Technologies Supporting Engagement in Everyday Activities in Later Life

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Technologies Supporting Engagement in Everyday Activities in Later Life

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This thesis calls for reimagining technological advancement from pure industrial innovation towards socially embedded, ethically grounded, and human-centred development. Policy frameworks must incentivise technological deployment that can support key aspects of health in older adults, such as engagement in everyday activities. Public investment should support community-based training programs, centralised information hubs, and national infrastructure that promotes equity in technology use and digital health. Technology must be envisioned as an adaptive, co-evolving companion in the everyday activities of ageing individuals. There is a need for an integrated approach to technology improvement that focuses on older adults.

WILLIAM SON GALANZA is a registered nurse with a master's degree in nursing from De La Salle University and a master's degree in medical science from the University of Gothenburg. With over 10 years of nursing experience, his expertise lies primarily in working with older adults. His PhD project was conducted within the Applied Gerontology research group, which is affiliated with the Centre of Ageing and Supportive Environments (CASE). He was also affiliated with the Swedish National Graduate School on Ageing and Health (SWEAH) during his PhD education.

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William Son Galanza

LUND UNIVERSITY

DOCTORAL DISSERTATION

Doctoral dissertation for the degree of Doctor of Philosophy (PhD) at the Faculty of Medicine at Lund University to be publicly defended on November 27th, 2025, at 13.00 in Belfragesalen D15 BMC Lund University, Sweden

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Abstract:

The global demographic is experiencing a significant increase in the ageing population, and simultaneously, technological advancements continue to reshape society. These trends highlight an urgent need and a unique opportunity to leverage technology. Smart home technology (SHT), welfare technology (WT), and wearable sensors can potentially support older adults in everyday activities. However, the development and research of such technologies is less focused on the needs and desires of older adults, which hinders adoption. Older adults need to be included in the broader process of technological development to ensure that innovations are relevant to their interests and independence, as well as to promote inclusion in an increasingly technology-oriented society.

This thesis employs a multi-method approach. We conducted a focus group in the first study aimed to examine factors that shape decision-making around adopting SHT among current and future generations of older adults. In the second study, we used a research circle process to elicit perspectives from members of current and future generations of older adults, professionals with expertise in SHT, and health science researchers. Co-produced prioritised ideas on SHT solutions that better match the needs and desires of older adults in supporting engagement in everyday activities were generated. We proceeded with a national survey for the third study. With the survey data, we investigated the relationship between various forms of WT user experiences and engagement in everyday activities. Finally, in the fourth study, we utilised a wearable sensor to collect data and develop a method to recognise everyday activities using deep learning models. This method can then be developed for monitoring purposes to potentially provide early detection of risks and optimise care to support independence among older adults.

The results of all four studies reveal the need for technological development that aligns with the needs, preferences, and lived experiences of older adults to better support engagement in everyday activities. The value and adoption rate of SHT, WT, and wearable sensors depend on a deeper understanding of how these technologies intersect with the complexity of everyday activities of older adults.

Key words: Older adults, quality of life, independence, gerontechnology, solutions, user, adoption, co-production, experiences, everyday activity patterns, artificial intelligence

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Populärvetenskaplig Sammanfattning på Svenska

Världens befolkning blir allt äldre samtidigt som den tekniska utvecklingen förändrar vårt samhälle i snabb takt. Dessa två trender skapar såväl ett behov som en unik möjlighet att använda ny teknik för att underlätta vardagliga aktiviteter för äldre personer. För att tekniska lösningar ska bli relevanta och verkligen stödja äldre personers självständighet och engagemang i vardagliga aktiviteter i ett alltmer digitaliserat samhälle behöver framtida användare involveras i utvecklingsprocessen. Hittills har dock forskning och utveckling inom teknikområdet i begränsad utsträckning utgått från äldres egna behov och önskemål. Genom att förstå och ta tillvara på äldre personers erfarenheter och perspektiv, kan tekniken vara mer användarvänlig som också används meningsfullt.

I avhandlingen används flera olika forskningsmetoder. I den första delstudien genomfördes fokusgrupper med tre generationer (30–39 år, 50–59 år och 70–79 år; n=9) för att undersöka attityder, behov och önskemål kring smart hem-teknologi (SHT). Vi studerade även faktorer som underlättar, respektive hindrar användningen av SHT. Den andra studien genomfördes som en forskningscirkel, där deltagare från tre generationer (30–39 år, 50–59 år och 70–79 år; n=9), två SHT experter samt fyra forskare inom hälsovetenskap möttes vid tre tillfällen och gemensamt skapade idéer om tekniska lösningar som bättre stödjer äldres engagemang i vardagliga aktiviteter. Den tredje studien analyserade hur olika erfarenheter av välfärdsteknik kan påverka möjligheten att delta i vardagliga aktiviteter med utgångspunkt i en nationell enkätundersökning. Den fjärde studien utvecklade en metod för att känna igen olika vardagliga aktiviteter med hjälp av bärbara sensorer och AI-baserade modeller. En sådan metod kan i framtiden användas för att främja självständighet, upptäcka hälsorisker i ett tidigt skede och optimera vård och omsorg för äldre personer.

Resultaten från de fyra studierna pekar samstämmigt på att teknikutveckling ska spegla den komplexa verkligheten i äldres vardag, samt beakta nuvarande livssituation såväl som hur äldre personer vill leva. För att framtida teknik ska bli värdefull och användbar för äldre personer krävs att teknikutvecklingen från industrin eller kommunerna, integreras i äldre personers vardagliga aktiviteter och utgår från deras önskemål. Genom långsiktiga samarbeten och samskapande metoder kan tekniken i högre grad utformas så att den motsvarar med äldres behov, preferenser och erfarenheter.

Abstract

The global demographic is experiencing a significant increase in the ageing population, and simultaneously, technological advancements continue to reshape society. These trends highlight an urgent need and a unique opportunity to leverage technology. Smart home technology (SHT), welfare technology (WT), and wearable sensors can potentially support older adults in everyday activities. However, the development and research of such technologies is less focused on the needs and desires of older adults, which hinders adoption. Older adults need to be included in the broader process of technological development to ensure that innovations are relevant to their interests and independence, as well as to promote inclusion in an increasingly technology-oriented society.

This thesis employs a multi-method approach. We conducted a focus group in the first study aimed to examine factors that shape decision-making around adopting SHT among current and future generations of older adults. In the second study, we used a research circle process to elicit perspectives from members of current and future generations of older adults, professionals with expertise in SHT, and health science researchers. Co-produced prioritised ideas on SHT solutions that better match the needs and desires of older adults in supporting engagement in everyday activities were generated. We proceeded with a national survey for the third study. With the survey data, we investigated the relationship between various forms of WT user experiences and engagement in everyday activities. Finally, in the fourth study, we utilised a wearable sensor to collect data and develop a method to recognise everyday activities using deep learning models. This method can then be developed for monitoring purposes to potentially provide early detection of risks and optimise care to support independence among older adults.

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List of papers

Paper I

Galanza, W. S., Offerman, J., Fristedt, S., Iwarsson, S., Malesevic, N., & Schmidt, S. M. (2025). Smart home technology to support engagement in everyday activities while ageing: A focus group study with current and future generations of older adults. *PloS one*, *20*(1), e0317352. https://doi.org/10.1371/journal.pone.0317352

Paper II

Galanza, W. S., Schmidt, S. M., Jonsson, O., Offerman, J., Iwarsson, S., Malesevic, N., & Fristedt, S. (Under Review). Co-produced ideas for smart home technology solutions to support engagement in everyday activities in later life

Paper III

Galanza, W. S., Fristedt, S., Malesevic, N., & Schmidt, S. M. (Under Review). The relationship between welfare technology experience and engagement in everyday activities

Paper IV

Galanza, W. S., Schmidt, S. M., Fristedt, S., & Malesevic, N. (Under Review). Recognition of everyday activities using experiment data from wearable sensors: A deep learning-based framework

Abbreviations

AI	Artificial Intelligence
ICF	International Classification of Functioning, Disability and Health
SEM	Structural Equation Modelling
SHT	Smart Home Technology
TAM	Technology Acceptance Model
UTAUT	Unified Theory of Acceptance and Use of Technology
WT	Welfare Technology

Introduction

Technology has become an essential part of everyday life across all countries, though to varying degrees. As older adults desire to maintain independence, technology-driven solutions such as smart home technology (SHT), welfare technology (WT), and wearable sensors have emerged as supportive tools. These technologies, encompassing a range of devices and systems, are created to enhance safety, security, convenience, and autonomy for older adults (Liu et al., 2016). In the long term, technologies can support older adults in remaining active by creating an environment where they can remain connected and engage in their interests (Liu et al., 2016; Ollevier et al., 2020). The potential of technologies is not limited to individual benefits but also extends to societal advantages by reducing healthcare costs, preventing health risks, alleviating caregiver burden, and addressing care labour shortages (Friedrich et al., 2023; Gathercole et al., 2021; Madara, 2016; Spano et al., 2018).

However, advances in technology are occurring simultaneously with the rapid ageing of populations worldwide. While technology can help address the needs and support the autonomy of older adults, it also raises concerns about accessibility, equity, and the readiness of systems to support this demographic shift. For example, a gap exists between individuals who can easily use technology and those who struggle to adopt it (Liu et al., 2016; United Nations Economic Commission for Europe, 2021; United Nations, 2022). Further studies are needed to deepen understanding of such technologies and identify ways to improve or develop them in order to promote greater adoption and provide solutions that better support older adults (Cook et al., 2016).

Societal Ageing

The ageing of the global population is a key contributing factor in the development of future societies. While the pace of this demographic shift varies between countries, it is consistently accelerating worldwide. Most countries in the world are experiencing growth in both the number and proportion of older adults in their populations. The global number of persons aged 80 or older is expected to triple between 2020 and 2050 (World Health Organisation, 2024). Sweden is experiencing a significant demographic shift, with one of the highest proportions of older adults in Europe. Approximately one-fifth of the population is aged 65 or older, and this proportion is steadily increasing (Statistics Sweden, 2022). In 2020, there were more than 2.6 million people in Sweden aged 60 years and older, representing a proportionally higher growth rate than the overall population (Statistics Sweden, 2022). Population ageing presents both challenges and opportunities: it will boost the demand for primary healthcare and long-term care, and require a huge and well-trained workforce, and a more age-friendly society (United Nations, 2022).

Most developed countries define older adulthood as beginning at age 65, whereas in many African contexts the threshold is set between 50 and 65 years (Aboderin & Beard, 2015; World Health Organisation, 2002). Although this cut-off is somewhat arbitrary, it is commonly linked to the age at which individuals become eligible for pension benefits. In Britain, the Friendly Societies Act of 1875 defined old age as beginning at any age after 50, although pension eligibility has more commonly been set at 60 or 65 years. The United Nations (UN) has not established a universal standard, but generally considers individuals aged 65 and above as older adults. This thesis will use 65 years of age and above as the general definition of an older adult (United Nations, 2022).

The Ageing Individual

Ageing is an inevitable phenomenon experienced by every human being. It is a universal, yet deeply personal experience shaped by a dynamic interplay of biological, social, and environmental factors (Bengtson & Settersten, 2016). This transformation has far-reaching implications for families, communities, and policy systems, necessitating a reconsideration of how societies understand and support ageing. Ageing is no longer associated merely with physical decline or retirement, but is increasingly recognised as a multifaceted stage of life that offers opportunities for growth, connection, and engagement (Chatterjee, 2019).

To understand the challenges and opportunities associated with ageing individuals, we must explore ageing from different perspectives, considering the unique needs and experiences of current older adults, as well as those of future older adults.

Current Older Adults

Today's older adults are navigating an era marked by rapid technological, social, and economic change. Older adults represent a diverse population with varying health conditions, cultural backgrounds, socioeconomic circumstances, and expertise (World Health Organisation, 2024). While some thrive in later life, maintaining high levels of independence and community involvement, others face significant challenges, including chronic health conditions, reduced mobility, and social isolation (Dannefer & Phillipson, 2010; Maresova et al., 2023; National Institute on Aging, 2019).

One of the defining characteristics of current older adults is their exposure to a period of profound societal transformation, from the Industrial Era to the Digital Age. This has influenced their attitudes towards technology, healthcare, and social engagement (Gorayeb et al., 2021). Studies reveal that older adults are more likely to embrace traditional modes of social interaction and healthcare. However, they also demonstrate adaptability when provided with the right training and support (Kamin et al., 2020). For instance, many older adults who initially resisted digital health solutions during the COVID-19 pandemic eventually adopted telehealth and remote monitoring systems to maintain health and independence (Haimi & Sergienko, 2024).

Health disparities among current older adults are a critical concern. Chronic conditions such as arthritis, diabetes, and heart disease affect approximately 75% of individuals aged 70 and older, with many experiencing multiple conditions simultaneously (DynaMed, 2025). These conditions not only diminish functioning but also contribute to psychological distress, social withdrawal, and increased healthcare costs. Moreover, social isolation and loneliness are particularly significant issues for older adults (Courtin & Knapp, 2017). According to Courtin and Knapp (2017), social isolation has been linked to adverse health outcomes, including an increased risk of depression, cognitive decline, and mortality. The structural and role determinants of loneliness, such as widowhood, retirement, and mobility limitations, underscore the importance of social support networks and engagement in promoting well-being among older adults. Community-based initiatives, community engagement, intergenerational efforts, and accessible technologies are key strategies for mitigating social isolation and fostering meaningful connections (Courtin & Knapp, 2017). The urgency of addressing these health challenges is vital, requiring an approach that integrates medical, social, and technological interventions.

Projecting Future Demands of Older Adults

The ageing trajectories of future older adults, comprising Generation X, Millennials, and the younger generation, will likely differ significantly from those of current older adults. Often characterised by greater familiarity with digital technology, urban living, and diverse cultural experiences, these groups will bring new attitudes and expectations to ageing (Rogers & Mitzner, 2017).

Future older adults will have spent much of their lives immersed in digital ecosystems, making them more likely to demand integrated technological solutions for healthcare, social engagement, and everyday activities (Rock et al., 2022). However, this reliance on technology raises important questions about accessibility, data security, and the potential for digital divides among socioeconomic groups

(Junaid et al., 2022). Additionally, future generations will face pressure to interact with information from communication networks and devices (Perilongo et al., 2023).

Despite their technological fluency, future older adults may face many of the same ageing-related challenges as previous generations, including a reduced ability to move freely and easily, as well as shifting social roles, which can negatively impact their engagement in everyday activities (Khan et al., 2024; Lim-Soh et al., 2025). On the other hand, as we consider the future of ageing and technology, it is important to recognise that not all older adults may embrace the pervasive presence of digital devices (Leuzzi et al., 2025; Porta et al., 2025). For many, withdrawing from technology, or using it selectively, is a deliberate choice rather than a result of exclusion. This choice often stems from a desire for simplicity, concerns about privacy, or a wish to avoid personal data collection by such technology (Leuzzi et al., 2025; Porta et al., 2025).

According to research by Ghorayeb et al. (2021), older adults often prefer helpful yet inconspicuous technologies that support their independence without being overly intrusive. Similarly, Zhang (2023) highlights that some older adults have a critical view of the role of technology in society, viewing it as a threat to the existing social environment. For example, there is diminishing demand for traditional in-person services which are being replaced by technology-driven options (Zhang, 2023). In these cases, stepping back from technology is a personal preference. This perspective among older adults could suggest that future design should not only promote access but also respect diverse preferences, including the choice to limit or reject technology. Supporting older adults means offering flexibility, control, and, most importantly, options that align with how they prefer to live (Ollevier et al., 2020).

Furthermore, work by Fristedt et al. (2021), Galanza et al. (2025), and Offerman et al. (2023) argues that when it comes to technology use, the differences are not just between generations; they also exist within them. Despite the common belief that all older adults struggle with or avoid technology, the reality is far more complex. While generational factors do shape digital habits, older adults are not homogeneous (Zang, 2023). Within the same generation, some individuals eagerly embrace new tools and devices while others are more hesitant, not because of their age, but because of their needs, educational background, past experiences, or simply personal values (Bechtold et al., 2024; Luo et al., 2023; Schroeder et al., 2023; Weck & Afanassieva, 2023). This suggests we must look beyond generational labels and consider the full picture of each person's everyday routines and choices.

However, ageism, including how people think (stereotypes), feel (attitudes), and act (discriminate) towards different age groups, can influence the extent to which individuals feel included or excluded from social and community activities (Butler, 1969). Many older adults face financial challenges due to limited savings, retirement, and rising healthcare costs (Bond & Doonan, 2020). These challenges can exacerbate disparities in access to essential services and technologies. Policymakers and researchers must explore strategies to address these inequalities and create feasible solutions that ensure better well-being for all older adults.

Engagement in Everyday Activities

As people grow older, the rhythm of everyday life often shifts. However, the desire to stay active and involved rarely disappears (Chatterjee, 2019; Jonasson et al., 2023). Participation, broadly defined as a person's involvement in physical, social, and cultural activities, reflects not only the presence of activity but also the quality and meaningfulness of engagement, shaped by both individual abilities and contextual factors (World Health Organisation, 2001). Engagement in everyday activities refers to the tasks, activities, or social interactions that individuals engage in on a daily basis, contributing to their overall well-being (Björk et al., 2017). For many older adults, engagement in everyday activities remains a key part of what gives life purpose, structure, and joy. Whether grooming, reading, preparing a meal, participating in a walking group, caring for grandchildren, or learning to use a new mobile application for video calls with family or friends, these activities offer more than just routine. For some, they provide a sense of meaning, identity, and connection (Shen et al., 2024).

Studies have shown that consistent engagement in everyday activities promotes better physical health, cognitive function, emotional well-being, and the combating of frailty (Kwan et al., 2023; Shen et al., 2024). Importantly, engagement in everyday activities is about participation and doing things that matter to the person. What feels meaningful to one person may not resonate with another, and that is where the individual nature of engagement becomes central. Björk et al. (2017) emphasise that an activity's emotional and psychological significance is as important as its form or frequency. In other words, how people experience activities matters as much as what they do. At the same time, being active and involved is shaped by the context of health, mobility, and motivation, which interacts with external conditions, such as access to resources, transportation, technology, and social support (World Health Organisation, 2008).

Today, as digital technologies increasingly become part of everyday life, discussions about engagement in everyday activities extend to virtual spaces. For some older adults, digital tools offer exciting new opportunities for individuals with or without mobility limitations to connect, learn, stay active, and engage in their environment (Appel et al., 2020; Garcia Reyes et al., 2023). For others, these technologies may feel alienating or overly complex (Farivar et al., 2020). Studies have shown that the experience of technology is far from uniform, and feelings of exclusion or discomfort can undermine digital engagement (Gallistl et al., 2020).

Understanding engagement in everyday activities in later life goes beyond observing activity performance. It may mean listening to older adults' preferences and personal values, recognising the diversity in their engagement, and creating physical and technological solutions that match their needs and desires to enable them to stay independent and meaningfully involved in their preferred living environment.

Supporting Independence at Home Through Technology

In Sweden, around 95% of people aged 65 and older live in their own homes, including 87% of those over 80 (Slaug et al., 2020), with a growing number expressing a strong desire to remain in their own homes as they age (Jarling et al., 2018). Sweden’s policy framework supports this preference. One of the central goals of Sweden's ageing policy is to support older adults in remaining in their own homes rather than moving into institutional care (Statistics Sweden, 2022). This is not limited to long-term care but also active hospitalisation. Sometimes, even when advanced medical care is needed, staying in the hospital for the entire treatment period may not be necessary. Instead, patients may be offered home-based care as an alternative, better known as hospital-at-home. This allows individuals to remain in the comfort of their homes while receiving daily visits from healthcare professionals, who provide advanced medical care, assessment, consultation, necessary treatment, monitoring, and support throughout the admission period (Hallgren, 2023; Region Skåne, 2025; Westerberg, 2021).

As the demand for care for older adults increases, the critical challenge of the shrinking workforce available to provide these services also increases (Swedish National Board of Health and Welfare, 2025). Even countries with advanced welfare systems, such as the Nordic nations, are experiencing such issues. Like many countries, Sweden is facing a shortage of care workers, which raises urgent questions about the sustainability of care provision and the quality of care and support (Swedish National Board of Health and Welfare, 2025). With fewer professionals available to deliver in-person support, alternative strategies are needed to maintain dignity, safety, and engagement for older adults living at home or in institutional care (Swedish National Board of Health and Welfare, 2025).

Over the past decades, there has been a notable decline in institutional care. In 1975, about 9% of Sweden’s older adults lived in institutional care, compared to just 4% today (Brändström et al., 2021). The shift has been accompanied by an expansion of home-based services provided under the Social Services Act. According to the Swedish National Board of Health and Welfare (2024), in 2023, the most commonly provided care services were safety alarms, home help services, and placement in special home care. These services allow older adults to receive necessary support with personal care or everyday activities while living independently in their own homes.

Technology plays a crucial role in enabling this model of support. Technologies, such as safety alarms, fall detection alarms, remote health monitoring, medication reminders, and mobility aids, can help delay the need for institutional care and support independence at home. The Swedish government has integrated such technologies into municipal care services, recognising their value in enhancing safety and quality of life (Nilsson et al., 2025). These technologies also assist formal and informal caregivers by easing physical demands and improving communication and coordination of care.

In the context of older adults, activities such as self-care, mobility, household management, and social engagement remain fundamental to identity, well-being, and life satisfaction (Nieboer et al., 2020; Park & Kang, 2023). Effective technological interventions sustain or enhance an individual's engagement in personally meaningful activities, taking into account the social and cultural contexts in which these activities are embedded (Lee et al., 2025).

Moreover, the benefits of technology use provide new ways to meet the growing demands for supporting independence and autonomy among older adults (Sixsmith et al., 2020). The following section focuses on ways in which SHT, WT, and sensors can contribute to engagement in everyday activities and the overall well-being of older adults.

Technological Potential in Engagement and Participation

Smart Home Technology

SHT refers to interconnected systems and devices that enable automation and remote monitoring of the home environment (Pira, 2021). Balta-Ozkan et al. (2013) and De Silva et al. (2012) describe SHT as capturing information, identifying actions or events, and responding to residents' needs through linked sensors and devices. SHT positively impacts users' economic, social, health-related, and emotional sustainability and security (Marikyan et al., 2019). From environmental sensors integrated with lighting to assistive tools such as voice-activated virtual assistants, SHT creates a personalised and adaptive living space that caters to individual needs. These systems are significant for older adults, as they mitigate age-related challenges, including physical mobility limitations, cognitive decline, and social isolation (Greenhalgh et al., 2013). Notably, SHT can be designed to provide health monitoring, medication reminders, and emergency response systems, thereby enabling users to maintain activities while ensuring safety (Lussier et al., 2019).

SHT systems can support optimal living conditions while accommodating the comfort preferences and health requirements of older adults. Furthermore, voice-activated assistants offer a range of functionalities, including reminders for medications and appointments, control of home appliances, and companionship. The potential benefits of SHT extend beyond the superficial hype of comfort and convenience. SHT includes fall detection mechanisms, emergency alert systems, and real-time video monitoring, which enhance safety and facilitate timely medical intervention. Such systems can help reduce response times during accidents and ensure that older adults can receive help even when living alone. Additionally, wearable technologies integrated with smart home systems enable continuous monitoring of vital signs, including heart rate, blood pressure, and blood glucose levels (Morita et al., 2023). These data can be transmitted to caregivers or healthcare providers, enabling early intervention and tailored care plans.

SHTs are not limited to addressing age-related challenges but have the potential to redefine how individuals interact with their living environments (Lee & Kim, 2020). Emerging trends, such as predictive analytics and adaptive learning algorithms, enable SHTs to anticipate user needs and adapt functions accordingly. For instance, smart refrigerators can track dietary preferences and suggest grocery lists, while automated lighting systems adjust brightness levels to accommodate circadian rhythms.

Moreover, SHTs can foster social connections among older adults. Virtual platforms integrated into SHTs facilitate video calls, social networking, and telehealth consultations, reducing the risk of social isolation and enhancing mental health outcomes (Liu et al., 2016). These features enhance convenience, promote holistic well-being, and support independent living (Gawrońska & Lorkowski, 2021). Despite the potentials of SHTs, there are still limited studies on their impact and benefits on the quality of life, health, and well-being of older adults (Ghafurian et al., 2023).

When SHTs are adapted to meet the needs of older adults, such as through the integration of smart digital door locks, automated medication dispensers, or remote emergency alerts, they become enablers of welfare-oriented care and support. This is where the intersection between SHT and WT becomes most evident.

Welfare Technology

Internationally, assistive technology encompasses devices and related systems that enhance functional ability, support independence, and promote engagement in everyday activities (World Health Organisation, 2018). In the Nordic context, this has developed into the broader concept of WT. WT is an umbrella term encompassing digital and assistive technologies designed with the intention to enhance the independence, safety, and well-being of individuals at risk or with functional impairments (Frennert & Baudin, 2019). The range of technologies involved is continually expanding. Some tools are familiar to many and integrated into everyday activities, such as safety alarms, digital medication reminders, or mobile health apps, allowing users to manage their appointments and prescriptions. Others represent more advanced state-of-the-art technologies, such as GPS tracking systems, especially for individuals with cognitive impairments; keyless door locks; video consultations with healthcare providers; and even robotic companions offering social interaction or physical support (Kamp et al., 2019; Peek et al., 2016). WTs have been shown to support older adults by promoting autonomy and improving quality of life (Lydahl & Davidsson, 2024; Nordic Welfare Centre, 2024).

Across Nordic countries, WT has become vital to the evolving health and social care landscape (Swedish National Board of Health and Welfare, 2025). At its core, this concept reflects a shift in how we think about supporting older adults and individuals with or at risk of disability, not only by meeting their physical and medical needs, but by implementing tools that help individuals live with greater independence, safety, and dignity. WTs are more than just devices; they are part of a broader societal effort to reimagine what it looks like to continue living in one's own home, empower older adults in activities, and ease the strain on healthcare systems and professionals (Peine & Neven, 2019).

WTs inevitably reshape how care is given and received, often redistributing responsibilities from professionals to informal caregivers, or even to the older adults themselves. Sensors supported with AI features are becoming potential enablers of many WTs, allowing them to operate using more responsive and predictive methods, for instance, to detect falls or provide early warnings of changes in health and activity patterns, allowing for more timely interventions. Sensor monitoring solutions are being explored as part of a broader strategy to support the wishes of older adults to live independently in their own homes, prevent serious health problems, and reduce pressure on healthcare systems (Jain et al., 2019; Matsui et al., 2020). AI-supported methods can be an important piece in realising the full potential of WT. Their ability to deliver accurate, real-time, and context-sensitive or larger amounts of data can transform WT from a reactive tool into a proactive, scalable, and personalised care solution.

Wearable Sensors and Deep Learning Models

Data collection in home environments can be challenging due to time constraints and privacy concerns. Traditional methods, such as observations, can be intrusive for assessing in-home activities. While interviews can yield data on typical habits, they are limited in their ability to show variations over an extended time frame (Chung et al., 2017).

In recent years, small, wearable devices like smartwatches and fitness trackers have revolutionised activity tracking. These devices contain inertial measurement unit (IMU) sensors, which measure movement with tiny accelerometers and gyroscopes. Wearable sensors are then used to collect data to monitor essential everyday activities, such as walking, preparing food, and sleeping (Matsui et al., 2020; Mekruksavanich & Jitpattanakul, 2021). The widespread adoption of wearable sensors has enabled the development of sophisticated activity recognition systems, which help monitor everyday activities and assess an individual's activity levels. These systems play a crucial role in healthcare, as staying engaged in everyday activities enhances both physical and mental well-being and reduces the risk of frailty, as well as chronic diseases, including cardiovascular conditions and diabetes (Kwan et al., 2023; Shen et al., 2024). However, the overwhelming amount and complexity of data generated by sensors can make it challenging for clinicians to utilise fully (Jain et al., 2019).

While monitoring activity is important for health, activity recognition has applications beyond healthcare. It is now used in smart homes, sports, security, and human-computer interaction. For example, in assisted living environments, activity recognition systems help detect falls, monitor daily routines, and ensure the safety of older adults (Kirk et al., 2024). Many smart home applications use sensor-based activity recognition rather than cameras, as video monitoring raises privacy concerns. Machine learning models are among the most promising developments and form the foundation of many emerging SHTs. These broader applications emphasise the potential of activity recognition to ensure safety and health monitoring, as well as support engagement in everyday routines, enabling older adults to maintain independence and participate more effectively in their environments.

Wearable sensors, ranging from rings, smartwatches, and fitness bands to skin-adhered biosensors, can increasingly collect data on physiological and behavioural indicators, including heart rate, movement, sleep patterns, oxygen saturation, and falls (Boyle et al., 2025; Morone et al., 2024; Patel et al., 2012). The relevance of this data is amplified when integrated with machine learning algorithms, which can analyse patterns, detect subtle changes over time, and even predict health risks before they manifest (Chen et al., 2021; Minor et al., 2025). For example, deep learning models, which are a subset of machine learning, have shown promise in identifying early signs of frailty, cognitive decline, or deterioration in chronic conditions, thereby enabling earlier, more tailored interventions (Mubashir et al., 2013; Requena et al., 2024; Wang et al., 2023). Early identification of both existing and potential health issues allows timely interventions before a crisis occurs. This shift from reactive to preventive care is especially valuable in supporting the well-being of older adults while reducing strain on healthcare systems. For older adults living alone or with limited mobility, these tools can provide a sense of security for themselves, family members, and caregivers.

Beyond individual use, the societal implications of wearable technologies are far-reaching. Healthcare systems, often stretched by increasing demand and ageing populations, can benefit from more proactive, preventive care models supported by AI methods. Deep learning algorithms can complement remote monitoring and reduce unnecessary hospital visits or rehospitalisation, which in turn lessens the demand on healthcare from older adults, ultimately improving care efficiency while lowering costs (Liu et al., 2016; Morita et al., 2023). At a broader level, aggregated anonymised data from wearable sensors could support population health monitoring, inspiring more grounded policies and planning.

Challenges of Technology Use

Despite the potential of technology to support independence and address the needs of older adults in care, its real-world implementation continues to face challenges. Multiple trends and knowledge gaps have been identified in the context of technology development, including a lack of collaboration across disciplines and the need to involve older adults in the process (Borg et al., 2022). Such gaps tend to overshadow human needs and preferences (Kim et al., 2020; Morita et al., 2023; Peek et al., 2016). Furthermore, issues of capacity, digital literacy, and trust remain relevant. Not all older adults feel confident navigating new technologies, and some may hesitate to adopt tools they do not fully understand. Also, tension arises when individuals feel overwhelmed by digital systems or fear losing personal interaction with care providers (Halvorsrud et al., 2023; Nilsson et al., 2025; Pols, 2017).

SHTs with virtual connectivity have been documented to have a potentially negative impact on older adults, such as the experience of virtual exclusion (Appel et al., 2020). In exploring the factors contributing to social exclusion among older adults, Appel et al. (2020) highlight the complex interplay between individual capacities and broader environmental influences. Their research identifies three key determinants that shape the experience of exclusion in later life, including virtual connectivity. As innovative tools and platforms become integral to communication and access to services, the digital divide can further marginalise those not equipped or confident in using them. Without intentional support, a lack of digital inclusion may exacerbate the exclusionary experience suffered by older adults in a rapidly evolving online world.

For technology to be effective, older adults must fully understand how to use it and recognise its potential benefits in their everyday lives (Mahoney, 2010; Zander et al., 2021). Many technology users struggle with unclear instructions, complex interfaces, and a lack of accessible support, which leads to frustration and ultimately results in the abandonment of the technology (Greenhalgh et al., 2017). Studies show that older adults may gain from step-by-step guidance, tailored information, and interactive training to feel confident using technology (Peek et al., 2016). Without these supports, the adoption may fail to foster meaningful use. Adoption refers to the decision to fully utilise an available innovation, as well as the degree and manner of its sustained use (Rogers, 2003). The digital divide exacerbates this challenge even further. Some older adults may struggle to navigate digital tools, which can be related to factors such as age and socioeconomic status, including living arrangements (Ghahfarokhi, 2025; Sumner et al., 2021; Zander et al., 2021). At the same time, some, especially those with prior technological experience or those less advanced in age, may integrate such tools more seamlessly (Ghahfarokhi, 2025). This raises critical concerns about how different levels of information and support influence user experience and the potential of technology.

For instance, as WT is deployed to support independent living and autonomy, its effectiveness depends on how older adults experience and interact with such technologies. A positive user experience – including aesthetic appeal, usability, perceived benefits, reliability, and perceived vulnerability – is crucial for fostering trust, acceptance, and sustained adoption (Garcia Reyes et al., 2023; Peek et al., 2016; Tian et al., 2024; Vandemeulebroucke et al., 2018; Zander et al., 2021). Poor usability, technical difficulties, or a perceived lack of relevance can result in disengagement and abandonment (Garcia Reyes et al., 2023; Mahoney, 2010; Tian et al., 2024). Furthermore, experiences with unreliable technology or devices that do not meet the needs of older adults negatively influence implementation (Zander et al., 2021). Despite the increasing need for and deployment of WT, there is limited research on how user experience influences engagement in everyday activities. Most studies focus on technical performance, overlooking the psychosocial factors determining whether older adults are able to meaningfully integrate WT into their routines (Peek et al., 2016). Understanding these dynamics is critical to maximising the potential benefits of WT that can enhance older adults' overall quality of life.

Another issue lies in the assumption that WT is universally beneficial, regardless of how it is introduced and supported (Frennert & Baudin, 2019). Many SHTs and WTs are designed for functionality and efficiency to support the user, but fail to align with user preferences and aesthetic expectations (Bertolazzi et al., 2024; Chang, Wang, & Gu, 2024). Older adults may perceive certain technologies as intrusive or disruptive to their established routines, leading to resistance or disengagement from the technology. On the contrary, even users who initially show interest in the technology may disengage if support is inadequate or the technology is challenging to use. For instance, a study by Niemeijer et al. (2010) found that older adults experienced the feeling of being watched rather than supported when using sensor-based monitoring technologies, which may be because they lacked clear information about how data were collected and used. Similarly, SHTs and WTs lacking customisability can contribute to disempowerment rather than autonomy (Galanza et al., 2025; Nilsen et al., 2016; Svärd et al., 2024). This raises important concerns about whether providing better information and user support can mitigate these negative perceptions and foster greater engagement.

Furthermore, unlike SHT, WT is nationally or locally subsidised, and differences in municipal funding, healthcare provider support, and social support networks may create disparities in how WT is integrated into older adults' lives. Some older adults can access digital literacy programmes, family support, or professional caregivers who provide training, while others must navigate WT alone (Hargittai & Dobransky, 2017). This inequality can lead to divergent user experiences, where well-supported individuals may engage fully with technology while others abandon it due to frustration or uncertainty. Policies often assume that users will naturally adapt once a WT is introduced. However, research suggests that engagement with such technology is contingent on access to reliable information and personalised support (Greenhalgh et al., 2013). Older adults may also hesitate to seek help due to embarrassment, fear of being perceived as incompetent, or reluctance to burden caregivers. Others may feel uneasy about digital privacy and data security or losing control over their personal information, which can deter them from fully engaging with technology (Niemeijer et al., 2010).

Sensor technologies and deep learning methods are not without ethical and practical concerns. Some older adults may feel uneasy about continuous monitoring or unsure about how their data will be used (Denecke et al., 2015). Furthermore, deep learning methods are only as reliable as the data on which they are trained, raising questions about bias, representativeness, and the potential for false positives or false negatives, as well as the neglect of individual context (Chen et al., 2021; Pols, 2017). Additionally, there is still a need to enhance data quality by developing a more advanced activity recognition system and exploring methods to more naturally encourage older adults to integrate the devices involved (Matsui et al., 2020).

Moreover, as with any technology, implementation must be human-centred (Pol et al., 2016; Sumner et al., 2021). Many older adults express concerns about privacy and autonomy (Ghorayeb et al., 2021). Technologies in the home can be intrusive if not handled carefully. Systems must be transparent, respectful, and responsive to users' needs and boundaries. This means involving older adults in the design and decision-making process from the outset, ensuring their voices shape how technologies are developed and deployed (Choukou et al., 2021; Peek et al., 2016). Technologies offer exciting possibilities for supporting the well-being of older adults. However, their true benefit lies in integrating them into the lives of those they aim to support. They must be introduced in ways that respect older adults' rights, preferences, and everyday realities, bridging innovation with satisfaction and care efficiency, while also facilitating everyday activities.

Against this background, there is a pressing need to understand the current state of SHT, WT, and wearable sensor monitoring, and how they can support engagement in everyday activities among older adults. There is a risk that the study of technology use or adoption in the context of older adults places emphasis on disability and care provision, rather than including engagement in everyday activities, where subtle manifestations of illness and declining capacity may be evident (Dannefer & Phillipson, 2010). The need to understand the role of technology on engagement in everyday activities has become more urgent in the wake of technology becoming mainstream and the continued ageing of society.

Aim

Overall Aim

The overarching aim of this work is to deepen the understanding of technologies that can support engagement in everyday activities among older adults. This aim was addressed by integrating insights from various perspectives, including adoption, co-produced ideas for solutions, user experiences, and activity recognition methods.

Specific Aims

Perspectives on Adoption Study (Study I)

- ✓ To explore factors involved in the decision-making process of adopting SHT among current and future generations of older adults. Another aim was to identify and understand barriers and facilitators that can better support older adults' engagement in everyday activities at home as they age.

Co-production Study (Study II)

- ✓ To co-produce ideas for SHT solutions to support engagement in everyday activities as people age.

User Experience Study (Study III)

- ✓ To investigate the relationship between various forms of WT user experience and engagement in everyday activities among older adults.

Activity Recognition Study (Study IV)

- ✓ To develop a method for accurately recognising everyday activities among older adults by utilising wearable sensors, including: (1) developing a deep learning model that can correctly recognise different everyday activities, (2) identifying a model with the minimal number of sensors to recognise everyday activities, and (3) exploring participants' experiences of the use of wearable sensors.

Thesis Framework

To explore how SHT, WT, and wearable sensors can support older adults in their everyday activities, this thesis draws on two complementary frameworks: the International Classification of Functioning, Disability, and Health (ICF) and activity theory. These frameworks provide distinct but intersecting perspectives that help illuminate the complex relationships between technology and the everyday activities of older adults.

The ICF, developed by the World Health Organisation (2001), offers a model relevant for research that seeks to support older adults in maintaining active and meaningful lives. The ICF framework describes participation in relation to a person's abilities and the environment in which they live, while also considering contextual factors such as access to resources, including technology (World Health Organisation, 2001). In this way, the framework aligns closely with the overarching aim of this thesis, which is to deepen understanding of technologies that can support engagement in everyday activities.

Moreover, in this thesis, the ICF can be directly applied to the design and improvement of technologies. For instance, deep learning models developed to recognise data on everyday activities align with specific ICF domains such as mobility, self-care, or domestic life (World Health Organisation, 2001). This mapping of older adults' everyday activity enables the development of tools that do more than monitor movement or behaviour but offer meaningful insights into engagement levels and identify potential changes in functioning over time. Notably, the ICF also promotes a strengths-based perspective, emphasising what individuals can do rather than focusing solely on limitations (World Health Organisation, 2001). This again connects with the broader ambition of leveraging technology to support autonomy and engagement.

While the ICF offers a structural and health-centred lens, activity theory brings a socio-cultural perspective that helps better understand how technologies are used in the real world. Activity theory, introduced in the 1960s, argued that the well-being of older adults is closely tied to staying involved in meaningful roles and routines (Havighurst, 1961). Since then, research has continued to affirm that active engagement can enhance mental and physical health when aligned with a person's interests and capacities (Everard et al., 2000; Menec, 2003). However, it is worth noting that despite the volume of literature, activity is a multi-dimensional construct, and no single measure can assess all facets (Sylvia et al., 2014).

Activity theory views that positive well-being is closely tied to the maintenance of roles, routines, and social connections that provide continuity, meaning, and satisfaction. Contemporary research has reaffirmed this link, showing that engagement in everyday activities supports autonomy, identity, and well-being in later life, even in the face of age-related decline (Adams, Leibbrandt, & Moon, 2011). From this perspective, engagement in everyday activities is not merely the capacity to perform tasks, it reflects a process of sustaining valued roles and a sense of purpose through active involvement in everyday life.

Activity theory is beneficial for understanding the everyday experiences of older adults as they interact with technology. It draws attention to the motives behind users' actions, recognising that technologies are not adopted randomly. Instead, they are incorporated into existing routines, shaped by personal routines, and influenced by the surrounding environment. In this sense, activity theory enables an exploration of older adults' needs and desires from the inside out. Although the availability of technologies plays a role, how they are experienced, accepted, or resisted in the context of everyday activities also matters.

In this thesis, the ICF provides a framework for participation and engagement, specifically in terms of the everyday activity of older adults. It supports the development of SHT, WT, and sensor technologies, as well as deep learning models that are interpretable and aligned with real-world engagement in activity. Activity theory, on the other hand, enriches this approach by illuminating the lived experiences, needs, desires, and social contexts in which SHT, WT, and wearable sensors are adopted and implemented. It helps explain whether these technologies facilitate or hinder the everyday activities that older adults value, underscoring the motivational and experiential significance of remaining active. Therefore, SHT, WT and wearable sensors are conceptualised as environmental facilitators that influence the extent to which older adults can engage in everyday activities and sustain them.

Methods

This thesis applies a transdisciplinary approach that involves transcending disciplinary boundaries and collaborating with interprofessional and community partners (Bengtsson et al., 2016), including the technology's intended users, on a shared problem (Boger et al., 2017). In addition, an integrative multi-method approach involving four studies (see Table 1), combining qualitative and quantitative methods, supports a unified inference (Seawright, 2016).

Table 1. Overview of the design and methods across four studies.

Study	Design	Data collection methods	Analysis methods
I	Qualitative research design	Focus group discussions	Thematic analysis
II	Qualitative research design	Research circle	Content analysis
III	Quantitative research design	Survey questionnaire	Structural Equation Model
IV	Quantitative research design	Structured activity protocol, camera and sensor monitoring	Deep learning

Perspectives on Adoption Study

Study Design

Focus group discussions were employed to explore perspectives and experiences on SHT. This method allowed for in-depth, interactive conversations that revealed diverse and complex needs, desires, and challenges related to SHT. The open group setting encouraged participants to share similar and differing views, providing valuable insights (Hennink, 2013).

Discussion Guide

We constructed a series of open-ended questions (Krueger & Casey, 2015) designed to spark meaningful conversations about SHT (see Appendix I). The discussion guide covered attitudes, desires, needs, and the barriers and facilitators to adopting SHT, which was inspired by previous research exploring various technologies across generations (Fristedt et al., 2021; Offerman et al., 2023). It aimed to encourage participants to share broad perspectives and personal experiences while aligning the discussion with the study's core objectives.

Recruitment and Participants

Participants were actively recruited through a multi-channel strategy to ensure diverse perspectives on SHT. Invitations were sent to existing mailing lists, including individuals interested in research, the user board network at the Centre for Ageing and Supportive Environments (CASE) at Lund University, and professional networks. To engage younger age groups, leaflets were distributed in public areas like universities, hospitals, gyms, supermarkets, cafeterias, and libraries. Recruitment ran from April 1 to May 30, 2023.

Interested individuals who responded via email or phone received detailed study information and were individually contacted to explain the study's purpose and procedures further. Participants were then selected from each generation: 30-39 years old, 50-59 years old, and 70-79 years old, and based on their availability for the scheduled focus group sessions. In total, 15 participants joined the study. Before the first session, participants were invited to ask questions or express concerns and provided informed consent, including audio and video recording permission.

Procedure

The focus group encouraged active participation and reflection both during and between sessions (Krueger & Casey, 2015). To capture diverse perspectives and strengthen insights around SHT (Patton, 2014), we conducted three focus groups with two sessions each (six sessions in total). The break between sessions allowed participants to critically reflect on their attitudes towards SHT, resulting in richer, more grounded data. The focus groups were conducted at the state-of-the-art Movement and Reality Lab (MoRe-Lab) at Lund University's Faculty of Medicine. This new facility features some SHT (see Table 2), allowing the participants to see and interact with the technology.

Table 2. Some of the smart home technology at the reality platform (apartment) of the movement and reality lab during the six focus group sessions.

SHT label	Image	SHT label	Image
Smart Home Hub		Video Door Phone	
Security Keypad		Infrared Camera Detector	
Door Contact Input		Robot Vacuum Cleaner	
Smart Plug		Smart Coffee Maker	
Water Detector		Smart Bulb	

Note. SHT = Smart home technology

In the first focus group session, we invited participants to share their prior experiences and understanding of SHT. To stimulate discussion, we presented the technologies available in the MoRe-Lab along with a short video on the use of such technologies. We then guided the discussion towards participants' attitudes, needs, and preferences regarding adoption and the role of SHT in supporting engagement in everyday activities. In the second session, we began with a summary of the earlier discussion before shifting the focus to perceived facilitators and barriers to SHT use. Participants also identified technologies and functions that they considered most valuable for enabling adoption and supporting activities at home.

We conducted both sessions as a team of two PhD students, with one of us acting as moderator and the other as assistant moderator, overseeing follow-up questions and note-taking. A senior researcher joined us as co-moderator in the first two sessions, while another observed and recorded the discussion from a control room. The assistant moderator's notes supported our reflections and helped us prepare for the subsequent session. Each focus group lasted approximately 90 minutes (see Figure 1).

Figure 1. Sessions from the focus groups.

Data Analysis

The audio recordings were transcribed verbatim, ensuring an accurate and detailed account of the sessions. Video recordings complemented the transcripts, helping us correctly identify participants, link narratives, and observe group dynamics.

The analysis began using a theory-driven deductive thematic approach (Braun & Clarke, 2021; Terry et al., 2017), allowing us to focus on predefined themes while staying open to new insights. This method satisfied the interest of our study by providing a structured framework to interpret the complex stages of adoption of SHT and to examine the data in relation to these established concepts. Our framework was grounded in Rogers' (2003) diffusion of innovations theory, specifically its five-step decision-making process, which we used to develop and refine themes.

The initial coding identified key attitudes, desires, needs, facilitators, and barriers to SHT adoption. These codes were mapped onto Rogers' five stages: knowledge, persuasion, decision, implementation, and confirmation. Continuous discussions were held among all co-authors to refine codes, emerging sub-themes, and themes (see Table 3). A second round of independent coding was conducted to validate our findings, ensuring consistency between the codes, themes, and their sources in the transcripts. This process clarified overlaps and distinctions within the five decision-making stages. NVivo software supported the analysis, enhancing the depth and accuracy of our results (QSR International, 2023).

Table 3. The analytical framework used for the deductive analysis including themes and sub-themes.

Five-stage decision-making process	Theme	Sub-theme
Stage 1. Awareness/Knowledge	Awareness and knowledge of SHT	○ Own desire to understand SHT
		○ Increased awareness supported by politicians and change agents
Stage 2. Persuasion	Desired, non-desired, and needs of SHT	○ Perceived advantages of SHT
		○ Potential impact of SHT on users' functioning and health
		○ User data integrity in SHT implementation
		○ Perceived need for SHT
Stage 3. Decision	Determining ease of use through trial	
Stage 4. Implementation	Integration of SHT into the home environment	○ Dealing with uncertainty and the consequences of implementation
		○ Ideas for re-invention that would support practical implementation
		○ Ideas for re-invention for AI-supported SHT
Stage 5. Confirmation	Positive reinforcement or rejection of the adopted SHT	○ Experiences supporting adoption
		○ Rejection of SHT after adoption

Note. SHT = Smart home technology

Co-production Study

Study Design

We used the research circle methodology (RC) to generate new knowledge and stimulate translation through collaborative efforts and discussions on equal terms among RC members (Harnsten, 1994; Löfqvist et al., 2019). An RC is a dialogue between different stakeholders where RC members prioritise and raise certain issues with the intention that they will benefit from joint discussion to generate knowledge (Harnsten, 1994). Thus, we utilised an RC involving nine people representing current and future generations of older adults, together with two professionals with expertise in SHT and four researchers in health sciences, to engage in a democratic collaboration.

Recruitment and Participants

A combination of voluntary responses to public advertisements and individual invitations to participate was used to ensure group diversity. Participants were selected consecutively to recruit three members from each generation: 30-39 years old, 50-59 years old, and 70-79 years old (n=9); some (n=3) had also participated in the previous focus group study. In addition, two participants with professional knowledge and expertise in SHT were invited to represent the technology industry. Participants available on the planned dates for the three RC sessions were finally included (N=11). Some participants did not complete all three sessions but joined one or two.

Procedure

Following Lee and Kim's (2020) recommendations that studies on SHT should be conducted in an environment that can induce active behaviours, the three RC sessions were conducted in the MoRe-Lab (see Figure 2). According to Lee and Kim (2020), this can facilitate a better understanding of the relationships between SHT solutions and RC members and develop ways of closing the knowledge gap between SHT developers and diverse stakeholders.

Figure 2. Sessions from the research circle.

Three 90-minute RC sessions were held, with two-week gaps in between (see Table 4). In preparation for each session, we (the researchers) discussed the procedure and reflected on the input and focus of the discussions. Towards the end of each session, a summary of the discussion was presented, which was broadly agreed to and confirmed by RC members.

Table 4. The process of research circle sessions, including the input, topic focus, procedure used, and output created.

	Input	Focus	Procedure	Output
RC session 1 09-15-2023	Summary of the findings from the previous focus group study on SHT.	Identify the most important issues to discuss, and identify the SHT that can support	Reflect and discuss in pairs, quartets, and whole groups about solutions to support engagement in everyday activities.	Prioritised issues to focus on in the next session: 1. Safety and security, 2. Loneliness, 3. Engagement in activity.
RC session 2 09-29-2023	The researchers partially developed personas based on prioritised issues from RC session 1.	Identify ideas for SHT and non-technology solutions to the prioritised issues and needs of personas.	Discuss in smaller groups to identify the everyday activities and needs of the selected persona.	Prioritised ideas for SHT solutions and non-technology solutions were identified.
RC session 3 10-13-2023	Continue working with the personas from session 2.	Develop ideas for identified SHT and non-technology solutions and generate new ideas.	Identify prioritised ideas for SHT and non-technology solutions.	Prioritised ideas for SHT and non-technology solutions.

Note. RC = Research circle; SHT = Smart home technology.

Session 1 opened with an introduction to the guiding principles of the RC, highlighting that all contributions carried equal weight regardless of members' background or experience, and that no answers could be considered right or wrong.

We also emphasised that the four researchers would join as RC members on equal terms with other members rather than acting as moderators. To initiate dialogue, we presented a summary of the findings from the previous focus group study, which helped frame and focus the discussion. The session closed with a collective decision to use personas in the next meeting as a way to deepen insights into older adults' needs and aspirations and to spark concrete ideas for SHT solutions.

Ahead of Session 2, we (the researchers) created five personas, each representing a different mix of life situations and potential needs inspired by the focus of interest raised by RC members in Session 1 (see Appendix II). These personas were presented at the start of the session, and participants were invited to reflect briefly on each one before selecting two to work with. Based on these choices, the group was divided into two smaller teams. Their task was to identify everyday activities that would be important for their personas, consider what was needed to enable these activities, and propose ideas for solutions to support them. At the end of the session, the group agreed to continue working with the same personas in order to further develop and refine the emerging ideas into concrete and practical applications.

Session 3 began with a recap of the personas and the ideas generated in earlier discussions. Together, we decided to focus on turning these ideas into more concrete solutions and to prioritise among them. The participants once again split into the same two groups to maintain continuity with their chosen personas and earlier ideas, while newly joined RC members joined one of the two groups, considering generational diversity and varied expertise. The session concluded with all members coming together to share and discuss the outcomes from their group work, providing feedback on each other’s suggestions, and finalising a shared list of prioritised ideas for solutions.

Data Analysis

All audio recordings were transcribed and supplemented by video recordings to correctly identify the RC members and link them to their narratives. Qualitative conventional content analysis (Hsieh & Shannon, 2005) was used to focus on the characteristics of discussions with attention to identifying and describing the contextual meaning of the RC transcripts. By focusing closely on the characteristics of the discussions, we sought to capture RC members' own language and perspectives, while also identifying and describing the contextual meanings embedded in their ideas. This method provided a flexible yet rigorous framework for exploring the nuances of ideas expressed within the RC and for ensuring that the findings were firmly grounded in the members' contributions. The orientation towards rules of text analysis was then set (Mayring, 2014) to analyse the content relating to ideas for solutions to the issues discussed in the sessions. The analysis was conducted with the aid of NVivo software.30 (QSR International).

To interpret the content of the transcripts, the analysis was done through a systematic classification process of coding. The coding process began with segments of text that were highlighted and labelled. This involved identifying recurring patterns in the participants' responses. Codes were then sorted and grouped based on their interrelations and development across the three sessions. After this, the codes were compared and re-clustered until preliminary sub-categories were identified. These emergent sub-categories were used to identify patterns and organise them into categories. During the analysis, codes, sub-categories, and categories were critically examined and discussed by the authors to verify the relevance and validity of the findings. All authors applied a critical stance towards the emerging findings in the final round.

User Experience Study

Study Design

We employed a cross-sectional quantitative design to measure key variables and examine the relationships between constructs (Creswell & Creswell, 2023). This approach allowed us to assess the strength and direction of relationships between constructs, which satisfied the following hypotheses (H).

- ✓ (H1) Higher perceived usability of WT is associated with greater engagement in everyday activities among older adults.
- ✓ (H2) Higher perceived control when using WT is associated with greater engagement in everyday activities among older adults.
- ✓ (H3) Higher perceived value of WT is associated with greater engagement in everyday activities among older adults.
- ✓ (H4) Lower perceived WT vulnerability is associated with greater engagement in everyday activities among older adults.

Recruitment and Participants

The sample was drawn from the Swedish state personal address register and consisted of randomly selected municipal residents aged 75 and older in 18 designated municipalities. The sample represented all categories within the classification of Swedish municipalities to ensure that the sample had national relevance/representation. The number of older adults contacted per municipality was determined based on its proportion of the total Swedish population of older adults aged 75 years and older. The survey was conducted through postal distribution. Respondents initially received a postal invitation, a 12-page questionnaire, and an informational letter explaining the purpose of the survey. Two follow-up reminders were sent by mail.

The Institute for Quality Indicators in Gothenburg – Fenix AB (Indikator) supervised the implementation, and quality control measures were rigorously observed. The survey was conducted between August 30, 2024, and November 4, 2024. All returned surveys were scanned and verified in Indikator's system. Verification, review, and plausibility checks followed guidelines developed in collaboration with the researchers.

Procedure

Questionnaire and Measures

The questionnaire was developed to explore the most important experiences, challenges, and unmet needs that could inform the improved development and implementation of WT in home care (see Appendix III). It was structured in two parts. The first part gathered background information about the respondents, while the second gathered information on the study constructs: WT user experience and engagement in everyday activities. The questionnaire items were informed by previous studies within the Welfare@Home project (Svärdh et al., 2024; Svärdh et al., 2025), ensuring that the content reflected insights grounded in earlier research.

In total, 15 items were included to capture aspects of the WT user experience, and four items to capture engagement in everyday activities. Each item was rated on a three-point scale, including (1) strongly agree, (2) partly agree, and (3) strongly disagree. The items relating to user experience were further inspired by established theoretical models, particularly the Technology Acceptance Model (TAM) (Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003), providing a framework to anchor participants' perspectives in existing knowledge.

Data Analysis

Data were analysed using descriptive statistics and structural equation modelling (SEM). In all tests, p-values less than 0.05 were interpreted as statistically significant. The analysis used the IBM SPSS version 30 statistical package and AMOS version 30 (IBM Corp., 2022; IBM Corp., 2024).

The SEM approach was applied to investigate the relationship between various forms of WT user experience (construct = perceived usability, perceived control, perceived value, perceived vulnerability) and engagement in everyday activities (construct = activity) among older adults (Collier, 2020; Kline, 2023; Thakkar, 2020; Whittaker & Schumacker, 2022). In addition, we controlled for four observed variables to determine if the measures differed in line with known differences in this population, i.e., age, gender, living arrangement, and home care. SEM is well-suited for analysing complex relationships between multiple latent constructs and observed items while accounting for measurement error and testing direct, indirect, and interaction effects within a single analytical framework (Kline, 2023; Thakkar, 2020; Whittaker & Schumacker, 2022).

Data Handling and Assumptions

To reduce bias in the analysis, we excluded respondents with a high proportion of missing data, which resulted in a final sample of 517 participants. Across the included cases, missing values on the observed items ranged between 0% and 7%. To address these gaps, we applied the full information maximum likelihood (FIML) method, allowing us to retain incomplete cases without compromising the validity of the results (Whittaker & Schumacker, 2022). An assessment of skewness and kurtosis further showed that the data were approximately normally distributed.

Reliability and Validity

We conducted an exploratory factor analysis to empirically examine the underlying structure of the observed items (Whittaker & Schumacker, 2022). All items were included in the analysis, applying a varimax rotation. This procedure revealed a four-factor solution, which was subsequently used to define the constructs for the independent measures, alongside a one-factor solution for the dependent measure construct. Each latent construct comprised two or more observed items, and Table 5 provides a summary of the constructs and their corresponding items.

Table 5. The summary of the constructs and the corresponding questions.

Construct	Questions (Items)
WT user experience	
Perceived usability	Exp14. WT fits into my home.
	Exp13. WT has an appealing appearance.
	Exp15. WT handles my information securely.
	Exp12. WT is adapted to my needs.
	Exp11. WT is easy to use.
	Exp10. WT saves me time.
Perceived control	Exp1. I feel confident using the WT I received.
	Exp4. I have control over the WT I received.
	Exp16. The WT I have meets my expectations.
Perceived value	Exp8. WT makes me independent.
	Exp2. WT is generally positive for me.
	Exp3. WT is generally negative for me.
	Exp7. WT makes me feel safe.
Perceived vulnerability	Exp6. I perceive WT as vulnerable.
	Exp5. I perceive that WT easily stops working.

Engagement in everyday activities	
Activity	Act1. WT supports my habits and routines.
	Act2. WT controls my daily routines and habits.
	Act3. WT facilitates my daily activities.
	Act4. WT facilitates activities I want to do in society.

Note. WT = Welfare technology.

Before testing the hypotheses, we confirmed each construct's factor loadings for the observed items. Items with factor loading (> 0.3) were kept, which most accurately represent the proposed constructs (Whittaker & Schumacker, 2022). Whittaker and Schumacker (2022) suggest that the standardised factor loadings should be greater than 0.3 to ensure that the observed items have sufficient validity to reflect the latent construct. This made it possible to assess how well the observed items reflected the latent constructs of perceived usability, perceived control, perceived value, perceived vulnerability, and activity. The bivariate correlations among observed items were computed using Spearman's rho.

We then confirmed the constructs' reliability and validity by assessing the model fit in a confirmatory factor analysis (CFA). The criteria implemented to consider the model's overall fit include comparative fit index (CFI), incremental fit index (IFI), normed fit index (NFI), and Tucker-Lewis index (TLI), which are all greater than 0.9, and root mean square error of approximation (RMSEA) is less than 0.08 (Collier, 2020). In addition, a chi-square minimum/degrees of freedom (CMIN/df) value of <5 was added to the criteria to accept a good-fitting model (Dash & Paul, 2021). We also examined the dependent constructs' squared multiple correlation coefficients (R^2) values to present the variance explained by the independent construct.

We reperformed the CFA repeatedly to adjust the model fit. We followed the suggestions from the modification indices results (using a subset of the data) to add additional covariances within a construct’s indicators. Also, some observed items with a regression covariance value exceeding 2.58 were removed to reduce residual covariance and model misspecification (Collier, 2020).

After initially establishing that each indicator loads on its respective construct and that the model has an acceptable fit to the data, we continued to assess the convergent validity of our model. The average variance extracted (AVE) was higher than .50, which denotes convergent validity on each construct. Furthermore, Taber (2018) and Collier (2020) suggested that Cronbach’s alpha (CA) and composite reliability (CR) values should be greater than 0.7 to ensure internal consistency. Using the standard reliability test formula, the CR was calculated by hand and added to the assessment (Collier, 2020). The analysis revealed that the measurement model has convergent validity and good reliability.

Figure 3 presents our initial full structural equation model with applied adjustments for age, gender, living arrangements, and home care. To obtain an acceptable model, the following steps were conducted in sequence: initial fit, modification (for example, modifications of the regression weights and model trimming), and refitting (Collier, 2020). The steps of modification and refitting were repeated iteratively until the model reached an acceptable fit.

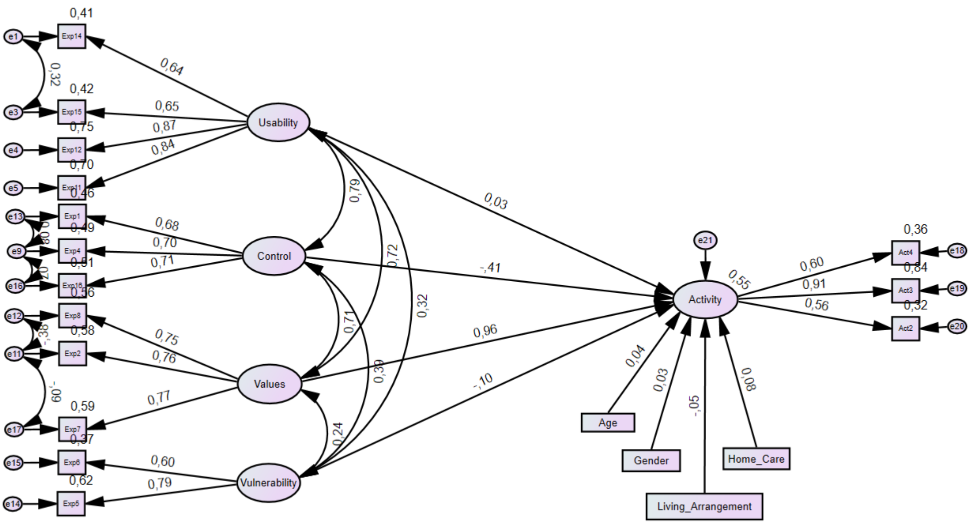

Figure 3. Initial full structural equation model with standardised estimates.

Activity Recognition Study

Study Design

This small-scale study aimed to develop a method for recognising everyday activities using wearable sensors. In addition, we explored participants' experiences with the sensors used through a brief questionnaire, addressing aspects such as design, privacy, comfort, usability, and their willingness to continue using the devices.

Recruitment and Participants

Participants were recruited through existing mailing lists, which included individuals who had previously expressed interest in research and related activities. Additionally, a digital leaflet was shared through professional and community contacts and posted in public areas such as universities and library receptions. Those interested reached out to the research team via email or telephone, received an information letter, and were subsequently contacted by the researchers to provide further details.

Eligibility criteria included being 65 years or older, feeling physically capable of participating, being able to travel to the study site, being willing to wear sensors, and being able to perform 14 everyday activities. Participants who met these requirements and volunteered were scheduled for sessions at times convenient to them. Ten older adults provided informed consent, including consent for audio and video recordings. At the start of each session, participants were encouraged to ask questions or raise concerns, though none were expressed. The participant group reflected moderate diversity in terms of gender, marital status, and income.

Procedure

Sensor Technology System

To capture detailed and accurate activity data, we employed the Xsens MVN Awinda motion tracking system, which uses 17 inertial measurement units to record various aspects of movements, including angular velocity, acceleration, and orientation (Roetenberg et al., 2009). This system provided a precise foundation for analysing activity patterns and understanding motion dynamics.

To ensure the reliability of the data, we complemented the motion tracking with video recordings. The MoRe-Lab was equipped with video cameras and microphones. The video recordings served as a ground truth for participants' activities, allowing us to manually annotate the sensor data by linking each motion sequence to its corresponding activity. This process also helped reduce potential noise or ambiguity in the sensor signals, adding an extra layer of validation. By integrating motion tracking and video recordings, we created a complementary approach for collecting activity data. This combined method enhanced both the accuracy and interpretability of the dataset, supporting its use in activity recognition analyses.

Trial

We conducted two trial sessions to test wearables' data capturing capability, battery life, comfort, synchronisation between the systems, and obtrusiveness in performing the 14 predetermined everyday activities. The trial provided a better understanding of the sensors' limitations in specific areas at the MoRe-Lab and made it possible to adjust the data collection time for each participant to allow a more natural execution of everyday activities.

The findings from these trials allowed us to refine the experimental setup, such as repositioning the base stations and avoiding problematic areas, ultimately ensuring better data collection and reliability during the main study.

Data Collection

The data collection process began with a detailed explanation of the predefined set of activities to ensure participants understood each task they were asked to perform. Following this briefing, we carefully placed 17 inertial measurement units at key body locations on the participants for capturing comprehensive motion data (see Figure 4). We then verified that each sensor had proper attachment and calibration, ensuring optimal functionality and minimal participant discomfort before performing the activity.

Figure 4. Sessions from the activity recognition study.

The 14 activities were then performed in the order listed in Table 6, lasting about 1 hour in total for each participant. The activities were based on the performance of everyday activities, which are important to sustain independence (Björk et al., 2017; Edemekong et al., 2025). Two researchers managed and supervised the activities and the interactions between the participants and the sensor systems, and guided participants through each process step. Simultaneously, the video camera and sensor data were recorded. We closely monitored the recording to ensure the cameras functioned correctly and that the recorded data were transmitted without interruption or interference.

Table 6. Activities included in the study.

Activity	Description
1. Reading a newspaper	Reading two articles in a magazine comprising several pages
2. Conversation via mobile phone	Calling the facilitator for small talk and instructions for the next activity
3. Taking medication	Eating a piece of chocolate or lemon candy (as medicine) from a plastic bottle container and drinking water afterwards
4. Making coffee	Brewing coffee with a smart coffee maker using coffee powder
5. Preparing food	Simulating toasting bread in a pan, flipping the bread, toasting both sides and making a sandwich afterwards
6. Eating and drinking	Eating the prepared sandwich with a knife and fork, and drinking coffee
7. Washing dishes	Washing used dishes and utensils either by hand or putting them into the dishwasher
8. Vacuuming	Simulating vacuuming open spaces and under furniture
9. Using the toilet	Simulating using the toilet without taking off clothes
10. Handwashing	Handwashing after a toilet visit
11. Putting on shoes	Simulating putting on shoes before going outdoors
12. Walking outdoors	Walking around the outdoor premises of the apartment
13. Taking off shoes	Simulating taking off shoes after going outdoors
14. Resting on the bed	Simulating resting

Data Analysis

Data Labelling

We synchronised the recorded motion tracking data (see Figure 5) with the video recording by having each participant perform a hand wave movement at the beginning and end of the recording session. Each video was carefully reviewed, and timestamps corresponding to the beginning and end of each activity were identified. The annotation process involved marking the data to reflect transitions between activities (e.g., moving from sitting to standing or walking to turning) and identifying any deviations or interruptions during the activities.

Figure 5. Xsens software platform motion visualisation and network of the recorded motion tracking activity.

Data Preprocessing

Within the deep learning framework, it was possible to select specific sensors (e.g., those placed on the right forearm or head) and their associated physical values (e.g., linear acceleration in the x-axis, orientation). The training-testing split was performed in a leave-one-out manner, meaning that the motion-tracking data was immediately divided into a training set comprising nine participants and a testing set comprising one participant (Lui et al., 2023; Shang et al., 2022). This cycle was repeated 10 times, and then the extracted feature signals were prepared for input into the Long Short-Term Memory (LSTM) network (Mekruksavanich & Jitpattanakul, 2021; Sherstinsky, 2020).

LSTM Model

Because human activities involve a mix of dynamic, cyclic, and static movements, it was important to capture kinematic signals within a defined time window. This allowed us to account for variability in how activities were performed, including brief pauses or stationary moments. To model these time-series data, we selected an LSTM network as the most suitable approach and centred our analysis on this architecture (Sherstinsky, 2020). The key LSTM parameters, sequence length (input history) and number of units, were optimised using the same procedure applied to tuning the sliding window size, stride, and sensor selection (Sherstinsky, 2020). Based on this optimisation, the network was configured with 256 units and an input history of 15 timesteps. With a stride of 60 samples, this provided a memory window of 900 samples (60 × 15), corresponding to 15 seconds at a 60 Hz sampling rate.

The LSTM layer was followed by batch normalisation, a dropout layer with a rate of 0.2, and a fully connected layer using a softmax activation function. Model training was performed with the Adam optimiser and the sparse categorical cross-entropy loss function. To prevent overfitting, early stopping was applied with a minimum delta of 0.0005 and a patience of five epochs. The validation subset used for early stopping was derived by splitting the training data into 80% training and 20% validation (Gomaa & Khamis, 2023; Kingma & Ba, 2015; Lui et al., 2023). All signal processing and model implementation was carried out in Python 3.7.

Analysis Framework

To assess the model's performance, we first considered accuracy, which reflects the proportion of correctly predicted cases out of all predictions (Rahayu et al., 2024). While useful, accuracy on its own can be misleading, particularly in the presence of class imbalance. To address this, we incorporated additional metrics, precision, and recall (Gomaa & Khamis, 2023). Precision indicates the proportion of true positives among all cases identified as positive, offering valuable insight in situations where false positives are costly. Recall, on the other hand, measures the model's ability to capture all actual positive cases by comparing true positives to the total number of positives. Together, these metrics provided a more balanced understanding of the trade-offs between sensitivity and specificity (Gomaa & Khamis, 2023; Rahayu et al., 2024).

In addition, we employed a confusion matrix to gain a more detailed picture of the model's performance. This matrix revealed not only the overall accuracy of predictions but also the distribution of misclassifications, helping us to identify strengths in the model's predictive capacity as well as areas where errors were more likely to occur (Gomaa & Khamis, 2023; Rahayu et al., 2024).

Survey Data

We gathered additional insights into participants' experiences with the wearable sensor technology through a brief questionnaire (see Appendix IV), drawing inspiration from the TAM (Davis, 1989). To analyse the responses, we applied descriptive statistics (Jones & Goldring, 2021), using frequency distributions to capture variations in how participants perceived and experienced the use of wearable sensors.

Settings

Movement and Reality Lab (MoRe-Lab)

The data for studies I, II, and IV were collected at the MoRe-Lab at the Faculty of Medicine, Lund University. This state-of-the-art facility for experimental health sciences features a movement platform, mobile platform, and reality platform. For all three sub-studies, we utilised the reality platform, which consists of a fully functional one-bedroom apartment within the lab, equipped with 17 cameras for recording and monitoring from a separate control room. Speakers and microphones enable auditory two-way communication. The apartment comprises a two-room apartment and an outdoor garden (see Figure 6). The apartment was designed to the highest accessibility standard in the Swedish building code for people with impaired mobility. The apartment allows researchers to examine and gain a deeper understanding of the complex interactions between people, technology, and everyday activity within a home setting.

Figure 6. Segment of the reality platform in the MoRe-Lab at Lund University.

Ethical Considerations and Reflections

All four studies included in this thesis were conducted under the Declaration of Helsinki (World Medical Association, 2013) and the Swedish Ethical Review Authority. The Swedish Ethical Review Authority (Studies I and II registration number: 2023-00119-01, Study III registration number: 2023-04236-01, Study IV registration number: 2024-02004-01) approved the study.

In all studies, participants received an information letter with information about the respective study, ethical principles on voluntariness, withdrawal possibilities, etc., as outlined by the Swedish Ethical Review Authority. Participants received clear, accessible information about the study and were encouraged to ask questions at any time. They were encouraged to clarify any concerns before signing written informed consent to participate in the studies and to be audio and video recorded (studies I, II, and IV) during sessions. In study III, participants were encouraged to raise any concerns and questions by calling the phone number indicated in the information letter. The information letter also provided information about the purpose of the survey, indicating that participants could continue with the survey once they consented to participate.

Exclusion criteria were established across all studies to maintain the integrity and ethical standards of the research. Individuals with cognitive impairments or insufficient language skills were excluded to ensure all participants could provide informed consent and participate in the discussions and surveys. This exclusion was deemed necessary to gather reliable data and uphold ethical standards by ensuring that participants fully understood the aim of the study and their involvement in it.

Privacy and confidentiality were maintained, including data from video recording. Identifying details were anonymised or pseudonymised, and data were securely stored in compliance with the General Data Protection Regulation and institutional guidelines. All data were stored in LUSEC, a secure data storage and analysis platform at the Faculty of Medicine, Lund University.

Reflections on the Research Process

Our studies with older adults in the context of technology were conducted with careful attention to ethical principles, particularly respect and inclusivity (Pols, 2017; Wang et al., 2023). Two of the studies include multi-generational participants. It was important to consider the perspectives of each participant, even though in some cases the older adult age group is the majority. Experiences and attitudes regarding technology were respected and given consideration, a principle that guided all interactions. Many participants expressed either curiosity, scepticism, or concern about technology. Some shared emotional reflections connected to ageing, independence, or digital exclusion. All these perspectives were given attention in all phases, from data collection to reporting of results. Also, interviews were paced to accommodate individual needs and limitations, such as hearing or sight difficulties.

As a researcher actively involved with participants in recruitment, data collection, analysis, and contacting them to disseminate the results, I engaged in ongoing reflection to maintain neutrality and stay oriented towards ensuring participants' safety, i.e., from physical harm or psychological distress. Consultation with the research team also supported my ethical awareness, especially when navigating sensitive or complex stages such as the interpretation of qualitative data.

Many participants appreciated being included in a dialogue about technology in which their voices are often overlooked. This reaffirmed the ethical value of inclusive research, which is not only to protect participants but also to empower them through active involvement in sharing their experiences of technology and providing suggestions for the development of solutions that better suit their needs and desires. The need to include older adults in developing technologies will become clearer as we navigate this thesis.

Thus, the ethical foundation of the thesis rests not only on the rules of ethical principles but also on relationships built through trust, transparency, and mutual respect. Involving older adults in technology research demands consideration of their needs and their right to shape the future being designed around them.

Results

The results section consists of three parts. The first part reports the results of our SHT study (studies I and II). Next, our results on WT user experience and its relationship to engagement in everyday activities are presented (study III). Finally, as we have explored the need and desire for technology in engagement with everyday activities as people age, the last section (Study IV) presents a method to recognise everyday activity using wearable sensors and deep learning models.

Perspectives on the Adoption of Smart Home Technology to Facilitate Everyday Activities (Study I and Study II)

1. Experiences and Perspectives Influencing the Decision-Making Process

For many participants, SHT was an unfamiliar concept, something they had heard of, perhaps in passing, but had rarely interacted with directly. Though limited, their experiences revealed a rich and complex relationship with SHT, shaped by curiosity, caution, aspiration, and, at times, resistance, such as scepticism. These stories were mapped onto the five-stage decision-making process from the diffusion of innovations theory: awareness and knowledge, persuasion, decision, implementation, and confirmation.

1.1 Awareness and the Quest for Understanding

The participants' first awareness of SHT often came through incidental exposure: something they had read online, seen in advertisements, or heard mentioned by friends and family. Nevertheless, knowledge was often patchy, with no complete understanding of what SHT was or what it could offer. The results also highlighted the crucial role of actors, including politicians, healthcare systems, and SHT professionals, in raising awareness. Friends and family also played a crucial role as informal influencers.

The desire to stay current and independent without being overwhelmed by technology also emerged. Most participants in the younger age groups demonstrated greater exploratory behaviour, such as actively researching, experimenting, and imagining how SHT might support them in the future. Older participants, by contrast, tended to frame their awareness in terms of risk management and necessity, rather than lifestyle enhancement. Nonetheless, across the generations, participants expressed a desire for greater digital literacy opportunities, particularly those that could help bridge the conceptual gap between everyday needs and available technology.

1.2. Persuasion and Personal Attitudes

As participants formed opinions about SHT, their perspectives ranged widely. Many had realised the potential of such devices to, for example, save time, conserve energy, enhance security, or even help them maintain independence as they age. Artificial intelligence (AI) and automation sparked genuine interest, particularly when linked to benefits such as smart energy consumption and enhanced everyday activities.

However, in some cases the interest was tempered by concern. Some questioned what might be lost in the process, such as physical activity, mental engagement, or even personal identity. Might too much automation make the user dependent or passive? Could digital reminders and apps, however helpful, replace the stimulation of managing life's small tasks? There were also concerns about integrity and privacy. The idea of devices constantly collecting data, which would possibly be vulnerable to misuse or breaches, created fear. While health data sharing with professionals was seen beneficial, surveillance technologies such as smart cameras were often perceived as crossing a line.

1.3. Making the Decision

The decision to adopt SHT was rarely impulsive. It often involved trial, observation, and critical questioning. Some participants embraced the idea readily and sought to install devices immediately. Others were cautious, instead considering a time in the future when such tools might become necessary.

Regardless of when they chose to engage, ease of use was important. Complicated interfaces, unreliable systems, and unclear instructions created hesitation. Many sought reassurance, such as having a technician call to help, ideally without incurring extra costs. While some were confident in troubleshooting using manuals or online forums, others admitted that tech issues made them feel inadequate. However, the decision to move forward with adoption (when made) was usually thoughtful, measured, and rooted in a real-life need or aspiration.

1.4. Implementation and Re-invention

Integrating SHT into the home involved, for many, a mix of excitement and frustration. The promise of seamless living often collided with everyday realities – for example, devices that did not always respond or systems that were hard to program.

Despite these issues, participants were open to solutions. They expressed ideas about how SHT could be improved. These included simpler interfaces, fewer wires, combined apps, and customisable functions. Rather than flashy, high-tech designs, they wanted intuitive, familiar tools that fit seamlessly into everyday activities.

Some even proposed innovative AI-supported features like smart fridges that suggest healthy recipes, automated reminders for exercise, or wheelchairs with built-in navigation. Yet participants remained cautious about over-reliance on data and notifications.

1.5. Confirmation, Satisfaction, and Letting Go

For those who had implemented SHT, the experiences varied. Many appreciated the added comfort, mainly from smart lighting, automated reminders for chores, and the ability to control home settings through a mobile phone or voice command. These technologies provided convenience and a sense of safety, especially for those managing busy households or living alone.

Yet, in some cases, the interest wore off when the technologies failed to deliver consistent efficiency. Privacy concerns also led to rejection, particularly home cameras that felt intrusive or untrustworthy. The sense of being forced into adopting SHT for the sake of keeping up with societal expectations was also highlighted. Some participants admitted they had not fully embraced the idea but felt pressured to conform and use the devices anyway.

2. What Perspectives on Adoption Stories Tell Us

The perceived need for SHT to support engagement in everyday activities often aligns with age, lifestyle, and health status. While older participants focused on how SHT could support their present needs for autonomy and safety, younger ones saw it as something to adopt in the future. Family dynamics played a role: those with children or caregiving responsibilities were more open to exploring SHT.

Cost remained an issue, though many were willing to invest if the product was durable and environmentally sustainable. Simplicity, adaptability, and trustworthiness were seen as more important than high-tech glamour. Ultimately, SHT had to feel user-friendly, something that worked with, not against, the rhythm of everyday activities. This highlights that simplicity and being tailored to the individual were important to adoption.

The adoption of SHT among older adults is not simply about whether the devices work. It is about whether they fit – with personal values, routines, capabilities, and aspirations. The focus group participants clarified that future SHT must enhance functionality that responds and adapts to the user's routine. To achieve the right balance in SHT innovation, a co-production approach that considers the needs of older adults could be a crucial element in bridging the persistent gap between older adults and technology.

3. *Ideas Generated in a Co-Production Approach*

The RC (study II) began by considering the SHT problems identified in the Perspectives on Adoption study (study I) and engaged RC members in iterative discussions to generate solutions. The resulting ideas for SHT solutions were not focused on popular gadgets such as smartphones or trending devices, but on solutions that could enrich social interaction, stimulate physical and mental activity, support independence, and ensure safety.

Consistent with study I, one subtheme in study II centred on creating a stimulating environment to encourage engagement in everyday activities. Examples included reminders for daily tasks like exercising, cooking, or taking medication, voice commands for ease of use, and updates about local community events to stay socially connected. Screens that could guide users through physical exercises or games designed for group engagement also surfaced as desirable features. Augmented and virtual reality solutions were suggested, enabling activities like virtual travel or social games, offering adventure and companionship from the comfort of home.

Furthermore, the results highlight the preference for simplicity in design, one-function controls over complex systems. A digital game, for instance, should be joinable with a single click. Smart features that merged with everyday items, such as eyeglasses with built-in GPS or furniture embedded with sensors, were also preferred. These items could track activity or prompt users to move after long periods of inactivity, blending seamlessly into everyday routines while supporting health goals. There was an interest in smart wheelchairs that could encourage physical activity through voice command or alarm to long periods of inactivity, and robotic exoskeletons to support strength and mobility.

SHT solutions for safety and security were equally important. SHTs designed with biometric security, such as facial recognition or fingerprint scanning, were viewed as an effective way to control access and enhance safety and security. While indoor cameras raised privacy concerns, they were more acceptable when used with consent for care-related monitoring. Across all design ideas, there was a clear desire for technology that respects autonomy and privacy while offering reliable safety.

Beyond the technology itself, the second central theme of the study highlighted the importance of implementation strategies and human support. RC members acknowledged that even the most well-designed systems could fall short without proper education, awareness, and integration into users' lives. This suggests a need for accessible and centralised sources of information, such as a continually updated catalogue or public SHT showrooms. Training programmes, ideally offered by municipalities, could provide hands-on experience, helping potential users build confidence and understand the possible benefits of SHT.

The results reflect a view that SHT should never replace human care but instead complement it. Informal carers, such as family members and friends, play a vital role in supporting older adults. SHT could ease their burden by enabling remote monitoring and reducing the need for constant physical presence. While meaningful social interaction remained essential, concerns about overreliance on technology were expressed, which might lead to emotional isolation. Ideas for SHT systems that could engage neighbours and local communities, coordinating support for less urgent needs more efficiently and fostering a stronger sense of belonging, were also prioritised.

The ideas generated in this study support the need for the human-centred design of SHTs that are adaptable and evolve alongside users' changing physical demands. In addition, there is an urgent need for a national strategy to support the integration of SHT into everyday activity, which involves collaboration between public institutions, private companies, caregivers, and community networks. Such a collective effort could help SHT fulfil its potential.

The experiences and needs of older adults are complex, which also brings another layer of challenges for technology developers and other involved actors. Nevertheless, technological development and future prototypes must include the experiences of older adults. The findings from studies I and II highlight that the participants' vision for SHT is centred on enabling older adults to engage in everyday activities in a safe, independent, and meaningful way. Building on this insight, the following section examines older adults' experiences with WT (which are implemented to support older adults' independence) and how these experiences relate to their engagement in everyday activities. Given that studies I and II have identified the desires and needs of older adults regarding SHT, it becomes essential to empirically explore how actual user experiences with WT translate into practical support for everyday activity. This approach enables us to understand with an empirical stance the ways that technology can support engagement in everyday activities.

Welfare Technology Experiences and Everyday Activities (Study III)

Various SHT experiences highlighted in the previous section show how older adults can abandon or disengage with such technology, which may prevents them from fully benefiting from the technology's full potential. These experiences are important in WT adoption as their deployment is meant to assist users in facilitating their independence and everyday activities. The findings of this study reveal a complex relationship between WT user experiences and older adults' engagement in everyday activities. While some results affirm what might be expected, others challenge existing assumptions and invite fresh thinking about the relationship between WT user experiences and engagement in everyday activities.

One unexpected finding is the negative association between perceived control and engagement in everyday activities. We often think of control as a positive factor that empowers users, giving them the confidence to engage more fully with their environment, which is partly supported by studies I and II. However, in study III, greater perceived control over WT use was linked to lower levels of engagement in everyday activities. This raises interesting questions about how perceived control operates in this context. Older adults who feel a high degree of control over their WT may engage with it more cautiously or selectively, relying on it only within comfortable, familiar boundaries. In this sense, perceived control might act less as a facilitator and more as a gatekeeper, limiting engagement in everyday activities rather than expanding it. This finding suggests that perceived control is more nuanced than commonly assumed and that its effects may depend heavily on context and interpretation.

In contrast, the role of perceived value was clear. When WTs align closely with what older adults value, engagement in everyday activities is significantly enhanced. This can mean that motivation from within, rooted in personal goals, is far more important than motivation driven by external features or technical design alone. The strength of this relationship suggests that for older adults, technology becomes truly meaningful when it resonates with their interests and what matters most to them. This highlights that to foster meaningful engagement, WT needs to be designed with a deep understanding of users' perceived value and the aspects of life they prioritise.

The perceived usability of WTs did not show a significant relationship with engagement in everyday activities. The role of perceived vulnerability was also minor. Although a slight negative trend was observed, indicating that perceived vulnerability might hamper engagement in everyday activities, this effect was not statistically significant. This suggests that concerns about WT reliability, while certainly relevant, may not be decisive factors in determining whether older adults engage with WT in everyday activities.

The findings in study III may imply that engagement in everyday activities does not mean merely making WT easier to use. Rather, engagement in everyday activities benefits from supporting WT experiences that connect with users' intrinsic motivations, and understanding how perceptions of perceived control can influence behaviour. This result, in turn, invites designers, experts, researchers, and practitioners to look beyond surface-level solutions and focus on what truly drives meaningful engagement, offering a more human-centred vision of how WT can support active, fulfilling engagement in everyday activities.

The following section explores how engagement in everyday activities can be accurately collected and analysed using wearable sensors and deep learning models.

This approach also aligns with the findings from studies I and II, highlighting older adults' desires for technologies capable of monitoring and analysing behavioural patterns. Such technologies can potentially support early detection or prevention of adverse conditions, ultimately promoting safety, autonomy, and well-being.

Recognition Model of Everyday Activities (Study IV)

The findings of this study illustrate the interplay between sensor quantity, placement, and system performance accuracy in activity recognition. Figure 7 illustrates the distribution of sensor positions on the body (e.g., hand, forearm, pelvis, head, legs) and the number of everyday activities recognised by each model. While Model 0 struggled with recognition, the other four deep learning models successfully recognised everyday activities. Model 2, employing seven sensors bilaterally across the forearms and legs, achieved the highest accuracy (90.22%). However, this outcome reflects not merely sensor quantity but also strategic placement and sensor signal.

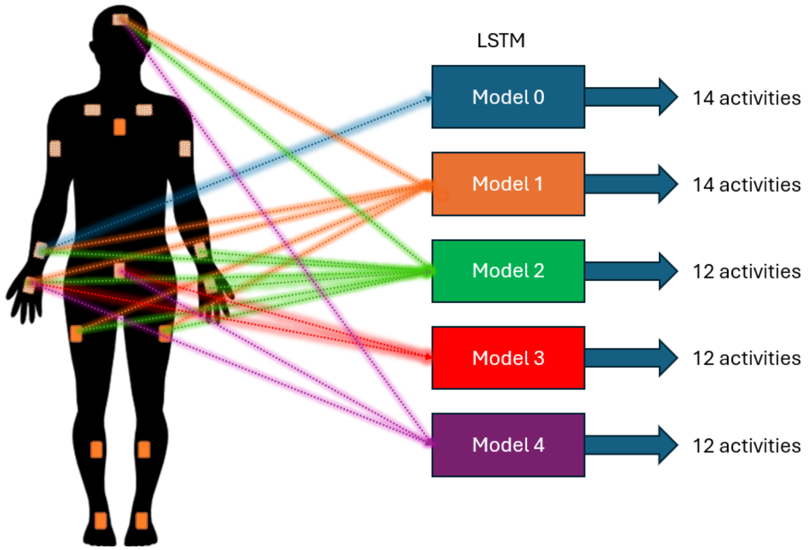

Figure 7. Sensor placements and activity recognition scope across five LSTM-based models. Each model utilises a different combination of body-worn inertial sensors (represented by orange squares) connected via colour-coded lines to the corresponding model (Model 0 to Model 4).

Model 3 achieved a comparable accuracy of 88.59% using only two sensors placed on the dominant side of the body. This finding disrupts the presumption that a higher number of sensors is necessary for effective recognition, instead underscoring the critical role of optimal sensor positioning. Beyond sensor placement, study IV highlights the impact of classification complexity on system performance. Model 1, tasked with classifying 14 activities using five sensors, achieved lower accuracy (83.66%) than models classifying 12 activities. This decline reflects that distinguishing between similar motion patterns becomes more challenging as the number of activities increases.

Activity duration further complicates this dynamic. Short-duration activities contribute limited training data, reducing the model’s exposure to intra-class variability and increasing misclassification risks. On the contrary, longer-duration activities provide richer datasets but risk overrepresentation, potentially biasing the model towards dominant classes and misclassifying underrepresented, brief activities. This means balanced, representative datasets in terms of activity types and coverage are needed to foster generalisable models.

Using Friedman and Wilcoxon signed-rank tests, the statistical comparisons across models revealed statistically significant differences between the performance metrics of Model 0 and Models 1-4. This highlights the importance of incorporating additional and diverse sensor data. On the other hand, the results also demonstrated no statistically significant differences in the performance of Models 1 through 4. This is visually and numerically supported by the close range and overlapping values of each model’s scores. For instance, although Model 2 exhibited slightly higher performance across all metrics and Model 4 showed somewhat lower values, these variations were not significant enough to distinguish one model as superior to the others in a statistical sense.

As Models 1-4 exhibit statistically comparable performance, their selection should prioritise pragmatic factors such as user comfort, wearability, battery life, system complexity, and ease of deployment. In this light, Model 3 emerges as a particularly viable configuration, achieving competitive accuracy with a minimal sensor setup. Considering the results of studies I, II, and III, Model 3 is also preferable. It is a less obtrusive, simpler system and less complex, requiring less control from the older adult. Based on the presented results, study IV proposed a two-sensor method (Model 3) to collect and correctly recognise data on everyday activities among older adults.

Participants' Experience of the Sensors

The survey revealed that participants generally responded positively to the sensors, though some reservations were noted. Eight out of 10 did not find the sensors intrusive or disruptive, and concerns about privacy or surveillance were minimal. Half expressed an interest in using the sensors to monitor everyday activities, underscoring their potential value. Notably, all participants reported that the presence of sensors would not interfere with their everyday routines at home or outdoors, suggesting broad acceptance of wearable technology in everyday life.

However, feedback was not entirely uniform. Six participants shared a positive overall experience, while others expressed neutral or negative views. Some noted discomfort when wearing the devices, and aesthetic concerns were more common, with seven out of 10 describing the design and appearance of the sensors as unappealing. These mixed responses highlight the need for further exploration into how comfort, usability, and design influence the acceptance and adoption of wearable sensors.

Discussion

This thesis sought to deepen the understanding of how technology can support older adults in engaging with everyday activities. Through four studies, this thesis illustrates the intersection of user needs, design, experience, and AI-supported technology solutions, providing an understanding of how technology can enhance day-to-day life as people age.

The first study examined generational perspectives on SHT, highlighting attitudes and needs of current and future older adults. It revealed both barriers and facilitators to adoption, emphasising the diversity of expectations across and within age groups. Building on these insights, the second study embraced a co-production approach, where members generated ideas for SHT solutions through an RC. This process ensured that the design concepts reflected users' priorities and values, reinforcing the importance of user involvement in the early stages of technology development.

The third study explored how experiences with WT relate to engagement in everyday activities. We found that perceived value strongly influences how older adults integrate WT into their lives, highlighting the emotional and practical dimensions of technology adoption. Finally, the fourth study focused on the development of a method to recognise everyday activities using wearable sensors and deep learning. This study demonstrated the feasibility of data-driven approaches to complement monitoring.

Potentially, SHTs offer environmental automation, WTs provide functional and safety support, and wearable sensors supply continuous, personalised insights. When integrated, these technologies create dynamic systems where sensor data can trigger SHT responses or welfare alerts, delivering more responsive and intuitive support tailored to older adults in their own homes. The overlapping results of the four studies regarding preferences, needs, and use of SHT, WT, and wearable sensors provide a perspective on the potential of these technologies to revolutionise the experience of older adults in their engagement in everyday activities. Furthermore, these potential benefits extend to the older adults' families, carers, and the society they live in.

However, there is work to do before the full potential of these technologies is achieved. The results underscore the need for transdisciplinary approaches to incorporate the needs and desires of older adults in technological development.

The Importance of Awareness in Technology Adoption

The SHT studies (studies I and II) presented in this thesis sought to understand how older adults engage with such technologies in the context of everyday activities, highlighting the needs and desires involved in SHT adoption. The findings illustrated that the SHT adoption process does not follow a binary of acceptance or rejection, but rather a series of attitude framing, evolving decisions, and demand for re-inventions shaped by perception and experience of using SHT.

The awareness of SHT demonstrated in the results reflects what Heart and Kalderon (2013) describe as the awareness–comprehension gap, in which exposure to technology does not automatically lead to informed engagement. As a result, many older adults are left navigating assumptions or stereotypes, for example, believing that such innovations are designed for others, mainly younger users and more tech-savvy individuals (Neven, 2015). Such perceptions can fuel self-exclusion, not due to disinterest, but because older adults do not see themselves reflected in the design or discourse surrounding SHT.

Rogers (2003) emphasises the importance of communication channels and informal networks in facilitating innovation adoption. The diffusion of innovations theory identifies awareness as the first stage in technology adoption, but emphasises that this stage must be followed by persuasion, decision, implementation, and confirmation. Without accurate and accessible information, individuals remain stuck in the early stages. This hesitation is compounded by broader issues with digital literacy, which remains highly variable among older populations (Czaja et al., 2006; Miller et al., 2024). Even when the desire to learn exists, a lack of structured support leaves many struggling to understand the potential applications of SHT in ways that feel personal and concrete.

The TAM (Davis, 1989) further reinforces this point, suggesting that perceived usefulness and ease of use are critical to adoption. However, such perceptions cannot form without a foundation of knowledge. Older adults must be allowed to interact with SHT and the context of use to be able to imagine how it might fit into their lives, supporting health, enhancing safety, or reducing everyday burdens (Dermody et al., 2021; Mitzner et al., 2010). This can be achieved by using an approach of "showing/doing with" versus "doing for" the older adult (Ambugo et al., 2022), while also recognising that different levels of technological maturity may need different approaches (Greenhalgh & Payne, 2025).

These insights highlight the urgent need for initiatives beyond general awareness campaigns, including cost-free technical support, a unified SHT brochure, and SHT showrooms within the community. Furthermore, intergenerational instrumental support may have a direct positive effect on awareness and the behavioural intention to use SHT (Wei et al., 2023). What is needed is targeted, meaningful education delivered through trusted community channels, supported by hands-on demonstrations, and designed to reduce fear and build confidence (Ambugo et al., 2022; Miller et al., 2024; Orellano-Colón et al., 2017). Participants in our studies called for clear guidance, tailored instructions, and the opportunity to ask questions in safe, supportive settings. The success of technology adoption also depends on the broader social, cultural, and organisational systems that support users in their everyday environments (Lee & Kim, 2020).

Reimagining Future SHT

The RC study (study II) shows how older adults envision SHT as a meaningful enabler of active, connected, and autonomous living in later life. SHT solutions that enhance everyday life, foster engagement, and support physical, cognitive, and social well-being were prioritised. This aligns with activity theory, which posits that engagement in activity, particularly when self-initiated and meaningful, is a cornerstone of higher well-being (Havighurst, 1961; Lemon, Bengtson, & Peterson, 1972). Furthermore, research shows that older adults who remain involved in activities that stimulate their bodies and minds experience slower cognitive decline, better emotional well-being, and a stronger sense of purpose (Rowe & Kahn, 1987). For RC members, the role of technology was not to replace these activities but to support and enrich them, making engagement more accessible, enjoyable, and consistent.

While showing potential, many SHTs fail to gain popularity among older users because they are too complex or poorly aligned with needs (Basarir-Ozel et al., 2023; Ghorayeb et al., 2021; Mitzner et al., 2010). In contrast, RC members imagined technologies that felt like an extension of themselves and their homes. The findings in our RC study reinforce the idea that technology design needs to draw inspiration from lived experience and that systems must evolve with users' changing needs, preferences, and identities. Designing less complicated systems can make the difference between successful adoption and rejection. The ample opportunities for modifying these technologies enhance rather than limit older adults' ambitions and aspirations, allowing them to decide how tasks will be done in their living environment (Dannefer & Phillipson, 2010). The ICF frames such resources as environmental facilitators for everyday activities (World Health Organisation, 2001). By reducing barriers through design ideas generated by RC members, these resources enable older adults to sustain their everyday routines, exercise autonomy, and remain actively involved in their communities, highlighting the critical role of such technology in promoting participation and well-being.

Can We Truly Tap into the Full Potential of Technology?

The studies included in the thesis support the role of technologies in sustaining older adults' engagement in everyday activities. SHT can facilitate engagement by integrating sensors, reminders, and adaptive interfaces that promote autonomy in managing personal care, household tasks, and social interaction. Wearable sensors have demonstrated utility in monitoring engagement in everyday activities and potentially preventing domestic accidents, which in turn can maintain or improve mobility and reduce disability. WT, including telecare and assistive devices, further contribute by enabling safe, confident navigation of the in- and out-of-home environment and extending the possibilities for engagement in everyday activities.

Crucially, these technologies do more than assist with tasks; they create opportunities for meaningful engagement. Voice-activated assistants, for instance, can serve as activity reminders while also acting as portals to music, conversation, and information, thereby reducing isolation and encouraging interaction (Appel et al., 2020). Augmented and virtual reality applications are emerging tools that support cognitive stimulation, physical activity, and leisure engagement, facilitating virtual engagement in travel, group games, or cultural experiences (Appel et al., 2020).

However, discussions on the effectiveness of these technologies continue. One critical challenge is usability. Technologies often fail to align with ageing users' sensory, cognitive, and motor capabilities, leading to high abandonment rates (Ghorayeb et al., 2021; Mitzner et al., 2010; Mitzner et al., 2019). Poor interface design, frequent software updates, or overly complex features can frustrate users and erode self-efficacy, undermining the autonomy these tools seek to support. The diffusion of innovations theory further supports that long-term use cannot occur without trust and confidence in using the technology (Rogers, 2003).

Ethical concerns further complicate adoption, as reported in some studies in this thesis. While monitoring technologies can enhance safety, they can also compromise privacy and autonomy. The perception of being constantly watched may evoke anxiety or resistance, particularly when data are collected passively without transparent consent (Pols, 2017). Moreover, many technologies rely on implicit surveillance, raising fundamental questions about dignity, agency, and the risk of digital paternalism.

Social engagement is another paradox. While some technologies promote connectivity, others risk reducing human contact if used as a substitute for rather than a supplement to social care. Courtin and Knapp (2017) warn that loneliness is a critical risk factor for older adults, linked to increased mortality and cognitive decline. Thus, technologies that diminish interpersonal interaction, however efficient, may ultimately be detrimental to long-term well-being.

Importantly, issues of accessibility and equity cannot be overlooked. Access to technologies remains uneven, disproportionately excluding older adults from lower socioeconomic backgrounds, rural areas, or with limited digital literacy (Barbosa Neves et al., 2019; Yang et al., 2024). Without targeted policies and inclusive design, these innovations risk exacerbating existing inequalities in health and adoption.

To overcome these barriers, this thesis suggests prioritising better involvement of older adults in the implementation and co-production design approaches. Consistent with all four studies in this work, SHT, WT, and wearable sensors must be simple, stimulate users, and be adaptive to their needs. Greenhalgh et al. (2017) emphasise the need for co-production and stakeholder collaboration to ensure that technologies are functional, meaningful, and contextually acceptable. Ghorayeb et al. (2023) and Lau and Kuziemsky (2017) argue that the use of flexible methods, such as mixed-methods or multi-method studies, that account for the complexity of technology integration in everyday settings, may help facilitate technology adoption. This requires collaborative innovation across research, design, and policy, grounded in the lived experiences of older adults.

A Holistic Approach to Technology Development

The Potential of Inclusive Technology Development

A human-centred approach emphasises that technology must function well technically and align with users' experiences, needs, and desires (Greenhalgh et al., 2013; Lindsay et al., 2012). For older adults, this means that technology development or improvement should account for the complex intersections of ageing, health status, cognitive abilities, social networks, and cultural diversity. All four studies included in this thesis support heterogeneity among older adults, making flexibility, adaptability, and personalisation central requirements in technology design and implementation.

Co-production and participatory design methods, at all levels, offer concrete strategies for achieving this inclusivity (Schubotz, 2020). Involving older adults early and throughout the development process ensures that their perspectives directly influence how devices function and how they fit into everyday routines and social lives (Ghorayeb et al., 2021; Mitzner et al., 2010). Lindsay et al. (2012) found that technologies developed with participatory input from older users significantly improved usability and overall acceptance. Successful examples show that when older users are treated as partners, technologies are more likely to result in a positive implementation, address real needs, and support older adults to overcome stigma (Peek et al., 2014; Sharma et al., 2025; Vargas et al., 2022).

For instance, wearable sensors vividly illustrate the potential benefits and challenges of technological innovation in supporting older adults. These devices can provide valuable real-time data to support health monitoring and promote independence. Yet, the results of this thesis clearly present concerns about privacy, autonomy, and surveillance that often inhibit sustained use, or even the initial step of adoption. A human-centred approach must therefore ensure transparent data practices, respect for user consent, and flexible usage options, empowering older adults to retain control over how and when they engage with technology (Vandemeulebroucke et al., 2018).

Legal Framework Supporting the Development of AI-Supported Technology

Expanding WT to formally include SHT and activity recognition methods in municipal infrastructures can help safeguard older adults' safety, independence, and engagement in everyday activities while promoting fairness, accountability, and transparency. Beyond the immediate benefits of supporting daily living, the integration of these technologies has the potential to strengthen preventive care, reduce unnecessary hospital admissions, and improve the overall efficiency of health and social care systems. By enabling continuous and unobtrusive monitoring, activity recognition can provide early warnings of health deterioration or risks, allowing caregivers and healthcare professionals to intervene in a timely and targeted manner.

From an organisational perspective, embedding these technologies within municipal infrastructures ensures that they are not only available to older adults who can afford them but are also distributed equitably through public care systems. This translates the results of our perspectives on adoption and the co-production studies, where older adults demand a more formalised and systematic integration of SHT. This approach can reduce the risk of digital exclusion, ensuring accountability and transparency in the implementation process, which builds trust among older adults, families, and care professionals. Sweden's legal and policy frameworks play a role in shaping how WT is adopted and governed. The broader social and organisational context into which WTs are introduced must be considered to balance individual needs with broader societal interests (Cuesta et al., 2020; Österholm et al., 2025; Swedish National Board of Health and Welfare, 2025).

The Ethics Guidelines for Trustworthy AI (European Commission, 2019) offer a valuable framework to guide the integration of AI-supported technology in the care of older adults, highlighting requirements for human agency and oversight, privacy, diversity, non-discrimination, and societal well-being. In practice, this means that the potential integration of SHT and activity recognition methods in WT must prioritise user autonomy and ensure accessibility for diverse older adults. Similarly, the AI Act (European Parliament & Council of the European Union, 2024) establishes a binding legal framework, categorising health- and care-related technologies as “high-risk,” which makes them subject to stringent requirements on data quality, transparency, and human oversight. For municipalities, this implies that SHT and activity recognition methods must be explainable, rigorously tested for safety, and embedded within care pathways where human decision-making remains central.

Finally, expanding WT to include SHT and activity recognition in accordance with these EU-level frameworks creates opportunities for municipalities to enhance care services. By aligning local strategies with ethical and legal obligations, municipalities can foster care models that balance efficiency with the better well-being of older adults. In this way, the dual goals of meeting rising care demands and safeguarding older adults’ engagement in everyday activities can be pursued in tandem, ensuring that technology becomes an enabler of a better environment for older adults and all stakeholders.

Practical and Social Responsibility in Technology Development

At the practical level, sustainable adoption requires more than regulation. It depends on awareness and knowledge of the technology among older adults, training for caregivers, accessible and user-friendly support services, and open public dialogue about the role of technology in ageing societies (Greenhalgh et al., 2013; Swedish National Board of Health and Welfare, 2025). At a deeper level, we need to shift how we frame technology in the context of gerontology. Too often, technology targeted at older adults is problematised around decline, frailty, and care dependency (Joyce & Loe, 2010). These assumptions about tech use or deficit-based framing can themselves become a barrier, reinforcing stigma and internalised ageism (Mannheim et al., 2023). This framing negatively influences the adoption of technology among older adults (Mannheim et al., 2023). Instead, an approach that highlights the meaningful engagement and continued contribution of older adults in the development of technology can be the key to advancing adoption. Technology should be positioned not simply as a compensatory tool, but as an enabler of growth and enjoyment in later life.

However, achieving genuinely inclusive technology development is not without challenges. It may demand time, investment, and economic considerations, and a willingness to embrace complexity and variability (World Health Organisation, 2017). It requires designers, policymakers, and industry stakeholders to recognise older adults not as a homogeneous market segment but as diverse individuals with evolving needs and aspirations. Nevertheless, the full potential benefits of technology for older adults, healthcare systems, and society are profound (Friedrich et al., 2023; Gawrońska & Lorkowski, 2021; Lussier et al., 2019; Lydahl & Davidsson, 2024; Marikyan et al., 2019). Technologies that are inclusive, trusted, and meaningfully integrated into everyday life can potentially strengthen older adults' overall well-being.

Technological improvements inspired by the needs and desires of older adults can be fundamental prerequisites for realising the full potential of SHT, WT, and wearable sensors. There is a need for innovative solutions grounded in partnership and contribution to enhance the richness of life across the ageing journey, benefiting both current and future generations of older adults.

Theoretical and Model Framework Standpoint

This thesis is strengthened through the lens of the activity theory, which emphasises the importance of continued engagement in roles and activities for well-being in later life (Havighurst, 1961; Lemon, Bengtson, & Peterson, 1972). From this perspective, older adults desire to maintain independence, social engagement, and a sense of purpose through engagement in everyday life. SHT, WT and wearable sensors can be facilitators that support this process by enabling older adults to sustain activities that age-related changes might otherwise limit.

Within this framework, technologies are not viewed merely as functional tools but as enablers of continuity and active participation, contributing to autonomy, identity, and quality of life. By supporting engagement in everyday activities, such technologies help older adults preserve social connections, maintain valued routines, and foster a sense of control over their environment. At the same time, the successful application of these technologies requires recognition of the needs and everyday contexts in which older adults live. Support from family, caregivers, healthcare professionals, researchers, technology developers and policymakers is crucial to ensure that technology use yields positive outcomes rather than new forms of dependency or burden.

Across the four sub-studies, SHT, WT, and wearable sensors emerged as potential facilitators of engagement in everyday activities. Study I revealed that older adults perceive SHT as tools for preserving independence with safety and a sense of security, as well as for staying active and supporting relationships, highlighting the role of technology in sustaining valued roles. Study II demonstrated that co-produced solutions empower older adults to shape SHT based on their individual needs and desires, reinforcing autonomy and the motivational significance of engagement. Study III showed that positive experiences with WT enhance engagement in everyday activities. In contrast, poorly adapted solutions can lead to disengagement, emphasising the need for alignment between technology and individual capacities. Study IV demonstrated that wearable sensors can offer objective insights into activity patterns, enabling interventions that support continued participation and functional independence.

The ICF framework (World Health Organisation, 2001) enriches this perspective by framing functioning and disability as dynamic interactions between health conditions, personal factors, and the environment (see Figure 8). In this context, SHT, WT, and wearable sensors can be viewed as environmental factors that either facilitate or hinder engagement in everyday activities. The findings from this thesis suggest that when technology reduces environmental barriers and aligns with older adults' needs and desires, it enables functioning and supports engagement. Conversely, when usability issues, negative experiences, privacy concerns, or complex integration create barriers, technologies may inadvertently restrict participation and negatively affect well-being.

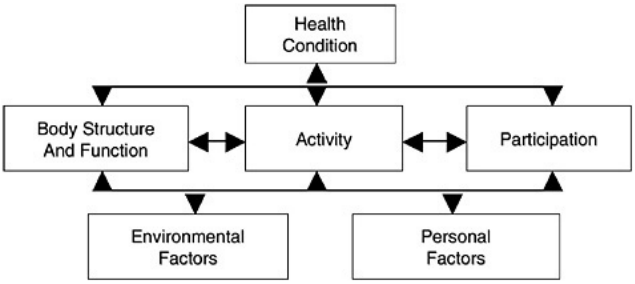

Figure 8. The International Classification of Functioning, Disability and Health model (World Health Organisation, 2001), illustrates the dynamic interactions between health condition, body structure and function, activity, and participation, as influenced by environmental and personal factors.

By aligning activity theory with the ICF, this thesis demonstrates that the successful implementation and sustained adoption of SHT, WT, and wearable sensors depend not only on the design of the devices themselves but also on their integration into the broader everyday routine and their ability to function as positive environmental facilitators. The multi-method findings suggest that when older adults perceive these technologies as supportive of their autonomy, complementing rather than replacing human relationships, they are more likely to embrace them as tools that enrich everyday life. Conversely, when technologies conflict with existing values (e.g., privacy), disrupt trust, or impose an imbalance between knowledge and technology use, the outcome may be resistance, rejection, or abandonment.

This integrated perspective underscores that SHT, WT, and wearable sensors should not be introduced in isolation. Instead, they must be embedded within formal structures, family networks, and supportive policy frameworks, while simultaneously designed to reduce barriers and strengthen engagement in everyday activities in line with ICF principles. In doing so, technologies can more effectively function as enabling artefacts that mediate engagement, highlighting the importance of considering the experience of older adults within the broader social, organisational, and regulatory dimensions of technology development, with significant implications for research, policy, and practice.

Methodological Considerations

Focus Groups Exploring the Perspectives on Technology Adoption

Our focus groups offered dynamic sessions in which participants could engage in discussion, both sharing their own views and responding to and building on the ideas of others. This interactive discussion was particularly valuable for exploring how attitudes and experiences shape the adoption of SHT.

Moreover, since not all participants had direct experience of SHT, the focus group method allowed the open discussion of speculative and hypothetical scenarios. Hearing others reflect on SHTs with which they themselves were unfamiliar often prompted participants to consider possibilities they may not have otherwise imagined. We strived to maintain a relaxed environment that encouraged reflection and discussions, which helped surface practical considerations and emotional and ethical concerns related to current and future use.

While alternative methods such as individual interviews or surveys could have been considered, they offered more limited opportunities for the kind of generative dialogue that study I sought to explore. Interviews, while more private, would have constrained the social dimension of perspective-building. Meanwhile, surveys would not have captured the nuance or context behind the participants' preferences and hesitations around SHT adoption.

Rationale for Using the Research Circle Method

Study II highlights our ambition to co-produce ideas for SHT solutions that support older adults' engagement in everyday activities. This requires both technological creativity and a deeper contextual relevance, the RC method was our primary choice.

The RC was well-suited for our co-production collaborative efforts and discussions on equal terms focused on addressing the issues which emerged in study I (Harnsten, 1994; Löfqvist et al., 2019). Unlike interviews, RCs are based on sustained collaboration over multiple sessions. The three sessions' iterative structure allowed RC members to gradually deepen their understanding of the problem and refine their ideas for solutions.

RC supported both idea generation and prioritisation (Persson, 2016). Participants were encouraged to contribute imaginatively, even when their input was based on hypothetical scenarios involving the personas (see Appendix II) or unfamiliar technologies which other RC members had suggested. Over time, the group developed a shared understanding of what mattered most in relation to older adults' everyday activities and what SHT solutions were needed and preferred to facilitate such activities. Through collective discussion, RC members generated SHT solutions based on their perceived value and alignment with the needs of older adults.

Furthermore, the RC method enabled the integration of user knowledge and professional expertise. As researchers, we introduced current knowledge on SHT, and professionals with expertise in the field offered insights on possibilities and design considerations. At the same time, the multi-generational members contributed with practical insights into their everyday lives and aspirations. This mutual exchange was instrumental in grounding the discussions in real-life relevance.

The Delphi technique would have offered a structured consensus-building, but this method often lacks the open dialogue and collaborative approach of RC, being experimental and innovative, in which members work in partnership as equal collaborators. Individual interviews provide depth but do not facilitate group negotiation or shared prioritisation.

Technology Experiences of Participants

Studies I and II created space for participants to share their views, generate ideas, and collaboratively suggest directions for technological improvement. The goal was to capture current experiences and understand emerging needs and desires for technology related to engagement in everyday activities.

However, a key consideration emerged during the process. Many participants spoke about technologies with which they had limited or no direct experience. While some had interacted with or adopted some SHT, others were encountering concepts like AI-supported automation or continuous sensor-based monitoring for the first time. As a result, discussions frequently moved between the concrete and the hypothetical. Participants speculated how they might feel about or use a particular SHT, often imagining scenarios based on general understanding rather than lived experience.

This combination of previous experience and imagined input presented both opportunities and challenges. On the one hand, it allowed participants to think beyond their current circumstances, offering insights into their ideas for future SHT design. In many ways, these imagined scenarios helped to uncover what participants valued most in technology, such as trust, simplicity, and relevance to their everyday routine.

At the same time, we were mindful that hypothetical responses might lack the depth or specificity that comes from actual use. For example, a participant might express enthusiasm about a monitoring system in principle but later feel differently once faced with its presence in their home. To support richer dialogue and bridge this experiential gap, we introduced visual and descriptive materials using a video presentation (on how the available SHTs in the MoRe-Lab are used) and personas (used in the RC). These supportive materials were introduced to help participants visualise how technology might fit into real-life contexts. We also encouraged RC members to reflect on some of the SHTs installed at the MoRe-Lab and those they were already familiar with, such as mobile phones, smart watches, and robot vacuums. This helped to ground abstract ideas and made the discussions more relatable.

Our approach reflects the nature of co-production at an early design stage, where ideas are shaped by suggestions for creative development (Brandsen et al., 2018; Fitzpatrick et al., 2023). The speculative quality of the conversations was less a limitation, but rather a necessary and generative part of the process. Even without direct experience, participants articulated scepticism, fears, hopes, and needs that can guide future iterations of technology development.

Nonetheless, it is important to interpret these insights with care. Preferences and attitudes expressed in a hypothetical context may evolve with exposure to the technology in practice. For this reason, future work could benefit from complementing co-produced dialogues with hands-on trials or longitudinal studies, allowing participants to engage with prototypes in their everyday environments. Such an approach would offer a more nuanced understanding of how technologies are used, integrated, and experienced.

The Use of Structural Equation Modelling

The WT user experience (study III) was a multifaceted construct through 15 questions involving, for example, experiences of usefulness, emotional responses, trust, confidence, vulnerability of technology, and perceived value (see Table 5). Likewise, engagement in everyday activities was covered by four questions concerning both home and outdoor activities (see Table 5). SEM is uniquely suited to this kind of complexity because it allows for the inclusion of latent variables, which are concepts that are not directly measurable but are inferred from multiple indicators (Collier, 2020). This was essential to capture the broader dimensions of user experience and engagement central to understanding the relationship between WT user experiences and engagement in everyday activities.

Another strength of SEM is its ability to test measurement and structural models within one framework. This enabled us first to validate whether our 15 survey questions reliably reflected the underlying constructs, and then to examine how those constructs related to each other through a CFA (Collier, 2020).

Multiple regression may be less suitable as all variables will enter the regression analysis simultaneously, and all independent and dependent variables constitute one linear regression model. Also, the first assumption of the regression model is that the measurement level of the independent variables can be either quantitative (continuous and interval) or binary (dichotomous). However, the dependent variable must be only quantitative (Nayebi, 2020). Our data, on the other hand, were categorical.

Like many studies using self-report data, study III encountered missing responses. Some participants skipped items, probably due to fatigue, uncertainty, or perceived irrelevance. Rather than omitting these cases entirely, we used FIML, a method supported within SEM software that estimates model parameters (Collier, 2020). This approach allowed us to retain the sample while reducing potential bias introduced by listwise deletion or mean imputation.

Concerns with Deep Learning Models

Deep learning has offered greater flexibility, scalability, and the potential for home monitoring. Despite their increasing widespread application, especially in research and technology development, these methods still attract a critical stance in several aspects.

A key issue is that most of these models are trained on data that poorly represent the diversity and complexity of older adults' lives. Datasets are often collected under controlled conditions, for example, in study IV, which was conducted at the MoRe-Lab, while other datasets are collected using younger, healthier volunteers performing activities (Junaid et al., 2022). The result is an algorithmic mismatch model with poor practical application (Junaid et al., 2022; Qureshi et al., 2025). When deployed in real-world contexts, where there is more variability in movements, their performance often degrades (Ustad et al., 2023; Qureshi et al., 2025). This is a structural limitation that calls into question the validity and inclusivity of these systems. Whose bodies are these technologies or models being trained on, and whose experiences are rendered invisible?

Strengths and Limitations

Among the strengths of this thesis is its multi-method approach, which combines both qualitative and quantitative approaches from four studies. This combination made it possible to explore SHT and WT from multiple perspectives, capturing experiences of older adults as well as empirically testing relationships between user experience and engagement. By weaving together in-depth qualitative insights with quantitative evidence, the research provides a broader understanding of how technology can support independence, safety, and engagement in everyday activity for older adults.

The execution of studies further reinforced the rigour of the work. The qualitative findings in study I informed the development of the co-production standpoint in study II, which was further strengthened by empirical evidence in study III, ensuring that the constructs measured were grounded in real-world user experiences. Meanwhile, the activity recognition model in study IV demonstrated how wearable sensors can be utilised in healthcare, adding an applied dimension to the thesis.

Another significant strength lies in how the thesis foregrounds co-production as a methodological principle. By actively involving older adults, current and future generations of older adults, professionals with expertise in SHT, and health science researchers in the knowledge production process, the thesis aligns with Arnstein's Ladder of Participation (1969), which distinguishes between different levels of stakeholder involvement. The participatory elements in the studies moved the research closer to the upper middle of the ladder, strengthening the thesis by demonstrating that older adults and other stakeholders were not passive informants but active contributors. This orientation enhances the validity and practical impact of the findings, making them valuable for both research advancement and practice, as well as the future development of SHT, WT, and wearable sensors.

On the other hand, some limitations need to be acknowledged. It is worth noting that in study I, participants from three generations participated; however, scheduling conflicts and participant dropouts prevented us from forming a fully multi-generational focus group, thereby constraining opportunities for cross-generational interaction. The demonstration and video presentation of the SHT system available in MoRe-Lab was used to spark engagement and support discussion. While this provided concrete examples, it also introduced potential bias by focusing on pre-selected technologies. Nonetheless, participants discussed additional systems during the focus groups and had opportunities to explore other options independently between sessions.

In study II, although RC members offered diverse insights, future studies would benefit from broader representation. Perspectives from older adults with different health profiles, varied geographic backgrounds, formal and informal carers, and a wider range of SHT professionals could have added depth. Furthermore, a key limitation of Study III lies in how we measured our main variables. Although the constructs were thoughtfully developed, we did not use standardised instruments to assess user experience or engagement in everyday activities, which may have led to varied interpretations among participants. This raises the risk that our measures did not fully capture the complexity of aspects such as usability, control, or value of WT. Moreover, the cross-sectional design limits our ability to conclude causality. Future studies would benefit from validated measures and longitudinal approaches to better reflect these experiences and their dynamics over time. In study IV, a limitation was that we did not systematically explore all possible model combinations across the 17 body-worn sensors, 14 everyday activities, and various fine-tuning parameters. A more thorough exploration could have offered more profound insights into optimal configurations and ways to enhance model performance.

Navigating Dual Roles in the Research Process

As both a member of the RC and the researcher facilitating the process, I occupied dual roles that shaped the design process, data collection and interpretation. This position offered unique strengths that enabled a richer dialogue with perspectives from the research field and concrete familiarity with the data. However, this may also introduce the potential for bias. While my experience from the sessions helped reveal nuanced understandings of RC members' challenges and aspirations, it also risked confirmation bias, where data might be unintentionally interpreted in ways that support my pre-existing assumptions or the prevailing consensus among RC members. Moreover, my authority as a researcher could have subtly shaped group dynamics, where RC members may have expressed agreement or approval to align with perceived expectations.

To mitigate these risks, I adopted strategies to maintain ongoing awareness of my role, boundaries, and expectations. These included incorporating a form of member checking at the beginning and end of each session, where participants validated the summary of their input. I also asked for feedback and consultation from other co-authors, which helped ensure transparency and accountability in the analysis and aligned with recommendations in co-production research (Clemensen et al., 2017; Lindsay et al., 2012; Schubotz, 2020).

Role of Experimental Health Science Infrastructure

The MoRe-Lab emerged as an important methodological asset. MoRe-Lab offers a unique environment that simulates a real-world setting. The value of this environment lies both in its technical capabilities and in the kinds of research it enables. Inviting participants and conducting research within a simulated two-bedroom apartment have been instrumental in generating results, providing a richer understanding of how SHTs and wearable sensors are experienced. In contrast to some laboratory studies that may limit specific interactions, MoRe-Lab encourages an approach where routines, perspectives, and responses unfold organically. This aligns with broader shifts in gerontology and technology research that advocate for contextually grounded, human-centred methodologies (Schroeder et al., 2023; Weck & Afanassieva, 2023).

Moreover, the space of the reality platform supports co-production processes by facilitating direct interaction between stakeholders, older adults, the researchers, and the technology (Lee & Kim, 2020). When older adults are invited to engage with technologies in settings resembling their homes, their feedback becomes more grounded, specific, and reflective of everyday needs and constraints.

However, despite these strengths, it is important to recognise the limitations of MoRe-Lab as a research context. While the reality platform simulates a home setting, it remains, ultimately, a lab. The awareness of being monitored and the absence of their familiar home environment may shape how participants act and engage. Nonetheless, MoRe-Lab is a facilitating infrastructure for advancing interdisciplinary and inclusive research in ageing and technology.

Conclusions and Implications

In a societal context, the findings presented in this thesis contribute to a growing body of research aligned with the Global Priority Research Agenda for Improving Access to High-Quality, Affordable Assistive Technology, developed by the World Health Organisation (2017). Assistive technology or WT is recognised within this agenda as one of the several key areas requiring urgent attention. This thesis also touches on several of these key points in the agenda, especially in exploring how WT can support autonomy, facilitate engagement in everyday activities, and enhance the overall quality of life for older adults. The potential of integrating WT, SHT, and wearable sensors can enable and revolutionise the state of the art of technology supporting engagement in everyday activities. This reflects the World Health Organisation agenda’s emphasis on leveraging technical innovation to address real-world challenges and the full potential of technology to contribute to a much larger global effort to provide high-quality technology for older adults.

Perhaps most crucially, this thesis calls for reimagining technological advancement from pure industrial innovation towards socially embedded, ethically grounded, and human-centred development. Policy frameworks must incentivise technological deployment that can support key aspects of health in older adults, such as engagement in everyday activities. Public investment should support community-based training programmes, centralised information hubs, and national infrastructure that promotes equity in digital health. Technology must be envisioned as an adaptive, co-evolving companion in the everyday activities of ageing individuals. There is a need for an integrated approach to technology improvement that focuses on older adults.

The full potential of technology lies in the deep recognition of older adults' needs and desires. All studies included in this thesis support that the design and implementation of future technologies should take into consideration the complexity of older adults’ lives, supporting their capabilities and how they wish to live. As the integration of SHT, WT, and wearable sensors into the lives of older adults continues to evolve, it becomes increasingly clear that technological innovation alone is insufficient. Instead, the success of such technologies rests on a deeper understanding of how they intersect with the everyday activities, identities, and aspirations of older adults.

Equally important are the clinical implications of this evolving technological landscape. Healthcare professionals must be prepared to assess medical needs, technological literacy, privacy preferences, and emotional responses to digital interventions. Technology should be deployed to enhance the quality of care, and clinicians must advocate for tools that genuinely empower older adults to maintain meaningful engagement in activities rather than passive roles as subjects of monitoring. Interdisciplinary collaboration, which brings together expertise from gerontology, nursing, medicine, occupational therapy, engineering, design, politics, and ethics, is crucial to ensure that technological solutions are holistic with high potential implementation success. Only through such a fundamental reimagining can technology genuinely contribute to a future where the technological solutions we generate serve not only to extend life, but to enrich it through meaningful engagement in everyday activities.

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Author's Contribution to the Papers

Paper I

Ethical application, recruitment, organising and data collection, data curation, formal analysis, analysis software management, result validation, writing (original draft, review and editing).

Paper II

Ethical application, recruitment, organising and data collection, data curation, formal analysis, analysis software management, result validation, writing (original draft, review and editing).

Paper III

Data curation, formal analysis, analysis software management, result validation, writing (original draft, review and editing).

Paper IV

Ethical application, recruitment, organising and data collection, data curation, analysis, writing (original draft, review and editing).

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Appendix

Appendix I: Discussion guide used in the perspectives on adoption study.

Genomförande för fokusgrupper

Titel:

Session 1 Studie om smarta hemlösningar

Introduktion:

Första fokusgruppstillfället inleds med allmän genomgång kring intervjun (öppet diskussionsklimat och även praktiska frågor kommer att diskuteras), syftet med studien och metoden.

Allmän genomgång om intervjun

- Alla deltagare presenterar sig för varandra
- En kort förklaring av syftet med studien, samt moderator och assisterande moderators roll och position i samband med fokusgrupperna

Fokusgruppen inleds med en öppen fråga om deltagarnas uppfattningar och erfarenhet kring smarta hemlösningar, för att få en överblick av deltagarnas förförståelse inom området smarta hemlösningar:

- Vad är uppfattning och erfarenhet av smarta hem och smarta hemlösningar?

Baserat på deltagarnas förförståelse kommer tillgängliga smarta hemlösningar att presenteras i MoRe-Lab

- Vilken typ av smarta hemlösningar är mest använd? Vad är intrycket för tekniken som presenteras? Hur känner ni för den?
- Vilka är attityderna till olika typer av smarta hemlösningar? Hur önskar ni att dessa tekniker kommer vara?
- Vilken roll har smarta hemlösningar att hålla sig aktivt? Vilka tekniker och hur ofta använder du de? Hur påverkar det din livskvalitet? Vilken skillnad blir det med smarta hemlösningar och utan?

- Vilka smarta hemlösningar som behöver för ett aktivt och hälsosamt åldrande? Vilka utmaningar som följer vid användning av dessa tekniker? Vilka tekniker hjälper dig mest? Vilka aktiviteter (t.ex. hemma, ute eller när du tar dig till aktivitet plats) utförs du med stöd av teknik? Hur tror du att dessa tekniker kan vara användbara för vardagsaktivitet, hälsa och trygghet?
- Vad som hindrar och underlättar för att ta till sig och använda dessa hemlösningar? Kan du beskriva vilka tekniker som är lätta att använda och vilka som inte är det? Vad är det som gör att de är lättare / svårare att använda just den tekniken? Hur påverkar denna situationer (till ex. hemma situation med familj eller bor ensam, fysisk eller kognitiv förmåga) i ditt sätt att använda teknik? Skulle du kunna berätta mer om det?

Rast/ Fika:

Avslutning:

- Finns det något annat som du skulle vilja tillägga eller diskutera ytterligare angående detta ämne/session?

Session 2

Introduktion:

- En kort genomgång om session 1
- Vilka smarta hemlösningar önskar använda för ett aktivt och hälsosamt åldrande? (Det kan vara teknik du känner från affären, tv, reklam, mm.)
- Vilken teknik? Varför? Vilka funktioner som gör att du önskar använda just den tekniken? Hur skiljer det önskad nya teknik i de tidigare version? Hur påverkar dessa ändringar i ditt dagliga liv? Humör? Socialt liv? Trygghet? Häls och vård påverkan? På vilket sätt skulle dessa förändringar öka din aktivitetsförmåga? Vet ni om det finns någon ny teknik på marknaden som skulle passa de behov och önskningar som vi har diskuterat om idag?

Rast/ Fika:

- Anledningar till att inte använda den tillgängliga tekniken (smarta hemlösningar). Hur fick du det här intrycket? Från vilken speciell erfarenhet? Är det fysiska funktioner eller det själva system som gör det? Hur påverkar det ditt liv/ förmåga att hålla engagerad till aktivitet?

- Vad underlättar användningen av smarta hemlösningar? Vilken teknik använder ni mest/ sällan? Varför? Vilka ändringar skulle underlätta för en smidigare användning? Hur kan detta leda till ökad aktivitet?
- Vilket stöd skulle du behöva för att använda dessa tekniker? Underlättar det om du får introduktion stöd som hjälper dig gå genom användning? Kommer det ge något skillnad med hjälp och utan hjälp att gå genom praktiska delen av teknik? Vilka skillnader?

Avslutning:

- Finns det något annat som du skulle vilja tillägga eller diskutera ytterligare angående detta ämne/session?

Andra fokusgruppstillfället avlutar med att tacka alla for deltagande och synpunkter. Information om när och hur får man del av resultatet kommer delas. Även kort information om del 2, forskarcirkel, kommer delas muntlig inför första tillfälle.

Appendix II: The five personas used in the co-production study.

Sune, 67 år har nyligen gått i pension. Nina, hans fru sedan nästan 40 år, gick bort för 5 år sen, så nu lever han ensam i en egen villa i en mindre ort med sin katt Missy. Sunes och Ninas dotter, Marie, bor med sin familj i Kalifornien och kommer sällan hem till Sverige. Men Sune brukar besöka dem ungefär varje tredje år, och vill gärna fira kommande jul och nyår med dotterns familj i Kalifornien. Sune älskar att spela musik och är aktiv i en lokal musikgrupp.

Han gillar att vara fysiskt aktiv på olika sätt (till exempel genom trädgårdsarbete, promenader, simning). Han besöker regelbundet vårdcentralen för att kontrollera sitt förhöjda blodtryck, men är för övrigt frisk. Sedan ett par år, händer det allt oftare att han glömmer saker som han lovat eller tänkt göra eller tider som han bestämt med andra.

Ulla-Britt, 89 år bor ensam, och hennes närmaste anhörig är en kvinnlig kusin, som bor någon mil bort. De ringer till varandra, men har inte setts på flera år. Ulla-Britt har flera olika sjukdomar som påverkar henne. Hon sitter i rullstol, och får hjälp av hemtjänst flera gånger dagligen. Hon kan förflytta sig själv med nöd och näppe mellan rullstol respektive fåtölj, toalett och säng. Hon har ett trygghetslarm runt sin handled, men hon använder det inte.

Hon tycker nämligen att det tar lång tid att få hjälp när hon larmar. Hon är dessutom tveksam till att öppna dörren om hon inte vem som kommer och vill inte släppa in personal som hon inte träffat tidigare på grund av rädsla och osäkerhet. Hon har nämligen hört och läst om äldre personer som utsatts för bedrägerier och andra brott.

Barbro, 75 år har nyligen haft en stroke och är sedan dess fumlig i sin hand. Hon kan gå några få steg med rollator inomhus, men sitter för det mesta i rullstol. Hon bor med sin make Yngve som är 79 år. Han hör dåligt och besväras av en del smärta. Barbro och Yngve bor i en stor, äldre lägenhet i ett mindre samhälle på landet där det finns en mataffär, men inga andra affärer eller samhällsservice. Yngve, gör trots och med smärta, det mesta i hushållet. Han handlar och lagar mat, sköter tvätt, städar lägenheten osv.

Barbro åker till sjukhuset ett par dagar per vecka för rehabilitering och uppföljning av blodprover etc efter sin stroke. Eftersom Yngve inte längre vågar köra bil så långt, så åker Barbro taxi (sjukresa) vid dessa tillfällen. Men de har ännu inte tillgång till färdtjänst för andra typer av resor.

Magne, 48 år är orolig för sina föräldrar Max 85 år och Alice 79 år som bor kvar i en egen villa. Alice skrevs nyligen ut till hemmet från sjukhus efter en höftfrakturoperation och sitter än så länge en del i rullstol en del, men gång tränar med hemtjänsten. Max börjar bli lite glömsk. Han klarar att ta hand om sig själv än så länge, men kan inte hjälpa Alice.

Hemtjänstpersonalen hjälper Alice med att komma upp ur sängen på morgonen, tvätta sig och klä på och av sig med mera. Magne är orolig för hur Max och Alice klarar sig när de är själva hemma. Magne är flera gånger i veckan hos sina föräldrar och hjälper dem, men det är inte hållbart i längden eftersom han har familj med två mindre barn.

Luna, 57 år har nyligen blivit änka efter att hennes man dog till följd av Covid-19. Luna jobbar i en mataffär där hon dagligen träffar många människor, och på grund av pandemin och av rädsla för att bli smittad av Covid-19, beslöt hon sig för att arbeta mindre. Sedan hon blev änka, har hon inte taget upp de aktiviteter hon vill och brukat göra.

Hon orkar inte arbeta mer än halvtid och hennes engagemang i sociala och fysiska aktiviteter har också minskat. Hon har inga nära anhöriga, och få nära vänner. Ensamheten gör att hon känner sig övergiven, otrygg och nedstämd. Hon har de senaste tiden blivit alltmer fundersam över hur hon ska klara sig framöver och när hon blir äldre.

Appendix III: Survey questionnaire used in the user experience study.

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Welfare@Home

Denna enkätstudie är en del av ett större projekt som avser att fånga ditt perspektiv som användare av välfärdsteknik. Syftet med projektet är att informera och stödja utveckling och implementering av användarvänlig välfärdsteknik inom hemtjänsten.

Enligt Socialstyrelsen är välfärdsteknik digital teknik som syftar till att bibehålla eller öka trygghet, aktivitet, delaktighet eller självständighet för bland annat äldre personer som har hemtjänst. Digitala trygghetslarm, nattillsyn via kamera, verktyg för kommunikation, medicinrobot och GPS-larm är några exempel på välfärdsteknik som kan förbättra livskvaliteten för äldre personer. Ibland räknas också produkter såsom intelligenta bidétoaletter, duschrobotar, osv, med i kommunernas utbud av välfärdsteknik. Välfärdsteknik kan tillhandahållas som bistånd via din kommun och kommunens personal.

Personer som har hemtjänst och kommunens hemtjänst-, vård- och rehabiliteringspersonal har hittills haft begränsat inflytande på utvecklingen och användningen av välfärdsteknik. Det finns alltså ett akut behov av kunskap som skulle kunna gynna framtagningen av ny välfärdsteknik samt bättre strategier för dess praktiska användning. Personer som du besitter just denna kunskap.

Så här fyller du i formuläret
Frågorna besvaras genom att sätta ett kryss i en ruta ☒. Om du skulle råka sätta ett kryss i fel ruta, fyll i rutan helt ■ och sätt därefter ett nytt kryss i rätt ruta.

(WEL24)

Frågor om dig och din situation

1. Jag är:

- ☐ Man
- ☐ Kvinna
- ☐ Annat alternativ
- ☐ Vill ej uppge

2. Mitt födelseår är:

☐☐☐☐ *(Ange årtal med fyra siffror t.ex. 1950)*

3. Jag bor i (ange kommun):

....

4. Jag har hemtjänst

- ☐ Flera gånger dagligen
- ☐ Dagligen
- ☐ Varje vecka
- ☐ Varje månad
- ☐ Inte alls

5. Jag är:

- ☐ Ensamboende
- ☐ Sammanboende

6. a) Om du är född i ett annat land, ange vilket:

....

b) Hur länge har du bott i Sverige?

☐ Flyttade hit när jag var barn (under 18 år)
☐ Flyttade hit när jag var 19-40 år
☐ Flyttade hit när jag var 41-60 år
☐ Flyttade hit när jag 61 år eller äldre

7. Vilken är din högsta utbildning?

☐ Grundskola, folkskola, realskola eller liknande
☐ Gymnasieutbildning / yrkesskola, yrkeshögskola eller liknande
☐ Universitets- eller högskoleutbildning

8. Hur bedömer du din ekonomiska situation i nuläget?

☐ Mycket god
☐ God
☐ Varken god eller dålig
☐ Dålig
☐ Mycket dålig

9. Hur ofta använder du internet?
Avser all internetanvändning oavsett om det är på dator, surfplatta, smartmobil (smartphone), spelkonsol, etc.

☐ Flera gånger dagligen
☐ Dagligen
☐ Varje vecka
☐ Varje månad
☐ Mer sällan
☐ Aldrig

10. Min hälsa i allmänhet är...

- ☐ Mycket god
- ☐ God
- ☐ Varken god eller dålig
- ☐ Dålig
- ☐ Mycket dålig

11. Min tillfredställelse med livet är i allmänhet...

- ☐ Mycket hög
- ☐ Hög
- ☐ Varken hög eller låg
- ☐ Låg
- ☐ Mycket låg

12. a) Har du fått information om vilken välfärdsteknik din kommun erbjuder?

- ☐ Ja
- ☐ Nej
- ☐ Osäker

b) Om ja, hur har du fått denna information?

Flera alternativ kan markeras.

- ☐ Kommunens personal inom hemtjänst och vård
- ☐ Släktingar
- ☐ Grannar
- ☐ Närstående
- ☐ Vänner eller bekanta
- ☐ Kommunens hemsida
- ☐ Annan, vem? ....

13. Vilka typer av välfärdsteknik skulle du kunna tänka dig använda?

Flera alternativ kan markeras.

- ☐ Trygghetslarm i min bostad
- ☐ Trygghetslarm som fungerar utanför bostad
- ☐ Nattillsyn med digital kamera
- ☐ Tillsyn dagtid med digital teknik
- ☐ Automatiskt larm/sensor (t.ex. dörrlarm, rörelselarm, larm vid fall)
- ☐ Brandlarm kopplat till trygghetslarmet
- ☐ Digitalt stöd för dagliga aktiviteter eller träning i dagliga aktiviteter (t.ex. påminnelser om aktivitet eller träning via mobilapp eller video)
- ☐ Stöd för digitala matinköp
- ☐ Digitalt lås till bostaden
- ☐ Medicinrobot (digital produkt som påminner om och tilldelar läkemedel)
- ☐ Intelligent bidétoalett (inbyggd spol- och torkfunktion i toasitsen)
- ☐ Duschrobot (duschkabin med kontrollpanel)
- ☐ Social robot (robotkatt, robotsäl, el. dyl.)
- ☐ Annat, vad? ....

14. Vilka typer av välfärdsteknik har du?

Flera alternativ kan markeras.

- ☐ Trygghetslarm i min bostad
- ☐ Trygghetslarm som fungerar utanför bostad
- ☐ Nattillsyn med digital kamera
- ☐ Tillsyn dagtid med digital teknik
- ☐ Automatiskt larm/sensor (t.ex. dörrlarm, rörelselarm, larm vid fall)
- ☐ Brandlarm kopplat till trygghetslarmet
- ☐ Digitalt stöd för dagliga aktiviteter eller träning i dagliga aktiviteter (t.ex. påminnelser om aktivitet eller träning via mobilapp eller video)
- ☐ Stöd för digitala matinköp
- ☐ Digitalt lås till bostaden
- ☐ Medicinrobot (digital produkt som påminner om och tilldelar läkemedel)
- ☐ Intelligent bidétoalett (inbyggd spol- och torkfunktion i toasitsen)
- ☐ Duschrobot (duschkabin med kontrollpanel)
- ☐ Social robot (robotkatt, robotsäl, el. dyl.)
- ☐ Annat, vad? ....

- ☐ Jag har inget av ovanstående

Om du inte har någon av ovanstående produkter/tjänster tackar vi för din medverkan - du är nu klar med enkäten. Glöm inte att skicka in enkäten i bifogat svarskuvert.

Om du har markerat någon av produkterna/tjänsterna, ber vi dig att ta ställning till de följande frågorna och påståendena.

15. Jag har känt mig delaktig i samband med beslut om välfärdsteknik som jag har fått.

☐ Instämmer helt
☐ Instämmer delvis
☐ Instämmer inte alls

16. Någon från kommunen har följt upp om den välfärdsteknik som jag fått fungerar för mig.

☐ Ja
☐ Nej
☐ Osäker

17. Jag känner mig säker kring handhavandet av den välfärdsteknik som jag har fått.

☐ Instämmer helt
☐ Instämmer delvis
☐ Instämmer inte alls

18. Var det någon som förklarade hur välfärdstekniken skulle användas när du först fick hem den?

☐ Ja
☐ Nej
☐ Osäker

19. Vet du vem du ska vända dig till om du har frågor om den välfärdsteknik du har?

☐ Ja
☐ Nej
☐ Osäker

20. Vi ber dig att ta ställning till nedanstående påståenden.

	Instämmer helt	Instämmer delvis	Instämmer inte alls
a) Jag får stöd i mina vanor och rutiner av välfärdstekniken	☐	☐	☐
b) Välfärdsteknik är över lag något positivt för mig	☐	☐	☐
c) Mina dagliga rutiner och vanor styrs av välfärdstekniken	☐	☐	☐
d) Välfärdsteknik är över lag något negativt för mig	☐	☐	☐
e) Jag har kontroll över den välfärdsteknik som jag har fått	☐	☐	☐
f) Jag upplever att välfärdsteknik lätt slutar att fungera	☐	☐	☐
g) Jag upplever välfärdsteknik som sårbar	☐	☐	☐
h) Välfärdsteknik gör mig trygg	☐	☐	☐
i) Välfärdsteknik gör mig självständig	☐	☐	☐
j) Välfärdsteknik underlättar mina dagliga aktiviteter	☐	☐	☐
k) Välfärdsteknik underlättar aktiviteter som jag vill utföra i samhället	☐	☐	☐
l) Det är viktigt för mig att ha välfärdsteknik som gör mig trygg	☐	☐	☐
m) Det är viktigt för mig att ha välfärdsteknik som gör mig självständig	☐	☐	☐
n) Det är viktigt för mig att ha välfärdsteknik som underlättar mina dagliga aktiviteter	☐	☐	☐
o) Det är viktigt för mig att ha välfärdsteknik som stödjer mig i aktiviteter som jag vill utföra i samhället	☐	☐	☐
p) Det är viktigt för mig att veta vem jag ska vända mig till vid problem med min välfärdsteknik	☐	☐	☐

21. Vem hjälper dig vanligtvis om du får problem med din välfärdsteknik?

Flera alternativ kan markeras.

☐ Kommunens hemtjänst-, vård- eller rehabpersonal
☐ Kommunal stödperson som hjälper till med digital teknik
☐ Vaktmästare eller bovärd i mitt hus
☐ Familj eller släktingar
☐ Grannar
☐ Vänner eller bekanta
☐ Jag löser det själv
☐ Jag har ingen att fråga
☐ Annan, vem? ....

22. a) Hur ofta händer det att din välfärdsteknik slutar fungera eller krånglar?

☐ Aldrig
☐ Mer sällan än varje månad
☐ Varje månad
☐ Varje vecka
☐ Varje dag
☐ Vet ej

b) Om din välfärdsteknik har slutat fungera eller krånglat, vilka orsaker till detta har du upplevt?

Flera alternativ kan markeras.

☐ Fel på utrustningen
☐ Ett allmänt fel (t.ex. en driftstörning) som drabbade fler
☐ En uppdatering
☐ Strömavbrott
☐ Handhavandefel (felanvändning)
☐ Annat, vad? ....
☐ Vet ej

23. Här följer en rad påståenden som vi ber dig att ta ställning till.

	Instämmer helt	Instämmer delvis	Instämmer inte alls
a) Välfärdsteknik sparar min tid	☐	☐	☐
b) Välfärdsteknik är lätt att använda	☐	☐	☐
c) Välfärdsteknik är anpassad till mina behov	☐	☐	☐
d) Välfärdsteknik har ett tilltalande utseende	☐	☐	☐
e) Välfärdsteknik passar in i mitt hem	☐	☐	☐
f) Välfärdsteknik hanterar information om mig på ett säkert sätt	☐	☐	☐

24. Jag kan tänka mig att få tillsyn med digital teknik i stället för av hemtjänstpersonal.

☐ Ja, alla besök
☐ Ja, vissa besök
☐ Nej, inga besök
☐ Vet ej

25. Den välfärdsteknik som jag har motsvarar mina förväntningar.

☐ Instämmer helt
☐ Instämmer delvis
☐ Instämmer inte alls

26. Jag är nöjd med den välfärdsteknik som jag har fått.

☐ Instämmer helt
☐ Instämmer delvis
☐ Instämmer inte alls

27. Om du har ett trygghetslarm, har något av nedanstående hänt dig?

☐ Har inte denna välfärdsteknik

	Dagligen	Varje vecka	Varje månad	Mer sällan än varje månad	Aldrig
a) Jag råkar trycka på mitt trygghetslarm av misstag	☐	☐	☐	☐	☐
b) Jag hör inte vad larmpersonalen säger till mig när jag larmar	☐	☐	☐	☐	☐
c) Jag larmar för att jag inte kan kommunicera med hemtjänstpersonalen på annat sätt	☐	☐	☐	☐	☐
d) Jag upplever att jag får vänta för länge när jag har larmat	☐	☐	☐	☐	☐
e) Jag undviker ibland att larma	☐	☐	☐	☐	☐
f) Jag kan inte trycka på knappen (t.ex. eftersom den är för trög, hal eller annat)	☐	☐	☐	☐	☐

28. Hur ofta har du varit med om något av följande?

	Dagligen	Varje vecka	Varje månad	Mer sällan än varje månad	Aldrig	Har inte denna välfärds-teknik
a) Mitt nyckelfria lås har inte fungerat optimalt för mig	☐	☐	☐	☐	☐	☐
b) Mitt nyckelfria lås har inte fungerat optimalt för hemtjänstpersonalen	☐	☐	☐	☐	☐	☐
c) Min medicinrobot har inte fungerat optimalt för mig	☐	☐	☐	☐	☐	☐
d) Min medicinrobot har inte fungerat optimalt för hemtjänstpersonalen	☐	☐	☐	☐	☐	☐
e) Min intelligenta bidétoalett har inte fungerat optimalt för mig	☐	☐	☐	☐	☐	☐
f) Min intelligenta bidétoalett har inte fungerat optimalt för hemtjänst-personalen	☐	☐	☐	☐	☐	☐

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g) Har du någon annan välfärdsteknik (produkt/tjänst) som inte har fungerat optimalt för dig? Ange vilken/vilka.

....

....

....

....

h) Har du någon annan produkt/tjänst som inte har fungerat optimalt för hemtjänstpersonalen? Ange vilken/vilka.

....

....

....

....

29. Har du något du vill tillägga som inte tagits upp i enkäten?

Observera: Eftersom du svarar anonymt på enkäten kan du tyvärr inte få återkoppling på eventuella kommentarer

....

....

....

....

Tack för att du svarade på enkäten!

Har du förlorat ditt svarskuvert?
Skicka frågeformuläret portofritt till:
SVARSPOST
Institutet för kvalitetsindikatorer
204 65 081
400 99 GÖTEBORG

(WEL24)

Appendix IV: Survey questionnaire used in the activity recognition study.

LUND UNIVERSITY

CASE
CENTRE FOR AGEING AND SUPPORTIVE ENVIRONMENTS

Enkätfrågor Studie 1

	Instämmer inte alls	**Instämmer delvis**	**Instämmer helt**
Jag upplevde sensorerna som påträngande	☐	☐	☐
Jag kände mig övervakad av sensorerna	☐	☐	☐
Sensorerna hindrade mina vardagliga aktiviteter inomhus	☐	☐	☐
Sensorer hindrade mina vardagliga aktiviteter utomhus	☐	☐	☐
Jag kände mig tryggare att utföra mina vardagliga aktiviteter tack vare sensorerna	☐	☐	☐
Jag funderar på om utomstående kan komma åt information om mig via sensorerna	☐	☐	☐
Sensorerna skulle passautseendemässigt in i mitt hem	☐	☐	☐
De väggmonterande sensorerna var störande	☐	☐	☐
Om du har valt "instämmer delvis" eller "instämmer inte alls" på ovanstående fråga så ange anledningen till att du erfor sensorn som störande nedan (flera alternativ möjliga):			
Sensorerna blinkade	☐		
Sensorerna lät	☐		
Sensorerna larmade för ofta	☐		
Annan störning, ange vad:	☐		

	Instämmer inte alls	Instämmer delvis	Instämmer helt
Armbandssensorn var lätt att sätta på	☐	☐	☐
Armbandssensorn var lätt att avläsa	☐	☐	☐
Armbandet var obekvämt	☐	☐	☐
Armbandet var varmt att bära	☐	☐	☐
Jag var rädd att skada den i vissa aktiviteter	☐	☐	☐
Den påverkade min hud	☐	☐	☐
Överlag är jag nöjd med de sensorer som jag provat	☐	☐	☐
Jag är positiv till att prova andra typer av sensorer	☐	☐	☐
Jag är i allmänhet positivt att använda sensorer	☐	☐	☐
Jag skulle vilja fortsätta att använda en armbanssensor för att följa mina vardagliga aktiviteter och min hälsa	☐	☐	☐
Jag skulle vilja fortsätta att använda väggmonterade sensorer för att följa mina vardagliga aktiviteter och min hälsa	☐	☐	☐

Är det något annat du skulle vilja berätta om sensorerna?

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