participant G, for instance, had more physical restrictions than the others; she mentioned that she likes animals and once had a pet, but keeping animals is hard due to her physical weaknesses.

- **Habits and Preferences Related to a Healthy Lifestyle:** Almost all participants mentioned they are paying more attention to eating healthy than they had before. Some of these behaviours include eating more vegetables; eating less meat; eating out less; thinking about a balanced diet; and taking supplements. Most of the participants believe that some form of spiritually fulfilling activity is necessary; however, each participant chose his/her own specific activity, such as artwork, emotional fulfillment by "reading poetry," "going to church," mentioned by Participants B, C, E, and F; "holy dancing," mentioned by Participant F; "tai chi," mentioned by Participant E; Pilates, or yoga, etc.

- **Emergencies at Home:** One of the purposes of HSHs is to provide help and support in an emergency at home. All participants had similar patterns for dealing with emergencies: feeling sick or problems happening; deciding how to react; using general sources for more information if the situation is not serious, such as contacting 311; calling an ambulance or having the caregiver take them to the hospital if the problem is serious; taking treatment and providing medicine based on the previous steps; gaining knowledge about the situation; and following up afterwards. This process is applicable to those who have a spouse and/or children, or an unrelated caregiver, at home. Those who are alone must make decisions and take action by themselves . In terms of an emergency, people preferred to connect directly to doctors or specialists rather than through their children, because their children may be busy, may not respond quickly, and/or may not have professional knowledge about the situation. Moreover, the participants mentioned that they did not like to make

their children worry about a situation that is not serious.

4.2.1.3 Successful Aging and Restrictions

This section is related to the participants' personal preferences, attitudes toward aging, definitions of independence, fears and hopes, aging in place, future life concerns, and barriers related to weaknesses.

- **Independence:** The most crucial issue for all participants and the main reason for their openness to smart technology. They defined independence as the ability to stay as long as possible in their home. For example, Participant D stated, "when you go to the nursing home, you will lose your independence! And decisions are made for you that you do not agree with." Participant I, who is not eager to use technology, declared that he could if it helped him to live independently in his home. Another participant mentioned that one thing that they like about being at home is having control over their treatment.

- **Fears and Hopes:** Loneliness is one of the greatest challenges for older adults. When they are alone, participants can do all they need to, but may do so more slowly than those who have assistance. Based on my observations, hope and motivation play vital roles in having a healthier lifestyle. "It's kind of nice when you get older that other people get older… you can compare your notes about health and conditions and medicine and treatment that you are using," Participant D reported.

- **Aging in Place:** Each person's home is associated with memories that are unique to that person. Participant D, who is retired from nursing, mentioned that "this is the big difference among personal home and homecare" because people have memories of places that are important to them. The participants considered care centres bad examples of aging in place because people are moved from one centre to another without a concern for their individual needs. She also pointed out, "Sending older adults from centre to centre is not aging in place!" Staying as long as possible at home rather than moving to a nursing home was preferable for all participants. In their own homes, people have control over their environments and are more willing to stay in places with which they have emotional attachments. Participant D noted, "what they call it today isn't really Aging-in-Place … one place would be in the home."

- **Future Life Concerns:** "I wish I knew what was happening to me," one participant said, explaining that when she was sick, she did not know what was happening. Participant C, who is a retired professor, mentioned, "You can't

guard against everything." Emergency events can occur, as one participant admitted when we talked about the future. He said that he would take action to maintain a healthy lifestyle, such as exercising, but that he could not prevent a sudden accident or diseases that are not predictable, such as strokes. Two participants, who were a couple, noted that, since they do not have family in Edmonton, their main concern is making sure that if something bad were to happen to one of them, the other would be taken care of. The husband wondered whether, if he became ill, he would be able to stay at home without having to go to a nursing home. Participant G noted that one must think about and design a plan for getting old. Also, a partner with a disability is often a primary concern for future decisions in designing the home.

- **Barriers Related to Weaknesses:** physical problems hinder participants from many activities. Many expressed concern about fewer chances to visit family members, inability to keep pets, or difficulties with environmental features. Mobility is a main concern. Also, participant C mentioned that "reaction time is not as good as before," which can cause new problems; less ability to handle difficult situations such as preventing falls. Vision is another critical factor, as participant G pointed out that she faced a problem when she was driving and parked in a place to check something on her phone. When she wanted to resume driving, her eyes could not focus on faraway objects, so she waited beside the road until she could do so again.

4.2.1.4 Technology and Considerations

Certain features of appliances and tools are more important in the design process for older adults than others. Some of these important features include devices, technology concerns, positive and negative attitudes toward new/smart technology, updates and upgrades, and familiarity with technology.

- **Features of Devices:** The main problems with devices the participants expressed were difficulty understanding the functions of those devices and the level of control over them. For instance, Participant E noted that some devices, such as (distance) controlling lights, can make life easier. The participants had the greatest expectations of direct and indirect control, autonomy of tools, and monitoring what happens in the home. Almost all participants used cameras controlled by themselves, not by others, in their design. Alarms and video cameras were requested by most of the participants. Another important issue that was raised was that if a device does not work properly, users cannot fix the device if they do not know how it works; as Participant G stated, "I made

the voice active one time accidentally … I couldn't make that active again … I would like to have it again … but I don't know how? It's like a miracle."

- **Technology Concerns:** safety and security of data gathered by equipment was mentioned as a fundamental concern. This was related to how data are collected, where it is sent, and who has access. Worries about being hacked, who has control over their homes, compromising security, and identifying thieves were other concerns regarding smart technology. In the workshop, one participant mentioned, "If you become hacked, you will see how much you are vulnerable!" Interviewee C said that he is "Worried about all devices nowadays [that] have a camera inside … recording all the time … very scary!" Transparency of device structures, components, and functions provide a sense of safety and security. Participant C expressed a concern over privacy, stating "I've worked on the assumption anything I put on my computer is public knowledge". Participants E and G argued with regard to accuracy and testing that "Services should be accurate," "results need to be carefully investigated," and "Assess the results regularly." Another concern the participants expressed is related to trust. One participant noted that she prefers to transfer money in-person rather than using an online transfer system; she stated that her primary reason is "I don't trust such systems." Important concerns about wearable technology included the potential of being forgotten if they are in hidden or out of sight, such as under clothing. The participants wanted wearables to be "accessible", "easy to put on", "many other [wearable devices] require hiding them within clothing and are hard to access right away, as a senior we are likely to forget them in our underwear", and "out of sight, out of mind". One participant currently using a Fitbit, a device for counting steps, showed it hanging on her bra. She was happy "that they're close to [my] body…. not falling off easily but also it is not visible." On the other hand, two other participants stated that "it shouldn't be something hidden". Participant C expressed the freedom of not wearing glasses: "I got free of glasses by surgery, why should I have another?"

- **Attitudes Toward New/Smart Technology:** participants were open to accepting smart technology. They believe that technology is life-changing, fun, and useful, and that it could act as support for prevention and cure, provide self-health management, and support in emergencies. One of the participants who was not interested in new technology at all, however, stated: "I don't need extra support currently from tech but maybe in the future for having a better life and living at my home I maybe need some support." On the other hand, they had some negative attitudes during the workshop: "They require extra effort

and are time-consuming"; "unnecessary evil"; "provide isolation"; "I prefer to talk in person or by text rather than virtual relationships"; and "it's nice if a nurse comes to you rather than a robot".

- **Updates and Upgrades:** This challenge received less attention from the other studies which can play a large role in applicability of technologies for older adults. Often participants use older devices, which may not be able to receive software updates. They do not have access to the latest devices, updates, or upgrades, which are more user-friendly and are better designed for older adults. Price and unfamiliarity with new technology are major hindrances to new technology.

- **Familiarity with Technology:** Participants are interested in using the latest technology and recognized that it would be helpful. For instance, Participant G pointed out that "I used Google Map when it has a voice during driving as it helped me find directions by listening to the instruction[s]." Many of the participants noted that if a device does not work, they cannot fix the problem; as one participant stated, "I used Skype for visiting family members, … but my computer starting messing up, I couldn't figure out what happened and how to fix it." Another participant mentioned that "it is necessary to work with new tech like computers but it can be frustrating sometimes."

4.2.1.5 Service and Support Preferences

Service and support for HSHs include money matters, information preferences, health-related services, educational preferences, physical weakness supports, and support needed from the government.

- **Money Matters:** the price of products or services is the first obstacle to new technology, based on the participants' responses. Money matters related to HSHs could be grouped related to the costs of new device or service, updates and upgrades, and adjustment costs of existing devices. All the participants at different stages of the project noted that life was more expensive for older adults with less government support: "Better services are more expensive even for the middle class." This is especially the case for unique situations: "as I am temporarily in a wheelchair it is not possible to use the Widening Door program, which is for permanently disabled in a wheelchair, so no funding is availabe." Another noted, "For low-income and for those who have more problems, many services are not affordable." Another challenge to accessible home environments is the cost: "for making a home accessible there are some costs associated which is hard to pay." New technology also requires spending

money on updates for new devices. For example, the older version of the smartphone which they have does not support newer services. On the other hand, buying new, well designed technology is costly: "good equipment needs lots of money".

- **Information Preferences:** Almost all of the participants were keen to gain information on maintaining health including healthy eating and lifestyles, and on how new technology can enhance their lives. They acknowledged that they hope to gain knowledge before something happens. For example, they need "more knowledge about what it feels like to have a stroke before it happens." Moreover, in preparing for the aftermath of medical treatment, Participant D described that she studied before taking health related decisions. Additionally, information required for new devices, technology, and treatments can be researched online. Finally, information related to the participants' current state of health informs their decisions on doing any surgery or using medicine.

- **Health-Related Services:** Time constraints and lack of integration are the participants' main concerns with current health services. Long waiting times are the main problem encountered in person at health centres. Because the salaries for homecare staff are low, high turnover rates are common, meaning that the patients do not have permanent care, with participant responses as follows: "not an easy job"; "they should find a time when a nurse is available so an older adult can be available" and "Care at hospitals is not good enough when there is no choice."

- **Educational Preferences:** They were acknowledged by all participants and were derived from my observations and interactions. Participants prefered to learn from a person: "some issues are not possible from watching a video." Moreover, teachers should be "patient answering all questions". Six of the nine participants directly noted the educational component of treatments, working with new technology, and healthy lifestyles as essential: Participant D stated, "We did not have these technologies before; we are not as used to it as new generations," and in terms of educational materials, "we need instruction [on] how to use new technologies." Some of them use online sources as the primary source for information rather than consulting with their doctor, including sources such as the Mayo Clinic, PubMed, Lifeline, and Healthlink. Participant C noted that "The Mayo Clinic has educational, reliable, trustable… and complete information." However, the participants also admitted that they need some specific information that is accurate and trustable: for example, one couple asked for the "ability to subscribe to health databases about diets."

- **Physical Strength Support:** The participants considered new technology helpful in compensating for age-related weaknesses. Participant B, who is currently in her last years of working as a nurse, noted that "new technologies can offer a lot in terms of physical weaknesses"

- **Lack of Government Support:** The participants considered government support in relation to both prevention and cure. For example, Participant E stated that "government will pay for you when you are sick … they don't pay for you when you are healthy to avoid being sick," while Participant F said that "government should provide support for how to look after yourself" and "government should make gym and fitness places for free for all populations not only for older adults."

4.2.2 Findings from Interviews with Experts and Visits to Two Health Smart Home Labs

Choosing a diverse range of interviewees allowed me to understand, on various levels, how a Health Smart Home laboratory is conceptualized and developed, and the main challenges in different areas of expertise. Conducting interviews with founders of these labs and observing their design provided a clearer picture of HSHs. For interviews with experts, I aimed to gather general ideas of how professionals viewed the design of HSHs for older adults, the role of designers in their team, where they felt design interventions might be useful. Here I provide a summary of discussions.

Interview with Elizabeth B. N. Sanders, Associate Professor, Design Department, Ohio State University, United States

Sanders introduced many of the tools, techniques, and methods that have been used to inspire design from a human-centered perspective. She has practiced co-designing across many design disciplines, and is co-author of *Convivial Toolbox* (2012). She is also the associate editor for *co-design: International Journal of Co-Creation in Design and the Arts*.

We began the interview with a discussion of her experiences related to participatory research. She mentioned that participatory design has long been practiced in northern Europe, but this approach and its value has more recently been recognised elsewhere. In her opinion, this recognition results from more open and collaborative attitudes among younger generations; broader opportunity for involvement provided by the internet; and gender-based approaches to co-creation, with women more likely to be interested in using participatory approaches. Sanders outlined two

benefits of the participatory approach in co-creation/co-design: improvement to the outcome of a product or service, and ownership of the result of collaboration. She considered this second benefit more important: "If we talk about the design of a public space like a hospital and the people who are going to use those spaces are involved in the design, the end result will be more relevant, but even more importantly those people feel that they were involved, they helped to make those decisions then their ability to work in and enjoy and maintain those spaces in great ways."

From the perspective of designing a participatory setting for research, Sanders discussed the qualifications of partners invited to participate and their need to be prepared for that role: "If they are not used to being in creating activities, there is a need to go through a process of preparing them." She pointed out that children are most receptive to collaboration because collaborating is in their temperament; additionally, people who are passionate about their work and are eager to work with other people, such as nurses and teachers, make the best co-designers. People who are used to telling other people what to do, such as people at the top of hierarchies and organizations, are less likely to be involved in co-design. Participatory projects whose participants take their experience and use it in their own lives or work are often the most successful. Sanders further stated that her research focus has not been on the result of collaboration, but on sharing the mindset and helping others to understand the potential and power of co-creation/co-design.

Sanders noted that "the way that I teach and share participatory practice is through hands-on experiences." People learn that they too can contribute and do this.

Sanders agreed that the definition of co-creation was confusing, even among researchers. She stressed that one reason for the confusion is that in the US, marketing companies use the term to be cool; they describe their activities doing co-creation, even though they are not really doing it: "The term is sort of being abused because it gained interest and popularity." In terms of defining co-creation or co-creation features, she stated that one "should truly believe the people with lived experience hold the expertise, that is essential for the design and the research process. Also, you need to truly believe everyone is creative. And people who hold the lived experience, they are creative, and they can be generators of the ideas, but you need to make sure they are prepared, and they are comfortable." She further noted "In particular as older adults probably haven't been invited in to this process before, it might take a little time to realize how important their expertise is." If one asks people about what has already been designed, it is not co-creation. This could instead be called "user-defined"; however, the difference between these terms can

be confusing. She clarified that the term "user" implies that you really only care about them when they are using; the term "consumers" suggests that you really only care if they are going to buy the product; "partners" or "participants" are therefore the preferred terms for people involved in co-design.

Responding to a critique of co-design claiming that "the weakness of co-design method is the lack of ability for generalizing," Sanders emphasizes that co-designers are not looking for generalizing results, but for ideas, unmet needs, and deeper understanding, which are then used for inspiration, innovation, and design. co-design is used at the front end of the process when we are trying to figure out what to design. After ideas and concepts are generated, quantitative research will follow, while exploration tends to involve qualitative processes: "Before bringing a product to the market, you need quantitative research to ensure that there is a market for that which is much later." She continues, "In academic literature, there is just a tendency to think that only one type of research is publishable, and that is a problem."

Designers in this new landscape, at the front end of the design process, need to understand social systems and people at the social level. This mindset is equally important to the traditional skills that a designer possesses.

Designers in the front end are interested in helping people to live better lives, traditionally designers would be needed later in the process. Sanders predicted that in the near future, instead of only designers being creative people, designers will use their creativity to help other people be creative. Finally, she suggested evaluating the success of the process of co-design as a way forward for other HSH projects.

Smart Condo Laboratory Visit and Interview with Antonio Miguel, Assistant Lecturer, Post-Doctoral Researcher, Occupational Therapy, University of Alberta, Edmonton, Canada

Miguel is working on the development of smart technology for homes for older adults. His research focus is technological interventions for older adults, including sensors and other technology to help older adults live independently. After visiting the Smart Condo, his interview provided insight into the functionality of a Smart Condo (Figure 34).

The Smart Condo is used to simulate home visits allowing healthcare professionals to increase their understanding of assisted living devices (e.g., wheelchairs, walkers) and to practice working respectfully within their patients' private and personal space. The integration of intelligent technology also provides opportunities to learn how to communicate and collaborate with patients living in 'intelligent' homes.

Figure 34. Smart Condo visit, it includes smart technologies with assistive tools

The Smart Condo website defines the project as follows:

> The Condo provides opportunities for research around the use of applied universal design principles; users apply knowledge of occupational performance, functional design and human factors (i.e., physical, cognitive and sensory) to design for aging or mobility impaired populations, with a focus on wellness.
>
> The integration of intelligent technology, such as wireless sensors for remote monitoring, can improve quality of life for chronically ill patients and reduce hospital stays. This technology will be used to monitor health-related events and to transmit collected information to an online virtual environment.

In defining *smart*, Miguel stressed that sensors and analytics that enable actions responding to data are what make a home smart. My interview focused on existing technology and applications, such as a home connection and appliance automatization technology called Domotics: "Domotics is the encounter of information technology, electrotechnics, and electronics. Equipped with a tool that allows us to control systems, devices, and automation." He stated that the future of HSHs would be altered as older adults would be more familiar with new technology than their predecessors. Technology involved could include proximity sensors, activity and position detectors, pressure sensors on the floor, and wearable smart devices. He referred to a comprehensive literature review on HSH technology, as discussed in Chapter Two, and emphasised that although such technology is on the market, there is little evidence of its effectiveness for HSHs. He also addressed the price of smart technologies and suggested that in design for services, the business models of these services could be flexible in order to reduce the cost. He recognized the value in conducting research with users through qualitative methods with a focus on prevention.

Lili Liu, Professor, Department of Rehabilitation Medicine and Occupational Therapy, University of Alberta, Edmonton, Canada

Liu's research focuses on user adoption of technology for rehabilitation assessments and interventions, and the ways technologies can help older adults and family caregivers. She is an investigator with AGE-WELL, a Canadian network that brings researchers, older adults, caregivers, partner organizations, and future leaders together to accelerate the delivery of technology-based solutions. She is the academic co-lead for the Smart Condo. She defined a smart home as one that is equipped with smart technology, that is designed based on universal design principles, and that meets the needs of occupants. She noted that the Smart Condo project focuses on seniors Aging in Place, with attention to their social circles and accommodating their needs with the use of technology, including applications to detect falls, to manage medication, and to track activity and location through ambient technologies, wearables, and apps collaborately with other disciplines such as computer science. The project participants take a user-centered approach to their research by showing their designs, testing them, and gathering feedback for improvement. Liu notes that they are trying to research alternative ways to engage users more in the process. Older adults work closely and collaborate in providing feedback on the design, helping voice over some parts of the software and even presenting work at conferences. Liu considers older adults as experts, because they know what they are experiencing.

On the importance of understanding users in academic research, Liu stated: "a perfect example was fall detection technology". They conducted a review of the literature to look at all the millions of dollars that was spent for laboratories to design fall detectors. For this research, researchers usually used young people, or they used very controlled environment situations that were not realistic, and they said this device worked. Liu said that another project found that all technology on the market claimed to be able to detect falls. None of those were in the study, none of these studies are on the market, and none of the published studies incorporated end users. She noted that one study of seniors falling in the bathroom, one of the most common places for falls, involved a subject who was on the floor for two days; although she was physically unharmed, she did not push the button to call for help because she did not want to disturb anyone. Other reasons subjects had given for not using the application were that they feared their families would send them to a nursing home, they did not want to bother others in the middle of the night, they did not want the ambulance to come get them, and they did not like to go to the hospital. She stressed that this is not a problem with technology, but a matter of user experience studies.

An Increasing numbers of studies do not just encourage, but demand that researchers involve users throughout the design process. Liu predicted that future research findings will require that as well. On the other hand, many new devices such as smart watches could also detect falls or heart problems, but these have not been tested on a variety of people; therefore, at this stage we do not know if they actually work. The hype surrounding these devices does not match the reality and is not connected to actual research, while the research does not become successfully commercialized due to the lack of user understanding.

Liu has worked with designers in communication media and industrial design, and admitted, "We were not always happy working with them. Sometimes it was overdesigned." Designers must be experienced in working and understanding the purpose of a product. It is not always about aesthetics; it is more about function, understanding the disease process or the health condition of users. Designers need to have a better understanding of health-related issues.

Liu thought the best skills that designers bring to a team include understanding what the team needs; providing suggestions; knowing about the project, and communicating effectively with the team. She advises designers to learn about the diversity of the Canadian population and consider the different cultures and sets of values that are present. The connections of older adults with their communities are also important, as are the various cultural definitions of independence: does

independence mean doing everything by oneself or continuing to do everything?

Liu's main concerns about the future were that "We are not ready to provide the services to the number of people who need it!" and "My main interests are not about technology, I think technology can help, but it is about the lack of preparedness to address and accommodate the needs of our future. For those that can afford to, they always can hire private help. But for the majority of people, they do not prepare, not even think ahead. I believe attitude and stigma are what often prevents us." She points out that all of us will be aging, and even though we do not like to think of ourselves as needing a wheelchair, it is better to be prepared as a society by adopting a universal design for the home, and by making telecommunication affordable in order to provide more health support at home. She emphasized that "We don't have enough manpower or human power in the service sector to provide care," and because of this, many seniors are waiting to be assessed in the home: "technology can provide a more efficient service and support for that."

Eleni Stroulia, Professor, Department of Computing Science, University of Alberta, Edmonton, Canada

Professor Eleni Stroulia co-led the Smart Condo project, we began our interview with a discussion related to the design of the Smart Condo. Stroulia explained that the project is based on monitoring daily changes and recording activities and performances. For instance, if an occupant becomes less active, the system recognizes the decline in activity and suggests more support. Gathered data has the potential to inform consumers, and provide records to their caregivers and service providers. Stroulia framed their two main challenges as in the areas of design and research.

Practical challenges in designing include embedding sensors for long-term usage and, more importantly, the relatively small amount of evidence of how smart technology works in the real world. For example, wearable devices can be helpful, unless the user forgets to wear them. Even though a system works in theory, in practice the system faces many challenges, one of which is the perception of older adults concerning Health Smart Homes: "We design it to help give control over their life, but their perception is the opposite. They feel they are losing control of their life. They do not like to have this service." For example, users may have negative perceptions of monitoring systems. During their research on the Smart Condo, the project team realized that older adults do not like to be monitored by cameras, preferring sensor action detection; Stroulia pointed out that monitoring in order to gather data can be accomplished by either method.

Stroulia stated that one of the challenges of conducting research in this area is the disconnect between what is necessary and what can be evaluated from the perspective of a computer scientist or an occupational therapist, as each field has different indicators. Another challenge is related to access to real participants and personal home environments. Additionally, she noted that participants may misuse smart tech such as wearables, which affects the quality of data. Similarly, the security of data is still an overarching issue. Although Stroulia and her colleagues strive to keep data safe, the value of the data comes from sharing, which must be done thoughtfully and ethically. Currently, the market is moving too fast without always placing the right, legal safeguards on the use and exchange of data.

Stroulia stated that the outcome of this MDes project would be of interest to answer the question "how we do shift the conversation so that they (seniors) do not dislike being observed by sensing?" She noted that the answer could be to design smart homes not only for seniors but for everyone:

> "If it becomes more popular, if every home is smart, it is not anymore the case that we just having this home just to make sure that grandmom is still alive…As a matter of fact, it becomes available for anyone, they can use it in many cases. Many services would apply to multi-demographics. When you are talking only about older adults, it is ageist. To make it democratic and available to all you require a different way of making these things available, make them part of the building, and different problems will arise. It will be not an age issue; it will be a construction issue."

Finally, she believed the future of Health Smart Homes is based on smart devices networking in a home, and that research will shift significantly to more smart devices rather than ambient systems.

Alex Mihailidis, Associate Professor, Department of Occupational Science and Occupational Therapy, University of Toronto, Canada

Professor Alex Mihailidis holds a cross-appointment in the Department of Computer Science at the University of Toronto. His research areas include biomedical and biochemical engineering, computer science, geriatrics, and occupational therapy, and he is an internationally recognized scholar in the field of technology and aging. He is the Principal Investigator and a joint Scientific Director of AGE-WELL. He stated that the goal of AGE-WELL is to keep older adults in their home as long as possible. He is currently working on the development of a social robot, a (coach) prompting system, and a method to predict dementia based on zero activity levels at home. He considers his prompting project the most successful so far, thanks to

closer work with end users, tests with people, and collected data. Although this system has not yet been commercialized, it has provided information that is useful for other projects. He pointed out that the current thinking around commercialization has not been working: although many different projects are in the works that have added new knowledge to the academic field, none of them have been successfully commercialized. Scholars need to look at how different models are used in other fields and apply them to their own work; they also need to understand the needs and experiences of users. To accomplish this goal, the AGE-WELL project works with other disciplines, policymakers, and researchers to understand different ways of thinking and incorporate those into their work. In terms of knowing users better, he cited an example of work related to the design of a robot. The project team chose affordability as their goal: the robot cannot do everything as doing so would make it too expensive; therefore, they focused on a reasonable price and chose to concentrate on cognitive functions rather than physical activities, which are more expensive.

The function of the robot is to demonstrate required activities to users. For example, older adults with dementia may need to be shown how to make a cup of tea or how to wash their hands. In terms of technology, general data will be sent to cloud-based services, but personal data will be stored locally in the home. He argued that when one builds a robot that stores all data physically on the device, the cost increases, and "The question is, what services should be on the cloud versus on the robot itself." Concerning future work related to aging and technology, he emphasizes that the key factor in the success of HSH is understanding the user, and the effectiveness of technologies at smart home still is not clear. He notes the following questions: Make it clear: *what do they (seniors) want? How do they want to interact with technology? What applications are important? How can caregivers interact with the technologies?* For Mihailidis, the role of designers is to become involved in developing "a physical device that is usable not only functionally but also statistically appropriate and fitting into the lifestyle of individuals".

After the interview, I had the opportunity to visit the Zero Effort Lab, a large interdisciplinary research lab for older adults with dementia. A PhD student showed me around the space. The lab was under development; it was a small unit in which every device would work automatically with an integrated system not requiring human intervention.

4.3 Chapter Summary

This chapter synthesizes the data gathered from contextual interviews, homework activities, and the co-design workshop with older adults. Five major themes were identified: Housing Features and Preferences, Living Arrangements and Family Support, Successful Aging and Restrictions, Technology and Considerations, and Service and Support Preferences. The data gathered from interviews with experts in the field of occupational therapy and computer science showed a gap between research and the market/industry, a lack of shared language for working in interdisciplinary teams, a need to know users better, a need for new research methods, a shift toward increasing roles for users in research, a need for designers to collaborate effectively in interdisciplinary research, a general lack of readiness for an aging future, and a need for changes in policy making. The main suggestions from design experts were that the main role of design in such research should be on the front end for the benefit of users, that the co-design method can produce better services and products in which involved users share ownership, that qualified participants are essential for effective collaboration, that everyone is creative and everyone can be an expert, and that co-design is preferable to user-centered methods at the beginning of the project process.

"Ageing populations and chronic diseases pose serious health challenges. And despite the fact that health technology has been slow to develop and is technically still in its infancy, there are exciting new developments aimed at solving these challenges."

—Mager et al., 2017, p. 25

5. Design Recommendations

This chapter starts with the tools enabling the transition from the research phase to the design phase, through the use of a User Profile and a Value Map. It then provides recommendations for designing Health Smart Homes (HSHs), focusing on the four main areas of Physical Environment, Equipment Features, Interactions, and Services, and suggestions on how to run an HSH project. Both sets of design recommendations are informed by the initial literature review and findings from primary research, including contextual interviews and co-design workshop with older adults, interviews with experts, and visits to HSH labs in Edmonton and Toronto.

5.1 From Research to Design

The purpose of using visual tools for transitioning from research to design is to develop solutions and recommendations based upon the needs of users and goals of HSHs. To do this, I defined the target group's needs, desires, and expectations, and clarified what future Health Smart Homes (HSHs) could look like for these users. Furthermore, it is an effective way to visualize possible scenarios to share findings and ideas with a whole team in interdisciplinary research. To help select the proper research tools, I evaluated many tools used in other projects. Some, such as *Personas*, which are used in user-centered design and marketing, employ a fictional character to represent a typical user of a product or service, but do not have the potential to clarify all aspects needed to know about users of HSHs in this project. Similarly, the *Customer Journey Map*, that shows the relationship between a customer and a particular service over time, is not effective for this project. The research tool that fit best with the aim and scope of this study is the *Value Proposition Canvas*, introduced by the Strategyzer firm (Osterwalder, Pigneur, Bernarda & Smith, 2014). Developed by Swiss business theorist Alexander Osterwalder, and Yves Pigneur, Professor of Management Information Systems at the University of Lausanne, this canvas includes the use of a Customer Profile and Value Map. Both tools were adapted specifically for this project because they helped me to better understand the pattern of values to be provided for HSHs, leverage the experience and skills of future HSH teams, make the scenario visible and tangible, and enable discussion. As these tools —the Customer Profile and Value Map— are useful for the design part of the research process, they are explained at the start of this chapter. They are my perceptions based on findings from primary and secondary research described in previous chapters.

5.1.1 User Profile

To understand their desires and expectations from an HSH, a User Profile describes a future user in a structured way, with details about the daily activities they are engaged in, pains (discomforts that they would experience), and gains (the advantages they would have) when living in an HSH (Osterwalder et al, 2014).

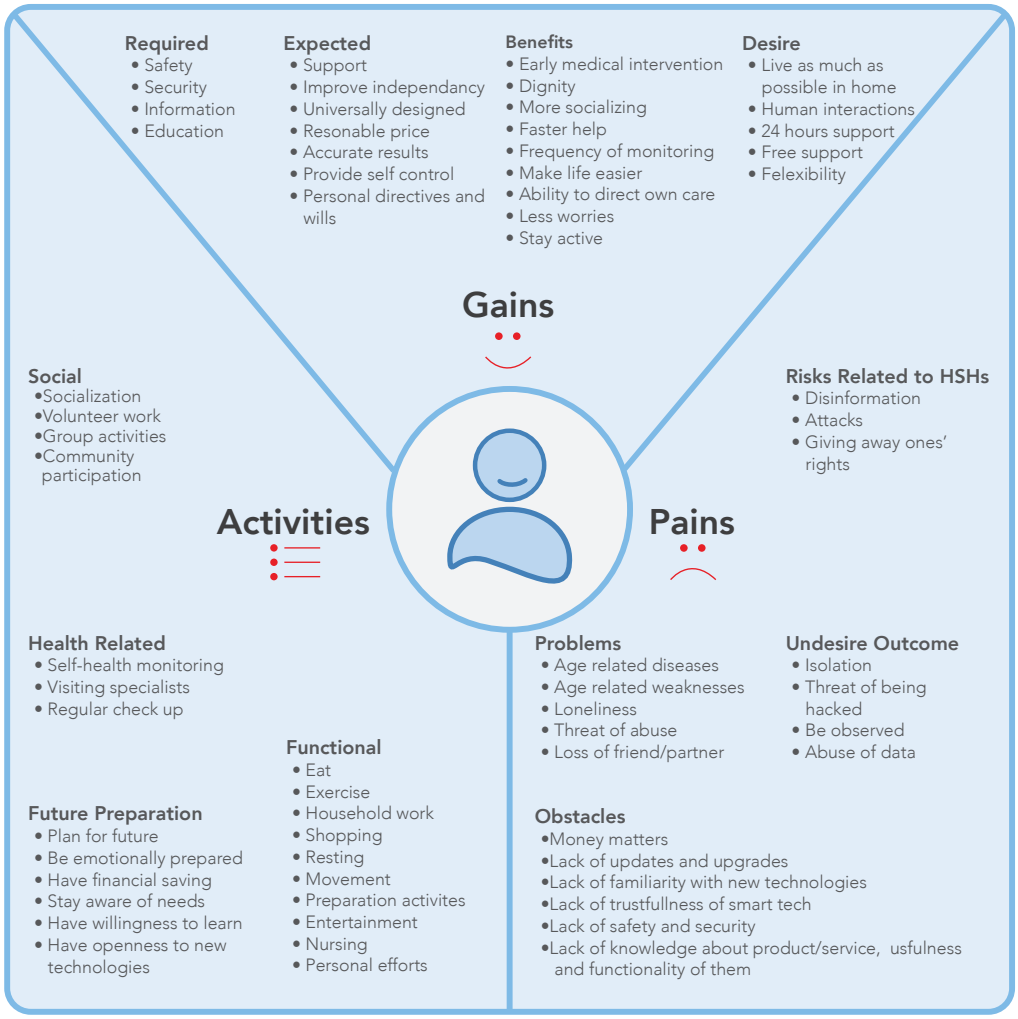

Figure35. User Profile developed for this project

5.1.2 Value Map

A Value Map is a structured and diagrammatic representation of identified values that are needed in HSHs. It does so by (i) detailing the desired products/services that could be incorporated into HSHs; (ii) suggesting pain relievers to improve products and services in an HSH; and (iii) identifying gain creators to create value for product and services in this context. A Value Map demonstrates how designers can address all three criteria in a Stakeholder Profile to create values for future users.

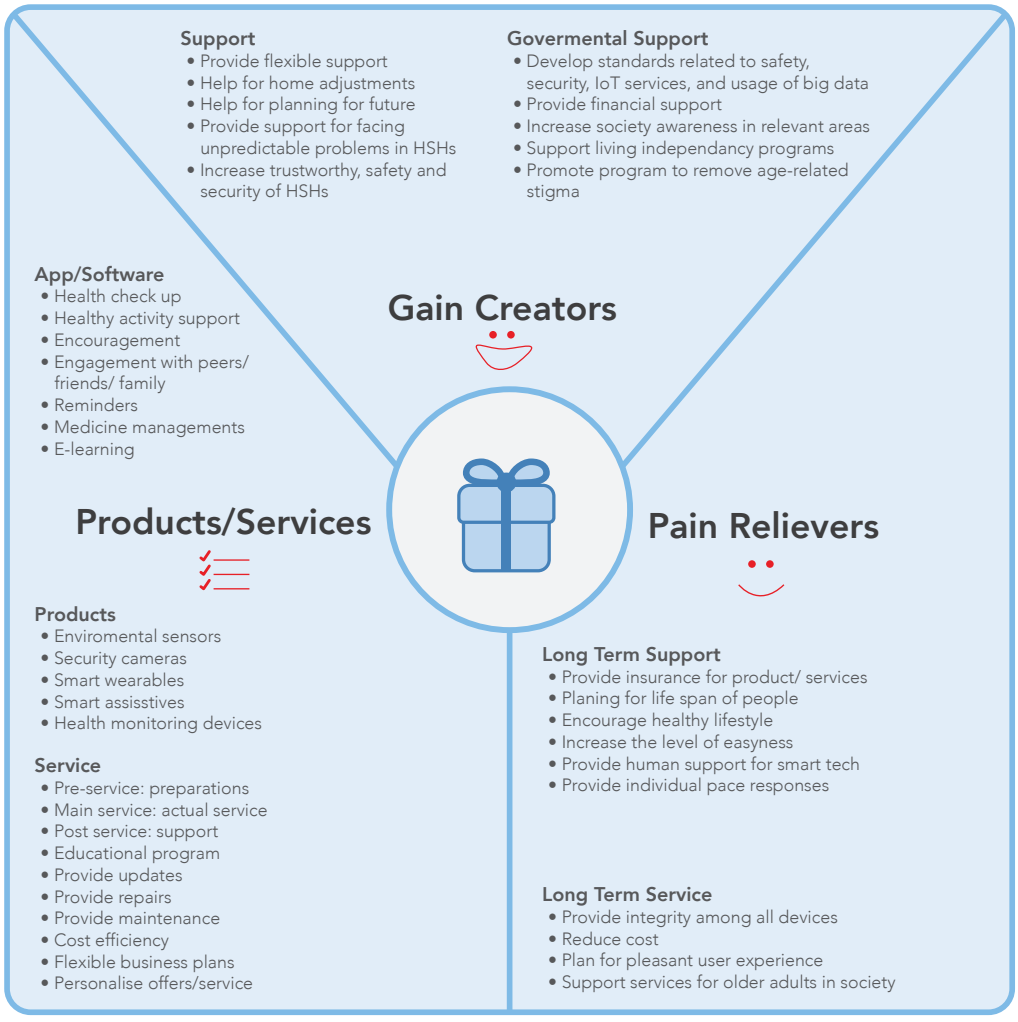

Figure 36. Value Map developed for this project

5.2 Design Recommendations

Ultimately, the data and the results of analysis are used to suggest strategies for designing Health Smart Homes. Developing a model for the design of HSHs is complex. Many actors and factors are involved in a dynamic system, which means any design solution will create new challenges. Designing each part of the project affects all other aspects at the individual, government, and health system levels. Based on the experiences and knowledge gathered in this study, I provide a set of recommendations to highlight the contributions of design to HSH projects.

5.2.1 Recommendations for the Design of Individual Health Smart Homes

Common themes arose throughout this study, including frequent challenges, worries, and desires of future users and designers of HSHs. The synthesized knowledge from previous chapters and transition tools informed my commentary on how we might design future health smart homes. Presented below are a set of designs for service recommendations on two levels. This set of designs is a combination of tangible and intangible features, as summarized in Figure 37. It is broken down into a main area concerning strategy and planning with a holistic view of all services and products and connections between all sub-categories; sub-categories including Physical Environment, Equipment Features, Interactions, and Services, with the hope to inspire HSH designers, researchers in design or other disciplines, and industry partners. All these are explained at a high level and each could be its own individual separate project.

5.2.1.1 Physical Environment

The considerations in the physical environment category are divided into two main categories: internal and external. Some features, such as safety, security, and consideration of universal design, are similar for both. As noted earlier, older adults are slower, and the chance of loneliness is higher. Therefore, providing a safe and secure environment is the most important consideration. All participants in this study used cameras in front of windows, at the front and back doors, and all entrances, in order to control their environments. Applying universal design principles and ergonomic factors are other important considerations, such as adaptations to accommodation including ramps, handrails, and door alerts (Mccreadie & Tinker,

2005). However, all environmental considerations are subject to change; the physical environment must be designed to be flexible based on long-term physical, mental, and support needs. Designers must consider modular features for opening space in different stages of home habitats. However, effortless home features, such as access ramps in place of stairs, or smart technology, may have the unexpected effect of encouraging laziness.

- **Internal Features:** Internal features require consideration of the emotional attachment between people and their living spaces (Axelrod et al., 2009). Some of these factors include personalization of space, accessibility, organization and storage, flexibility of furniture, adjustment of home features and furniture, and control over air quality, temperature, and lighting. As mentioned in previous chapters, fall prevention is key to maintaining independence and depends on the assessment and minimization of risk; one such approach is a zero step environment, with minimal thresholds in entrances and on floors.

- **External Features:** Easy access to medical centres and community, recreational, and commercial resources are important to prevent isolation among older adults, as are walkable areas and easily available public transportation. The design of space around the home, such as the garden, is also significant, especially with regard to maintenance of the environment.

5.2.1.2 Equipment Features

When designing physical devices or software apps, functionality, privacy, security, and types of equipment must be considered. Designers must ask what the aim of the device or app is, which category of health support or monitoring it belongs to (prevention or cure), which problems it alleviates and how it does so, and how it can create greater value.

- **Functionality:** During our interviews, four of the nine participants asked whether my audio recorder was still working whenever my smartphone screen went dark. This demonstrates the importance of designers knowing user perceptions of devices or apps. Second, the level of autonomy differs from person to person and must therefore be adjustable. Third, the misuse of devices must be prevented or minimized, because, as Stroulia pointed out in her interview, misuse leads to incorrect data, which in turn contributes to wrong management decisions. Fourth, devices must be designed so as to minimize harm to users. Fifth, in terms of the functionality and appropriateness of devices, different participants mentioned that "seniors need to be able to access one device instead of multi devices which may be lost or misplaced,"

"I don't like too many controls for each digital device," and "one device for all." Sixth, transparency of functions of devices or apps is vital because HSH inhabitants must know what smart devices they are using, how they function, and what type of data they are gathering.

- **Privacy and Security of Device/App/Software:** Safety and security play very important roles in the design of HSHs, for both experts and users. Some challenges include safety of the person and place, security of information gathered, and safety of devices. For smart devices, security features are needed to prevent hacking or personal data being stolen, because abuse of this information can make users vulnerable. HSH features could increase the chance of losing privacy through observation, monitoring, and gathering of information. Questions to be considered include deciding what information should be gathered, what the least disturbing way to gather data would be, and where to store gathered data off the device.

- **Type of Physical Products:** This section discusses preferred equipment from the perspective of users introduced in this session, based on what co-designers used in their design and on my insights.

  - Wearables: These should be easily wearable (i.e. small and light), simple to work with, visible to the user but not the public, and not recognizable as assistive for older people. If a device is recognizable as only for seniors, users may attempt to hide the device, which may increase the chances of the device not being used or being forgotten. Among current wearable smart-technology devices for health support, almost all participants preferred watches, because they are "Not something visually obvious," "not hard to access to it," "easy-to-use," and "not only for older people." The main concern raised about wearable smart tech was charging time; one participant asked, "When is it charging? At bedtime? What if something happens at that time?" The devices must also be compatible with human tissue, non-invasive, comfortable, and durable enough to survive.

  - Sensors: Fall detection sensors were the most popular smart technology used in all participants' HSH designs, particularly in the living room, bedroom, bathroom, and stairs. Other such devices included motion sensors to turn lights on/off and sensors for air quality. Participants found monitoring sensors more acceptable than cameras.

  - Robots: Preferred for helping with difficult tasks at home such as vacuuming, cleaning bathrooms and toilets, taking out the garbage, and washing floors.

Although one participant mentioned robots as a social companion, this study suggests the use of robots in assisting in work, as most participants still preferred a human touch: "having a person beside you is nice."

- Smartphones: Smartphones are not a separable part of smart homes; they are at the heart of these services and their potential for helping seniors must be considered. One participant mentioned that "my smartphone is like my insurance when I'm out!" She further explained, "If I get lost or in case of emergency, someone attacks me, anything happens to me, or I fall while outside, I have my phone support…I can call others so I have it always with myself." Designers must think about what type of apps should be on the device, particularly in the context of older adults: some concerns include which emergency services users can call, how these apps can be reached, and which smartphone features older adults most need.

- Monitoring Tools: Monitoring devices are crucial in three main areas: user control of the environment, detection and prevention of health problems, and self-tracking of health improvement and progress. None of the participants in this study liked to be observed by camera. However, they did note that security cameras are useful for "having control over who's coming and who's going and what's happening" and should be placed at the "front door and back door". Monitoring health-related issues such as fall detection, alarm systems, or emergency calls should be automated, non-intrusive and provide users with accurate information about such monitoring systems. Equipment for monitoring personal health issues is essential; self-check devices for health were popular and used in all designs: "When you get older you like to keep track of your health." Some examples included diabetes devices, glucometers (voice activated for emergency situations), and monitors for blood pressure, pulse, and respiratory control. The participants also referred to devices and apps for monitoring exercise achievement such as step counting apps, and self-tracking devices that support user management of life, such as sleep, nutrition, exercise, or mood, through the provision of feedback, and that are made possible by recording and analyzing personal health data (Vaziri, 2018).

- Other Smart Technologies: Other examples discussed by the participants include smart kitchen appliances such as refrigerators (for food tracking), dishwashers, and stoves. Games and videos that support health needs should also be considered. For older adults with more restrictions, voice-activated devices, door openers, and light controls are essential.

- **Considerations of Digital Products (Apps and Software):** Design of apps and software is a large field, most of which is beyond the scope of this project. Therefore, I focus here on the role of the design of digital products in HSH services. The design of digital products considers the design logic of the program, the interface, and its functionality. This section discusses several of the most important and problematic areas identified by this study's co-designers as main fields of concern.

  - Speed of response is an important consideration in the design of digital products. This refers to both starting and loading; however, pacing for older adults may require a slower response time.

  - Physical weaknesses in all five human senses, as noted in Chapter Two, are a significant concern. If digital products are not compatible with older peoples' abilities, the usefulness of the products is questionable.

  - User friendliness for seniors will improve the quality of apps; however, the definition of friendliness can be challenging. Participants in this project defined these considerations as simplicity, ease of understanding, and ease of use: apps must be "simple and clear in terms of structure and appearance." Type sizes on smaller screens such as smartphones are also an area of concern.

  - Ease of use and ease of learning were also identified as important factors: a participant explained, "I defined it easy-to-use when something doesn't have many steps. You can turn it on and you do what you want to do!" Still another described a successful app as "Easy to learn, easy to work, easy to receive responses."

  - Usefulness depends on the needs of users. Needs may vary, but the most frequently desired services for older adults include reminders, medicine management, calendars, and calculators.

  - The use of visual language will improve effectiveness and quality of digital products, as one participant stated: "If I usually see something visually, I would rather have that…I like visual cues."

  - Standards for the design of digital products for people with disabilities or other restrictions is necessary, especially given the current dearth of user-friendly interfaces and training, particularly for older adults (Sun, Florio, Gui & Blondia, 2009).

5.2.1.3 Interactions

The various types of interactions that could be possible in HSH systems include human-human, human-animals/plant, human-machine, and machine-machine interactions. Each is related to specific disciplines.

- **Human–Human:** This category includes all the interactions between a home inhabitant with a partner, family, caregivers, HSH providers, health professionals, nurses, and all people related to healthcare services. Moreover, the relationships between the user and others, such as between caregivers and specialists, must be considered during the design process of social interactions both real and virtual. Considering the role of each in the system is important. For example, in terms of an emergency, we must keep in mind who should be contacted, who is at home with the person, and what human interaction needs are present in the system. Some issues, such as losses, illnesses, and dependencies, affect the quality of these kinds of human interactions.

- **Human–Animal/Plant:** Animals and plants are considered good companions; however, they are associated with problems, commitments, and costs that have been discussed earlier.

- **Human–Machine:** This category includes all interactions of users – older adults, caregivers, family, nurses, and all health-related supporters – with digital products such as smart devices and apps. These interactions are the most important factors in HSH design. Collaboration between interactive design experts and policymakers will help to develop better standards for such interactions. User experience is highly related to the design of interactions between machine and human. As HSHs are a new area of service and are still at the laboratory level, further work in this field is necessary before the commercialization stage.

- **Machine–Machine:** This category includes all interactions between HSH equipment and all Internet of Things (IoT) services. The ability of different types of technology to work together successfully is crucial for the success of HSH design. For example, my visit to the Zero Effort Home (University of Toronto) demonstrated to me that due to company policy, exclusiveness, and compatibility Apple products only work well with other Apple products; they present challenges to connectivity between other smart devices in the home. As long as these systems cannot work collaboratively, the improvement and coverage of support will not be clear.

5.2.1.4 Services

Services are one of the most important parts of HSH systems and are mostly intangible. This category can be divided into three sub-categories: pre-service, main service, and post-service. Human experiences throughout the process, and interactions with service and products, must be designed carefully. The efficiency, reliability, simplicity, and safety of these services will affect their quality. Some services overlap, while some are complementary to each other, which may result in repetition. During the design phase, a clear vision of service stages and an awareness of what is needed for each stage is essential.

- **Pre-Service:** Pre-service is the main stage for mental, physical, and financial preparedness for acceptance before using HSHs. Developers might provide information and educate users about the applications and all provided opportunities. Based on my observations, the needs, willingness, and expectations of users will emerge at this level: "There is no need to use [a] smartphone… If I need it, I'll have it," one participant explained. The role of design at this stage is to identify these needs and help people gain awareness of what HSH technologies can offer them. User adoption, affordability, accessibility, independence, confidence, and privacy are the main concerns at this level. Furthermore, educating people of all ages to remove stigma is related to this stage. Because people in this stage are planning for their future, cost planning is part of the pre-service process.

- **Main Service:** After people decide to have an HSH system, the main service interactions will be based on mental, physical, and social needs. At this level, users' experiences will form based on Pre-Service interactions. Meeting the needs of individuals, modifying costs, and defining a business model which works for different socioeconomic levels are necessary. The quality of service will be reviewed in this stage. Providing primary care, specialty care, and emergency care regardless of physical mobility or location are the goals that should be met here. Complementary services at HSHs, such as the use of wearables or in-home rehabilitation, should also be considered at this stage in order to provide a comprehensive service. It should be noted that design for Health Smart Homes is not just related to health monitoring, but should incorporate all aspects of daily life and needs for a healthy lifestyle.

- **Post-Service:** The stage after the delivery of the Main Service is called Post-Service. All supporting parts of the process, including feedback from HSH users, family members, and healthcare professionals, are located here. If the two previous service areas were successful, experiences meet expectations,

and generally, users will be satisfied. However, maintaining satisfaction for a service is a long-term effort. Some specific services are essential at this level, such as providing 24-hour support, ensuring that "somebody is always available to answer". Additionally, technology must be well-supported, be intuitive, provide regular software updates, and provide maintenance support at the HSH. The need for updates and upgrades of devices are the most important findings with regard to services. For example, one participant's comment "I am not buying another iPad!" inspired a new line of inquiry: what if Apple provides specific support for their digital products for people older than 65? In fact, all companies could provide a form for "App Insurance". Many apps have been designed and developed for older adults, but due to their price or lack of support for older phones, those apps may not actually be available for this target group. Distance care services, such as for travel, also fall under the category of post-service.

- **Service Types:** Generally, services can be divided into preventative services and curative services in HSHs. Examples include encouraging users to maintain healthy lifestyles through diet, weight management, and regular exercise. This categorization will help the designer to determine the aim of a specific service or product, support that may be needed from the other sides of service, and the respective percentages of preventative and curative services.

- **Service Experiences:** User experiences are formed based on all interactions and experiences in the three categories of service described above. The most valuable experience is defined by personalized service. As people's needs, abilities, and life situations are different, services for HSHs should be designed based on individuals and be adaptable, not only for different people, but also for a single person during their lifetime. Other important aspects of service are integrity and continuity, especially in providing yearly checkups, health planning, and delivering reminders. HSHs services should be comprehensive and trustworthy, as they should help older adults to stay healthy and active.

5.2.1.5 Strategies and Planning

Service strategies and regulations in healthcare have been influenced by service design. By involving stakeholders in earlier stages of research, designers have the capacity to shift the mindsets of policymakers and regulators (Mager et al., 2017). The sub-categories and standards for Physical Environment, Equipment Features, Interactions, and Services are formed at the base of this layer. A service design approach brings a holistic perspective to the project. Strategies must meet people's

lifelong goals and consider changes not only in the later years of life, but for the entire lifetime, with different levels of support. Considerations at this stage can be divided into four main categories: Big Picture, Strategic Areas, Opportunities and Challenges, and Financial Planning.

- **Big Picture:** An overview, or big picture, is necessary for all HSH stakeholders:
  - Older Adults: Liu stated in her interview that people must plan for their futures to prepare for the ability to remain in their homes. This holistic view includes planning, researching, saving money, and preparing homes earlier.
  - HSH Service Providers: Having a big picture of the overall service will help service providers find new opportunities such as considering a network of HSH users or cost reductions by using more cloud services or smart technology. These new opportunities could help reduce the cost of service.
  - Governments: Governments can play an important overarching role in the lives of citizens and in the healthcare system through financial support, education, and awareness about stigma about assistive tools for older ages. Long-term preventative strategies could help reduce health service costs.
- **Strategic Areas:**
  - Service Safety and Security: Strategies are needed to provide both cohesive and safe services.
  - Encouraging: programs to encourage active and healthy lifestyles should be started earlier for prevention and then continued through care.
  - Developing Standards: standards are required for home structure, safety and security of information, types of information gathered, storage of data, distribution of data, and smart technology and Internet of Things (IoT) systems. Governments must have authority over issues relating to user data. According to the Task Force on Research and Development for Technology to Support Aging Adults Committee of the US National Science and Technology Council (2019):

    > Development of usability standards and the application of these standards to the design of technology for older adults, even under circumstances of diminished functional capacity, will provide efficient and effective support. Increased research efforts are necessary to determine the optimal accessibility and usability guidelines to support older adults using IT (p. 24)

  - Designing for Consistency and Integrity: Consistency and integrity are needed amongst all stakeholders, private and public sectors, healthcare services, and telecommunication services.

- Dignity and Autonomy of People: these factors are crucial in maintaining and improving the self-esteem of older adults. Strategies are needed to develop more support and provide information and awareness.
- Planning for Educational Support: Continued educational support can be counted as a strategy of life for people of different ages. Developing programs that reduce the stigma of aging and that explore the possibilities for smart technology in healthcare or how such technology assists people living at home, can be useful. Providing gradual educational support for the adoption of new devices and services, and for the use of existing technology, is very important. One of the Baby Boomer participants, noted: "My philosophy is providing opportunities for people to better themselves through education." Rapid changes in new technology and digital products mean that people's knowledge of these items must also be updated. Education could help elderly people overcome technological barriers and enjoy the benefits of technology, thus increasing their self-esteem and feelings of usefulness (Sun, et al., 2009).

- **Opportunities and Challenges:** Living in a Health Smart Home provides both opportunities and risks for both individuals and governments. Designers must focus on the opportunities and try to reduce the risks in order to create value and improve users' quality of life. The main points in this area are listed below.
  - Network of Users: The use of various chains of users for HSH services holds great potential to reduce the cost of those services by intangible investing, volunteer work, and using the potential of different community relations, such as older–younger, older–older, and older–government. One such example is the "time bank" scheme, in which people take care of senior citizens who are living alone with no family support: "People engage in time banking—an alternative currency system in which hours of service take the place of money—in dozens of countries worldwide." (Cahn & Summer, 2015).
  - Social Aspects: The roles of friends and extended communities in the circle of service are important. For example, a friend's suggestion of a digital product could increase the level of reliability of information. Moreover, considering the abilities and experiences of older adults at a social level could help reduce negative attitudes toward aging, such as the perception of older adults as non-productive and a burden on society. For instance, in Japan, RISTEX (Research Institute of Science and Technology for Society) seeks possible solutions, based on community potentials, to a wide range of problems arising from an aging population.
  - Consider Challenges in a Comprehensive Service: Social isolation is a

significant concern compounded by overuse of technology and lack of communication between assisted people and outside communities (Sun et al., 2009). Privacy issues such as hacks or leaks should be addressed at the level of strategy development with a larger view.

- **Financial Planning:** Cost is the most important hindrance to good quality of support and living for older adults and to stakeholder planning such as requests for support or equipment. Costs include those of new product or services, updates and upgrades, and adjustments. Furthremore, meeting possible ways for paying the price of HSH services in older ages is crucial. There is some evidence indicating a significant overall cost reduction with the use of assisted living (Kim, Gollamudi & Steinhub, 2016). Financial security is a key factor in extending independent living for older adults. Currently, a majority of financial self-assessment tools are geared toward young people, and the needs of older people in this area must be addressed (Emerging Technologies to Support an Aging Population, 2019). Studies in economic assessment in home health-monitoring technologies are still low (2.08%), and more studies are needed to provide high quality and cost-effectiveness of home health-monitoring technologies (Liu et al., 2016)

5.2.2 Recommendations for Structuring Health Smart Homes Projects

This project focuses on different aspects and possibilities for the design of Health Smart Homes. It demonstrates that design can contribute effectively to the addressing of this wicked problem. One unique aspect of the design discipline is the approach designers take when working on a project. This section provides recommendations for planning and development of HSH projects in relation to design. My background in computer engineering and industrial design, two disciplines related to HSH design, and my current master's degree in visual communication design provide me with a wider view to suggest recommendations for an interdisciplinary project such as the design of HSHs. Provided recommendations are based on the findings of this study and on my experiences. These suggestions are divided into four main categories: Mindset for Team Members, People Involved, Tools of Use, and Process.

5.2.2.1 Mindset for Team Members

Design thinking is an effective mindset for interdisciplinary projects such as HSHs, as discussed in Chapter Three. In approaching questions related to HSHs, a design mindset allows researchers to imagine a larger picture to better understand the problem.

Most HSH projects are currently conducted by engineers. Unlike designers, engineers often have a question already formed and are looking for the answer, which narrows the field. Many engineers employ techniques that either decide what type of questions should be asked or that limit responses. As a result, participants may provide answers based on their previous experiences, which is not helpful for predicting future usage, whereas proactive approaches, such as design methods, could capture a wider range of hidden needs (Witell et al., 2011). Moreover, unlike engineers who use technology or science as their starting point, designers typically start from people. Designers have the ability to find opportunities, to see potential experiences, to turn innovative ideas into practice, and to see through the eyes of the end users by employing empathy. Designers can create hands-on experiences for other team researchers and project stakeholders, which provide room to think about areas not considered previously and to find new opportunities. Having a multidisciplinary team is not an easy job; however, multidisciplinary teams are able to fill gaps by using knowledge from other disciplines in addition to their own, as both Mihailidis and Liu pointed out in interviews. Similarly, Iroko Akiyama, Professor of Social Psychology, University of Tokyo, Area Director of the Redesigning Communities for Aged Society project has noted in this project website:

> It is difficult to resolve the problem of an aging society through individual efforts. Many of the problems require a multi-disciplinary perspective, which takes into consideration the psychological, physical and social status of the senior citizens. Exploring a problem resolution from various perspectives, including the humanities and the social sciences, will lead to more effective models for the aging society. (RISTEX, n.d.)

Stroulia has stated that one of the greatest challenges in multidisciplinary research is that each discipline has its own language. Design thinking as a mindset, is therefore essential to keep the project, people, and process together. Design thinking, can facilitate collaborations in multidisiplinary team, reduce costs, and improve the outcome by using human-centred approaches.

5.2.2.2 People Involved

Usually in research related to HSHs, collaboration between designers and field experts in the health sciences (rehabilitation, gerontology, etc.), policy makers, engineers, computing scientists, and social sciences is needed in order to meet all requirements of design for HSHs. As one of the aims of this project was to document how design can contribute to this area, this section discusses the role of designers in HSH projects. My primary and secondary research demonstrate that design and designers are currently not being incorporated successfully into the process.

In industry, designers and design thinking have been increasingly present throughout the process of designing for products and services. The experts I interviewed for this project have all identified a gap between industry and research. With its tools, mindset, and techniques, design can help bridge this gap by providing insights into users' lives and fostering empathy that can lead to finding errors, providing creative solutions, and using prototyping to prevent large costs and helping to develop more appealing and user-friendly services and products. Designers should be part of the team not just after the development of the final component but from the beginning of the project. This study has documented a small design intervention in the early stage of a Health Smart Home project (figure 39). Different types of designers, such as service, strategy, visual communication, and industrial designers, can play roles at different stages. Finally, designers can oversee the whole process of research for efficency and innovation as well as increaseing creativity of the process and outcomes from beginning to end of the project.

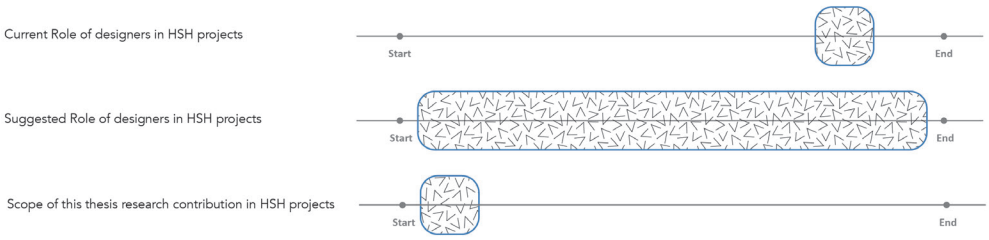

Figure 39. Design intervention

5.2.2.3 Tools of Use

Assessment of user needs and usability are significant factors in maximizing the usefulness of HSHs. This assessment should include interactions with target groups from a range of socioeconomic backgrounds, caregivers, and clinicians with different attitudes towards and experiences with technology. Service design is a human-centred approach that provides tools and techniques to improve design solutions.

Conventional user-centred design methods are not completely appropriate for wicked problems such as these. Based on primary and secondary research in this study, the usage of participatory design methods, especially co-design methods in the early stages, would be a good option for dealing with such problems. However, because characteristics, cultures, environments and motivations of users affect the research outcome, methods should be adopted for the specific project target group, with tools and techniques that complement one another. Sanders, in her interview, suggested using qualitative methods such as co-design at the front end of the project and using quantitative methods at later stages.

The results from this study has shown that the co-design session itself helped participants think about their futures and how smart technologies can be helpful; it also helped me learn more about the participants. Stroulia was interested in knowing how the conversation with older adults would shifted their preferences of sensing. Co-design is one answer to this question, because it facilitates discussion between researchers and users, helps to improve final outcomes, and provides a sense of ownership for the participants.

Design for services not only provides a holistic view of complex problems but also pays attention to details that can identify new values for users and may often be missed in traditional research. Design for services can provide service touchpoints, document user interactions, and satisfy people's experiences at the operational and organizational level (Lee, Jaatinen, Salmi, Mattelmäki, Smeds & Holopaine, 2018). Finally, although field studies are a fundamental stage in any kind of design project, in service design it is a key factor to open new opportunities, disrupt traditional methods of thinking, and initiate new collaborations. This is particularly true when service design is paired with co-creation methods; for example, empathetic conversations can help to bridge between analysis and design phases (Meroni & Sangiorrgi, 2011).

5.2.2.4 Process

The process of a HSH project can be broken down into four steps: Discover, Define, Develop, and Deliver. In the design for process of an HSH research more work in the early stages is essencil to identify the needs, alternatives, benefits, concerns, and social influences of participants. from the point of view of all stakeholders. Openness in defining problems with help of stackholders in the early stage is one of the benefits suggested for conducting HSHs projects. Interviews with computer scientists and occupational therapists have shown that they are aware of the role of users in research and do know of user-centred research approaches, but they are not entirely

certain as to how to incorporate user information into the design process. In addition, observation and empathy play important roles, as does the use of design prototypes, particularly in the early stages of the process. The prototyping method in design, as explained in Chapter Three, is a fast and cheap means of creating and testing ideas. Designers can provide suggestions for fast and affordable prototyping to help understand users' behaviour and empathize with the users. Such approaches provide flexibility in the face of project limitations, and can reduce the cost of user research. As part of this study, a model for the front stage of HSH design was developed based on the double loop suggested in *Design a Better Business* (Van Der Pijl, Solomon & Lokitz, 2016) (Figure 40).

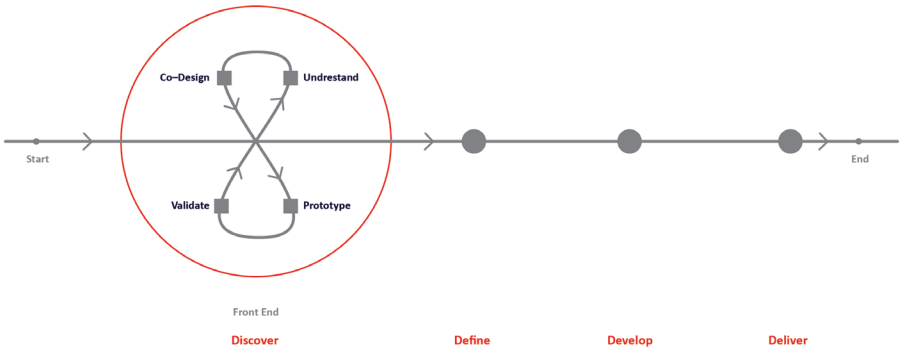

Figure 40. Suggested practice for front end of the HSH research

5.3 Chapter Summary

This chapter focused on recommendations for the design of Health Smart Homes, including tools for the transition from the research phase to the design phase and higher-level suggestions for designers and developers of HSHs. Major outcomes of this research design recomendations for design of HSHs. Additionally it provides suggestions for conducting an HSH project by considering the role of designers in the process, design thinking as a mindset, the effectiveness of service design and co-design in HSH projects as well as openness and paying attention to the front stage of the research. Designers who are involved in the development of HSHs must be involved in the whole process, especially in learning about the needs and expectations of the users and in developing the aims of the project. In order to do so, designers should engage in interdisciplinary research and collaborate actively with the members of the project team.

"A service design approach creates the structure for other disciplines to collaborate creatively to frame the opportunity differently, to quickly model and test out experiences that will challenge the existing system, to really design around the motivations of people on the ground, and create new, financially sustainable solutions that span public, private and individual spheres."

—Meroni & Sangiorgi, 2011, p. 138

6. Conclusion

This chapter discusses the implications of this study's findings, beginning with a review of those findings based on the body of knowledge presented in the literature review in Chapter 2. It then discusses the participatory methodology employed and explained in Chapter 3, summarizes the importance of the study findings as discussed in Chapter 4, and outlines recommendations provided in Chapter 5. The chapter ends with a discussion of the challenges and limitations of the study, as well as recommendations for future research.

6.1 Summary of Study

Due to the increase in aging populations around the world and shortages of resources, public health movements have sought to help older adults live independently at home. Individuals generally prefer to continue living in their homes rather than in care institutions (Yusif, Soar & Hafeez-Baig, 2016). Public health policymakers recognise a need for new approaches to enable more older adults to continue living independently in their homes. In 2017, as noted in *Service Design Impact Report: Health Sector*, service designers collaborating closely with health centres stressed that in the near future health technology will greatly affect all areas of health, especially for self-management and improving preventative health practices. One possible technology-based solution is Health Smart Homes (HSHs). However, the HSH research area is large and this research focused on one kind of technology which is called Ambient Assisted Living (AAL).

As discussed in Chapter One, designing Health Smart Homes (HSHs) is a wicked problem, with solutions yet to be found. This project proposes possible ways forward by creating convergence among different research areas, demonstrating the possibility of a design thinking approach in interdisciplinary research, showcasing the use of co-design methods and providing a framework for human-centered research in HSH projects.

Bringing together different research areas, this study focused on both users and experts from diverse fields of computer science, occupational therapy, and design. The role of design thinking was at the heart of this study. All the activities and techniques in this project are focused on the users of HSHs, investigating the feasibility of technology and using generative techniques to help non-designers become co-designers in the process of generating ideas. New approaches like those discussed here are needed to transition from top-down design processes toward more collaboration between co-designers (Meroni & Sangiorgi, 2011). Moreover,

co-designing ideas with Baby Boomers allows both users and designers to better understand the needs for HSH services. Design for services moves from user-centered design toward human-centered design, from design for people to design with people, and from field studies to enhancing empathy through co-creation.

For this study, through a participatory approach, I recruited nine Baby Boomers to collaborate with and to gather information about current life situations and imagine futures together concerning the design of HSHs. They participated in contextual interviews individually at their homes, completed homework activities to prepare for co-designing, participated in a co-design workshop and provided feedback about the entire experience. Moreover, I conducted five interviews with experts from the fields of computer science, occupational therapy and design, and visited two HSH laboratories in Edmonton and Toronto. The aim of these activities was to gain more empathy, insight and knowledge about the past, present and future of Baby Boomers, and to gain perspective on users and researchers. All the data gathered from my primary research are presented below.

6.2 Key Questions and Findings

The questions I tried to answer were "What are the essential factors that can positively influence the design for HSH services from the perspective of Baby Boomers?" and "What is the role of design in an interdisciplinary project such as the creation of HSHs?"

To address these questions, the findings are divided into two main categories. First, from the Co-Design participants' activities (Contextual Interviews, Homework Activities, and Co-Design Workshop) I identify five major influences on the design of HSH services for Aging in Place:

1. **Housing Features and Preferences:** Essential concerns identified related to indoor and outdoor spaces, accessibilities, organizations, set up, main home features, location, and neighborhood.

2. **Living Arrangements and Family Support:** The daily patterns for all nine participants included regular activities, health-related activites, companionship, and emergency situations at home.

3. **Successful Aging and Restrictions:** As noted, participants were open about smart technology in hopes of keeping their independence. Loneliness is one of the greatest challenges for older adults. In additon to physical problems, hope and activity motivation, staying at home as long as possible with support,

maintain health, and preventing falls and injuries are the main criteria.

4. **Technology Considerations:** The main concerns about technology included perception, safety and security, trust, and having access to the latest devices, updates, or upgrades. Worries about future smart technologies were related to time consumption, isolation and reduction in personal relationships.

5. **Service and Support Preferences:** Service and support for HSHs include planning for costs, available devices and technologies, time constraints and lack of integration, education, reliability of sources for information is paramount.

The second part of my findings stems from my expert interviews and visits to Health Smart Home labs, complementary to my previous findings. The interviewees provided information about HSH laboratories, design and development, and challenges in research and practice. The findings reveal a gap between research and the market/ industry; a general lack of readiness for an aging future; challenges understanding disciplinary practices in interdisciplinary teams; a need to better understand of the role that users can play, and how researchers can adopt these practices process; new research methods; a need for designers to collaborate throughout interdisciplinary research; and changes in policymaking. Other identified areas include a need for more attention to the early stages of research, which assists in identifying appropriate problems and more innovative responses; the importance of co-design methods for better services and products in which involved shared ownership; and the need for qualified participants in effective research collaboration.

6.3 Recommendations

The first set of recommendations from this project concerns the design of individual Health Smart Homes and the second set of concerns for structuring Health Smart Homes projects .

6.3.1 Recommendations for the Design of Individual Health Smart Homes

These recommendations form a multi-layer model that is related to the Physical Environment, Equipment Features, Interactions, Services and Strategies at governmental, service designer/strategists, researcher and industry levels. Finally it should be noted that although recommendations in this part have been broken into categories many of the specific recommendations overlap or relate to each other.

For the first set of recommendations, the following outlines the key findings for the design of individual Health Smart Homes:

Physical Environment: Issues that must be considered here include safety and security, consideration of universal design, self-control over the environment, ergonomic factors and environmental flexibility based on lifelong needs, modularity of features for changing spaces, emotional attachment and personalization of space, accessibility, organization and storage of home features and design to prevent falls.

Equipment Features: Key features for consideration of digital products include functionality, perception, autonomy, integrity of devices, and level of automated systems. Safety and security of digital products (devices/apps/software), including protection against hacking or leaking of personal information and other digital vulnerabilities, is paramount. Preferences related to physical products including wearables include comfort, size, minimization of loss, simplicity of use, visibility without being recognizable as an age-related assistive device, and multi-functionality. Stated possible preferences include robots for household work, smartphones, and environmental sensors. Monitoring tools are noted for user control of the environment, detecting and preventing of problems, informing health centres, and monitoring self-health tracking. Other smart technology home appliances such as refrigerators, dishwashers and stoves work automatically; still other devices include games and videos to support health. Important factors for digital products such as apps and software include interface, functionality, speed of response, consideration of physical weaknesses in older adults, user friendliness, simplicity, and the use of visual language. The possible negative effects of overuse of these digital products, such as social isolation or laziness, also need to be recognised.

Interactions: This section covers all types of interactions that could be possible in HSH systems. This includes human-human, human-animals/plant, human-machine, and machine-machine interactions. Each is related to a specific discipline and must be designed in relation to products and services to provide better experiences.

Services: Services are one of the most important parts of HSHs and are divided into three stages: Pre-Service, Main Service and Post-Service. Human experiences are informed by intangibles such as trustfulness, efficiency, reliability, simplicity and safety of services, and this affects the quality of the service. Considerations of Pre-Service include planning for the future, such as finances and space, and the mental, physical, and educational preparations that are required. Needs and expectations will form at this level, with a variety of considerations including knowledge, user adoption, affordability, accessibility, age-related stigmas and privacy. In the Main Service stage of interactions, the experiences of users build upon the previous level. Meeting the needs of individuals, modifying costs, and defining a business model that works for different socio-economic levels are necessary here. Services related to the continued

mental, physical, and social needs and planning for providing primary care, specialty care, and emergency care regardless of physical mobility or location should also be met. Complementary services at HSHs should be considered in this stage. In the Post-Service stage, all support, reports and feedback provided to older adults, family members and health care professionals are delivered. Services are designed to be preventative and curative in HSHs and encouraging a healthier lifestyle for inhabitants is dependent on the types of services offered. Users' experiences are based on all interactions and experiences in all three parts of the service.

Strategies and Planning: The previously mentioned categories of Physical Environment, Equipment Features, Interactions, and Services are formed at the base of this layer, which provides a holistic view of the relations between all categories. All developed standards for other categories are formed at this level. A long-range, big-picture approach is essential for all HSH stakeholders, including older adults (planning ahead affects ability to stay at home and live healthier), Health Smart Home service providers (to find new opportunities and efficiency), and governments (strategic planning can reduce overall costs of health services).

6.3.2 Recommendations for Structuring Health Smart Homes Projects

This thesis demonstrates that design can contribute effectively to planning for a wicked problem such as Aging in Place (AiP) with the help of smart technology. The following section presents recommendations related to the design of HSH projects are presented, divided into four main categories: Mindset for Team Members, People Involved, Tools of Use, and Process.

Mindset for Team Members: Design thinking as a mindset allows us to imagine a larger, more open problem space to capture a broader range of hidden needs, turn innovative ideas into practice, identify potential experiences, and empathize with end-users as well as create hands-on experiences for the research team and stakeholders.

People Involved: Expanding beyond current team compositions, mostly of computer scientists, engineers and health-related practitioners, to include designers can be helpful throughout the process of designing for a product or service. Based on primary and secondry research, design with its tools, mindset and techniques, can help to bridge this gap. Designers can help in finding errors, providing creative solutions, and prototyping to develop services and products that are more appealing for users. This study suggested that designer with different expertise can be involved

in different stages of the entire research process for better outcomes.

Tools of Use: In terms of a research approach, service design has the capacity, tools and techniques for identifying problems and solutions to result in a superior designed response. In addition, co-design is particularly effective in the early stages of projects. However, methods must be specifically geared to the target group of the project.

The feedback and findings of this participatory setting reveal success and suggest possibilities in other HSH and related projects. The collaborative experience benefited the stakeholders' understanding of future possibilities of smart technologies and the opportunities that such a home could offer them. Discussion of design was most popular part of the workshop: Participant D noted that the benefit of the workshop was to "get others' perspectives on plans for future aids in their homes" and "sharing of different ideas and resources." Participant I stated, "What I liked best was hearing the other people's presentations." Participant D said that being involved in the study "made me look at our home a bit more closely, but my husband and I have discussed many aspects that could be adapted as the need arises. The use of technologies was interesting, and I am more aware of how they might be used in the future."

Process: The design process is an iterative one consisting of the four steps of Discover, Define, Develop, and Deliver. The project should be open-ended at the beginning and use cost effective and fast prototyping. In particular, the early stages of this study include understanding, co-creating, evaluating and iteratively prototyping.

6.4 Challenges and Limitations

There are a variety of limitations and challenges associated with this research, this includes:

- Due to nature of the human-centered design approach adopted, Baby Boomers were partners in this study, and adopting the role of co-designers took a considerable period of time. As the topic and process were new to the participants, providing knowledge of future designs was challenging.
- The selection of participants was a challenge that affected the collaboration session and the final outcomes. Personality, background, expertise and openness for group work are examples of indicators for selection.
- An important limitation of the selection of tools and the workshop was cost. Costs were related to face-to-face interactions, workshop materials, homework

material, and participation workshop costs such as parking, snacks, or prints.

- Designing the appropriate tools for data gathering is critical, especially when creating tools to allow non-designers to collaborate effectively. On the one hand, these tools should prepare participants to design creatively; on the other, the provided material must stay in line with the aims and goals of the project and cannot be too open-ended. Also, it must make sense and be easy to understand for different participants with different backgrounds, levels of education and abilities.

- The largest challenge related to the design of participatory research processes and tools was keeping participants engaged throughout the entire process. In this study, collaborators were required to participate in an interview, complete homework activities, participate in a workshop and provide feedback. The process of the study indicated success in keeping them engaged, as all continued to the last steps. Key factors include making the project fun and easy, minimizing difficulties, and reducing barriers.

6.5 Future Research

- With more time and financial support, I would continue workshops with this group, in order to gain more knowledge of, and empathy for, their experiences.

- Due to time constraints, the scope of my research and the challenge of receiving ethics approval, I did not involve other stakeholders, such as health providers or researchers from other disciplines, in the workshop.

- I did not have opportunity to investigate the cultural aspects of HSH systems. The cultural characteristics of the adoption of smart home services are currently understudied. Understanding the role of culture in adoption practices may inform design and marketing and elicit a focus on ethical principles of autonomy and the rights of people.

- There is a growing market for Aging in Place for Baby Boomers, including assistive tools, customized software and apps. Current examples include voice-activated interfaces such as Alexa, Internet of Things, digital health, robotics and telehealth services. However, many scholars have noted that more research into the effectiveness of these devices is necessary.

- The literature review conducted in this project indicates a minimal use of participatory research approaches investigating older adults' needs in HSH

services. Methods such as co-design in the early stages of research will be effective in educating, evaluating, and improving outcomes, and ownership of outcomes by stakeholders. This provides greater understanding for all team members in HSH projects.

- Research and work concerning issues of strategy and service in regards to the design of HSHs is necessary. This required work will affect many aspects of individuals' lives, and the future of healthcare, government and industry. Design for services is beneficial in this area, and this project demonstrates that this approach is being implemented.
- Although the process of participatory research is time-consuming and costly, I highly recommend that other designers practice it in their research as it is useful for all key stakeholders involved.
- Currently, there is little evidence of designers being involved throughout the whole process of research projects, particularly in the early stages, a specific area to which design and designers can contribute.

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8. Appendices

Appendix 1: Research Ethics Board (REB)

Date: Wednesday, August 14, 2019 7:39:03 PM Print Close

1.1 Study Identification

*All questions marked by a red asterisk * are required fields. However, because the mandatory fields have been kept to a minimum, answering only the required fields may not be sufficient for the REB to review your application.*

Please answer all relevant questions that will reasonably help to describe your study or proposed research.

1.0 * **Short Study Title** *(restricted to 250 characters)*:
Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach

2.0 * **Complete Study Title** *(can be exactly the same as short title)*:

Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach

This is a participatory design research to better understand future users' needs and desires in smart homes with a focus on health-related technologies for smart homes.

3.0 * **Select the appropriate Research Ethics Board (***Detailed descriptions are available at http://www.reo.ualberta.ca/Human-Research-Ethics/Research-Ethics-Boards.aspx***):**
Research Ethics Board 1

4.0 * **Is the proposed research:**
Unfunded

5.01 * **Name of local Principal Investigator:**
Azadeh Mokhberi

6.0 * **Type of research/study:**
Graduate Student

7.0 **Investigator's Supervisor (required for applications from undergraduate students, graduate students, post-doctoral fellows and medical residents to REBs 1 & 2. HREB does not accept applications from student PIs):**

Aidan Rowe

8.01 **Study Coordinators or Research Assistants:** People listed here can edit this application and will receive all email notifications for the study:

Name	Employer
Azadeh Mokhberi	Student

9.01 **Co-Investigators:** People listed here can edit this application and will receive email notifications *(Co-investigators who do not wish to receive email, should be added to the study email list team below instead of here).*
If your searched name does not come up when you type it in the box, the

materials to participants?
As it is made for this project which is in the process of participatory design, it will not return to the participants. However, participants are provided by photograph of their work if they wish to have it. It means they will have access to outcome of the workshop if they ask for it.

6.0 **Will you be using audio/video recording equipment and/or other capture of sound or images for the study?**
● **Yes** ○ No

If YES, provide details:
Audio recording will be used for semi- structured interviews and video recording will be used for workshops. Photos may be taken during the workshops as documentation of the practice-led research process. Images and videos will only be used if consent is given by participants. Names will not be attached to images or videos.
The main reasons of video recording is reviewing what participants mentioned and act, how the workshop held and showing the process of participatory design research to public.

2.7 Participant Observation

1.0 **Who will the observer be?**
Azadeh Mokhberi- The graduate researcher

2.0 **Who is being observed?**
Participants at participatory workshop

3.0 **Why are they being observed?**
Their interaction and the process of decision making about designing a smart home with a focus on health-related technologies will provide more information for researcher.
Also, in the process of design with empathy, it is essential to review the reactions and responds. In order to get more empathy with older adults. This is an important step to explore about target group.

4.0 **When and where will participants be observed (i.e. during class, during their workday)?**
In the participatory workshop which will be held at University of Alberta.

5.0 **Will others be present who are not being observed (i.e. non-participants)?**
○ Yes ● **No**

6.0 **What data will be collected?**
Video and/or audio recordings
Photographs
Field notes

3.1 Risk Assessment

1.0 * **Provide your assessment of the risks that may be associated with**

this research:
Minimal Risk - research in which the probability and magnitude of possible harms implied by participation is no greater than those encountered by participants in those aspects of their everyday life that relate to the research (TCPS2)

2.0 * **Select all that might apply:**

Description of Possible Physical Risks and Discomforts

No	Participants might feel physical fatigue, e.g. sleep deprivation
No	Participants might feel physical stress, e.g. cardiovascular stress tests
No	Participants might sustain injury, infection, and intervention side-effects or complications
No	The physical risks will be greater than those encountered by the participants in everyday life

Possible Psychological, Emotional, Social and Other Risks and Discomforts

No	Participants might feel psychologically or emotionally stressed, demeaned, embarrassed, worried, anxious, scared or distressed, e.g. description of painful or traumatic events
No	Participants might feel psychological or mental fatigue, e.g intense concentration required
No	Participants might experience cultural or social risk, e.g. loss of privacy or status or damage to reputation
No	Participants might be exposed to economic or legal risk, for instance non-anonymized workplace surveys
No	The risks will be greater than those encountered by the participants in everyday life

3.0 * **Provide details of all the risks and discomforts associated with the research for which you indicated YES or POSSIBLY above.**
The risk to research participants is minimal and not greater than what they may experience during interviews and collaboration workshop.

4.0 * **Describe how you will manage and minimize risks and discomforts, as well as mitigate harm:**
- respecting the dignity of all participants and what is being asked of them
- ensure informed consent
- carefully describing the research study to the participants while outlining the risks and benefits of being involved and how the data will used and disseminated
- allowing participants to withdraw at any time during the research study. The participants will be notified and reminded at the beginning of workshop that they can withdraw from it at any time without consequences
- in case of mental fatigue, they can stop the work and relax or even leave the workshop if necessary.
- refreshments will be provided during the workshop

In particular, as the collaboration workshop will be held in the University of Alberta, the place will be chosen will be: Accessible for all, close to the hospital and will be referred to appropriate services as necessary; family or friends will be contacted on their behalf if required.

5.0 **Is there a possibility that your research procedures will lead to**

unexpected findings, adverse reactions, or similar results that may require follow-up *(i.e. individuals disclose that they are upset or distressed during an interview/questionnaire, unanticipated findings on MRI, etc.)***?**

○ Yes ● **No**

6.0 **If you are using any tests in this study diagnostically, indicate the member(s) of the study team who will administer the measures/instruments:**

Test Name	Test Administrator	Organization	Administrator's Qualification

There are no items to display

7.0 **If any research related procedures/tests could be interpreted diagnostically, will these be reported back to the participants and if so, how and by whom?**

3.2 Benefits Analysis

1.0 * **Describe any potential benefits of the proposed research to the participants. If there are no benefits, state this explicitly:**
There is no direct benefits from participating in the research. however, participants will gain some knowledge about health smart technologies which are currently available, their usage and some are underdevelopment.

2.0 * **Describe the scientific and/or scholarly benefits of the proposed research:**
This proposed research will generate knowledge about a better understanding of the needs and desires of older adults about health smart home and factors which affect their acceptance of such houses. Also, the finding of this research may apply to other groups such as people with disabilities. In this study, the perspective of older adults about smart home will be collected. So, such perspectives offer valuable insights toward designing new services which will meet their values and concerns.

The research will test the effect of designed services, created by target group and inspired from their personal experiences, with the aim of creating smart home services with more empathy. Also, it will help build a model or design suggestion guideline for this practice that will be shared publicly through a research report so that it can be a reference for similar design research.

3.0 **If this research involves risk to participants explain how the benefits outweigh the risks.**
-

4.1 Participant Information

1.0 * **Will you be recruiting human participants** *(i.e. enrolling people into the study, sending people online surveys to complete)***?**

● **Yes** ○ No

1.1 Will participants be recruited or their data be collected from Alberta Health Services or Covenant Health or data custodian as defined in the Alberta Health Information Act?

○ Yes ● **No**

4.2 Additional Participant Information

1.0 **Describe the participants that will be included in this study. Outline ALL participants** *(i.e. if you are enrolling healthy controls as well):*

Participants that will be included in this study are:

Group 1: (participant in workshops) 8-10 voluntary participants, age range:55-75, living in Edmonton.

Group 2: 4-8, Field experts, such as: smart home providers, smart devices providers, health specialists, Occupational therapists, computer scientists, and gerontologists

Participants in interviews and workshops need to understand and communicate in English well.

2.0 * **Describe and justify the inclusion criteria for participants** *(e.g. age range, health status, gender, etc.):*

Group 1: age range:55-75, both male and female, immigrants and natives, have children at home or does not have, with varying states of marriage also come from a variety of cultural and socioeconomic backgrounds living in Edmonton.

Group 2: Should be experienced in the field of research, have worked with older adults, or design product or services for them, and company owners of smart technologies

3.0 **Describe and justify the exclusion criteria for participants:**

Those who can not communicate and understand English language well are excluded from the study

4.0 **Participants**

4.1 How many participants do you hope to recruit *(including controls, if applicable?)*
18
4.2 Of these, how many are controls, if applicable?
0
4.3 If this is a multi-site study, how many participants do you anticipate will be enrolled in the entire study?
18

5.0 **Justification for sample size:**
The ideal number would be 8 voluntary participants for Group 1 and 8 voluntary participants for Group 2 (Field Experts).

The minimum number of participants needed will preferably be as follows:
Group 1: The sample of the size of older adults for doing activities and interviews would ideally be 8 but no less than 6 participants, to be able to have 6 different types of living experiences and expectations of from various demographics, to showcase the multiple forms of life. No more than 10; as the nature of qualitative is going deeper and data analyzes would become complicated more than that.

Group 2: The sample size of field experts would ideally be 8 but no less than 3 to get data from 3 different field studies of gerontology, computer science, and industry.

4.4 Recruitment of Participants (non-Health)

1.0 Recruitment

1.1 How will you identify potential participants? Outline all of the means you will use to identify who may be eligible to be in the study *(i.e. response to advertising such as flyers, posters, ads in newspapers, websites, email, list serves, community organization referrals, etc.)*
Recruitment Method 1:
The first group of participants in this study will be older adults ranges from 55-75 volunteers. I will send email to some non-profit centers and centers of aging who consent verbally, request to circulate the email to those who will be interested in participating in this research; they will call or email me directly before the start.

Recruitment Method 2:
If I can not find enough volunteers according to first method, I will put some flyers in some public places to find out enough participants.

Recruitment Method 3:
The experts who will be identified at the university faculty and experts who are working in smart technologies (like smart condo project) and will found through online and library research, word of mouth and references, will be contacted.
I will send a letter of initial contact requesting an interview via email to approach these participants of the study.

Recruitment Method 4:
snowball sampling which means I will ask ask potential participants to pass on the invitation to others.

1.2 Once you have identified a list of potentially eligible participants, indicate how the potential participants' names will be passed on to the researchers AND how will the potential participants be approached about the research.
It will be as explained above.
Moreover, after they approach to the researcher, she will contact potential participants. Volunteer participants in group 1 will call me directly for a debrief on the type of workshop and required activities they will take part of.

2.0 Pre-Existing Relationships

2.1 Will potential participants be recruited through pre-existing relationships with researchers *(e.g. Will an instructor recruit students from his classes, or a physician recruit patients from her practice? Other examples may be employees, acquaintances, own children or family*

members, etc.)?
○ Yes ● **No**

3.0 **Will your study involve any of the following?** *(select all that apply)*
Reimbursement for any expenses incurred by the participants, e.g. parking costs, child care, lost wages, etc

4.5 Informed Consent Determination

1.0 **Describe who will provide informed consent for this study***(i.e. the participant, parent of child participant, substitute decision maker, no one will give consent – requesting a waiver)*
http://www.pre.ethics.gc.ca/eng/policy-politique/initiatives/tcps2-eptc2/chapter3-chapitre3/#toc03-intro

All participants have capacity to give free and informed consent

1.1 Waiver of Consent Requested
If you are asking for a waiver of participant consent, please justify the waiver or alteration and explain how the study meets all of the criteria for the waiver. Refer to Article 3.7 of TCPS2 **and provide justification for requesting a Waiver of Consent for ALL criteria (a-e)**
http://www.pre.ethics.gc.ca/eng/policy-politique/initiatives/tcps2-eptc2/chapter3-chapitre3/#toc03-1b

1.2 Waiver of Consent in Individual Medical Emergency
If you are asking for a waiver or alteration of participant consent in individual medical emergencies, please justify the waiver or alteration and explain how the study meets ALL of the criteria outlined in Article 3.8 of TCPS2 (a-f)**.**
Not applicable in this research

2.0 **How will consent be obtained/documented? Select all that apply**
Signed consent form

If you are not using a signed consent form, explain how the study information will be provided to the participant and how consent will be obtained/documented. Provide details for EACH of the options selected above:

3.0 **Will every participant have the capacity to give fully informed consent on his/her own behalf?**
● **Yes** ○ No

4.0 **What assistance will be provided to participants or those consenting on their behalf, who may require additional assistance?** *(e.g. non-English speakers, visually impaired, etc.)*
As participants are living in an English language city, it is supposed they can read English texts. However, each part which is not clear to understand will be described for them verbally.

In the case of special needs, the researcher will ensure that all the necessary assistance will be available. Mobility impaired participants will be provided with easy access.

5.0 * **If at any time a PARTICIPANT wishes to withdraw from the study or from certain parts of the study, describe when and how this can be done.**
Participatory workshops participants:
Participants are free to withdraw at any time if they feel discomfort. In case of withdrawal, we
would ask whether participants wanted to keep their made materials in the database or excluded from the study. If they did, their data would be withdrawn, and all participants' designed products, belonging to the withdrawn participant, will be packed in an envelope and will be returned to them. All the materials produced and designed by participants will not reveal their identities at any point during research. Participants identities will be protected at all times.

Expert semi structured interview participants:
The interview will be documented with their names and they are free to with withdraw as well.

6.0 **Describe the circumstances and limitations of DATA withdrawal from the study, including the last point at which participant DATA can be withdrawn** *(i.e. 2 weeks after transcription of interview notes)*
The last point of data withdrawal will be two weeks after the research activity has been conducted. This will be outlined in the consent form and information sheet

7.0 **Will this study involve any group(s) where non-participants are present? For example, classroom research might involve groups which include participants and non-participants.**
○ Yes ● **No**

4.6 Expense Reimbursements and Incentives

1.0 **Expense Reimbursements:**

1.1 Describe in detail the expenses for which participants will be reimbursed, the value of the reimbursements per item as well as the total maximum reimbursement and the reimbursement process *(e.g. participants will receive a cash reimbursement for parking at the rate of $12.00 per visit for up to three visits for a total value of $36.00)*
As the workshops will take palace at the University of Alberta, the parking will be provided as any participants required for having the parking lot. Also, refreshments will be provided for the break at the middle of workshop

1.2 IF you will be collecting personal information to reimburse or pay participants, describe the information to be collected and how privacy will be maintained.
No

2.0 **Incentives:**

2.1 Will participants receive any incentives for participating in this

research *(i.e. gift card, cash payment, prize draw)***? If yes, provide details of the value, including the likelihood (odds) of winning for prize draws and lotteries.**
https://www.ualberta.ca/research/support/ethics-office/human-research-ethics/use-of-incentives-in-research

-

2.2 What is the maximum value of the incentives offered to an individual throughout the research?
-

2.3 IF incentives are offered to participants, they should not be so large or attractive as to constitute coercion. Justify the value of the incentives you are offering relative to your study population.
-

5.1 Data Collection

1.0 * **Will the researcher or study team be able to identify any of the participants at any stage of the study?**
● **Yes** ○ No

2.0 **Primary/raw data collected will be** *(check all that apply)***:**
Directly identifying information - the information identifies a specific individual through direct identifiers (e.g. name, social insurance number, personal health number, etc.)
Indirectly identifying information - the information can reasonably be expected to identify an individual through a combination of indirect identifers (eg date of birth, place of residence, photo or unique personal characteristics, etc)
Made Public and cited (including cases where participants have elected to be identified and/or allowed use of images, photos, etc.)

3.0 **If this study involves secondary use of data, list all original sources:**
NA

4.0 **In research where total anonymity and confidentiality is sought but cannot be guaranteed** *(eg. where participants talk in a group)* **how will confidentiality be achieved?**
Materials made during participatory workshop, images, and writings will remain anonymized

Interviewed participants will be asked on the consent forms whether or not they would like their name to be use as part of my thesis report and/or exhibition. This will give them the opportunity to have their opinions cited and connected to their name to preserve intellectual property if they consent to do so.

Also, in workshops, the responsibility for maintaining confidentiality and anonymity lies not just with the researcher (who presumably can guarantee this normally), but also with the participants, who could discuss the session and who participates with others, and is outside the researcher's control. In information letter, I explained to participants that they have a shared responsibility to not share with others any discussion and who participates, but maintaining confidentiality and anonymity cannot be guaranteed.

5.2 Data Identifiers

1.0 * **Personal Identifiers:** will you be collecting - at any time during the study, including recruitment - any of the following *(check all that apply)*:
Telephone Number
Email Address
Full Face Photograph or Other Recording
Age at time of data collection

2.0 **Will you be collecting - at any time of the study, including recruitment of participants - any of the following** *(check all that apply)*:
There are no items to display

3.0 * **If you are collecting any of the above, provide a comprehensive rationale to explain why it is necessary to collect this information:**
Telephone Number, Email Address:
They will be used for the communication during the research for set a time for the workshop for example.

Full Face Photograph or Other Recording:
As the workshop is recorded via video camera and there is a photography during the workshop, we will have their video and images from them.

Age at time of data collection:
It is essential to know who (in which age) answered questions and made materials for future home and other activities.This is an important part will be attached to each work.

Materials made during participatory workshop, images, and writing will remain anonymous
unless the participate would like to be acknowledged for his or her work. In this case, the participate will have to fill out and sign a consent for acknowledgement form.
Interviewed participants will be asked on the consent forms whether of not they would like their name to be use as part of my thesis report and/or exhibition. This will give them the opportunity to have their opinions cited and connected to their name to preserve intellectual property if they consent to do so.

4.0 **If identifying information will be removed at some point, when and how will this be done?**
Telephone Number, Email Address will be removed from database after giving them feedback about the result of project and have their feedback on it. all the email and messages will be deleted from phone and computer.
Full Face Photograph or Other Recording and Age at time of data collection will be kept.

5.0 * **Specify what identifiable information will be RETAINED once data collection is complete, and explain why retention is necessary. Include the retention of master lists that link participant identifiers with de-identified data:**
Participants who wish to have their name attached to their opinions will be cited as part of my thesis report and/or exhibition. Therefore, the information will be retained in the thesis report.
Also, age will be attached to the work .

6.0 **If applicable, describe your plans to link the data in this study with data associated with other studies (e.g within a data repository) or with data belonging to another organization:**
-

5.3 Data Confidentiality and Privacy

1.0 * **How will confidentiality of the data be maintained? Describe how the identity of participants will be protected both during and after research.**
Protecting the anonymity of all people and treating them with courtesy and respect is essential in this research. The privacy of all individuals involved in this research will be respected at all times. Due to the nature of the group setting in the workshop anonymity cannot be guaranteed. However, confidentiality will be discussed at the beginning of the workshop. Participants will be informed that everything said in and done in the workshop will only be identified by pseudonyms if they like not to use their real name. After the interviews, and workshops all data will be documented using the chosen pseudonym. This will be the same for giving surveys feedback after designing the service.
Confidentiality in the interviews will be verbally explained before the interview begins and it will also be noted in the information letter given to the participants.
Visual, verbal and written data will be collected, documented and stored on an external hard drive,
with password protected encryption, and stored in a locked drawer. Also, all participants made materials will be kept in a locked drawer.

2.0 **How will the principal investigator ensure that all study personnel are aware of their responsibilities concerning participants' privacy and the confidentiality of their information?**
The researcher has no study personnel.

3.0

External Data Access

* **3.1 Will identifiable data be transferred or made available to persons or agencies outside the research team?**
○ Yes ● **No**

5.4 Data Storage, Retention, and Disposal

1.0 * **Describe how research data will be stored, e.g. digital files, hard copies, audio recordings, other. Specify the physical location and how it will be secured to protect confidentiality and privacy.** *(For example, study documents must be kept in a locked filing cabinet and computer files are encrypted, etc. Write N/A if not applicable to your research)*
Visual, verbal and written data will be collected, documented and stored on an external hard drive,
with password protected encryption, and stored in a locked drawer. Also, all participants made materials will be kept in a locked drawer.

2.0 * **University policy requires that you keep your data for a minimum of 5 years following completion of the study but there is no limit on data retention. Specify any plans for future use of the data. If the**

user does not have the Principal Investigator role in REMO. Click the following link for instructions on how to Request an Additional Role.

Name	Employer
There are no items to display	

10.01 **Study Team:** *(co-investigators, supervising team, and other study team members) - People listed here cannot view or edit this application and do not receive email notifications.*

Last Name	First Name	Organization	Role/Area of Responsibility	Phone	Email
There are no items to display					

1.5 Conflict of Interest

1.0 * **Are any of the investigators or their immediate family receiving any personal remuneration (including investigator payments and recruitment incentives but excluding trainee remuneration or graduate student stipends) from the funding of this study that is not accounted for in the study budget?**
○ Yes ● **No**

2.0 * **Do any of investigators or their immediate family have any proprietary interests in the product under study or the outcome of the research including patents, trademarks, copyrights, and licensing agreements?**
○ Yes ● **No**

3.0 * **Is there any compensation for this study that is affected by the study outcome?**
○ Yes ● **No**

4.0 * **Do any of the investigators or their immediate family have equity interest in the sponsoring company? (This does not include Mutual Funds)**
○ Yes ● **No**

5.0 * **Do any of the investigators or their immediate family receive payments of other sorts, from this sponsor (i.e. grants, compensation in the form of equipment or supplies, retainers for ongoing consultation and honoraria)?**
○ Yes ● **No**

6.0 * **Are any of the investigators or their immediate family, members of the sponsor's Board of Directors, Scientific Advisory Panel or comparable body?**
○ Yes ● **No**

7.0 * **Do you have any other relationship, financial or non-financial, that, if not disclosed, could be construed as a conflict of interest?**

data will become part of a data repository or if this study involves the creation of a research database or registry for future research use, please provide details. *(Write N/A if not applicable to your research)*
Data will be used for the Master of Design thesis report, exhibition and in research papers. All the raw data will not destroyed for at least 5 years. This would include audio and video recordings, photographs, and other data and material that are collected.

3.0

If you plan to destroy your data, describe when and how this will be done? Indicate your plans for the destruction of the identifiers at the earliest opportunity consistent with the conduct of the research and/or clinical needs:
personal identifiers (phone number and email addresses) will be destroyed right after finishing research, and all the raw data will not destroyed for at least 5 years. This would include audio and video recordings, photographs, and other data and material that are collected.

Documentation

Add documents in this section according to the headers. Use Item 11.0 "Other Documents" for any material not specifically mentioned below.

Sample templates are available in the REMO Home Page in the **Forms and Templates**, or by clicking HERE.

1.0 Recruitment Materials:

Document Name	Version	Date	Description
9- EMAIL INVITATION - User.pdf	0.11	3/19/2019 11:34 AM	
11- EMAIL INVITATION - Initial email for those accept to participate - User.pdf	0.11	3/19/2019 11:34 AM	
10- EMAIL INVITATION - Expert.pdf	0.05	3/19/2019 10:04 AM	
16- Poster advertisement 6.pdf	0.02	3/15/2019 11:18 AM	

2.0 Letter of Initial Contact:

Document Name	Version	Date	Description
3- INFORMATION LETTER - Interview with expert.pdf	0.10	3/19/2019 10:04 AM	
2- INFORMATION LETTER - Workshop and Semi-structured interview with user.pdf	0.07	3/19/2019 10:04 AM	

3.0

Informed Consent / Information Document(s):

3.1 What is the reading level of the Informed Consent Form(s):
simple

3.2 Informed Consent Form(s)/Information Document(s):

Document Name	Version	Date	Description
8- CONSENT FORM - Interview- Expert.pdf	0.10	3/19/2019 11:34 AM	
4- CONSENT FORM - Semi-structured Interview - User.pdf	0.10	3/19/2019 10:05 AM	
6- CONSENT FORM - Workshop - User.pdf	0.07	3/19/2019 11:33 AM	
7- CONSENT FORM - After activities - User.pdf	0.04	3/19/2019 10:06 AM	
5- CONSENT FORM - Homework activities - User.pdf	0.04	3/19/2019 11:33 AM	

4.0 Assent Forms:

Document Name	Version	Date	Description
There are no items to display			

5.0 Questionnaires, Cover Letters, Surveys, Tests, Interview Scripts, etc.:

Document Name	Version	Date	Description
12- Interviews questions - Experts.pdf	0.02	3/15/2019 11:18 AM	
13- Oral instructions for interview with User.pdf	0.02	3/15/2019 11:19 AM	
14- Oral instructions for the Homework.pdf	0.02	3/15/2019 11:19 AM	
15- Workshop Protocol.pdf	0.03	3/15/2019 2:00 PM	
17- Homework activities.pdf	0.02	3/19/2019 11:34 AM	

6.0 Protocol/Research Proposal:

Document Name	Version	Date	Description
1- PROTOCOL.pdf	0.09	3/19/2019 10:07 AM	

7.0 Investigator Brochures/Product Monographs:

Document Name	Version	Date	Description
There are no items to display			

8.0 Health Canada No Objection Letter *(NOL)*:

Document Name	Version	Date	Description
There are no items to display			

9.0 Confidentiality Agreement:

Document Name	Version	Date	Description
There are no items to display			

10.0 Conflict of Interest:

Document Name	Version	Date	Description
There are no items to display			

11.0 Other Documents:
For example, Study Budget, Course Outline, or other documents not mentioned above

Document Name	Version	Date	Description
There are no items to display			

Final Page

You have completed your ethics application! Click "Continue" to go to your study workspace.

This action will NOT SUBMIT the application for review.

Only the Study Investigator can submit an application to the REB by selecting the "SUBMIT STUDY" button in My Activities for this Study ID:Pro00086353.

○ Yes ● **No**

Please explain if the answer to any of the above questions is Yes:

Important
If you answered YES to any of the questions above, you may be asked for more information.

1.6 Research Locations and Other Approvals

1.0 * **List the locations of the proposed research, including recruitment activities. Provide name of institution, facility or organization, town, or province as applicable**
Edmonton

2.0 * **Indicate if the study will use or access facilities, programmes, resources, staff, students, specimens, patients or their records, at any of the sites affiliated with the following** *(select all that apply):*
Not applicable

List all health care research sites/locations:

3.0 **Multi-Institution Review**

* **3.1 Has this study already received approval from another REB?**
○ **Yes** ● **No**

4.0 **If this application is closely linked to research previously approved by one of the University of Alberta REBs or has already received ethics approval from an external ethics review board***(s)*, **provide the study number, REB name or other identifying information. Attach any external REB application and approval letter in the Documentation Section – Other Documents.**

2.1 Study Objectives and Design

1.0 **Provide planned start and end date of human participant research.**

Start Date:
11/5/2018

End Date:
11/11/2019

2.0 * **Provide a lay summary of your proposed research which would be understandable to general public**

The population of the older adults is increasing rapidly compared to the other groups. This phenomenon has different consequences for society and needs to be dealt with urgently. One of the important areas is health-

related concerns for both individuals and governments. In this regard, new smart health technologies would be very helpful and effective for independent life.

The broad aim of this research is to study the factors that make a smart home helpful, effective, and appealing for older adults. A smart home is a convenient home setup where appliances and devices can be controlled automatically and remotely; smart health technologies at these homes monitor health-related issues by using a mobile or other networked devices. If something is amiss (for example, a person has a fall or doesn't take their medication) family and/ or care providers can be notified immediately. However, the person living in the smart home maintains his or her autonomy and sense of independence. Also, these homes feature direct connections to family members and health professionals.

For finding the above mentioned factors, we are going to adopt a participatory research approach in the study. The study focuses mainly on better understanding of the personal everyday experiences, interactions, and preferences about health services and supports at home. Unlike engineers who use technology or science as their starting point, designers start from people. Participatory design approach in this research attempts to actively involve stakeholders in the design process to help ensure the result meets target group's needs and will be usable. Therefore, a participatory workshop will be designed to precisely observe and closely collaborate with older adults. The design of this workshop will be based on the data collected from semi-structured interviews with the experts of the field.

Baby boomers as a group within the large group of older adults will participate in this study. Baby boomer is a term used to describe a person who was born between 1946 and 1964. The baby boomer generation makes up a substantial portion of the world's population, especially in developed nations. In near future they will be considered as older adults where as they are different with previous generations of older adults as they are familiar with new technologies. So, they should serve with different and new ways of services and product designed for older adults in near future.

This research will investigate what baby boomers like and do not like about living in a smart home in the future with a focus on health-related issues, how smart home technologies would affect the quality of their life, and how it will help them to be more independent at home. As a result of this investigation, we are hoping to provide further suggestions and/or improvements for the design of smart homes. The findings of this study are expected to be applied in developing a service (e.g. a website) to facilitate the communication and interactions between older adults and smart home providers in the future.

3.0 * **Provide a full description of your research proposal outlining the following:**

- **Purpose**
- **Hypothesis**
- **Justification**
- **Objectives**
- **Research Method/Procedures**
- **Plan for Data Analysis**

Purpose

The aims of this study are:

- To investigate the effectiveness of participatory design work in providing distance care for older adults to live more independently and comfortably in their place.

- To investigate the factors which are important for living in smart homes.
- To improve the existing smart home products and services for prospective users
- To provide suggestions for developing user-friendly designs; considering users in the process of designing a service is the key differentiator.

Hypotheses

- Designing smart homes with more empathy with users can increase the acceptance of such products and services. Therefore, older adults would be able to live independently and more importantly, comfortably with a sense of safety and security at their own home.
- Living in mart home is a vision that should be encouraged. It offers plenty of opportunities for patient empowerment and control, as well as lowering health expenses in many situations both for individuals and public health services.

Justification

- According to United Nations report in 2015, virtually all countries are expected to see substantial growth in the number of older persons between 2015 and 2030, and that growth will be faster in the developing regions than in the developed regions. Statistics show that the seniors in 2016, for the first time in Canada, slightly outnumbered the children at 14 or under.
- In older ages, people are more likely to face physical and mental problems which would reduce the chance of living independently. Older adults may also encounter psychological issues such as loneliness; e.g., it can be caused by the loss of immediate relatives and children leaving home.
- Baby Boom Generation will be a different generation of seniors, comfortable with technology and with different expectations for a health care system that engages them and adapts to their needs and preferences. So, there is a need to study their needs and preferences.
- Technology is now in place as a key differentiator in service delivery. Using new technologies can address the problems as mentioned earlier for improving the quality of older adults' lives. Smart home technologies as a good example can provide distance control for both care providers and specialists to give more individual and close care to the users of such homes.
- Discovering target group motivations, desires, and the process of decision making is the main factor to promote the feeling of being safe and secure in a smart home.
- Smart homes can add value to the healthcare continuum of care, improve the quality of care, and reduce the mounting pressures on a healthcare system that in many ways is over capacity. Also, experts agree that many health conditions, especially chronic diseases, could be monitored and treated in a home equipped with necessary smart home products.

Objectives

The study has four primary objectives:

1) To better understand older adults' preferences and needs: what they like, what their priorities are, and what their expectations are

about future healthy smart homes that can be installed in their houses. Also, we can better understand what they do not like about existing health-related technologies.

2) To Provide more opportunity for collaboration between the providers of smart homes and older adults for designing home in the future. For designing smart home services, we need to go to the process that brings together skills, methods, and tools for increasing interaction with customers to create value for them, and to create long-term relationships between providers and customers.

3) To develop a participatory design model that can be adopted by the researchers and developers of smart homes in the future.

4) To come up with a set of design suggestions and guidelines related to health technologies for smart home providers to improve the quality of older adults' lives via good experiences which support their values.

Given these realities, many people – patients, family caregivers, governments, and smart home providers– are concerned about how high-quality and affordable smart homes could be provided in the future. These questions present genuine challenges, but also offer valuable opportunities to thoughtfully design services with more empathy.

Research Procedure

- Planning stage: This stage will consist of interviewing professionals such as occupational therapists, Computer scientists, and smart home providers. The interviews will allow the researcher to design the workshop as well as further interviews
- Research stage: This stage informed by the previous step and conduct literature reviews. The research method for this research is qualitative. It will be including two participatory workshops with older adults and semi- structured interviews with 4-8 experts. Each workshop will be around 2-3 hours long, with a break after each working hour. 3-4 volunteer participants will participate in each workshop; followed by semi- structured interviews or discussions. The workshops will be held at the university of Alberta. My role during the workshops will be recorded by camera.
- Production stage: At this stage, the materials from the workshops, semi- structured interviews with experts and literature reviews will be used for providing design suggestions and probably designing a service based on findings.
- Feedback stage: This stage is about showing the results of the production stage to participants, smart home providers, and specialists in order to get feedback on the designed services and required refinements. The survey will provide information on the effects of designed services and the messages they convey. During all stages, participants' identities will be protected.

Research Method

In this participatory design research, we consider older adults as 'experts of their experiences' that play a huge role in knowledge development, idea generation, and concept development. In our approach to designing for service innovation, we integrate some activities across a service development process that includes exploratory, generative, and evaluative research. In this research we have organized our approach within a conventional design process framework, leveraging exploratory, generative, and evaluative

research methods along the way. So, the research has three main steps:

First, explore— Uncovering and Understanding Latent and Masked Needs: In this exploratory research, techniques are used to define "what is" in the current situation. The Methods used is drawn from ethnography, including semi-structured interviews, participant observation, and contextual inquiry.

Second, generate— Determining What Is Meaningful: In generative research, the goal is to verify the framing of the "what is" and assumptions about how to respond to the needs identified with representatives of the service participants. Pre activities such as photography and first part of the workshops designed for this reason which is generative. Early on in generative research the activities are more projective and include exercises that help people express ideas, emotions, and desires, the exercises are designed to help people express or explore what is usually hard for them to communicate.

Third, co-creation— exploring what is in the future: the goal is to better understand about future of needs and future of technologies. A participatory workshop will be the main tool for knowing about these issues. The activities in the second part of the workshop are intended to improve collaborations between designers and participants in sessions to encourage creativity and conversations. This Participatory Design workshop is simple exercises in which we give our participants the tools to create and design mock-ups of the smart home they would love to use in the "perfect world" scenario while also asking them to explain why they built their perfect smart home in that particular way. From observing their building process and listening to their explanations on why they built something in this or that way, we learn a lot of the things we wouldn't understand through a mere interview with the user.

Plan for Data Analysis

In order to generate findings that transform raw data into new knowledge, this is the strategy for this research to analyse the qualitative data:

- Taking notes in the field, at the time of observation, interviewing, and workshops, as the researcher identifies problems and concepts that appear likely to help in understanding the situation.
- Writing transcripts; I will make frequent notes in the margins to identify important statements and to propose ways of coding the data
- Developing and Applying Codes by making list of the concepts reflected in the notes and diagramming the relationships among concepts with affinity diagram. Coding can be explained as categorization of data. A 'code' can be a word or a short phrase that represents a theme or an idea. All codes will have meaningful titles.
- Identifying themes, patterns and relationships. Analytical and critical thinking skills of researcher plays significant role in data analysis in this qualitative research. Looking for *Word and phrase repetitions, Primary and secondary data comparisons, Search for missing information, Metaphors and analogues*, comparing primary research findings to phenomena from a different area and discussing similarities and differences are examples of activities for identifying themes and patterns.
- Summarizing the data would be the last phase for analyzing the data

4.0 **Describe procedures, treatment, or activities that are above or in addition to standard practices in this study area** *(eg. extra medical or health-related procedures, curriculum enhancements, extra follow-up, etc)*:
Mentioned above

5.0 **If the proposed research is above minimal risk and is not funded via a competitive peer review grant or industry-sponsored clinical trial, the REB will require evidence of scientific review. Provide information about the review process and its results if appropriate.**
-

6.0 **For clinical trials, describe any sub-studies associated with this Protocol.**
-

2.2 Research Methods and Procedures

Some research methods prompt specific ethical issues. The methods listed below have additional questions associated with them in this application. If your research does not involve any of the methods listed below, ensure that your proposed research is adequately described in Section 2.1: Study Objectives and Design or attach documents in the Documentation Section if necessary.

1.0 * **This study will involve the following***(select all that apply)*
Interviews and/or Focus Groups
Materials created by participants (eg. artwork, writing samples, photo, voice, etc.)
Participant Observation

NOTE 1: Select this ONLY if your application SOLELY involves a review of paper charts/electronic health records/administrative health data to answer the research question. If you are enrolling people into a study and need to collect data from their health records in addition to other interventions, then you SHOULD NOT select this box.

NOTE 2: Select this option if this research ONLY involves analysis of blood/tissue/specimens originally collected for another purpose but now being used to answer your research question. If you are enrolling people into the study to prospectively collect specimens to analyze you SHOULD NOT select this box.

2.5 Interview and/or Focus Groups

1.0 **Will you conduct interviews, focus groups, or both? Provide detail.**
Semi- structured Interviews (eg. in person, Skype, etc)
Participatory Action Research(eg. participatory workshop)

2.0 **How will participation take place (e.g. in-person, via phone, email, Skype)?**
In person:
All interviews will be one on one
Each workshop will be in as small group of 3-4

Skype:
There is a probability of needing to have an interview with experts in the field and people from health- smart home industry via Skype in a private room

3.0 **How will the data be collected (e.g. audio recording, video recording, field notes)?**
Recording voice
Recording video
Field notes
Photography by participants from the home environment and some daily products

2.6 Material Created by Participants

1.0 **Provide a summary of the materials created by participants that will be included in this research project:**
They are given some materials such as printed photos (these photos were taken from objects and places from home), papers, sticky notes, pens and so on to make some collages.
They are given a floor plan of a home to make it as a health smart home they prefer to have in the future.
Also as an activity they will ask to take some photo from their home environment and home objects

2.0 **Who will have access to this data?**
Just the researcher and the supervisor

3.0 **When publicly reporting data or disseminating results of your study (eg. presentation, reports, articles, books, curriculum material, performances, etc) that include the materials created by participants, what steps will you take to protect those who may be represented or identified - both participants and non-participants?**
Collected data may be shown in the Master's exhibition, thesis documentation, reports, public presentations and papers. Participants will only be identified by any name they prefer(real name or chosen pseudonyms).
Should the researcher quote any of their comments, researcher will use any name they prefer(real name or chosen pseudonyms). to ensure anonymity. Data will be kept in a secure place for 6 years following completion of the research, electronic data will be password protected and devices will be encrypted.

4.0 **What opportunities are provided to participants to choose to be identified as the author/creator of the materials created in situations where it makes sense to do so?**
The workshop and semi-structured interviews with older adults, participants are free to choose a pseudonyms and I will use any name they prefer to ensure anonymity.

5.0 **If necessary, what arrangements will you make to return original**

Appendix 2: Ethics Application Support Documents

PROTOCOL

Participatory Study

Study Title: Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach with a focus on health-related technologies

Principal Investigator: Azadeh Mokhberi, University of Alberta, mokhberi@ualberta.ca, (780) 919-6829

There are two main group of participants in this research. One will be experts in the area of smart technologies, older adults and design. The other group will be potential users of health-smart homes born between/ around 1944 and 1964.

Before the activities take place on the day of the interviews or workshop, all participants will be informed about the research study details, benefits, risks and details. They will then be asked to read a consent form and sign it. The older adults will choose whether or not they allow me—the researcher—to use their visualizations, images, and made works from the activities as part of my final research report and thesis exhibition. They will also sign the consent form in order to notify me if the data from discussions and pictures from the workshop can be included as part of the research project.

The role of me—the researcher— at the start of research is explaining the process of participating in this research. This research contains interviews with experts and users separately, homework activities such as photography, and a participatory workshop.

The role of me—the researcher— at the workshop is facilitating the process of creativity for participants. I will explain to them about three steps at the workshop and then the materials they can use for each part and what is required as an outcome of the workshop. Then after finishing part one—making a smart home, they will use their imagination for future life they would prefer to have in a smart home with a focus on health-related technologies, In this part, they will use photos taken from their home to make it more personalized. , in part two— there is a short lecture about health-smart home technologies which are exists and some video will be shown to provide a better perception about health-smart homes. , In part three, we will have group discussion and activities based on previous steps.

The rationale behind providing this participatory workshop is to have a better understanding of older adults' expectations, and desires for designing a smart home and designing with people instead of for them as we consider them as the experts of their life. The concepts behind the process of the workshop are providing a framework for individuals by tools and techniques such as using open questions, metaphors, ambiguity in activities, and storyboards which will lead to boasting people's creativities. This framework contains three layers of exploration; knowing about the facts in their lives, asking about what they enjoyed and preferred, what was the rationale or reasons behind that and their desires for the future.

REB Project Number: Pro00086353

INFORMATION LETTER

Participatory Study| Workshop and Semi-structured interview with user

Study Title: Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach with a focus on health-related technologies

Research Investigator:
Azadeh Mokhberi
3-71B FAB
University of Alberta
Edmonton, Alberta, Canada T6G2E5
mokhberi@ualberta.ca

Supervisor:
Aidan Rowe
3-77A FAB
University of Alberta
Edmonton, Alberta, Canada T6G2E5
aidan.rowe@ualberta.ca

Background

To better understand important factors for designing health-smart home, you are being asked to participate in this study. Your experiences and understanding of the daily activities, health plan and technology usage are the main issues researcher need to know more about in this study.

The results of this study will be used in support of my Master's thesis report and exhibition, and other related papers and presentations in academia (e.g. conferences, published papers, etc.).

Research participants include people who were born between/ around 1944 and 1964 and who live in Edmonton

Purpose

The proposed research aims to investigate the factors which makes a health-smart home helpful, effective and appealing for older adults in the near future.

The research outcomes could lead to the dissemination of information about the better design of smart homes and provide design suggestions with a focus on health-related technologies.

Study Procedures

You are being asked to participate in an interview, doing some homework activities such as photography (at home and this is between the interview and the workshop), and participating in a workshop to design and create future health-smart home.

List of activities:

1) The first step is having interview at your home: The interview will take around 30-45 Minutes. It mostly is about me gaining knowledge about your lifestyle, daily activities, and health condition and plan.

2) The second step is doing some homework activities to become ready for the workshop. At the end of the interview, you will be given some homework to do them before coming to the workshop. It includes photography, a short writing activity and word game. The purpose of these activities is for researcher to know more about places and objects that are in favour of the users; It will help researcher to have a better idea about your current problem with living environment and your preferences in the home

REB Project Number: Pro00086353

environment. Also, these activities will prepare you for the workshop activities. You will have 7days to complete them.

As you will need to use these photos from your living environment in the next step, photography will not an optional task but researcher could help you doing that.

3) The third step is participating in a workshop: You will be invited to join other participants (4 to 10 people) with age range between/ around 55-75. The workshop activities will be held in three parts with refreshments in between. Each part will be approximately 30-45 minutes and the workshop will take 3 hours at most. In individual activities, you will use photography (photos that you take in previous step), drawing, writing note, and art marking to illustrate your daily experiences, to design a health-smart home which you prefer to live in the future. In group activities, you will be asked to brainstorm and explore concepts for the design of a health-smart home. Then you will see some examples of health smart technology used at home; we will have group discussion about what you designed.

During the workshop my role is to facilitate the design process and discussion.

Data will be collected by way of voice recording for interviews. Video as well as photography will be recorded during the workshop by researcher. All material created by participants will be collected and used by researcher for data analyzes and will not be returned (print and digital copies provided to the researchers will not be returned). Recording video from workshop will be helpful to show during presentation of the research to show the role and importance of participatory research in academia (e.g. conferences, published papers, etc.). It will help other researcher to see the process of participatory work and the innovation happening during such collaborative works.

Names will not be attached to any of the data that is collected. For each participant researcher will use a pseudonym or using an alphabet letter to identify data from interview, the artworks and photos.

Benefits

Adding to the existing body of knowledge around design for smart homes with a focus on health-related technologies.

Identifying possibilities for using participatory design (Participatory design is an approach to design attempting to actively involve future users in the design process to help ensure the result meets their needs and is usable)

The participatory design approach in this research will be beneficial for the researcher to gain a better and in-depth understanding about users' needs and desires about future health-smart homes

Participants could gain some knowledge about health smart technologies which are currently available, their usage and some are underdevelopment.

For participants there may not be direct benefits

Risk

The risk to participants is minimal and no greater than what may be expected during everyday activities

Voluntary Participation

You are under no obligation to participate in this study

Participation in this research is completely voluntary and has no penalty or gain attached to it

REB Project Number: Pro00086353

Even if you agree to be in the study, you can change your mind and withdraw from the research activity including the interview or workshop at any time without consequence

For answering any questions, you are not under any obligation to answer if you do not wish to

Concerning the interview, you can withdraw your answers before the workshop day. After workshop day you can not withdraw your interview data from the study.

Concerning the homework materials (including photos and writings), you can withdraw or modify your answers before the workshop day. After the workshop begins, you can not withdraw your materials and photos from the study.

Concerning the workshop, once the workshop begins, it will no longer be possible to withdraw all materials made individually or in a group, but you can elect to stop at anytime. As participants will be working together throughout the workshop and contributing to all created material together it is impossible to remove individual contributions and materials as well. However, you can leave the workshop anytime without any consequences by letting the researcher know.

Agreed travel costs associated with participating in this research (such as bus ticket, parking) will be paid by researcher

Confidentiality & Anonymity

Collected data may be shown in my Master's thesis report and exhibition, public presentations in academia and in written articles for academic journals.

Photos taken by participants, artworks and written materials collected from participants could be presented in academia (e.g. conferences, published papers, etc.). Also, video taken from workshop will be shown in public places in academia such as exhibitions, galleries which are related to academic research. Also, in academic papers, conferences and publications.

All photos will be shown to participants to make sure they are satisfied with what will be published.

For the photos or video in the workshop, if you are not giving consent to be identified, your face will be covered or blurred in all publications.

All the data that will be gathered during interviews will be kept confidential. If is necessary to quote you, a pseudonym will be used.

You will not be identified by name in the exhibitions, reports, public presentations and in written articles

Data will be kept in a secure place for at least 5 years following the completion of my research project

Any information about your personal identity like your name, email, address will be removed from material or files. As the workshop will be recorded by video and photos will be taken, steps will be taken for anonymity, however as this research may be also be shown in public it may be impossible to be guaranteed

Visual, verbal and written data will be collected, documented and stored on an external hard drive, with password protected encryption, and stored in a locked drawer. Also, all participants made materials will be kept in a locked drawer. Electronic data will be password protected and devices will be encrypted

REB Project Number: Pro00086353

The privacy of all individuals involved in this research will be respected at all times. Due to the nature of group activities, it is a shared responsibility of the researchers and the participants not to discuss what happens and who attended to workshop to others, still workshop confidentiality and anonymity cannot be guaranteed.

The results and photos of participatory activities will be presented in exhibition, articles and other related papers and presentations in academia. The researcher can control what information is included in any presentation, but cannot control whether someone recognizes a participant in those photos and videos. It will be guaranteed that participants will see these prior to being presented, and they will be able to ask that they not be included or their image modified

A week after the workshop day, you will be asked to sign a consent form to give permission for the photos that you take or photos of you which will be publish or presented in academia (e.g. conferences, published papers, etc.)

The data for all uses will be handled in compliance with University of Alberta standards.

Further Information

If you have any further questions regarding this study, please do not hesitate to contact me,
Azadeh Mokhberi at mokhberi@ualberta.ca, or my graduate supervisor Aidan Rowe at aidan.rowe @ualberta.ca
The Research Ethics Board at the University of Alberta has reviewed the research plan, for its adherence to ethical guidelines. For questions regarding participants' rights and ethical conduct of research, contact the Research Ethics Office at (780) 492-2615. This office has no direct involvement with this project.

REB Project Number: Pro00086353

CONSENT FORM

Participatory Study | Homework activities - User

Study Title: Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach with a focus on health-related technologies

Principal Investigator: Azadeh Mokhberi, University of Alberta, mokhberi@ualberta.ca,

Research Activities for Homework: You will be asked to take 5 to 8 pictures from pre-specified parts of your home and objects that you regularly use at home and then send these to the researcher. Also, there are some small writing activities about your life experiences and a word game related to the concepts of care, home, technology and future.

Research Investigator:
Azadeh Mokhberi
3-71B FAB
University of Alberta
Edmonton, Alberta, Canada T6G2E5
mokhberi@ualberta.ca

Supervisor:
Aidan Rowe
3-77A FAB
University of Alberta
Edmonton, Alberta, Canada T6G2E5
aidan.rowe@ualberta.ca

Do you understand that you can withdraw interview and homework data from the research only before starting the workshop, without consequence?	Yes	No
Do you understand you can not withdraw any of data after workshop started?	Yes	No
Do you understand I will use the photos that you take of your home and objects in my research?	Yes	No
Do you give me permission to publish all homework materials such as photos, artworks and written materials collected from homework activities in academia?	Yes	No
I realize and accept that there is a chance that my identity will be revealed through photos Or responds from this research	Yes	No
Do you understand that you are free to refuse to participate, or to withdraw from the research at any time, without consequence?	Yes	No

REB Project Number: Pro00086353

This study was explained to me by the researcher, Azadeh Mokhberi
I have read and understood the attached information letter and agree to take part in this study:

Participant Name: ……

Signature of Participant: …… Date (yyyy-mm-dd):……

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

Signature of Investigator: …… Date (yyyy-mm-dd):……

You will receive a signed copy of this form to keep.

REB Project Number: Pro00086353

INFORMATION LETTER

Participatory Study | Interview with expert

Study Title: Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach with a focus on health-related technologies

Research Investigator:
Azadeh Mokhberi
3-71B FAB
University of Alberta
Edmonton, Alberta, Canada T6G2E5
mokhberi@ualberta.ca

Supervisor:
Aidan Rowe
3-77A FAB
University of Alberta
Edmonton, Alberta, Canada T6G2E5
aidan.rowe@ualberta.ca

Background

You are being asked to participate in this study because of your experiences, knowledge and expertise will help me to conduct this research in a better way and it is a very important part of my research

The results of this study will be used in support of my Master's thesis report and exhibition, and other related papers and presentations

Purpose

The proposed research aims to investigate the factors which makes a smart home helpful, effective and appealing for older adults in the near future.

The research outcomes could lead to the dissemination of information about the better design of smart homes and provide design suggestions with a focus on health-related technologies.

Study Procedures

You are being asked to participate in a one-on-on interview. The interview will be approximately 30-45 minutes. The information from the interview will enrich the research.
Data will be collected by way of a voice recording. Photos may be taken during the interview.

Benefits

Adding to the existing body of knowledge around design for smart homes with a focus on health-related technologies.

Identifying possibilities for using participatory design (Participatory design is an approach to design attempting to actively involve future users in the design process to help ensure the result meets their needs and is usable)

The participatory design approach in this research will be beneficial for the researcher to gain a better and in-depth understanding about users' needs and desires about future health-smart homes

REB Project Number: Pro00086353

For participants there may not be direct benefits

Risk

The risk to participants is minimal and no greater than what may be expected during everyday activities

Voluntary Participation

You are under no obligation to participate in this study

Participation in this research is completely voluntary and has no penalty or gain attached to it

Even if you agree to be in the study, you can change you mind and withdraw from the research activity including the interview or workshop at any time before the activity without consequence

For answering any questions, you are not under any obligation to answer if you do not want to

Concerning the interview, you can withdraw or modify your answers within two weeks after the interview. Due to preventing research suffering from a large setback, you can not change or withdraw from this research from two weeks after the interview

You are free to choose the place for interview at your place or University of Alberta

Data Handling

Collected data may be shown in my Master's thesis report and exhibition, public presentations and in written articles

Data will be kept in a secure place for at least 5 years following the completion of my research project

Electronic data will be password protected and devices will be encrypted

The data for all uses will be handled in compliance with the University of Alberta standards

Further Information

If you have any further questions regarding this study, please do not hesitate to contact me,
Azadeh Mokhberi at mokhberi@ualberta.ca, or my graduate supervisor Aidan Rowe at aidan.rowe @ualberta.ca
The Research Ethics Board at the University of Alberta has reviewed the research plan, for its adherence to ethical guidelines. For questions regarding participants' rights and ethical conduct of research, contact the Research Ethics Office at (780) 492-2615. This office has no direct involvement with this project.

REB Project Number: Pro00086353

CONSENT FORM

Participatory Study | Semi-structured Interview - User

Study Title: Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach with a focus on health-related technologies

Principal Investigator: Azadeh Mokhberi, University of Alberta, mokhberi@ualberta.ca,

Research Activities in the interview: the researcher will conduct a one-on-one semi-structured interview with you for 30 to 45 minutes.

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Supervisor:
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3-77A FAB
University of Alberta
Edmonton, Alberta, Canada T6G2E5
aidan.rowe@ualberta.ca

Do you understand that you have been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached Information Sheet?	Yes	No
Do you understand the benefits and risks involved in taking part in this research?	Yes	No
Have you had an opportunity to ask questions and discuss this research?	Yes	No
Do you understand that you are free to refuse to participate, or to withdraw from the research, without consequence at any point during this research?	Yes	No
Has the issue of confidentiality been explained to you?	Yes	No
Do you understand who will have access to your information?	Yes	No
Do you understand I will use the photos taken during interview in presenting my work public in academia such as exhibitions and publishing the result such as papers?	Yes	No
I realize and accept that there is a chance that my identity will be revealed through Photos and videos in reports from this research	Yes	No

REB Project Number: Pro00086353

Do you understand that I will voice record the interview? Yes No
(It is needed to provide accurate transcripts and without
Giving permission to voice record, the interview will not be conducted)

This study was explained to me by the researcher, Azadeh Mokhberi
I have read and understood the attached information letter and agree to take part in this study:

Participant Name: ……

Signature of Participant: …… Date (yyyy-mm-dd):……

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

Signature of Investigator: …… Date (yyyy-mm-dd):……

You will receive a signed copy of this form to keep.

REB Project Number: Pro00086353

CONSENT FORM

Participatory Study |Workshop - User

Study Title: Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach with a focus on health-related technologies

Principal Investigator: Azadeh Mokhberi, University of Alberta, mokhberi@ualberta.ca,

Research Activities in the workshop: You will be asked to participate in a workshop that the researcher will facilitate. It will be a participatory workshop, which will last 3 hours at most, with refreshment and breaks. There will be 3 to 10 participants and it will be held at the University of Alberta. If needed travel costs and parking costs will be paid by researcher. It will have three main parts, asking participants to use materials to design a future health-smart home, we will also have a group discussion around health, design and technology.

Research Investigator:
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Supervisor:
Aidan Rowe
3-77A FAB
University of Alberta
Edmonton, Alberta, Canada T6G2E5
aidan.rowe@ualberta.ca

Do you understand that you have been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached Information Sheet?	Yes	No
Do you understand the benefits and risks involved in taking part in this research?	Yes	No
Have you had an opportunity to ask questions and discuss this research?	Yes	No
Do you understand that you can not withdraw data of workshop from the sresearch?	Yes	No
Do you understand that you are free to refuse to participate, or to withdraw from the research at any time, without consequence?	Yes	No
Has the issue of confidentiality been explained to you?	Yes	No
Do you understand who will have access to your information?	Yes	No
Do you understand that anonymity cannot be guaranteed within a group workshop setting?	Yes	No
Do you understand that the workshop will be video taped? (It is needed for reviewing workshop activities, providing an accurate report	Yes	No

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and presentation of the workshop as part of my research)

I realize and accept that there is a chance that my identity will be revealed through photos and videos in reports from this research	Yes	No
Do you understand that the workshop will be photographed? (It is needed for reviewing workshop activities, providing an accurate report and presentation of the workshop as part of my research)	Yes	No
Do you understand that all the group made materials of all participants will be published for dissemination/publication/presentation? (If you say no, it is not possible to participate in workshop)	Yes	No

This study was explained to me by the lead researcher, Azadeh Mokhberi
I have read and understood the attached information letter and agree to take part in this study:

Participant Name: ……

Signature of Participant: …… Date (yyyy-mm-dd):……

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

Signature of Investigator: …… Date (yyyy-mm-dd):……

You will receive a signed copy of this form to keep.

REB Project Number: Pro00086353

CONSENT FORM

Participatory Study | After activities - User

Study Title: Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach with a focus on health-related technologies

Principal Investigator: Azadeh Mokhberi, University of Alberta, mokhberi@ualberta.ca,

Research Investigator:
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Supervisor:
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3-77A FAB
University of Alberta
Edmonton, Alberta, Canada T6G2E5
aidan.rowe@ualberta.ca

Have you received a copy of all photos taken from you during this study?	Yes	No
Do I have your permission to publish your taken photo and photo of you during interview for dissemination/publication/presentation?	Yes	No
Do I have your permission to publish your homework and individual made materials during workshop for dissemination/publication/presentation?	Yes	No
Do you ask me to remove any of the above mentioned materials for dissemination/publication/presentation? If yes, please mention which one	Yes	No
Do you ask me to obscure you in any of workshop's photos taken from you for dissemination/publication/presentation? If yes, please mention which part from which photo?	Yes	No
Do you ask me to obscure you in any of workshop's video taken from you for dissemination/publication/presentation? If yes, please mention which part from which photo?	Yes	No

REB Project Number: Pro00086353

This study was explained to me by the lead researcher, Azadeh Mokhberi
I have read and understood the attached information letter and agree to take part in this study:

Participant Name: ……

Signature of Participant: …… Date (yyyy-mm-dd):……

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

Signature of Investigator: …… Date (yyyy-mm-dd):……

You will receive a signed copy of this form to keep.

REB Project Number: Pro00086353

CONSENT FORM

Participatory Study | Interview- Expert

Study Title: Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach with a focus on health-related technologies

Principal Investigator: Azadeh Mokhberi, University of Alberta, mokhberi@ualberta.ca, (780) 919-6829

Research Investigator:
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Supervisor:
Aidan Rowe
3-77A FAB
University of Alberta
Edmonton, Alberta, Canada T6G2E5
aidan.rowe@ualberta.ca

Do you understand that you have been asked to be in a research study?	Yes	No
Have you read and received a copy of the attached Information Sheet?	Yes	No
Do you understand the benefits and risks involved in taking part in this research?	Yes	No
Have you had an opportunity to ask questions and discuss this research?	Yes	No
Do you understand that you are free to refuse to participate, or to withdraw from the research activity two weeks after the activity, without consequence?	Yes	No
Has the issue of confidentiality been explained to you?	Yes	No
Do you understand who will have access to your information?	Yes	No
Do I have your permission to audio record during the interview?	Yes	No
Do I have your permission to take picture during the interview?	Yes	No
Do I have your permission to quote you on my research with your real name? (If you say no, researcher will use pseudonym)	Yes	No

REB Project Number: Pro00086353

This study was explained to me by Azadeh Mokhberi
I have read and understood the attached information letter and agree to take part in this study:

Expert Name: ……

Signature of Expert: …… Date (yyyy-mm-dd):……

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

Signature of Investigator: …… Date (yyyy-mm-dd):……

You will receive a signed copy of this form to keep

REB Project Number: Pro00086353

UNIVERSITY OF ALBERTA

Volunteers Needed

Do you know the value of your life experiences towards health research?

Let's design a health-smart home together

Are you between 55 and 75?

You are invited to participate in this design research

The aim of this study is to design efficient health-smart homes, which are more user-friendly for older adults and will help them in future to live more independently in their home. For this purpose, we need to understand your needs, problems and barriers with the home environment and technological devices. Together, we will develop and design concepts for future homes.

Participants will be asked to

be interviewed | take photos | Participate in a Workshop

To join our team, Please contact Azadeh Mokhberi

Tel: [redacted]

Email: mokhberi@ualberta.ca

Appendix 3: Study Approval Letter by REB

Notification of Approval

Date:	March 20, 2019
Study ID:	Pro00086353
Principal Investigator:	Azadeh Mokhberi
Study Supervisor:	Aidan Rowe
Study Title:	**Service Design with Empathy: an investigation of smart homes for older adults with a participatory design approach** This is a participatory design research to better understand future users' needs and desires in smart homes with a focus on health-related technologies for smart homes.
Approval Expiry Date:	Wednesday, March 18, 2020
Approved Consent Form:	Approval Date Approved Document 3/20/2019 4- CONSENT FORM - Semi-structured Interview - User.pdf 3/20/2019 7- CONSENT FORM - After activities - User.pdf 3/20/2019 8- CONSENT FORM - Interview- Expert.pdf 3/20/2019 5- CONSENT FORM - Homework activities - User.pdf 3/20/2019 6- CONSENT FORM - Workshop - User.pdf

Thank you for submitting the above study to the Research Ethics Board 1. Your application has received a delegated review and been approved on behalf of the committee.

A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the Research Ethics Board does not encompass authorization to access the staff, students, facilities or resources of local institutions for the purposes of the research.

Sincerely,

Stanley Varnhagen, PhD.
Chair, Research Ethics Board 1

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Appendix 4: Thesis Exposition

Department of Art & Design
University of Alberta, 2019