Use of Welfare Technology in Elderly Care

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Abstract

This thesis is an interpretive qualitative research study exploring the use of welfare technology in elderly care. In Norway, health care and social services for elderly people are important parts of the welfare policy. A growing elderly population is putting a strain on the society's welfare system. Scarce welfare resources restrict human care services for our future generations. Alternative housings and the use of welfare technology are effective techniques that can be used to transform current elderly care into a more sustainable service delivery. This thesis reports from two interpretive case studies and an action research study where I explore upon the use of welfare technology in a care housing and a nursing home. These studies form the basis from which I intend to answer the thesis's main research questions. The questions are as follows:

RQ1: What are the key constraints and benefits of the current use of welfare technology in elderly care?

RQ2: What are the elderly users' barriers to the adoption and use of welfare technology?

RQ3: How can technology-supported services better be incorporated into the elderly care work?

A key constraint of elderly care is the primary focus on formal care services and the lack of attention paid to technology-supported services that *all* elderly people actually can use. Technology-supported care services are often introduced too late thus resulting in a failure to support users in practice. Some users experience difficulties and gaps in the services provided when traversing the "care staircase". This is heightened by the vast array of care services and their interaction with the different caring locations, including ordinary homes, care housing and nursing homes. Moreover, the lack of infrastructure and a standard for welfare technology is constraining users who want to prolong independent living. My findings indicate that the key constraints of using welfare technology are more pronounced than its potential benefits. However, I stress that the identified key constraints lie in the importance of knowledge in the processes of transforming elderly care, as the constraints can be solved by expanded use of technology. The use of welfare

technology in the overall elderly care is diverse; however the most essential function is to support users with safety and security measures. The traditional safety alarm is seen as limited because it requires users to understand how to use it regardless of their cognitive and physical capabilities. I recognise a need for separating welfare technology into the active and passive use of technology. Welfare technologies should be designed with different levels of automation to support unstable user needs and the diversity of users. I recognise elderly care as a collaborative effort including joint work contribution from elderly people (self-care), family and volunteers (informal care), and paid health care providers (formal care). The use of technology can play a role in the division of elderly care work and be an important tool in delegate work responsibility back to the elderly people, with or without backup support from informal and formal care providers. I believe that all of those involved in care work will benefit from the increasing use of technology-support services. Furthermore, I present one practical approach of how to transform conventional home care practice into a new service delivery with use of welfare technology, such as telecare, to increase independence of the elderly care users and decrease the need for fully supported care. Moreover, I call for a re-design of the current “care staircase” to overcome the key constraints and to realise the use of welfare technology in order to exploits full potential and reap the resultant benefits. Thus, I propose a conceptual elderly care trajectory that includes the joint collaborative care work with assumptions for technology-supported services for the various types of care work.

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List of papers

The following papers are included in this thesis (see Part II):

1. ***Dealing with Breakdown of Welfare Technology***

   Anita Woll

   In Proceedings of the 36th Information Systems Research Seminar in Scandinavia (IRIS 36), Issue Theme "IRIS 36 Digital Living", vol. 4 (2013), pp. 77- 90.

2. ***A Collaborative Change Experiment 1 out of 3: Telecare as a Means for Delivery of Home Care Services***

   Suhas Govind Joshi and Anita Woll

   In Proceedings of the 3rd International Conference, DUXU 2014, Held as Part of HCI International 2014, Heraklion, Crete, Greece, Design; User Experience, and Usability. User Experience Design for Everyday Life Applications and Services. Lecture Notes in Computer Science, Springer Berlin Heidelberg, vol. 8519. pp. 141-151.

3. ***A Collaborative Change Experiment 2 out of 3: Diagnostic Evaluation of Telecare for Elderly Home Dwellers***

   Suhas Govind Joshi and Anita Woll

   In Proceedings of the 6th International Conference, DHM 2015, Held as Part of HCI International 2015, Los Angeles, CA, USA, August 2-7, 2015; Duffy V. (eds) Digital Human Modeling. Applications in Health, Safety, Ergonomics and Risk Management: Ergonomics and Health, Lecture Notes in Computer Science, Springer Berlin Heidelberg, vol. 9185, pp. 423-434.

4. ***A collaborative change experiment 3 out of 3: Post-experiment evaluation of home telecare for elderly home dwellers***

   Suhas Govind Joshi and Anita Woll.

   In Proceedings of the 6th International Conference on Applied Human Factors and Ergonomics (AHFE), Las Vegas, USA, Elsevier B.V., vol. 3 (2015), pp. 82 – 89.

5. ***A trajectory for a person-oriented elderly care***

   Anita Woll and Tone Bratteteig

   Submitted for publication in CSCW journal.

6. Is ageing the new disease?

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In Proceedings the 9th International Conference on Advances in Computer-Human Interactions (ACHI) 2016, Venice, Italy, 24 – 28 April 2016.

7. Introduction of telecare mediated home care services pushes forward a re-delegation of the cooperative care work

Anita Woll

In Proceedings of Zhou J., Salvendy G. (eds) Human Aspects of IT for the Aged Population. Healthy and Active Aging. ITAP 2016. Lecture Notes in Computer Science, Springer Berlin Heidelberg, vol. 9755.

8. Activity theory as a framework to analyze technology-mediated elderly care

Anita Woll and Tone Bratteteig

Submitted and accepted for publication in Special issue (Activity theory as a framework for human-technology interaction research) of Mind, Culture and Activity (Taylor and Francis).

My contributions

As the sole author of paper 1, 6 and 7, I took the full responsibility for the data collection, analysis and writing the paper.

Paper 2, 3 and 4 was a collaborative effort with equal responsibility and contributions from both authors including Suhas Govind Joshi and myself. However in regards to paper 3, I conducted the necessary fieldwork and data collection for the study.

Paper 5 and 8 is a collaborative effort, however, I am listed as the first author because I took the overall responsibility for data collection, analysis and drafting the paper, however I benefited from numerous fruitful discussions, supervision and proofreading by Tone Bratteteig.

1. Introduction

This thesis presents research performed on the basis on two case studies and an action research study within the elderly care domain. The aim of the presented research is threefold: (1) to study constraints and benefits of using welfare technology in elderly care (2) to study elderly users' barriers to adoption and use of welfare technology (3) to study how technology-supported services better can be incorporated into the elderly care work. In doing so, I present two proposals, one practical approach and one conceptual approach aiming to overcome the identified key constraints in order to realise the use of welfare technology to its full potential. The growing elderly population is putting strains on the society's welfare system. Scarce welfare resources restrict human care services for everyone in the future. Thus, it is essential to transform elderly care arrangements to assure that elderly people who need it the most, are still provided with personal care in a satisfactory manner. The government aims to expand the use of technology-supported care alongside several other care options in an effort to make elderly care more sustainable. The technology utilised in this setting has been dubbed "welfare technology", which is the Scandinavian notion for assistive technology. In the present work, I will use the terms interchangeably. It relates to a broad range of technologies intended to support different user functions in everyday life. A public report defines welfare technology as "The concept of welfare technology is primarily technological assistance that contributes to increased safety, security, social participation, mobility and physical and cultural activity, and strengthens the individual's ability to fend for themselves in the everyday lives despite illness and social, psychological or physical impaired functioning. Welfare technology can also act as technological support for relatives and otherwise help to improve the availability of resources and quality provision. Welfare technological solutions can, in some cases, prevent the need for services or institutionalisation" (NOU 2011:11, p. 99).

Welfare technology is often categorised by the user functions it seeks to support (NOU 2011:11):

1. *Safety and security* technology e.g. various safety alarm systems, various sensors to log and alert care givers to certain activities or the lack of activity, door controllers to alert or restrict passing of selected doors, video surveillance.

2. *Compensation and wellbeing technology* e.g. grasp arm forceps and other simplifying tools and arrangements, wheelchair, walker, lifting arrangements, flush and dry toilet, environment control, robots, games, exercises and memory aids.
3. *Technology for social contact* e.g. video communication, web services and robots.
4. *Technology for care and treatment*, e.g., monitoring technology, video conferencing, medication dispensers and sensors.

1.1 Elderly care in Norway

In Norway, health care and social services for elderly people are important parts of the welfare policy. The municipal health care and social services offered form a care staircase which differentiates the level of care and services connected to private homes, care homes, and nursing homes, see Figure 1. The services are offered according to a principle of lowest, effective level of care (NAKU 2013); the elderly person is assigned with sufficient services, but no more than necessary.

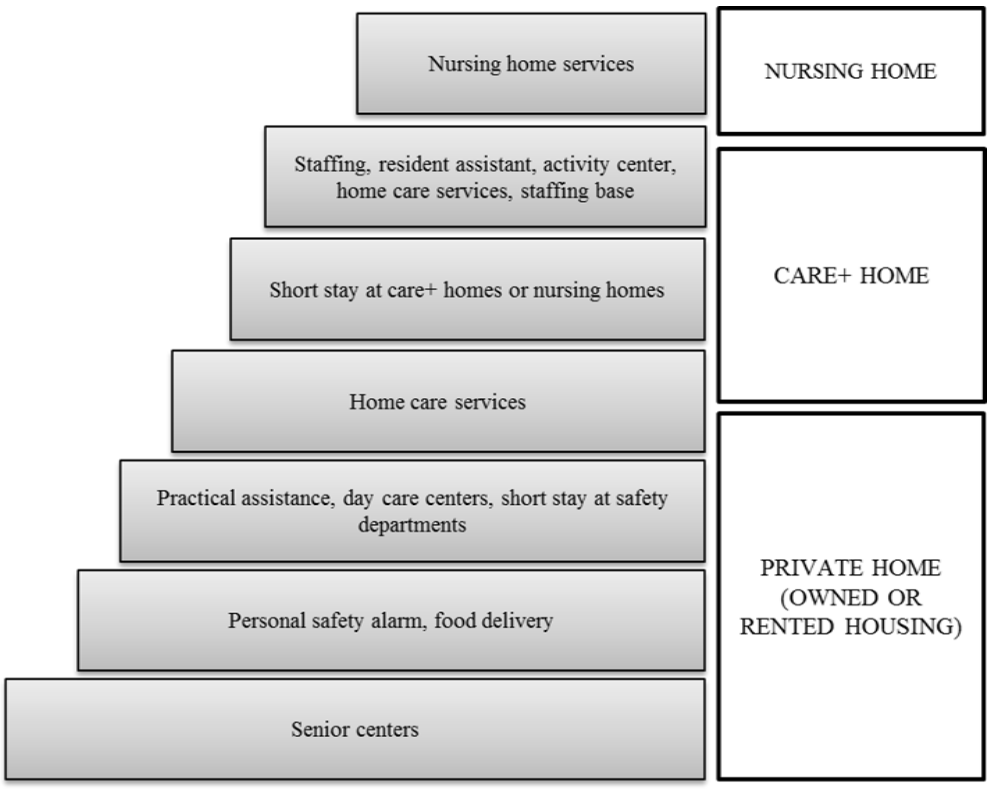

Figure 1 illustrates the municipal elderly care service offered and shaped as a care staircase to differentiate the levels of care.

There are none reliable reports on how the care receivers traverse the staircase or the duration of their stay in each housing establishment (Daatland and Otnes 2014). However, housing arrangements and the use of formal care services for elderly Norwegians, from the age of 67 years, were examined by Statistic Norway in 2013, see Figure 2. The ideal way to traverse the staircase is on a step by step basis, starting at the bottom and progressing one step at a time to the top. The first step in this journey is to access the services that are offered to elderly people living in ordinary homes. The following steps then escalate these services as the need for caring increases. This includes the transfer of elderly people to care housing. Finally, the top of the staircase is in-patient care in the nursing home, see Figure 1.

The potential care receivers have to apply to get access to the staircase's services[1]. Elderly home-dwellers and/or their relatives have to make a formal application and enclose a physician's statement and a medical certificate to document their needs to formal services. When the application office registers a new applicant, the local home care office makes a home visit to assess the applicant's actually needs and housing situation. Based on the physician's statement, the assessment made by the home care staff and oral information from the applicant, the application office makes a formal decision about the applicant's needs for e.g., a personal safety alarm, food delivery, practical assistance, short-term stays and home care services etc. All applications are evaluated individually and decisions are formally made on the applicant's cognitive and functional ability and housing situation.

Elderly persons feeling unsafe in their own homes can apply for a short-term stay or long-term stay at care housing. An application for care housing is assessed according to a set of criteria based on formal regulation for allocation of care homes (Formal law regulation 2011). For example, applicants have to be over 67 years and have a medical certificate of prolonged disability. Prospective residents are also expected to master independent living and have the capacity to partake in, and benefit from the in-house services. However, those who need home care services can apply in a similar manner as elderly people living in ordinary homes. In Norway, receivers of homecare services pay a reduced amount for homecare services and a monthly rent

[1] There are exceptions, for example visits to a senior centre and short term stay at safety departments, which are low threshold services accessible for all elderly people.

for care housing. The rates are set by the local municipalities and vary from municipality to municipality.

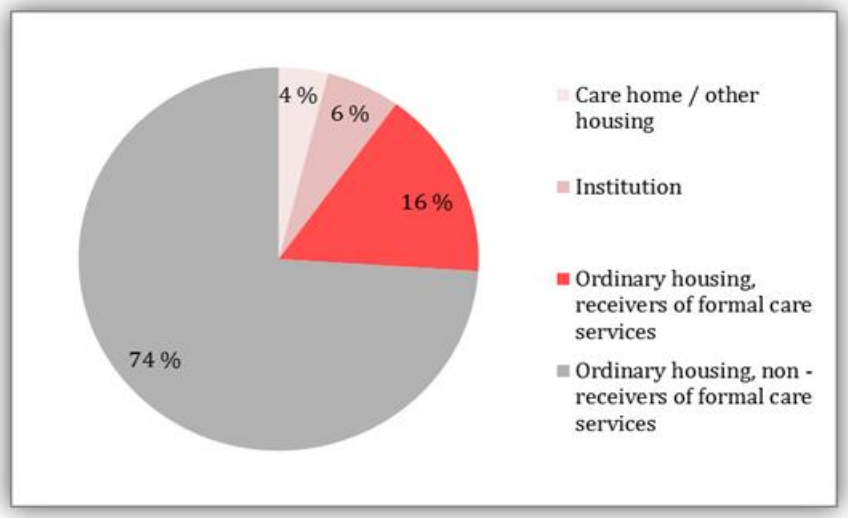

Figure 2 displays the housing arrangements and formal care services for elderly Norwegians as from 67 years of age. (Statistics Norway 2013).

Applications for short- or long-term stays in nursing homes are based on the applicant's functional ability and current care situation: on where in the care staircase he or she is placed. Those who are on short-term stays in nursing homes are often highly motivated to return to their ordinary homes, unless they are under assessment for long-term stays or are under terminal care. Those who are granted a long-term stay in a nursing home are assessed as a person with extensive and complex care needs that cannot be met by the offerings of care housing and/or home care services. A long-term stay in nursing home is a permanent residence with around the clock in-patient care. Stays in a nursing home are expensive for both the municipalities and the resident[2]. The high cost is associated with the 24/7 staffing. The maximum payment for a long-term stay is 75% of the social security payment. However, if the residents have additional assets the municipality can also claim up to 85 % of these savings.

[2] Estimated cost is 900 000 NKR a year (Hektoen 2014)

Although most elderly Norwegians are self-dependent after retirement (74%) (Statistics Norway 2013), the majority of elderly people are using health care services during their final years of life, in particular for the end of life care (Gabrielsen, 2013). In 2014, Daatland and Otnes reported that 68% of elderly people (aged 80 years or over) died in nursing homes, 8% died in sheltered housing and 20% of elderly people who died were receiving one or more "other services". This means that 96 % of elderly people (aged 80 years and over) who received the services available in the care staircase did so during their end of life care (Daatland and Otnes 2014). Thus, the death has become a responsibility of the formal health care service providers. Consequently, it is argued (e.g., in the Senior Report (2014)) that people receiving end of life care should be "taken back" to their homes, as was the case years ago so that they may die in peace, in a familiar environment together with the closest family and friends.

Health care concerns were raised in the 90s due to the growing elderly population with estimations of it reaching a critical mass of 800,000 elderly Norwegians by 2020 (NOU 1992:2, Statistics of Norway 2014). The large increase in potential care receivers will inevitably put a strain on the society's welfare resources as the growing elderly population means fewer tax revenues (a smaller proportion of the population is working). Moreover, the population is estimated to be above 1 million (Statistics of Norway 2014) in 2035. Life expectancy has also increased for both genders. The number of elderly people of 90 years or older has been and is predicted to remain relative stable during 2010-2020 (6%), but is estimated to increase to 9 % during 2020 – 2025 (Statistics of Norway 2014). Increased age means an increase in chronical illness and age-related diseases such as dementia, with Alzheimer's disease being the most common type of dementia. It is estimated that 71,000 Norwegians (Norwegian Directorate of Health 2014) have Alzheimer's diseases and Alzheimer's is listed as the second most common cause of death in Norway (GBD 2013).

There is also a deficiency between amount of potential care receivers and the availability of health care professionals' in future elderly care. This shortage in staff is another critical aspect that threatens elderly social care. In order to assure human care services to those who need personal care and grooming, the responsibility of caring has to be re-organised. Several Norwegian municipalities have chosen to privatise parts of their elderly care by procuring private care providers to deliver the

care services. However, the municipalities have the overall responsibility for providing elderly people with formal care services.

The Welfare Policy states that elderly care should primarily be home – based, thus there is a focus on so-called housing-oriented care (NOU 1992:1).

"Home is home, and everything else is not home" Klinkenborg (2012).

The concept of home is more than just a place; it is about *feeling* at home (Klinkenborg 2012). People can live in a place, but not have the feeling of homeliness. Home is associated with familiarity and belongings, and the society is structured by inhabitants having their private sphere or shelter called home (Verschaffel 2002). The location of the home adds a further dimension to the idea of "the home". Homes can form part of a larger network of homes situated in the same area. This larger network of homes often form a community which has access to nearby services like public transportation, public school, grocery stores, health care services, gyms, various department stores, friends, and family, and so onwards. In addition to location, privacy and safety are also important aspects of the home. An individual can relax and be themselves within their own home. They can let their public façade slip and take a break from the social requirement of being presentable. It must be understood that the home is not always a space merely for one individual. The home can be a space shared by several people such as housing collective or a family. The home can also provide negative associations such as isolation and unsafety, and for some, the home can be associated with fear and anxiety for those who live in unhealthy relationships or do not master living on their own. Nevertheless, the home has a strong impact on one's daily routines. It is the sound basis of living and the space for daily living activities such as eating, sleeping, cleaning and dressing, among others. The term domesticity means the "*lived experience of private life*" (Cohen 2012) and refers to taking care of the family or handling family life activities, which in the past was associated with activities that the wife would perform around the home. However, today we are seeing a shift towards people living alone with Statistics Norway observing a sharp increase in comparison to past decades (Statistic Norway 2013). The position of the wife in the home has weakened as both women and men have equal access to education and careers. They are both able to be pursuing careers and thus, both pay taxes to the welfare society. Prior statistics on Norwegian society (Statistic Norway 2013) show that people who

live together as a family use less public health care services than those who do not. This is due to the fact that giving care is often performed by family members and the result of private efforts. Thus, as the family relationships have become increased egalitarian nuclear family, care for the elderly people and other dependents have been de-familiarized in today's society. Thus, older people have a greater need for formal care services as they age and become more fragile. The Ministry of Health and Care Services in Norway intends put in place mechanisms that will help most elderly people remain within their own or family homes. Hofmann (2014) describes the wave of nostalgia among the young central European men in the 1600 century. These men were away from the home as soldiers or students. The initial symptoms of nostalgia were isolation, melancholy, insomnia and a loss in appetite, which could later develop into apathy and fever with the worst cases of nostalgia resulting in death (Hofmann 2014). The only cure for the disease was to return home (Hofmann 2014). We cannot ignore the fact that most people want to live in their homes with the home forming a fundamental element in every person's life.

Older people and individuals with disabilities should have their own home in the same way as other citizens do (NOU 1992:1). Health policy also recommends that the elderly people should own or rent their homes. An ideologically institutional critique was part of the motivation for this. There is a desire to normalise the life of individuals with extensive care needs (NOU 1992:2). The municipalities have an obligation to provide housing for people who cannot look after their interests in the housing market (Ministry of Health, 2011c § 3-7). The municipalities have by this law, a responsibility to assist those with special needs such as the elderly people who have cognitive and physical disabilities. There are two programmes for assisted living: care housing (sheltered housing) or nursing home (institutions). However, the government aims to reduce the amount operational nursing homes as these are costly both for the municipality and the elderly residents. The shift of caring by institutions to home-based care has already occurred in the care system for younger care receivers, however elderly care receivers continue, due to cultural and historical norms, to be moved to nursing homes when they are unable to care for themselves. Health policy states that older persons who need extensive health care services for a short or long term period should be offered short or long-term stays at smaller housing units as an alternative to institutional care. Assistive living, such as care housing, is believed to play a fundamental role in future elderly care. Institutional

care can then be scaled back and the family driven care can take a bigger and more active role in the caring for old people.

The government reports that they are not able to provide the same number of care homes and nursing homes to serve the growing elderly population as they are currently doing for the elderly population. Elderly people are motivated to self-care to a greater extent when supported by family, voluntary resources and technology. It is arguable that health care services can be transformed by increasing welfare technological support, e.g., routine tasks can be covered by technology or parts of routine tasks can become tasks that are allocated to technology – supported services. The use of technology will play an important part of the re-organisation of elderly care. However, there are still relatively few research studies providing empirical investigations on the use of welfare technology in elderly care practise. Moreover, the government's high ambition of the role that welfare technology could play for the future organisation of elderly care requires increased knowledge about how elderly people are able to utilise the use of welfare technology.

1.2 Related work

Relatively few CSCW studies on health care have focused on the introduction of assistive technology within the homes of elderly people, nor the use of such technology in care housing or nursing homes; however some studies do exist. Proctor et al. 2016 have studied the work arrangements of the telecare call centre staff, who act like the response unit of calls and alarms to support elderly people to prolong living in the home. The authors state that it is a gap in the political ambitions of the use of assisted living technologies and the actually use of such technologies among elderly people in practise. Moreover, the authors pinpoint the lack of match between the elderly people's need for daily life support, and the technologies that is in reality provided to support them. However, even if "care at a distance" has received critics for being impersonal and reducing social face-to-face contact, the authors report findings of call centre staff acting as the "glue" (p. 79) in the network of carers by "providing the all-important link between otherwise fragmented services" (p. 79).

Aaløkke Ballegaard, Bunde-Pedersen and Bardram (2006) conducted a research project into assisted living that concerned the use of a tablet for access to home-based

services targeting elderly people. They argued that the technology should merge together with the changing functional abilities of older people. Moreover, they criticise the fact that assistive technologies often are introduced as follow-up initiative after sudden decline of health, so-called in acute phases of older people's lives, and they recommend the introduction of the technology before the acute phases as a way to prevent acute situations. Moreover, the authors address the challenge of designing healthcare technology "which will be able to fit into the everyday life of the citizen." (p. 1808). The authors argue that health care technologies should be an integrated part of the home environment, and not necessarily being visible as something that could stigmatised the resident by having health care equipment in the home, see Figure 3.

Figure 3 illustrates Aaløkke Ballegard et al. 2006 point of users hiding assistive technology to avoid stigmatisation. Copyright: Aaløkke Ballegard et al. 2006 p.375.

Much of the current literature on assistive technology pays particular attention to technology-supported follow-up services after hospitalisation, especially concerned the patient transition from hospital and back home (Grönvall and Kyng 2012, Korhonen et al. 2003, Milligan et al. 2011, Aarhus et al. 2009, Grönvall and Verdezoto 2013).

Aarhus and Aaløkke Ballegaard (2010) provide a distinction between being a patient in the hospital versus in the home, also in regard to the use of technology. They refer to their informants who express that hospitalisation allow one to "concentrate on

being sick” (p. 1230), in contrary to staying home where the focus is not solely on the disease management, but also on daily practical- and social arrangements including having different family roles to handle. The authors state that “at a hospital there is somebody to take care of the patient and to receive help from, while patients at home are more on their own.“ (p. 1230). In the hospital, the patients are often “just patients”, but in the home the person is representing various roles, in addition to managing the disease(s). Thus, in the home the person is “more” than just the disease, while in the hospital the patient role is represented by the disease. In care situations, where the residents are receiving follow-up services after hospitalisation, the home becomes a place for both public and private matters, in which, many informants are reporting to hide health care technologies.

The focus on technology-supported out-patients returning back home remain narrow in dealing merely on follow-up services after hospital admission, consequently, they are not bringing attention to technology supporting people as part of the elderly care practise. Thus, as these users can experience shifting needs over time. Moreover, there is a gap in the CSCW research concerning technology support in relation to the transfer from short-term stay at care housing and nursing home to the return back home. Similarly, there is lacking research on the move from private home to care housing and/or nursing homes, also in regard to technology-supported services to support the users in various phases during the elderly care.

Fitzpatrick and Ellingsen (2013) recognised the introduction of technology into the home as a "movement towards technology-enabled care at home with a greater focus on self-care." (4, p. 637). They further stated that the exploration of such technology for the purpose of monitoring or self-care can indicate a drift towards reduced human health care resources being physically present in the home, as well as an increased focus on the users and their experience of well-being and comfort. Hofmann (2013) argues further that “Many kinds of welfare technology break with the traditional organisation of health care. It introduces technology in new areas, such as in private homes, and it provides new functions, e.g. offering social stimuli and entertainment. At the same time welfare technology is developed for groups that traditionally have not been extensive technology users.” (p. 389). Moreover, Hofmann raises concerns about the ethical implications of such development of health care services, saying “If advanced health technology spreads from hospitals to private homes, the challenges

recognised in hospitals will spread to the home: withdrawal of treatment, autonomy to refuse treatment, advance directive" (p. 398). Additionally for related work concerning social aspects of welfare technology use, see Woll (2016b)

According to Fitzpatrick and Ellingsen (2013), CSCW studies about cooperative work arrangements in health care settings mainly focus on exploring place and time issues in work practices of health care professionals (e.g., Wagner 1993) or the coordination of these cooperative work arrangements (Bossen et al. 2013, Bardram 2000, Berg 1999). CSCW research studies put emphasis on coordinated work as a basis for designing situated computer systems that support and organise work, including computer support for health care professionals with partly unpredictable workflow (Fitzpatrick and Ellingsen 2013). One of the few CSCW contributions concerned with home care work is by Nilsson and Hertzum (2005). They have studied the role of rhythms in the collaborative coordination of mobile work. Their focus is also concerned *time*, *place*, and work *schedules* by analysing the "collaborative rhythms of a tightly regulated work setting characterized by local mobility" (p. 156). Moreover, Pinelle and Gutwin (2002, 2003) have looked at the collaborative nature of home care workers and point out that "home care collaboration is limited by several characteristics of the setting, including the mobility of clinicians, schedule variability between team members, and the rarity of face-to-face meetings between team members." (p. 621). The authors (Pinelle and Gutwin 2003) recognise the mobile work of home care workers by the characteristics of "loosely coupled collaboration style" (p. 75) Pinelle and Gutwin (2003) argue that "since collaboration and interdependencies are minimized, workers usually have the flexibility to deal with the unpredictability of the work setting without consulting others" (p. 83). Petrakow (2007) examined the design and development of a health care information tool by use of a binder to support both cooperation and coordination of elderly care services in the home. Petrakow reported the functions of the existing paper-based SVOP binder and further makes suggestions in regards to an IT tool that could compensate for the restrictions of the paper-based binder system. In her study, Petrakow argues that home care work is more complex than hospital work, the reason being that work activities in the home take place in a context that is difficult to change. These work activities have to be coordinated, not only, between the various care providers within one organisation, but also between different organisations due to the fact that an individual's care network is often fragmented and consists of a

number of different care providers. Petrakow argues that the care work needs to be coordinated between the various workers who are located in different places and work in shifts. She emphasises the importance of the binder supporting the patient-centric view, which is complementary to the clinical-centric view presented by Fitzpatrick (2004). Together these studies provide important insights into the work of home care staffs, however these contribution lack to put the attention to the care receiver as an essential partaker of the collaborative care work. For additional related work on coordination and home care work, see Joshi and Woll (2014, 2015a and 2015b) and Woll (2016a)

There are several research studies looking at the use of a particular welfare technology. Some research projects are aimed at support for medication administration in the homes of elderly people (Siek et al. 2011, Dalsgaard et al. 2013). Furthermore, there are studies into: how the elderly are dealing with interactive interfaces (Culen and Bratteteig 2013, Haikio et al. 2007), how the elderly are using modern technology (Heart and Kalderon 2011), the applications for social participation (Alaoui et al. 2012, Dewsbury et al. 2007), and self-monitoring and home technologies for rehabilitation (Grönvoll and Verdezoto 2013, Axelrod et al. 2009). Several studies concern how remote care technologies change the home context and the conventional care work practices (Milligan et al. 2015). In their discussions about the move of health care into the home Bratteteig and Wagner (2013) explored how homecare technologies changed how caretaking in the home was being carried out and discussed how the home is turned into a workplace for professional caregiving. They recognised the many different kinds of work that the care receivers and givers do by building on the prior research of Corbin and Strauss (1991). However, there is a lack of CSCW research that have explored how technology can support the various types of elderly care work. Moreover, how the balance or mix of self-care, formal care and informal care can play out in care arrangements.

Procter et al. (2014) explore user experiences of elderly people that have support from assistive technology and health care services. They argue that successful ageing is socially and collaborative accomplished by the joint efforts of older individuals and their care network. Procter et al. (2014) further argue for the importance of simple and easy customisation of technology to support individual needs. Moreover, they

state that mutual awareness of technology use is essential to reduce response times when care receivers experience adverse events or accidents.

Piras and Zanutto (2010) bring attention to the recent re-delegation of health care activities, delegating care from health care workers to patients. They exemplify this by reporting on patients that have gone from being passive health care receivers to active ones and taken on increased responsibility for self-care. The authors argue for the need for a tool that supports the patients/users in dealing with this responsibility.

Aaløkke Ballegaard et al. (2008) have explored supportive healthcare technology for elderly home dwellers. They state that older people carry out several activities during a day and that use of (supportive) technology is only one of these. They recommend integrating such technology as a natural part of the home, preferable to build services on familiar and existing technology in the home to maintain the “continuity” (p. 1813) in users daily life activities. Elderly people may hold the belief that modern technology is an interruption to their daily life activities, hence “taking a citizen view, the main design concern becomes to minimise the disruptive nature of new technology. This line of thought will focus on the citizen's daily life and routines and try to designs for continuity in the citizen's life, e.g. despite a medical condition.” (p. 1813). The authors argue for adopting a participatory design approach when designing supportive healthcare technology for elderly people in order to let the older people have a say. A similar approach is taken by Joshi and Bratteteig (2015), who argue for building new technologies based on the competencies of the elderly people. They describe how older people can participate in the design and demonstrate how technology can prolong their capacities.

Aceros, Pols, and Domènech (2014) carried out an ethnographic study of elderly home dwellers using a personal alarm system to help them alert people in cases of emergency. The aim of the technical assistance was to support the elderly home-dwellers’ safety and well-being. However, the elderly felt home-bounded as the alarm did not work outdoors and the use of such technology contradicted with the purpose of elderly being independent; especially in regards to older people who wished to partake in more social activities outside their homes. Aceros and Colleagues (2014) further argued that assistive technology stands the chance of failing in certain real-life cases due to its limitations. The use of such home-bound alarm systems can cause elderly people to feel unsafe outdoors, which in turn can result in safety alarms

having an adverse impact on their well-being. It results in older people being effectively locked up in their homes due to fear, which has the effect of making them more isolated and inactive. We thus end up with opposite effect of the noble intentions behind supporting active and independent ageing.

Greenhalgh et al. (2013) performed a study on assistive living and the actual user needs of elderly people. They addressed how increasing health challenges of elderly people are likely to affect their ability to use assistive technologies and the materiality of the introduced technologies; both the material features of the technology and the sociological implication of its use. Greenhalgh et al. (2013) refer to findings similar to the EFORTT research team (2013) who concluded that telecare is not a quick solution to support the growing elderly population. Neither does it replace traditional home care services as the technology itself cannot perform the care work. First and foremost, telecare is operated by people, whereas the technology has to function and then be incorporated into the work practice of someone who can take action and follow up when telecare is not working or require additional measures such as a personal visit.

Milligan, Roberts, and Mort (2011) have studied how the growth of telecare technologies affects the context of the private space, as well as the user experience of the care service. They stated that “Telecare affects the nature of care interactions within the home; hence the widespread adoption of these technologies is likely to have a significant impact on the broader landscape of care.” (2011, p. 349). Milligan et al. (2011) argued that the fact that homes that are transformed into institutional environments – with all kinds of medical devices and public regulations – conflicts with the intended positive aim of staying in the home for these home dwellers. They argue that designers have addressed these issues in recent times by developing and integrating telecare devices that match the layout of the home in order integrate assistive technologies in a subtle manner by providing “invisible” (Milligan et al. 2011, p. 353) support in the home. Doyle, Bailey, and Scanaill (2014) confirm that few studies have looked into the use of technology in practice and further argue that independent living technologies should be integrated into the homes of elderly people. This way it can be tested in the real environment to assess the actual value of the design and to study the impact that the technology could have on the users’ lives. Goodman-Deane and Lundell (2005) continue the discussion on how the design of

technology should meet the needs of the elderly by emphasizing the importance of capturing the needs of "real older people, including "baby boomers" still in employment, frail older people with disabilities and the full range in between" (p. 3).

Compagna and Kohlbacher (2014) explored the design of assistive technologies such as care robots for elderly people through the use of participatory technology development (pTD). The authors reported several weaknesses of such an approach, yet concluded that it has the potential to work if designers and developers move their work into real user environments and include the various end-users, e.g. the care workers and the elderly people. Clemensen and Larsen (2014) studied the introduction of telemedicine for the treatment of foot ulcers in the home. They concluded that telemedical treatment could provide the home-dwellers with improved continuity in treatment as such consultation requires real-time collaboration with the home care nurse, patient, and the doctor. However, they also experienced that introduction of telemedicine in the home resulted in coordination challenges such as the physician having to wait for the home care nurse to arrive at the patient's home. Thus, the authors suggest that a function for coordination is included in the design of the technical solution. Loe (2014) explored the role of technology in relation to active ageing from the perspective of the oldest group of elderly people including elderly adapters of technology, reluctant users, and non-users. The author emphasised the importance of capturing the old people's views on technology – and she further argued that the policy makers, designers, and caregivers should listen carefully to the elderly people who have already adopted technology into their lives.

Relative few HCI studies have study the use of welfare technology prototypes in practice, however there are exceptions, e.g., tools for self-care or treatment, intended for the resident in private homes (Mamykina et al. 2008, Tap 2001, Aarhus, Aaløkke Ballegaard and Hansen 2009).

Blythe, Monk, and Doughty (2005) explored the user needs of the elderly and how these provide design implications for HCI. Their study is based on findings from structured interviews with health professionals and older people. Blythe et al. (2005) expressed concerns about technologies used for monitoring and the fact that less attention appears to have been given to the social context of the home. Other HCI studies report findings from collaborative or interactive services where elderly people use the television at home as a platform to receive telecare or similar services

(Miyazaki et al. 2013). Several studies have produced findings that concern age-related challenges when designing for the elderly generation (Carmichael et al. 2007, O'Neill et al. 2014, and Weiner et al. 2011). Others have provided new knowledge on how to develop interfaces usable for older people, e.g., (Hawthorn 2000, Baunstrup and Larsen 2013). For instance, Baunstrup and Larsen (2013) point out that the television has evolved from a one-way monologue into a communications platform offering increased dialogue-based services. They also argue that an iTV provides more "complex interaction paradigm" (p. 13) since it usually involves additional equipment such as set-top box, additional monitor and media streaming device. Other research contributions put emphasis on the importance of studying elderly people who have already mastered the interface in the search for compensatory strategies that may apply to this user group to improve the user experience (Van de Watering 2005). Van de Watering (2005) points out that previous studies, e.g., Hawthorn 2000, mainly deal with the physical, sensory and cognitive limitations that come with aging, while they believe that one should also consider the aspects of "privacy, acceptability, stigma, control, trust, choice and social alienation" (van de Watering 2005, p. 614) when entering the design process. Specifically, they believe that privacy and trust are key elements that should be considered when HCI research occurs in regards to private homes and communities.

There are no other HCI studies that have explored the effects that certain disease could have in regards to the ageing population and their use of technology. However, several studies from interdisciplinary research communities have examined various ethical aspects of assistive technology use, often in the context of people with dementia and Alzheimer's diseases. These research contributions focus on concepts and issues in regard to the following:

- Autonomy (Tosato et al. 2007, Satchell et al. 2009, Shankar 2010, Skubic et al. 2009, Bjorneby et al. 2004, Landau et al. 2010, Sharkey and Skarkey 2012, Sparrow and Sparrow 2006),
- Privacy issues (Remmers 2010, Bharucha et al. 2009, Demiris et al. 2004),
- Stigma of assistive technology use (Hensel, Demiris and Courtney 2006, Faucounau et al. 2009, Magnusson, Hanson and Nolan 2005), affordance (Coughlin et al. 2007, Penhale and Manthorpe 2001)
- Safety (Hertogh 2004, Melander-Wikman, Faltholm and Gard 2008, Landau et al. 2010).

Moreover, Greenhalgh and co-authors (Greenhalgh et al. 2013) study the effects of illness and frailty on the living body through the use of phenomenology. The authors develop a theoretically model of assistive technology adoption by older people based on phenomenology and socio-materiality studies. However, they do not discuss ageing in the light of the different perspectives on diseases, but rather how the "lived body" influences the technology use and appropriation. In phenomenology, the understanding of the lived body is your own body as experienced by yourself, as yourself (Greenhalgh et al. 2013). The authors argued that providers of assistive living technologies are not supporting the users in coping with their illness in everyday life activities. Moreover, the authors stated that introduction of technologies to support independent living requires a solution to be found that will help users in "think with things" (p. 86) to increase the usability and the user experiences.

There remain several aspects of the use of welfare technology within elderly care, where relatively little is known. In view of all that has been mentioned so far, one may suppose that it is a need to bring more attention to the introduction of assistive technology within the homes of elderly people, as well as in the care housing or nursing homes. By looking at the use of technology in the context of the overall elderly care pathway and connecting work arrangements. Much of the available literature on the use of welfare technology deals with a specific welfare technology tested as part of pilot studies. These studies are giving glimpses of the user situation in the context of elderly care, and do not look at past and future user needs. The evidence reviewed here seems to suggest a pertinent role for studying the work of elderly care. While, there are some studies that address home care work; however, none of these bring attention to the use of welfare technology from the care receiver's viewpoint, neither do they support the users' need of safety and security measures, nor bringing attention to the care receiver as an essential contributor to the collaborative work of elderly care. Moreover, there is a lack of studies that put attention to the actual user needs of elderly people, especially by showing *how* technology can evolve together with their need for care services.

I have found no empirical studies, other than those presented in this thesis, that have focused on the use and the constraints and benefits aspects (of the use) of welfare technology as part of the overall municipal care staircase. Hence, no other studies have brought attention to the actual user needs of elderly people and studied how

these better can be supported in practise. There is a lack of research based on how welfare technology better can be introduced and incorporated into the elderly care work.

1.3 Objectives and research questions

The main objectives of this thesis are to investigate empirically how welfare technology is used in practice in care housing and in nursing homes by capturing the user viewpoints including the perspectives of the elderly people and their care providers. Additionally, it aims to increase knowledge on how welfare technology can be incorporated to its full potential in order to benefit future elderly care. This thesis aims to address the overall problem of how we can improve the incorporation of welfare technology so that we may improve the elderly care sector as a whole. It aims to do this by addressing the following three research questions (RQ):

RQ1: What are the key constraints and benefits of the current use of welfare technology in elderly care?

RQ2: What are the elderly users' barriers to the adoption and use of welfare technology?

RQ3: How can technology-supported services better be incorporated into the elderly care work?

This thesis consists of eight papers that all aim to address the overall research problems with the exception of paper 8. The answers to the main research questions posed are summarised in this Summary chapter and include findings addressed in the papers as sub-questions. Additionally has this chapter contribution beyond what is presented in the papers to supplementary answers to RQ1, RQ2 and RQ3. More specifically, RQ1 is dealt with in Papers 1, 5, 6 and 7. RQ2 is dealt with in Papers 1, 3, 4, 5 and 7. RQ3 is then dealt with in Papers 2, 3, 4, 5 and 6. Paper 8 indirectly addresses the overall research questions in that it concerns the use of theory in the analysis of technology-supported elderly care studies.

1.3.1 Research Setting

In order to explore the use of welfare technology in practice, I have conducted two interpretive case studies and an action research study, see section 3.5 for the data collection that forms the basis for answering the thesis's main research questions. I wanted to understand how the introduction and use of welfare technology was appropriated by the residents (hereby also referred to as users) in the care housing setting. I found the care housing setting particular interesting because it is seen as a lighthouse project due to the large scale use of welfare and smart house technologies, at least in the Norwegian context. Moreover, the care housing setting is a service that falls in between two stages of the care staircase. The residents living at the setting need more assistance than they can get in their ordinary homes, but are evaluated to not need in-patient care such as that provided in nursing homes. Thus, their current use of technology and their need for care services can be seen in the light of their past and future use of technology and their need for care services. As my study progressed I altered the focus of my fieldwork to studying home care services, in particular, home care services delivered to active ageing residents in the care housing setting as part of a two-year action research study. As my fieldwork unfolded my curiosity in regards to how technology better could support actual user needs in the care housing, moreover, how the use of technology better could fit in the overall elderly care increased. I noted that several elderly people found it troublesome to actively use technology in the care housing setting. The users struggled to master technology interaction or viewing technology as something useful and ready at hand. The struggle was not so much about aging, but rather with the loss of interest and being too overwhelmed / distracted about coping with disease(s). Thus, I considered it necessary to understand the utilisation of technology in the nursing home setting. This because the residents having formal decision for nursing home stay are reported to be the oldest old and/or for those with extensive need for health care services.

The technology-supported services involved within my research were connected to different housings types including: ordinary, care and nursing homes and they represent the movement towards *housing-oriented care*. Housing – oriented care equates to care services provided by stepwise escalating formal care services by residents' health care needs. The escalating offering of services includes both health care services and housing. Thus the way in which services are offered is best

described as a care staircase or care pathway. Most elderly people are non-users of formal care services (74%) (Statistics Norway 2013) and are living in their homes being support by their family. However, those elderly people who need assistance to live independently are offered various home-based services. The ambition is to provide most users with home-based services to support them living in ordinary homes. However, elderly people who, for various reasons, are unable to live in regular homes are able to apply for residence in care housing which offers additional services beyond those provided to individuals residing in regular homes. Thus, care housing is planned to reduce the need for nursing home stays. Thus, nursing home services can be down scaled, whilst maintaining the ability to offer short – term stays for temporary in-patient care. The shift towards housing-oriented care assumes the active involvement of elderly people, family members, volunteer resources, and a robust and extensive home care service. Use of technology can play a major role in the shift towards housing-oriented care. In particular, the utilisation of technology could be a tool to help support the various types of elderly care work including self-care, informal care and formal care.

1.3.2 Research contributions

This thesis builds on studies undertaken by Computer Supported Cooperative Work (CSCW) and Human-Computer Interaction (HCI), see Table 1. The research studies add to the existing body of knowledge, in particular knowledge concerning the transformation of elderly care work by the active and passive use of technology to support various types of care work. Whereas the elderly care work is recognised as a collaborative effort including self-care-, formal- and informal care workers. Moreover, this thesis has a theoretical contribution addressing limitations and potential of activity theory when applied as the theory to analyse technology-supported elderly care studies. Relatively few researchers have brought attention to the overall elderly care work in CSCW. However, several contributions explore fragmented parts of technology-supported elderly care services, both addressed to CSCW and HCI (see section 1.2 Related work).

	RQ1: What are the key constraints and benefits of the current use of welfare technology in elderly care?				
	RQ2: What are the elderly users' barriers to the adoption and use of welfare technology?				
	RQ3: How can technology-supported services better be incorporated into the elderly care work?				
no.	**study**	**research field**	**RQ**	**Theory used**	**Answers**
1.	Dealing with breakdown of welfare technology	CSCW	1,2	Activity theory, Articulation work	Well-known technology fails in everyday use.
2.	Telecare as a means for delivery of home care services	HCI	3	Usability	A step-wise approach to introduce technology into the homes of eldlery people and as part of new work practise. Starting with usability study in a demo-apartartment.
3.	Diagnostic evaluation of telecare for elderly home dwellers	HCI	2, 3	Diagnostic evaluation	A step-wise approach to introduce technology into the homes of elderrly people and as part of new work practise. Moving from the demo-apartment to the homes of the elderly people.
4.	Post-experiment evaluation of home telecare for elderly home dwellers	HCI	2, 3	Post - experiment, summary	Lessons learned from the step-wise approach to introduce technology into the homes of eldlery people and as part of new work practise
5.	A trajectory for a person-oriented elderly care	CSCW	1, 2, 3	Strauss and Corbins trajectory work	Suggetion of a re-design of the current eldery care by e.g., increased incorporation of technology into the staircase
6.	Is aging the new disease?	Social aspects of HCI	1,3	Different perspectives on disease	A study to understand the elderly population, aging versus diseases
7.	Introduction of telecare mediated home care services	CSCW	1, 2	Activity theory	A study to understand how introduction of technology influences current care work practise.
8.	Activity theory as a framework to analyse technology-supported elderly care studies	CSCW/HCI	(1,2,3)	Activity theory, articulation work, Strauss and Corbins trajectory model	A study showing uses of AT in elderly care studies, and how (among other) increased use of automated services challenges the traditional view on human computer interactions.
9.	Summary Chapter	CSCW	1,2,3	Elaboration on the findings from the papers	The summary chapter add to the exisiting papers and elaborate more on inquires RQ1 and RQ2.

Table 1 shows the studies and the contribution made to the research communities, and the papers connection to the thesis's main research questions.

The main contributions are listed as follow:

- Identification of constraints and benefits of current welfare technology use (see Summary chapter and Paper 1, 5, 6 and 7).

- Identification of elderly users' barriers to the adoption and use of welfare technology (see Summary Chapter and Paper 1, 3, 4 and 5).
- Presentation of a practical approach that will allow selected home care services to transform into new work practice (See Summary chapter and Paper 2, 3, 4 and 7)
- Presentation of a conceptual proposal that envisages a re-design of the elderly care trajectory to better fit actual user needs and to overcome the identified key constraints that are preventing welfare technology being used to its full potential (See Paper 5 and 6).
- This would include increasing the use of technology to support the joint collaboration of elderly care work such as formal care, informal care and self-care.
- Identifications of the limitations and potential of using activity theory as the theoretical framework for analysing technology-supported elderly care services (see Paper 8).

The thesis also aims to offer new knowledge to health government/decision makers, welfare technology vendors and healthcare professionals, for example by the identification of elderly users' barriers to the adoption and use of welfare technology, and the conceptual proposition of the elderly care trajectory etc.

1.4 Outline of the thesis

This thesis is organized as follows:

1.4.1 Summary chapter

Section 1 presents today's elderly care in Norway, relevant related work, the objectives and the research questions in the light of the research setting. Moreover, this section presents the research contributions and the outline of this thesis including the Summary chapter and its associated eight papers. Section 2 introduces the theoretical background of this thesis's work such as activity theory, Strauss and Corbin's trajectory model, levels of automation and aging versus disease. Section 3 presents the research context, the research techniques used in this thesis, and my role as a researcher. Section 4 describes my empirical data of welfare technology use in practice as experienced during fieldwork as part of the case studies and the action research study. Section 5 presents the results of my overall research questions.

Section 6 sums up the results and discusses these in the light of implications for use and research. Section 7 provides my conclusions.

1.4.2 Papers

Eight papers are included in this thesis, each of which is briefly described below.

Paper 1, Ageing in Place: Dealing with Breakdown of Welfare Technology (Woll 2013). This paper concerns the breakdown of socio-technical relationships in a care housing setting. This paper displays that use of well-known and familiar welfare technology and smart house installations in the context of elderly care is sometimes failing in the ambition of the use in practise. Moreover, it highlights the importance of redundant solutions and services based on levels of automation. The abstract states: This paper is about breakdown that occurs within the contextual frame of elderly aging in place by support of innovative welfare technology. The paper presents use of Activity Theory as a constructive framework to explore laypeople experiences with occurrences of breakdown including the subsequent coping mechanisms for recovery from such. Findings in the study display that articulation work plays an essential role to manage temporary workarounds or to accomplish recovery from breakdowns. Additionally is it sought for a minimum system requirement for robust infrastructure and high availability of services in order to prevent occurrences of medium to complete breakdowns as they in worst cases may harm the life and health of elderly people aging in place.

Paper 2, A Collaborative Change Experiment: Telecare as a Means for Delivery of Home Care Services (Joshi and Woll 2014). This paper presents a usability study of telecare as the means of delivering home care service in a controlled environment, a demo-apartment. The study is using the familiar television as the building block for home telecare. This is 1 out of 3 papers presenting from the collaborative change experiment. The abstract states: This paper presents a collaborative change experiment that introduces telecare as a means for delivery of home care service. The television is used as platform for delivery of services from the home care nurses to the elderly care recipients. Through the collaborative change experiment, we seek to address the interdependent relationship between the home care nurses and the elderly people by studying the usability and user experiences on both sides of the interaction. Our work includes usability testing with the aim of optimizing the design of telecare.

This paper reports findings concerning the spatial design, compensation of declined motor skills, audio-visual considerations and control mechanisms.

Paper 3, A Collaborative Change Experiment: Diagnostic Evaluation of Telecare for Elderly Home Dwellers (Joshi and Woll 2015a). This paper presents a diagnostic evaluation of telecare as a means of delivering home care service in a real environment. More precisely, this paper addresses the complexity of moving technology from the demo-apartment into the private homes and daily life's of elderly people. This is 2 out of 3 papers presenting from the collaborative change experiment. The abstract states: This paper presents the diagnostic evaluation of a longitudinal collaborative change experiment that introduces telecare as a means for delivery of home care service to elderly home dwellers. The television is used as platform for delivery of care services from the home care nurses office to the private homes of the elderly home dwellers. We have included 34 participants in three sessions with evaluation and we use the results from the diagnostic evaluation to discuss how we can optimize the design of remote care in real environment. Our main findings concentrate on contextual factors that made impact on experienced usability issues, including timing and unstable network connection, complexity, and privacy and trust. In our study, we found that telecare is not for every elderly home dweller as it requires a high degree of functional capability in order to be experienced as appropriate and useful for the elderly users.

Paper 4, A collaborative change experiment: Post-experiment evaluation of home telecare for elderly home dwellers (Joshi and Woll 2015b). This paper presents results from post – evaluation of the collaborative change experiment as the means of delivery home care service in a real environment. This is 3 out of 3 papers presenting from the collaborative change experiment. The abstract states: This paper presents results from the final phases of a three-year collaborative change experiment that introduces telecare as a means for delivery of home care services to elderly home dwellers. During the five phases of the experiment, we have included a total of 78 participants in a new housing for local care homes in Oslo. Our goal has been to gather enough empirical knowledge to inform future design of telecare. We present and thematically analyse the results from a final post-experimental workshop and case study, and we use this analysis to discuss the overall findings of our research.

Our main findings cover different aspects of the design of telecare, including organizational, technical and health aspect.

Paper 5, A trajectory for a person-oriented elderly care (Woll and Bratteteig unpublished). This paper suggests a re-design of the current municipal care staircase by the proposal of the elderly care trajectory. The elderly care trajectory aims to increase knowledge on how welfare technology can be incorporated to its full potential in order to benefit future elderly care. The abstract states: In order to enable elderly people to live independently in their own homes governments de-institutionalize elderly care services by downscaling nursing homes and increase home care services and sheltered housing. Increased use of assistive technologies will play an important role in this transformation of care services. In this paper we suggest a person-oriented elderly care trajectory that includes technology in all phases and, in particular, in transition between the phases. We build our trajectory on empirical studies of elderly people in a sheltered housing complex using assistive technology, and experiments about new ways of using well-known technologies for new assistive technology-based health care services, in addition to Corbin and Strauss' classic work. Our person-oriented elderly care trajectory fits with the municipal care staircase but challenges its minimalist service level focus as well as its late introduction of technology.

Paper 6, Is ageing the new disease? (Woll 2016a). This paper discusses the phenomenon of ageing by applying Hofmann's three perspectives on disease including disease, illness, and sickness role. Moreover, it explores how the introduction of technology-supported elderly care changes our perspectives on ageing, making it more disease focused. The abstract states: In this paper, we discuss the phenomenon of aging in relation to Hofmann's three perspectives on disease including disease, illness and sickness role. We further discuss how the introduction of technology supported elderly care changes our perspectives on aging into becoming more disease focused. Especially, in user situations where technology supported care is introduced in order to prevent and reduce individual risks of prospective elders at risk of becoming wanderers, or who need support in order to avoid- or reduce outcomes of falls. Thus, even if early introduction of technology supported care is recommended in order to realize assistive technology to its potential

benefits, we raise critical concerns in how this also can change our view of aging from being a natural process of life into a disease focused phenomenon.

Paper 7, Introduction of telecare mediated home care services pushes forward a re-delegation of the cooperative care work (Woll 2016b). This paper compares the changes of the collaborative work dynamics when replacing traditional home care services with telecare mediated home care services. The abstract states: In this paper, we apply activity theory as a theoretical framework to study conventional home care service practice versus telecare as a means for delivery of home care services. In doing so, we translate home care services into work activities to explore the cooperative nature between the nurses and the elderly care receivers. Findings indicate changes in how the cooperative care work are distributed when moving from conventional home care services to telecare mediated home care services. In our work, we conclude that introduction of new work practice results in increased delegation of responsibility and practical self-care activities to the elderly care receivers. Thus, telecare such as video consultation in the home is not appropriate for all elders. Nevertheless are those who mastery these responsibilities, rewarded with increased flexibility in their daily life activities since the delivery of services is more predictable and timely.

Paper 8, Activity theory as a framework to analyse technology-mediated elderly care (Woll and Bratteteig forthcoming 2017). This paper discusses how activity theory can be applied as the theory for analysis of technology-mediated elderly care. In order to support elderly people who suffer from diseases and various declines, increased use of automation in technology-supported elderly care activities may be needed. Thus, in this paper we discuss how automated tools challenge the researcher in applying AT by discussing "instrumentality" versus motivated action of elderly people. Furthermore, we highlight the messy difficulties of applying theory. The abstract states: This paper presents a field study of technology-supported elderly care analysed with an Activity Theory (AT) perspective. Leont'ev's hierarchical structure of an activity is proved useful for analysing how elderly people learn new technology-mediated care practices, and Engeström's activity system for studying the specific work context. We combined Corbin and Strauss' trajectory concept with AT to address elderly care in a timeline perspective. AT was found constructive when analysing problematic work activities in such transitions. Our analysis of technology-

supported care includes increasing levels of automation, and shifting relations between the subject and the tool to maintain stability of the object.

2. Theoretical background

This section presents theories used for analysis in this thesis. I have applied activity theory (Woll 2013, 2016a, Woll and Bratteteig forthcoming 2017), Corbin and Strauss's trajectory model (Woll and Bratteteig unpublished, forthcoming 2017) and Cummings levels of automation (Woll and Bratteteig unpublished, forthcoming 2017). In doing so I have used these theories to inform my understanding of technology-supported elderly care work. Moreover, I have looked at the ethical implications of welfare technology use by applying the different perspectives on disease to better understand the phenomenon of ageing. Lastly, I will address my thesis's contribution on the basis of the theoretical background.

2.1 Activity theory (AT)

Activity theory (AT) originated with the psychologists Vygotsky (1978), Rubinstein (1968) and Leont'ev (1978, 1981) in the former Soviet Union. The theory provides a framework applicable in studies aimed at describing the totality of work and human practice and intentional processes meant to change these activities. AT is based on the assumption that all human activity, from a historical standpoint, is mediated by the use of cultural tools (Leont'ev 1978). Thus, AT uses the activity itself as the unit of analysis (Kaptelinin 2013). The motivation behind the activity separates one activity from another (Kutti 1991). The cultural tools used in motivated activities can vary in shape and can originate in the material world and the ideal world (Kutti 1991).

AT has developed over time. The first generation of AT was developed by Vygotsky and co-workers and is based on the view that every goal-oriented human activity is carried out by the mediation of a tool related to the objective world (Vygotsky 1978). Vygotsky (1978) states that it is this mediation that shapes the human culture and history. It was also Vygotsky (1978) who originally proposed the single "activity triangle" model that includes the relationship between the subject and the object mediated by a tool. Vygotsky was a revolutionary scientist. His primary work was in human development. In his work, he conceptualised the tool and this resulted in the methodology. In the epigraph to Vygotsky's "Thought and Language" (1962), one finds the famous Francis Bacon quote "neither hand nor mind alone suffices the tools

and devices they employ finally shape them". This Bacon quote perfectly catches the core in Vygotsky's framework.

The second generation of AT was developed by Leont'ev, who recognised the collective activity. Leont'ev (1978, 1981) understood human activity as "units of life, which is organised in three hierarchical layers" (1981). Leont'ev (1978, 1981) designed his collective activity as a three-layer hierarchical structure of motivated activity, actions and operations (Kaptelinin 2013), see Figure 4 below.

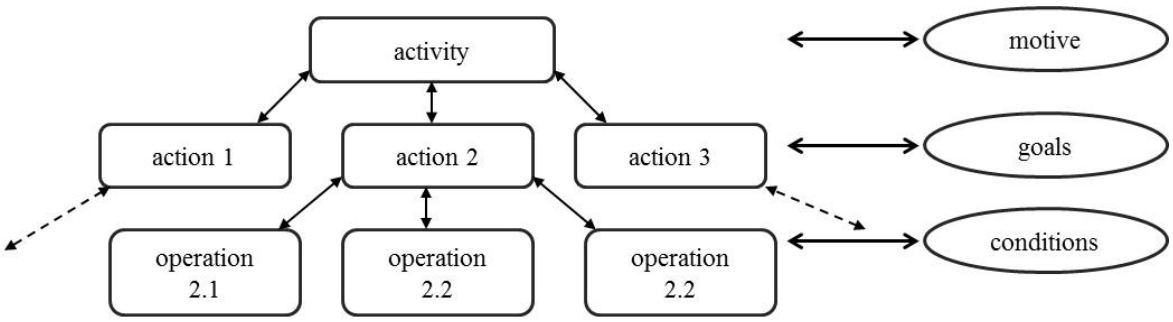

Figure 4 illustrates Leont'ev's hierarchical structure of activity (Kaptelinin 2013).

He further argued that human activity is mediated by the use of tools that need to be learned by repeated measures (Leont'ev 1978). Leont'ev (1978, 1981) states that it is only after these repeated measures that a human is able to become an experienced practitioner (Koschmann et al. 1998). When learning a new practice, the practitioner carefully plans the incremental actions that are necessary in order to reach the object of the activity. Thus, only when these consciously goal-oriented actions are sufficiently repeated is new practice learned and users become experienced practitioners (Koschmann et al. 1998). Thus, users can implement learned actions as familiar operations of routine work. Leont'ev (1978, 1981) states that experienced operations may be disrupted and changed during an unfolding activity. Such disturbances force operations to revert to back to the level of actions, where practitioners again have to repeat certain measures due to the fact that new practices need to be revised and learned (1978). The shifting mechanism between conscious actions and unconscious routine operations is the driving force behind all human activity, where recurring experiences develop human mediation of cultural tools.

The third generation of AT was developed by Engeström (2000). Engeström introduces the activity system model based on the prior generations of AT (see Figure

5). In doing so, Engeström modifies the Vygotskian's model by including a third element in the model: the community. The model is supplemented by a social aspect: the context in which mediated actions take place. This addition is illustrated by the second "upside down" triangle in the diagram below. Engeström thus recognised cooperation within the system through dialogue and multiple perspectives in the activity system. Engeström brings particular attention to disruptions referred to as contradictions within and between parallel activity systems, to capture the collaboration process and to generate the development of potential change in the system(s). Kutti identifies the collaboration within the activity system to be the mediating tool(s) that creates a product or service (Kutti, 1991).

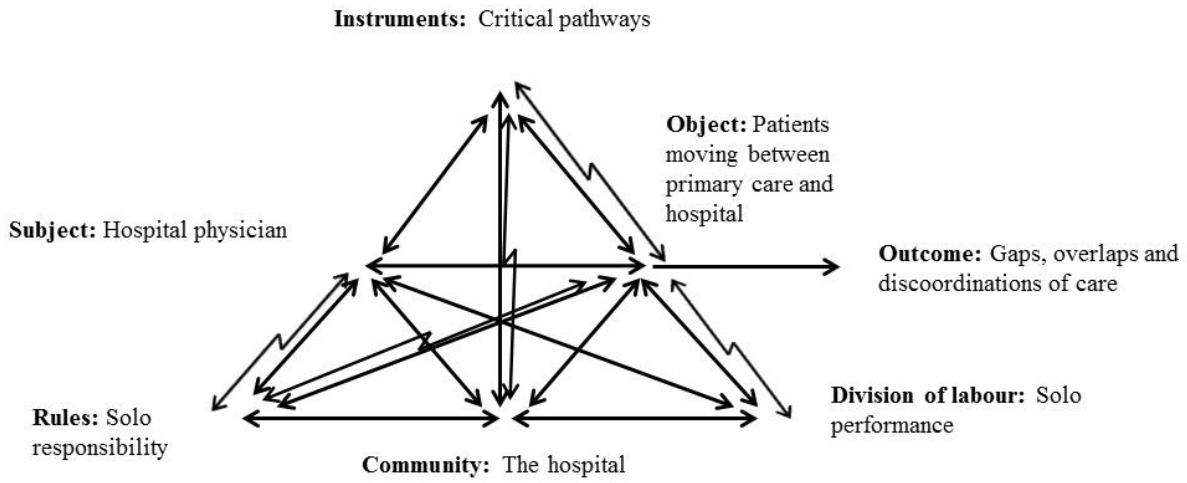

Figure 5 shows a human activity system and its contradictions in a hospital setting (Engeström 2000 p. 965).

Engeström acknowledges that the activity system is influenced by multiple viewpoints, conflicts of interests and norms that are shaped over time (Engeström 2000). He stresses that it is the contradictions and disturbances within the system that are the driving forces for change in the system (Engeström 2000, 2001).

Engeström also makes suggestions for the next generation of AT, the fourth generation, in which he also recognises that the activity system model is the structure for the mediated activity (Engeström 2009). He contends that the future development of AT should take into account the fast pace of new configurations of activities characterised by social media and participatory practices (Engeström 2009).

2.1.1 AT as a framework for analysis in CSCW and HCI studies

AT is an acknowledged theoretical framework in CSCW and HCI. Among the first to adopt this theory was Bødker, in analysing newspaper production systems (Bødker, 1989). Kuuti, shortly after, argued for AT as a theory for analysing CSCW (Kutti, 1991). Later Bødker, together with Bannon applied the theory to the analysis of human actions and interactions in mediation with tools in a cultural-historical perspective (Bannon & Bødker, 1990). Kaptelinin and Nardi (2006) contend that in HCI research AT provides a constructive and efficient framework for understanding structure, context and development of technology in support of activities. Engeström and Escalante (1996) study the introduction and 'destiny' of the Postal Buddy kiosk as part of the United States Postal Services (USPS). Their scope of study on the technological innovation was concerned with "macro- and micro-level events and interactions" (p. 325). During their analysis, they applied and explored the use of Actor Network Theory (ANT) when addressing the macro level of the Postal Buddy network, and applied AT when looking at micro level aspects of Postal Buddy use in context.

Frambach et al. (2014) reflected on the use of AT and argued that AT is useful for culture researchers as it offers a framework where culture is understood as a dynamical processes within a specific context of practice. They stated that the theory's focus on contradictions can be beneficial since it allows researchers to better understand the breakdowns that occur within the various processes. However, it can also be a limitation as researchers can search solely for contradictions within the mediating relationships, and by doing so, actually neglect the processes that are in harmony. Furthermore, Frambach and colleagues also stated that AT does not offer an easy way of systematising the complexity under study, as it requires researchers to set boundaries for the specific activity system.

Several researchers have applied AT when studying the health care setting or public services in regards to the research field of CSCW. First and foremost, Engeström (2000, 2001) applied and extended AT in his activity system model. He referred to AT as a framework that, "overcomes the aged dichotomies of micro- and macro-, mental and material, observations and intervention in analysis and redesign of work" (Engeström 2000, p. 961). He discusses the redesign of a work practice in a children's hospital by applying AT. Engeström (2000) also discusses systemic

contradictions and disturbances that he describes as “deviations from standard scripts” (p. 964). Bardram (1998) applied AT in a study of the dynamics of cooperative work activities aiming to support the workflow in a surgical ward. He argued that the localisation of cooperative breakdowns is central for informing design processes and, therefore, breakdowns should not be viewed as a problem. He uses the hierarchical levels of activity to explore the dynamics of cooperative work by looking at the transformation that takes place between the levels of co-ordination, co-operative and co-constructive inspired by Engeström et al. (1997).

Halverson (2002) discusses the use of AT and Distributed Cognition (DCog) in her comparative study, exploring what the two theories can offer to the CSCW community. Halverson (2002) refers to Barthelmess and Anderson (2002) who argue that appropriation of a theory is not merely based on the effort of achieving an objective representation of the study’s empirical setting, but also an endeavour to borrow “theoretical lenses” that enable researchers to gain new knowledge of the unit of analysis. Halversen (2002) highlights that theories like AT and DCog are both useful for CSCW, albeit in different ways, however, none of these theories can fulfil every researcher’s needs as they also set boundaries in the form of restrictions to the scope of the unit of analysis. Hasu and Engeström (2000) study the handover of medical technology from the developers to the users. They discuss the shifting location of the technology during different use scenarios (from breakdown situations to actually use on patients) where the users were the subject of the activity. The technology shifts from being a tool to an object during the innovation processes, where designers strive to transform “the artefact from an object (for designers) to a tool (for users)” (p. 73). Miettinen and Hasu (2002) study the transformation of a medical device from research pilot to clinical practice by analysing the collaborative design of the move as being a network of activity systems. Miettinen (1999) also explores what AT and actor-network theory (ANT) can offer when studying technical innovations. He compares ANT’s generalised symmetry and heterogeneous network with AT’s dialectical activity system when understanding the technology innovation setting. (Miettinen 1999). Miettinen (1999) find the use of merely symmetrical heterogeneous networks limiting, thus they recommend the studying technical innovations as networks of activity systems instead.

Kaptelinin (2005) highlights the importance of understanding the object of activity. He refers to the object of activity as “the raw material” or “problem space” (p.10) of “the true motive” (p.11) behind the activity that “is transformed into outcomes” (p.11). Kaptelinin further argues that this view apposes Leont’ev take on the object of activity as Leont’ev states that the object and motive of activity can be the same. Kaptelinin finds this problematic and stresses the importance of separating object and motive of activity.

Relatively few researchers have used AT in empirical studies of elderly care. I have applied AT as the framework of analysis in two studies of technology-supported care work (Woll 2013, Woll 2016a). Moreover, I have evaluated how AT could inform the design of an overall elderly care trajectory (Woll and Bratteteig forthcoming 2017). During this work, I have reflected on my own experiences and the potential and limitations of AT. I present and discuss these findings in Woll and Bratteteig (forthcoming 2017)

2.2 Strauss and Corbin trajectory model

Corbin and Strauss (1991) describe a trajectory as the illness or chronic condition path that evolves and is formed by collaborative work made by the individual, his/her family, and health care providers. Corbin and Strauss (1991) and Strauss et al. (1985) refer to trajectory work as the management of a patients’ trajectory through different types of work required for serving the trajectory and the inter-relationships between the various people involved in this work (Corbin and Strauss 1991, Strauss et al. 1985). They also acknowledge the patients’ work during hospitalisation and characterise this work as invisible work, since patients’ contributions during hospital stays are usually not considered as work by the healthcare providers (Strauss et al. 1985). Moreover, Strauss and co-authors emphasise that care work is “people work” and is an essential aspect of the health care work (Strauss et al. 1985). They argue that unless the patient is unconscious or completely physically challenged, the patient can influence the care work. Also, the patient can join collaborative care activities and become a care worker themselves. For the patients to better handle their trajectory work, Strauss et al. suggest that they are supported with the necessary technology. In this context, technology refers to any assistive support and can range

from walkers to fully automated services. Corbin and Strauss's Trajectory model consist of six steps as follows.

1. Identifying the trajectory phase.
2. Identifying problems and establishing goals.
3. Establishing plans to meet goals.
4. Identifying factors that facilitate or hinder attainment of goals.
5. Implementing interventions.
6. Evaluating the effectiveness of interventions.

Having identified the trajectory's phases, Strauss and Corbin further suggest that each phase should be divided into three sub-phases (upward, downward, and stable). They also argue that sub-phases within a specific phase can span over an extended period of time. The sub-phase concept points to the fact that the course of the trajectory varies: in sub-phases within each phase as well as short-term and even daily variations. Thus, the patient can traverse a trajectory both horizontal and vertical. Dementia, for example, is not a linear process: when a person is sick or stressed, s/he tends to be more forgetful and the forgetfulness may disappear when s/he gets better or begins to relax. However, in cases when the general condition varies to such an extent that it is unsafe for the person to live in the ordinary home, the person might have to move to care housing in order receive increased assistance for independent living. This movement is referred to like the notion of transition.

2.2.1 Transition

Transition through the elderly care trajectory is understood as a process, and transfer is the process of moving from one location or housing to another. The terms transition and transfer are often interchanged in the literature. Thus, it is important to separate these notions to provide appropriate services across the trajectory as it unfolds. Hence, the transition between phases can be unpredictable and the elderly person's functional abilities must be assessed over time to evaluate the need for transfer to the next phase of the trajectory. Thus, this intermediate state between the

phases, a “grey area” or a gap where the person may not fit either of the phases, or rather fits into both in varying degrees, is termed “transition”.

2.2.2 Patient doing work

In this thesis the self-care work of elderly people is recognised as “trajectory work” (Strauss, Fagerhaugh, Suczek, & Wiener, 1982). Strauss and co-authors were perceived as rather radical when they claimed, in the early eighties, that patients during hospitalisation were doing work. Their view on patients’ contributions is now widely acknowledged and it is universally claimed that patients should be supported with the necessary technology to deal better with their trajectory work. Strauss and co-authors described a patient’s trajectory as the physiological aspects of a patient's illness, which includes the overall organisation of work required to serve a patient’s illness path, as well as the implications this has for the people involved in the work and organisation. Strauss and co-authors refer to “trajectory work” as the management of a patient trajectory by means of different types of work that are required to serve a patient’s trajectory. Additionally, this work includes the inter-relationships between the various people involved in this work (Strauss et al. 1982), e.g. research, monitoring, intervening and re-intervening to treat or alleviate the patients' health problems. Strauss acknowledges the patients work during hospitalisation, but he refers to this work as often being invisible work, since health providers do not necessarily consider the patient's contribution to work. Strauss also stresses that chronically ill patients are often highly knowledgeable since they are “experienced” patients, and often have been passively or actively involved in repeated procedures concerning their care and treatment. Strauss further address different patient’s scenarios during hospitalisation in which patients make contributions that should be recognised as work as follows:

- Expecting patients to work

- Demanding patients to work

- Inviting patients to work

- Negotiating patients to work

- Teaching patient to work

Strauss and co-authors also discuss patient work during problematic trajectories and decision-making. During a transition in the elderly care trajectory, there is likely to be both minor and major decisions to be taken by the elderly persons and their family. Older individuals and their family often put in considerable effort into researching information regarding the formal services available, both concerning technical and social services, rehabilitation and the prognosis of an illness. By introducing new technology that provides elderly people with access to relevant and accurate information, in a common shared space that details standard elderly care trajectory information, the elderly would be better equipped to handle their trajectory work.

2.2.3 Articulation work

Strauss (1988, 1993) refers to both articulation work and the articulation process to understand work arrangements. Strauss states that articulation work is a basic part of the overall articulation process. He sees the articulation process as a set of wide-ranging actions including "the overall process of putting all the work elements together and keeping them together" (Strauss 1988, p. 164).

The notion of articulation work is also defined by Schmidt (2002) as "… work to make work work. Or to be exact, articulation work is cooperative work to make cooperative work work." (Schmidt 2002, p. 184)

Articulation work is an important concept in CSCW, whereas articulation work is integrated as part of the cooperative work arrangement, which according to Schmidt and Bannon (1992) can also be understood as "a set of activities required to manage the distributed nature of cooperative work" (p. 12). They further state that "In order to be able to articulate the distributed activities of a cooperative work arrangement, the participants need access to appropriate means of communication" (p.13)

Carstensen and Schmidt (2003), together with others, recognised that the CSCW community has primarily two dominant viewpoints in their field of research. The first viewpoint is a social approach that involves studies of how people perform cooperative work. The second viewpoint is a technical approach that includes studies of work practice needed to develop IT systems in support of cooperative work. This study involves both viewpoints since both social and technological aspects are of

potentially high relevance to the thesis research questions. Schmidt (2011) further separates articulation work into first and second order: first order articulation work concerns planning and coordination of collaborative work activities, a typical delegation of work responsibility ahead of the work shift, e.g., who is doing what, when and where. Second order articulation work is the work dealing with unexpected incidents or re-delegation of work tasks to get the work done or to handle random or unforeseen work tasks essential for carrying out various work activities.

Fjuk et al. (1997) argue that AT and ToA together can offer an "operationalization of articulated actions in terms of how the work is done" (p. 2). They discuss articulation work in their take of combining AT and ToA. Articulation work is not entirely encompassed within the idea of AT. The lack of focus on articulation work in AT may be accounted for by the theory's origin. The first generation of AT includes the human individual and its mediation of a tool and not the collective activity (Fitzpatrick, Tolone and Kaplan 1995). The articulation worker during elderly care process is likely to be an administrator, such as the elderly person her/himself, if capable; or a close family member; or the person's main care provider, if receiving formal care services such as a head nurse in home care situation or in a nursing home, who together give instructions for past, present and future elderly care phases. In Woll and Bratteteig (forthcoming 2017) we discuss the different aspects of articulation work in more detail, especially what articulation work can offer to better understand the increased technology-supported care work in the elderly care context.

2.3 Levels of Automation (LoA)

Cummings (2004) brings attention to "the balance of automation and human control in decision and action selection" (p. 2). She recognizes, similar to Parasuraman and Riley, 1997, "that automation does not replace the need for humans; rather it changes the nature of the work of humans" (Cummings p. 24). Cummings further states that an essential challenge in system design is to select the level of automation for services including human interaction with a machine. She argues that full automation is preferable for work task that leave no flexibility in decision-making and breakdowns. Moreover, system design for use in a "dynamic and changing environment should not include higher levels of automation ….because of the risks

and the inability of an automated decision aid to be perfectly reliable" (Cummings 2004 p. 24).

Cummings presents 10 levels of automation, which are listed in below.

1. The computer offers no assistance: human must make all decision and actions.
2. The computer offers a complete set of decision/action alternatives, or
3. narrows the selection down to a few, or
4. suggests one alternative, and,
5. executes that suggestion if the human approves, or
6. allows the human a restricted time to veto before automatic execution, or
7. executes automatically, then necessarily informs humans, and
8. informs the human only if asked, or
9. informs the human only if it, the computer, decides to.
10. The computer decides everything and acts autonomously, ignoring the human.

Cummings stresses that incorporation of higher level of automation to support humans in decision – making in order to avoid or limit "human error and workload" can, together with unreliable systems, "cause new errors in system operation if not designed with human cognitive limitations and biases in mind." (p. 5). She concludes that the "design of an intelligent system that provides decision support must consider the human not just as a peripheral device, but also as an integrated system component that in the end, will ultimately determine the success or the failure of the system itself." (p. 5).

Cummings's understanding of levels of automation is recognised as an informative framework when designing technology–supported services for elderly people, especially, when supporting care arrangements where users have different cognitive and functional capacities. Elderly people have different abilities in decisions making, and in mastering the responsibility of taking the necessary actions that are required to

get assistance. Thus, they could benefit from technology-support that is adjustable with different levels of automation in order to fit with their current need for support.

2.4 The phenomenon of ageing and disease

What is it that causes a condition to be defined as a disease? Moreover, is ageing a disease? According to Hofmann (2014) the answers to these questions can differ depending on who we are addressing them to. There are well established international classification systems such as the International Classification of Diseases (ICD) that define and classify diseases on the basis of a minimum set of criteria (ICD 2015). However, even the ICD system changes over time as new diseases are constantly introduced, and some diseases are reclassified as being a natural phenomenon as new knowledge is gained. Hofmann (2014) argued that the classification systems and the criteria used to define diseases fluctuate between cultures and over time and that these changes are based on our worldview or gained knowledge and science. The classification of a condition is dependent on the different perspectives certain individual bodies have: the medical health professionals (disease), the person who is ill (illness) and Society (sickness role) (Hofmann 2014).

Albert, Munson and Resnik (1988) stated that a "…disease is best understood as a departure from normal functioning" (p. 160). The normal functioning of an elderly person can be a subjective experience and is dependent on context and the individual's past functioning ability.

The onset of biological ageing starts at 20 years of age, where ageing is characterised by a gradual decline of the organs reserve capacities. These capacities are reduced to approximately 50% at the age of around 70 years (The Norwegian Medical Association 2015). The reduction of an organ's reserve capacity is especially evident for the heart, lungs, and kidneys (medlineplus.gov). Ageing cells are partly the causality behind declining organs because the loss of cells influences the organs' function. However, the reduction of an organ's function is a slow process and often not that apparent in elderly people except in stressful situations that require the organs to work harder than usual. For example, when an older person's heart is "working" harder than normally, the heart may not be able to increase function. Other examples are the liver's decreased ability to break down and absorb drug compounds

(reduced metabolism). Elderly people who take a number of medications can experience undesirable side-effects and medication interactions. Side-effects of medication use can be misinterpreted as marked symptoms of other diseases as the side effects can mirror these symptoms. Thus, management and regular follow-ups of medication use are particularly important for elderly people.

Loss of cells and a reduction in an organ's functional capabilities is not classified as a disease, however, it can make older people increased vulnerable to diseases, mortality and stress (The Norwegian Medical Association 2015). Thus, it is important to separate ageing and age-related diseases. Moreover, not all organs lose a significant number of cells. For example, marked symptoms of substantial losses of cells in the brain can also be disease related, e.g., stroke, Alzheimer's diseases, or Parkinson disease.

Most elderly people experiencing illness often have common characteristics of marked symptoms: acute confusion, incontinence and inability to stand up and maintain balance (fall tendencies) (The Norwegian Medical Association 2015).

Additionally, to the biological ageing process, there is also a mental and social ageing process that onset later in life (The Norwegian Medical Association 2015). Mental ageing refers to reduced memory capacity and the subjective experience of everything going slower than it did before. Social ageing is associated with a decrease in social contact. The reduction in social life is especially present after retirement. The energy level of elderly persons decreases and even if the elderly person wants to participate in a social activity they are often cutting down on social networking, which can make them vulnerable to loneliness and isolation (The Norwegian Medical Association 2015).

The prognosis of relatively harmless diseases such as the seasonal flu can be significantly worse for elderly people over 65 years of age because their immune system is beginning to weaken with age (Center for diseases control and prevention 2015). Other minor illness can also cause more severe effects in the elderly people, for example urinary tract infections and constipation can lead to acute delirium (The Norwegian Medical Association 2015). Moreover, hip fractures increase the risk of mortality and hip fracture patients over 80 years are especially vulnerable (Hektoen Faksvågen 2014). The mortality is not directly linked to the fracture itself, but on the

strains the fracture places on elderly people's general health. Falls are shown to be the eighth most frequent causes of death in Norway in 2013 (GBD 2013).

2.5 The thesis contribution

My research adds to the existing body of knowledge of CSCW and HCI and brings attention to various aspects of the use of welfare technology in elderly care by borrowing the lenses of theories as presented in the sections 2.1-2.4.

I have used activity theory (AT) to better understand the experienced breakdowns of socio-technical relationships in the care housing (Woll 2013). I have found Leont'ev's hierarchical structure of an activity useful for analysing how elderly people can learn new technology-mediated care practices. I have taken AT as a lens for understanding the changing dynamics of collaborative work in elderly care when introducing technology as part of the care service delivery (Woll 2016a). I found Engeström's activity system to be a constructive approach when studying the specific elderly care work contexts. Using AT in my analysis supports the position that technology can play an important role in supporting collaborative care work. Moreover, technology can also be delegated work tasks and responsibilities, hence increase and be part of an enhanced technology mediated self-care and informal care.

I have used AT as the main conceptual framework for analysing technology-supported elderly care (Woll and Bratteteig forthcoming 2017), however, identifying both potential and limitations of the theory. I suggest combining AT with Strauss' Theory of Action (TOA). TOA and Corbin and Strauss's trajectory model in particular can supplement AT by offering a macro level analysis by adding time and transitions between "steps" as essential aspects of the elderly care trajectory (Woll and Bratteteig unpublished). AT is useful for describing learning development, but I find TOA better suited for describing decline as development and in particular decline as a non-linear process. In addition, I have used Strauss's concept of articulation work as a lens for understanding the increased technology-support in elderly care work (Woll and Bratteteig forthcoming 2017). Articulation work concerns both the making of arrangements, and the work to carry them through in a cooperative work setting. Gaps in the delivery of health care services can occur when, e.g., elderly people experience sudden shifts in their capabilities of handling the

technology-mediated object of activity. Articulation work is necessary to find and carry out a planned activity in an alternative way. The notion of articulation work is particularly useful for understanding situations where work has to be re-delegated so that the subject and the object of activity is shifted, see Woll and Bratteteig (forthcoming 2017)

The proposal of a conceptual elderly care trajectory presents increased use of technology-supported service deliveries that include increasing levels of automation as well as shifting relations between the subject and the tool to maintain stability of the object of the activity. I suggest layers of support by balancing the use of automated services relative to the users' physical and cognitive capacities. Different levels of automation can act as layers of support by combining active and passive use of technology. I argue that active use of technology alone is not sufficient as technology support for the oldest users or users suffering from diseases and cognitive (or physical) decline. Passive use of technology can be essential as a preventive measure to avoid accidents, to decrease response time if accidents occur, and redundant technical solutions (both active and passive) can act as a “plan B” when users experience a sudden decline in health. Elderly people, who have a severe illness requiring personal care cannot be expected to actively operating the technologies I have studied. Passive use of these technologies can support and maintain their safety and security.

In order to accomplish the aim of increasing technology-supported care, I argue that technology has to be introduced to "healthy" elderly persons so that they can appropriate the technology and learn to use it, which will make them better prepared at a later stage if or when they need additional care support. However, early introduction of technology-supported services is also a dilemma because it rises critical concerns about how such interventions in "healthy" persons’ lives can change our view on aging from seeing it as a natural process of life to seeing it as a disease (see Woll 2016b). In Woll (2016b), I discuss different perspectives on disease in the light of aging to better understand aging and how our view of aging has implications for welfare technology design and use.

3. Research methods

This section presents the research context, the research techniques used in this thesis, and my role as a researcher.

3.1 Research context

The research context for this thesis is threefold, which is highlighted in the Figure 6. First, I studied the use of welfare technology in a care housing (green circle) in the municipality of Oslo. The care housing consists of 91 apartments for mainly single elderly residents (two apartments for couples). The housing includes in-house services like a 24/7 reception desk, café (open all day for cheap meals), activity center, gym, and service staff such as the receptionist, activity facilitators, physiotherapists, music therapists, safety alarm responders etc. Technology played a key role in this housing. The housing has implemented various smart home technologies like energy saving, controls, stove guard, water lock, flood alarm, in-house personal safety alarm, and a Wi-Fi tablet. The personal safety alarm was a part of the welfare technology procurement of the housing, and not a service from the public safety alarm response unit in the municipality of Oslo. Second, I studied how welfare technology can be used in home care services in the district of old town in Oslo, which were a study limited to the residents living in the care housing (yellow circle). The context for this study was the home care service organisation. This study focused specifically on the service delivery to active ageing residents living in the care housing. Home care services play an essential role in supporting elderly people in living independently in their private residences. However, the home care service organisation face challenges in their daily work due to the fact that they have to provide services to an increasing group of care receivers with a broad range of health issues. Thus, the use of welfare technology to decrease the work load of nurses by delegating routine tasks to the technology or using the technology to make services more efficient is an important initiative, especially when exploring how welfare technology can be employed in this context. The aim of the action research study was two-folded as Joshi and I searched for design solutions that could better support users receiving home care services at a set and accurate time, whilst at the same time I was

interested in exploring how the transformation of health care services can be implemented into the home care service context.

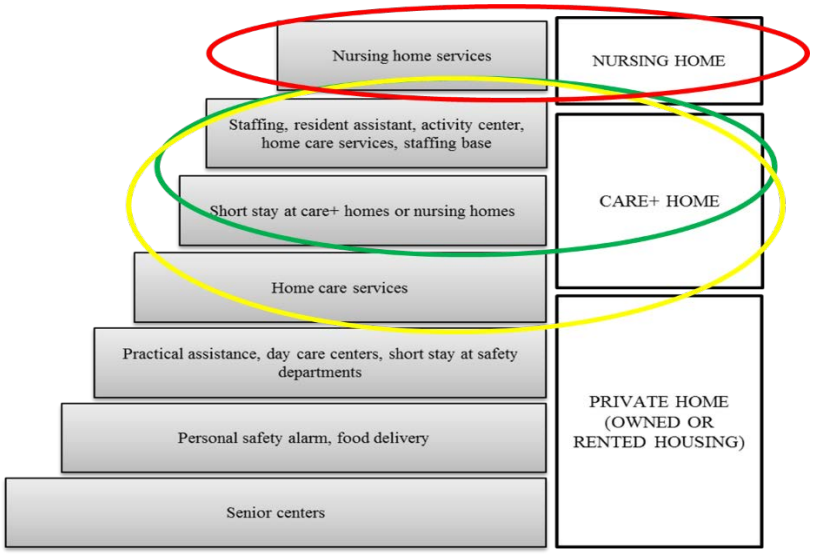

Figure 6 shows the research context for this thesis, which is threefold: the care housing (green circle), the care housing and home care services (the yellow circle), and nursing home (the red circle).

Finally, I studied the use of welfare technology in nursing homes (red circle). The main nursing home under study was a newly constructed building, which had a "state of the art" nurse call system with connected welfare technological measures. The nursing home had 64 residents divided on eight housing units and a day-care center for other residents in the municipality. The technology used in the nursing home context was aiming to support both the residents and the health care workers. However, my interest was particularly on the residents' use of technology.

Overall the research context is focused on services connected to types of housing in the care staircase. I also got in touch with a number of elderly people living in (ordinary) private homes as these were users of the various housings' service facilities like the cantina, activity center and the day-care center. However, I was not able to study or test the use of technology in their homes. During the action research study in collaboration with the home care service, we were trying to expand the telecare solution to residents living in private home, more precisely, living in apartments outside the care housing. However, none of the prospective care receivers

had access to Internet services; thus, to set up the telecare solution in their home was not possible. This is a limitation of the contextual aspects of this thesis work.

3.2 Research perspective

I position my research perspective and underlying philosophical assumptions to the qualitative interpretive research paradigm. Thus, my research studies are contributions mainly to the interpretive research paradigm. As an interpretive researcher, I work under the "*assumption that access to reality (given or socially constructed) is only through social constructions such as language, consciousness and shared meanings*" (Myers Living version). Moreover, my understanding of the interpretive research paradigm builds on Walsham (1993) definition. Thus, Walsham defines interpretive research study as being an inquiry to understand the phenomena under study through the meanings that people assign to them. Moreover, Walsham (1993) states that methods used in interpretive studies are "*aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context*" (Walsham 1993, pp.4).

Walsham (1993, 2006) has repeatedly referred to Geertz (1973) when explaining the status of the data collected in interpretive studies, whereas Geertz declares that "*What we call our data are really our own constructions of other people's constructions of what they and their compatriots are up to.*" (p. 9). I support Geertz's view on data as I also recognise the data collection, which produces the basis for my interpretive research studies as own interpretations of others people's interpretations of the phenomenon under study. However, use of theories to analyses data in order to gain new insights and knowledge of the unit of analysis can also be a way to support interpretive researchers (to some extent) with an objective stance to the data.

On the contrary, critical research studies approach the social reality as being historically constituted, whereas reality is shaped and reshaped by people over time. Thus, this research paradigm is based on the assumption that people have the agency to change their social and economic situations; however, the human agency is restricted by various forms of social, cultural and political power (Myers Living version). Thus, I understand that the research studies presented in paper 1, 6 and 8

boarder on the critical research paradigm. In these three studies, I have applied what activity theory can offer to analyse breakdowns in human activities (paper 1), in addition, I discuss different perspectives on disease in relation to ageing (paper 6) and these studies focus on the contradictions and conflicts of technology use in context. Moreover, I have together with co-author emphasised how AT is challenged as a theory (paper 8) by the increased use of automation such as also is the case in elderly care services, e.g., "instrumentality" versus motivated action of elderly people. Thus, I am aware of the fact that I have mix the use of interpretive and critical research paradigm.

3.3 Research method

This thesis is conducted by use of qualitative research methods, which, according to Myers (Living Version), are methods developed in social science communities to enable researchers to study social and cultural phenomena. Myers (Living version) further emphasised that as different philosophical perspectives can inform qualitative research studies, so can different qualitative research methods. Myers (Living version) states that "a research method is a strategy of inquiry which moves from the underlying philosophical assumptions to research design and data collection. The choice of research method influences the way in which the researcher collects data".

I have chosen to use case study research and action research as the strategies to research my thesis' inquiries.

The case study design was applied because the objective of this research is to explore and provide insight into the phenomenon of technology-supported elderly care work, thus it is important to study the use of technology in this work practice. In the case studies, I have explored the use of welfare technology in a care housing (referred to as Case study1) and in nursing homes (referred to as Case Study 2). Case studies are especially useful for such exploratory research where an in-depth understanding of a phenomenon in its context is desired.

The action research study is a response to a problem of unpredictable work flow of the nurses, sometimes resulting in "late" home care visits. Thus, the use of a telecare solution is tested as a means of delivery home care services more timely to active ageing residents. The action research design was therefore found constructive in order

to find a potential practical solution to the problem together with a collaborative group, and study the intervention at the same time. In using this methodology, the researchers are experienced to take a “helping-role” (Myers Living version), and often researchers “have a vision on how the reality should be, not value free” (Myers Living version).

Originally, I was planning to conduct an ethnographical research design, however, I early on experienced to focus my research on specific research problems e.g., breakdowns. Thus, I found my research not that open-minded to fit my work within this methodology. However, I argue that I indeed had an “explicit interest in understanding social practices and interactions in diverse communities as they unfold in everyday life” (Myers Living version). However, I was not that closely to the residents to state that I immersed myself in the world/lives of the people I studied. Thus, I argue that my chosen research design of case- and action research study tailored my research approach the most. The case studies and the action research study are presented respectively in the subsections that follow.

3.3.1 Case studies

Case study 1: Use of welfare technology in a care housing

Case study 1 is an interpretive in depth case study of welfare technology use in a care housing setting located in the old town of Oslo, Norway.

A case study is according to Myers (Living version) an empirical inquiry that seeks to examine a present phenomenon in a real-life context. Moreover, in depth interpretive case studies, where researchers give attention to the “human interpretations and meanings” (p. 74) of the phenomenon under study, require regular fieldwork over time (Walsham 1995). Thus, by choosing this research strategy, my objective is to “explore and describe a phenomenon within their contexts” (Baxter and Jack, 2008:544). The defined case in this study is the use of welfare technology to support the joint elderly care work in care housing including the use of technology that supports residents in self-care, informal care, and formal care. The municipality of Oslo has built and renovated several buildings for sheltered housing purposes and one of these housing arrangements is called care housing or care housing “plus” . This type of accommodation is part of a formal option for elderly people above 67 years of age and is an in-between setting that is offered to elderly people who do not have to

functional or cognitive capacities to live in the ordinary home. However, they can self-care to an extent that they do not need in-patient care such as the care provided in nursing homes. The aim of this type of housing is for elderly people to maintain independent living as long as possible. My initial field work was carried out at the newest care home plus building in the old town of Oslo, Norway.

Figure 7 shows pictures taken in the care housing setting. Picture A is the care housing as seen inform the street. Picture B is the cafeteria area. Picture C is the welfare technology package including a tablet and an in-house safety alarm. Picture D is the gym.

The housing consisted of 91 private care homes that have each implemented various forms of smart home technologies (including energy saving and lighting control, stove guard, water lock that turns the power off in cases of water deluge in the bathroom) and welfare technology (including in-house personal safety alarms and Wi-Fi tablets). The implemented welfare technology was initiated as part of the EU program Intereg[3] titled eSenior, and the municipality of Oslo was one of the several partaking municipalities[4]. The main objective of the eSenior project was to develop and test new products and services that can support elderly people and enable them to have a well-functioning life in ordinary homes. The municipality of Oslo chose to use

[3] Interreg is established to promote social and economic integration across borders by regional cooperation.

[4] Other partakers were the municipalities of Sarpsborg, Fredrikstad and Gøteborg (Sweden)

their grant to test the welfare technology utilised in this type of care housing and to provide a showcase for this kind of technology. Hence the municipality decided to purchase well established and tested welfare technology solutions to gain experience in how the technology can be used to support the growing number of elderly people. The tablet gave users access to a number of in-house services, such as the daily café menu, the options for dinner, the overview of and registration for social events, their calendar, photo album, web-TV and online newspapers. I entered this setting as part of my initial fieldwork which involved studying the social and cultural environment in which elderly residents and staff explored the use of welfare technology in the context of care housing. I did so using ethnographical methods. The fieldwork started ahead of the technical installations in December 2012 and lasted for two years. Thus, I was able to observe the residents moving in and the staff as they began to understand the space that was their new workplace. The number of residents grew in this period, from approximately 50 before the official opening in early autumn 2012 to 92 at the end of 2014. The housing has an open reception desk and 24/7 staff who provide residents with support in regards to practical matters. Moreover, the housing has a common area in the lobby where people can meet and several other common areas that can be booked for private gatherings such as birthday celebrations. The housing is also close to the district's activity centre which is available to residents as well as other elderly people living nearby. The centre offers activities such as knitting and other art and crafts. The care housing has a cafeteria where residents can buy light dishes and dinner. The housing has an in-house gym where users can log their activities by use of a chip card to support users during training, as well as allowing them to follow their own development and frequency of training. The housing also has a small library that gives residents access to use of stationary computers. The staff are also involved in organising activities for the elderly residents, like arranging computer classes, quiz events, musical and cultural arrangements and bus trips for adventures. The in-house staff are not supposed to support the residents with health care services, thus the residents who need such services must apply to the district's municipal home care services in order to receive them. The belief is that this kind of housing arrangement fosters an environment and provides facilities that in combination can support the residents sufficiently in order to enable them to become self-dependent, and by this, the residents' will have a reduced, or even no need, for formal care services.

Case study 2: Use of welfare technlogy in nursing homes

Case study 2 is an interpretive in-depth case study of welfare technology use in a nursing home setting. The main informant of this case is the head nurse of a nursing home, located in the municipality of Skien. Additionally, the case includes the use of welfare technology in three nursing home settings and a care housing setting as part of my development of three tenders as an ICT advisor. These tenders were the basis for an innovative public procurement of nurse call systems, including welfare technology and automation.

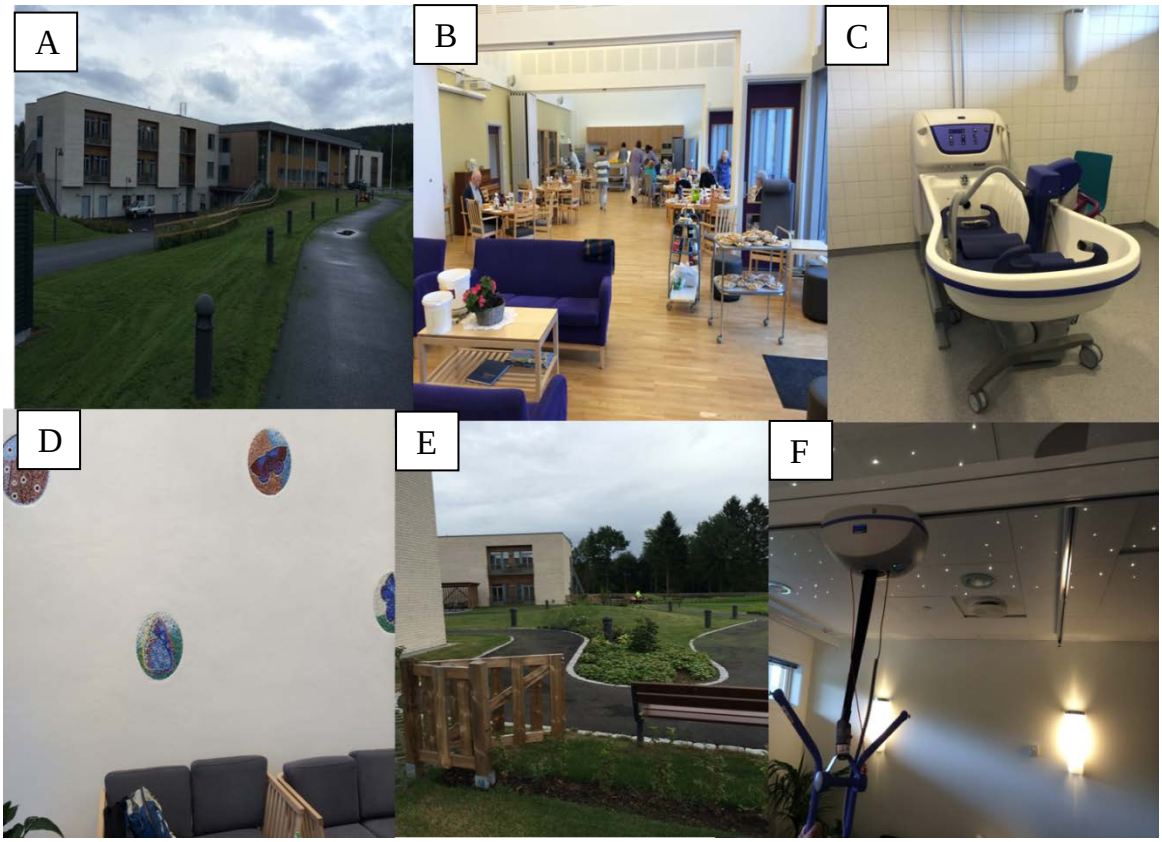

Figure 8 shows field pictures taken from a nursing home located in the municipality of Skien. Picture A shows the street view of the nursing home. Picture B the area within the daycare center where seniors within the municipality can take part in various activities including eating meals. Picture C is an advanced bathtub supporting the well-being of residents. Picture D is from the common area on the first floor where a local pottery artist has decorated the walls with beautiful butterflies motifs. Picture E is from the tactile garden. Picture F ishows lighting in the common bathroom and the flexible lift installations that support movement of residents with mobility issues (this picture is from the same room as picture C).

The defined case in this study is the use of welfare technology to support the joint elderly care work in the nursing homes including the use of technology that supports residents in self-care, informal care and formal care. The reason for exploring this research setting is to establish how users in the nursing homes handle use of technology because I observed how some residents in the care housing really struggled to make any sense out of technology use. I wanted to understand if and how technology is used in nursing homes because the residents who stay in this type of housing arrangement are individuals with extended health care needs, and fall within the highest age bracket. Moreover, nursing home care is the final level of the care staircase that is offered to elderly people.

I also gathered additional information in regards to actual user needs and technology use in the nursing homes by participating in several building projects as an ICT advisor. During these projects, I worked with three municipalities and assisted them in developing tenders including defining functional requirements of nurse call systems with belonging welfare technology and automation. These procurements were not regular procurements, but innovative procurements, which means the users, like head nurse managers, are actively involved and there are several meetings with the actual users and the vendor providers. Thus, these types of procurements are highly user driven and therefore informative for me as a researcher.

3.3.2 Action research study

Action research methods were used during the field experiment entitled the collaborative change experiment. Action research study is, according to Myers (Living version), a collaboration with a group of people experiencing a problem. Whereas action research places the researcher(s) in the role of the facilitator and it is a method used when aiming to understand a problem and change it at the same time (Susman 1983). The approach of this research methodology includes an action research cycle (see Figure 9) which is as follows:

I. Diagnosing a problem
II. Action planning
III. Action taking
IV. Implementing
V. Evaluating outcomes.

Whilst the action research cycle is an ongoing iterative cycle where the evaluation of an outcome can result in a new diagnosis, the contribution of action research is dual as it includes action, such as a change of practice, as well as research, e.g. theory developing. Moreover, researchers that spend time in the fieldwork over time and are involved in close collaborative relations often have a pre-defined solution for the problem (Living version).

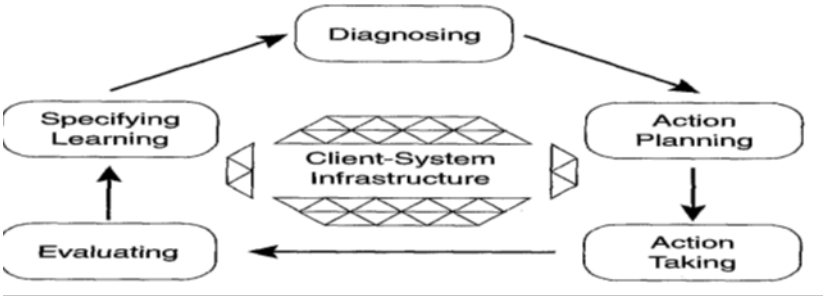

Figure 9 illustrates the Action research cycle according to Susman (1983). Copyright: Susman 1993.

In order to understand home care work, I entered the fieldwork with an open mind to explore what was occurring by studying users in context. By users in context, I mean primarily healthcare staff and elderly care receivers; however, the user perspectives of the staffs in the care housing is also of high importance. This because they are so close connected to the residents, and they see the residents' needs in everyday life better than anyone. In addition, the managers at the home care service office were also significant, thus they also were included in the collaborative group. The reason why health care staff and elderly care receivers are defined as the main users is because they are the ones who are the primary care "workers". Thus, they are the ones who are most affected in practise by the transformed work practice. A challenge when working with elderly people and health care professionals is that they often have fewer expectations about the outcome of the design process, as they may not always know what technical solutions exist (Simonsen and Robertson 2013).

Figure 10 shows pictures taken during the action research study. Picture A is from the demo – apartment as initial testing was taking place ahead of the usability study. Picture B is of one of the participants from the diagnostic evaluation study, it shows the participant testing the setup of the TV camera in her home. Picture C is taken from the home care service office and pictures the various stakeholders. Picture D is a picture taken in a private home in the care housing, it shows one of the participants using her tablet as an alternative to testing telecare solution in the demo apartment.

Joshi and I developed an own model for the different steps included in the cycle for the action research study, see Figure 11. Our model is similar to Susman's model, but adjusted to support our need for research methods. We wanted a model that included the stepwise transformation of selected home care services by solving a "user problem" by introducing technology such as telecare. Thus, the objective of the collaborative change experiment was to understand the users' needs and address this issue by incorporation of welfare technology. Our joint research contributions were particularly aimed at the HCI community, thus the model is adjusted to include HCI methods. Additionally, I wished to focus on making contributions to CSCW, thus I also focused on the practice of elderly care, more precisely how traditional work practices could be transformed to address a specific user problem. Our research

cycle builds on Susman's model (1983) and the steps included in our model are therefore comparable to Susman's cycle. The Collaborative Change Experiment Cycle's initial step "Preliminary Field Work" is similar Susman's step "Diagnosing" because both these measures have the same purpose: to understand a problem within a user-context. The Collaborative Change Experiment Cycle's "Task Elicitation" step is comparable to the action research cycle "Action planning" as both steps are concerned with how one should find a solution to the identified problem observed during the time spent in the field. Susman's "Action Taking" step coincides with the Collaborative Change Experiment Cycle's step 3 "Usability Testing in Controlled Environment" and step 4 "Diagnostic Evaluations in Real Environment".

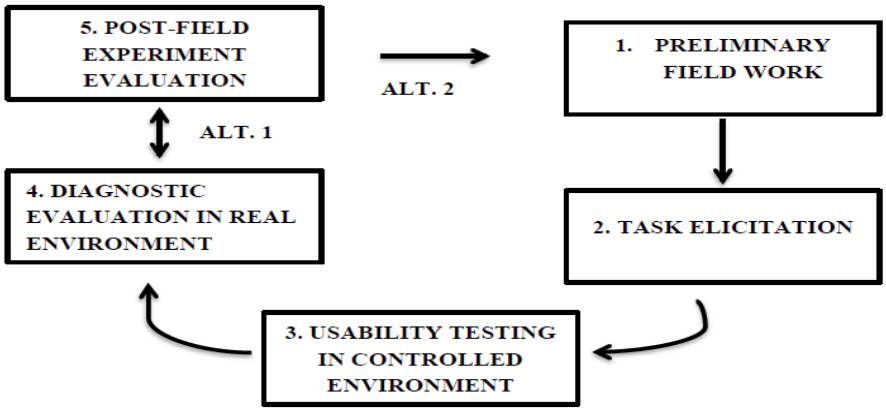

Figure 11 illustrates the collaborative change experiment cycle (Joshi and Woll 2014).

We found it constructive to split Susman's step "Action Taking" into two steps, thus, we adjusted this step so that it contributed to the HCI methods. Additionally, we did not want to move technology directly into the private homes of the participants. Thus, first, we trained and tested the solution in a demo apartment (step 3) before moving the solution into the home (step 4). Our proposed cycle then evaluates the action taking in step 5 "Post-Field Experimental Evaluation". This step is similar to Susman's "Evaluating" step. Our model has no step that coincides with Susman's "Specifying Learning" step, however, we have incorporated two directions that our cycle may take after the "Post-Field Experiment Evaluation", and these are indirectly similar to Susman's final step. The result of the cycle's evaluation will determine if the collaborative group has to make smaller adjustments of action, such as the transformation of work practice (illustrated as Alternative 1 in Figure 11) or

alternatively, repeat the cycle again (shown as Alternative 2 in Figure 11) because a new problem has arisen as a result of the evaluation.

3.4 Unit of analysis

This thesis includes two case studies and an action research study that brings attention to the use of welfare technology as part of the joint collaborative elderly care work.

The use of technology in these studies cannot be separated from its context, namely the care work. Thus, the care work mediated by the use of various technologies is the primary unit of analysis.

To limit the scope of the unit of analysis, I am not exploring the notion of infrastructure; however, I am aware of the fact that infrastructure is a necessity and a strong foundation for welfare technology use. I briefly touch on infrastructure as there is a lack of necessary infrastructure to scale technology – supported services. Moreover, the infrastructure has to be robust and scalable to support present and future care needs.

3.5 Data collection

Table 2 shows the thesis' data sources for the various research studies. The data sources consisted of several participants involved including elderly residents and their informal care givers, staff at the care housing, staff at the vendor site, staff at the city council, staff at other care housings in Oslo, researchers and master of sciences students from the University of Oslo and staff at the nursing homes. The duration of study cannot be mixed with actually time spent in the field work as the studies went over time and where put on hold for various reasons e.g., when recruiting participants for the action research study. The total amount of time spent in doing field work was beneath a half work-year. Due to my health care background as a formal assistant-nurse, I was also given the opportunity to study our co-designed telecare system in a more participatory manner than just through direct observation. In the action research study, I was assigned the home care responsibility for four elderly home dwellers that all had previously participated in the usability testing and diagnostic evaluation. This

study, as part of the diagnostic evaluation, replicated the work routines of the home care service – elderly participants were called from the home care service office, and those who did not answer were visited at home. The elderly home dwellers were visited daily for one week, and all interaction or attempts at interaction were logged. Two of these participants needed additional home care services, which I was responsible in doing, among other to assist them in getting out of bed in the mornings and to get dressed.

DATA SOURCES	METHODS USED	TIME PERIOD	PARTICIPANTS INVOLVED (STAKEHOLDERS)	NUMBER OF PARTICIPANTS (N)	ACTUAL TIME SPENT IN THE FIELD (HOURS)
Case study 1	Passive and participant observations, unstructured and structured interviews, photos taken, regular meetings with stakeholders.	Aug 2012–Des 2015	Elderly residents and their informal care givers, staff at the care housing, staff at the vendor site, staff at the city council, staff at other care housings in Oslo, researchers and master of sciences students from the university of Oslo (UiO).	**40**	**385**
Case study 2	Unstructured and structured interviews. Regular meetings with stakeholders, dialog meetings with welfare technology providers, development of system requirement of nurse call systems.	Aug 2013– Aug 2016	The head nurse and department nurses at four nursing homes. The janitors who supported the technical installations. ICT operations supporting the municipal technical installations.	**16**	**120**
Action research study	Passive and participant observations, unstructured and structured interviews, photos taken, partaker in practise, usability testing, diagnostic evaluation, workshop, regular meetings with stakeholders.	Des 2012– Des 2015	Home care staff (manager, district head nurses, nurses, nurse assistants, ergotherapist, physiotherapist, manager at practical assistance), elderly residents and care receivers (both participants and those refusing to participate), researcher from UiO, staff at the city council and staff at the vendor site.	**78**	**328**
Total sum				**134**	**833**

Table 2 Illustrates data sources, methods used, participants involved and the duration of field work.

Case study 1 was carried out on the basis of initial fieldwork in the care housing and concerned data collection of the breakdown of welfare technology use as observed during field work or reported by stakeholders during our regular meetings. Methods used to gather data were passive and participant observations, unstructured and structured interviews, photos taken, and regular meetings with stakeholders. Each reported breakdown was logged in a notebook together with the following additional information: 1) What happened? 2) Who was responsible? 3) When did it take place? 4) Where did it take place? 4) Why did it happen? 5) How was it resolved (if resolved)? Data collected during the initial fieldwork in the care housing setting was also used as part of analysis of the limitations and benefits of welfare technology use, which is in turn presented in the summary section of this thesis and addressed in research question 1. Moreover, data collected during the initial fieldwork is also used as part of the proposed elderly care trajectory.

The data collected during case study 2 is gathered to understand the use of welfare technology in the nursing home setting including how elderly people, who fall at the top end of the age bracket, and users with the most severe health care issues can appropriate the use of technology. Methods used to gather data were unstructured and structured interviews, regular meetings with stakeholders, dialog meetings with welfare technology providers, and development of system requirement of nurse call systems. The data was used as a basis for the proposed elderly care trajectory study (paper 5) and in the summary chapter to address research question 1.

Data collected as part of the action research study is reported in paper 2, 3 and 4 and in paper 5, paper 7 and the summary chapter in answering the main research questions as it focuses on both usability issues, transformation of work practices, and input into the re-design of elderly care trajectory. Methods used to gather data were passive and participant observations, unstructured and structured interviews, photos taken, partaker in work practice, usability testing, diagnostic evaluation, workshop, and regular meetings with stakeholders.

3.6 Role of the Researcher

My role as a researcher is influenced by my values and experiences, especially as an interpretive researcher. No researcher is entirely neutral in a fieldwork setting and I

am aware of the fact that my past experiences colour my observations. Thus, my studies are biased due to the fact that that interpretation of my observations is influenced by my life experiences. However, use of theories for analysis can compensate for this and give some objective distance to the data material. In the past, and during my student years, I worked as an assistant nurse for many years. I then worked evenings and nights shift in the home care service, in nursing homes and hospitals. I believe that these experiences have coloured my fieldwork: some of my past experiences of elderly care worker were re-experienced during fieldwork, and I have an extensive understanding of the health care domain. I am aware that I may be observing things that do not necessarily capture the interest of other researchers. I think that my experiences can also have a positive effect as I easily connect with the elderly care receivers and healthcare staff and gain their trust quickly. In addition, I am familiar with the health care terminology and norms. Moreover, I am a “trained” home visitor of elderly people. Thus I am known that I need to behave in a certain manner and show respect when entering private homes of participants. There is a big difference between care in the home and care in, hospital, for example. During a stay in a hospital care setting, the staffs are in charge and can provide the patient with instructions and “orders” that the patient, more or less, has to follow. They must follow these “orders” as they will directly contribute to their healing and the establishment of preventive measures. For example, a nurse may request that a patient get out of bed and go for a walk as soon as possible in order to prevent the possibility of blood clots following surgery. However, care in the home is provided on the common understanding that the resident is in charge. Instructions and recommendations have to be given with care and with the understanding that home based residents have their way of doing everyday life activities. Too many instructions from “outsiders” can serve to stress elderly people. By way of example, I always take my shoes off when entering a private home or put on the blue shoe protectors to avoid dirtying their floors. I also always plan on having extra time, as many elderly people get stressed by rapid movement or hasty behaviour and many older people need more time and a calm atmosphere. In addition, I also asked for permission before sitting down on a chair when doing a home visit.

I assisted some participants with assistive nursing tasks during the action research study. Thus, I could partake in the fieldwork as an involved researcher during the diagnostic evaluation, in contrast to outside researchers. I must state that I have been

sensitive and critical in regards to my interpretations as I am aware of my bias, I know that I colour my interpretations.

Communication skills are essential when doing data collection and fieldwork. When conducting interviews and workshops with the health care personnel involved I also felt that it was beneficial that I had knowledge of the area of work and subject matter: I know the challenges and the complexity of elderly care. During the action research study I worked alongside fellow researcher Suhas Govind Joshi and I believe that this served to reduce my researcher bias due to the fact that we discussed and analysed the data together whilst also discussing findings from our different viewpoints.

I am an industrial PhD[5] student, my employer is Ramboll[6] and I am hired in a permanent position as an ICT advisor in the department of technical systems in the buildings sector. I have partaken in a four year PhD contract during which I undertook one-year duty work as an ICT advisor in Ramboll. Thus, I have professional experience of developing tenders for procurement of nurse call systems including both welfare technology and automation for both care housing and nursing homes. I am aware of the fact that my researcher role has influenced my advisor role and vice versa. For example, I am not advising clients to procure technical solutions that I have learned during my fieldwork are not appropriate for users. I have noticed that I have become more technically critical during my time as a researcher, before my time as a PhD student I had in general a positive view of technical devices. However, when seeing the use of technology in practice, in a real environment, I realised that incorporation of technology in elderly care has socio-technical complexity at several levels. Thus, I advise my clients to aim for simple and robust solutions. My experience as an advisor has also influenced my researcher role as I have technical skills in relation to nurse call systems that were particularly useful during the case studies. This skill can also make me more critical of the technical solutions already procured. I can compare the solution in place with another solution, in place at a different housing setting, and can, thus, be left wondering why such an

[5] Industrial PhD Industrial is an ordinary doctoral education undertaken while the candidate is employed by an enterprise.

[6] Ramboll is a global advisory company founded in Denmark in 1945. In Norway, the company has 1500 employees' in 17 offices. The business has a total of 13,000 employees located in 35 countries. Ramboll works across markets including Buildings, Transport, Environment and Health, Water, Energy, Oil & Gas, and Management Consulting.

inappropriate solution was installed. However, my unit of analysis has been to study the care work mediated by the use of technology so my focus has been on the socio-technical relationships and not solely technology. Thus, I have written this thesis as a PhD research fellow and I have enforced a critical distance to my advisor role.

4. Use of welfare technology in practice

This section describes my empirical data of welfare technology use in practice as experienced during fieldwork as part of the case studies and the action research study.

4.1 User perspectives from the application office for formal services

As a starting point of my empirical data material, I will present the perspectives of a unit manager (herein referred to as “Sara”) working at the municipal application office in the old town in Oslo municipality. Sara shares her experiences from her work and in particular her experiences concerning evaluation of applications for formal care services. The outcome of an applicant’s application is either a formal decision that the applicant should receive formal services according to their needs or a rejection of access to services. The application office is, therefore, “the gateway” through which an elderly individual must pass in order to gain access to formal services. Sara stated that an application in regards to the need for care services is evaluated according to the applicant’s functional capacities (hereafter the applicant is referred to as a user), as well as the user's wish to receive the services: receiving elderly care is voluntary. Each application from the applicant is assessed individually. There is no universal or national standardised form that is used when mapping prospective users’ functional capabilities, but each district in the municipality of Oslo has an auxiliary tool that is used to support decision-making during the home evaluation visits.

Sara reports that the first step in the care staircase of formal services is the users need for practical assistance such as housekeeping/cleaning in the home. In the past there was a rule that said that practical assistance in the home is provided to users at a minimum of four hours a month. However, this rule has now been removed and practical assistance is now allocated to users according to their need. Thus, often users get less than 4 hours practical assistance during a month; however this does mean that more users can receive the services.

Users and their family can apply for access to the services themselves, but it is the home care service that assesses the actual user needs and writes the application for

the user. The application is then given to the application office in the local district where the users have residence. As the home care staff initially assesses the user's needs few applicants get a rejected, however in cases of rejection the applicant can appeal for a new evaluation. The elderly people who are successful in their applications have often had practical assistance already and so the housekeeping staff simply alerts the home care office about the users' additional needs. Some users get home care services after hospitalisation, where it is the hospital that alerts the home care office that the users have a need for follow-up care after hospital admission.

Sara reports that several users in the old town of Oslo receive comprehensive and complex care services that are comparable to in-patient care. She confirms that the criteria for gaining the formal decision in regards to a care housing apartment is based on separate law regulations for allocation of residential care. Sara informs that in the old town of Oslo there, is in total, 160 care homes (this conversation took place in November 2014). However, these apartments are for the entire municipality of Oslo and not just for residents living in the district. Residents who move to one of these care homes from other districts of Oslo do so following a formal decision, which they have received from their former district of residence. The services are provided by the home care staff working locally but paid for by the previous district for the following two years. After this period the resident is "transferred" to the local district, at which point the local district has the overall responsibility of providing the resident with formal services.

Prospective users of formal care services can apply for short or long-term stays at nursing homes either by themselves or by asking for support of home care staff. Sara further reports that a considerable amount of elderly people who live in the ordinary home are using nursing homes for a short-term stay, for example for rehabilitation or to relieve their family or to wait for a transition between steps in the care staircase.

She further states that each formal decision letter that is sent to a user has a reference to the principle that will be providing the formal services at the Lowest Effective Level of Care. Thus, the district seeks to provide adequate services to the user whilst providing no more services than are absolutely necessary. The provision of services in this manner is the result of scarce health care resources and the fact that it is difficult to take away services that are provided in accordance with formal decisions made even after the user may no longer need a number of those services, for example

they may have recovered from an illness or accident. Thus, in the early onset of the staircase the users are provided with sufficient services which are later increased in increments in parallel with users need for assistance in accordance with the current design of the care staircase. However, there is an exception or a movement towards transforming the focus in care practise into home-based everyday rehabilitation. This movement is called Active Participant in Own Life (acronym to ADEL in Norwegian). ADEL is a strategy to change the focus of elderly care from care and treatment into home-based rehabilitation where prospective users are evaluated by an interdisciplinary home care team. The team provides these users with intensive teaching and training in a short period. The users can experience that they have to spend extra time in getting everyday life activities done, but still they can manage in doing them. Thus, the aim is that the users will be rewarded by health benefits and can prevent or slow down the further decline of their functional and cognitive capacities. Moreover, when users maintain some degree of self-mastery they can reduce their services. The goal of ADEL is to become self-dependent again.

Sara states that the district of the old town of Oslo has focused on welfare technology use. Thus, she emphasises that she find the use of welfare technology beneficial as it has the potential to make formal services more efficient and reduce nurses workloads by delegating routine tasks, such as Pilly[7].

Sara stated that few elderly people are dying in their homes and that those who are doing so often have experienced unforeseen and sudden deaths. Moreover, she reports that elderly people most often die during short or long-term stays in nursing homes or during hospital admissions. However, some people such as those with cancer decide to die at home and then receive 24/7 support from the Fransiscus - support. Fransiscus - support is a mobile service so-called "nurses on wheels" that is provided by a not for profit organisation with affiliations to the Catholic Church. Fransiscus - support is primarily on offer to cancer patients, it is free of charge and the nurses' main tasks are to provide pain relief during the end of life care (palliative care).

[7] Pilly is an automated medication dispenser. The dispenser is pre-programmed to open the correct "slot" for its users in order for them to take accurate medication dosage at the right time. The dispenser beeps to alerts and remind users to take medication, and send alerts to the home care service office if users have not taken the medication within a fixed time interval.

Further in this section, I will present my experiences from field work, which are initially based on a case study at a (the then) new care housing setting, a field experiment carried out by use of action research methods and a case study of how technology is used in nursing homes.

4.2 Case study 1

During the initial fieldwork, I approached care housing with a curious and open mind. My main interest was to understand what was going on in the field and, initially, I hoped to get to know the residents and the staff working at the care housing setting. The care housing setting got a lot of public attention as the scale of welfare technology and smart house technology use was one of the largest of its kind in the Nordic countries. There were a lot of expectations of what these installations could do to support the users in living independently. During my fieldwork two health ministers came on a public visit and the current commissioner for social services and the elderly in the municipality of Oslo stated that the aim of this housing was to support residents to such an extent that they did not need any formal services. Thus, the ambition and enthusiasm in regards to the role that technology could play in the care housing setting was observed as relative high. The staff seemed to have a more realistic view of the technology and they experienced how time consuming the administration of the different control systems was for them. For example, the central operating control system alerted the staff to all events and did so frequently that the staff had to learn which alerts to address and which they should overlook. They needed to be able to differentiate between alerts requiring their attention and those not requiring their attention as their main work, such as providing residents with assistance for practical matters, had to be their main priority. Some technical installations were delayed and therefore some of these were installed after the residents had moved into the building. The first residents who moved into the building arrived earlier than had been originally planned. This was due to the fact that they urgently required shelter because their last residence had burned down. The main concern of these residents was the wish to feel safe as the experience of having a large scale fire in the former building was traumatic. Thus, they were less interested in learning about the use of new technologies that were installed or part of their apartment services.

Each apartment was equipped with a tablet called the “info-assistant” and a personal safety alarm. The apartment also had various smart house technologies installed such as sensors for water lock performance (as a security measure in cases of flooding) and night lighting. The info-assistant was an application that ran on a touch based 12” tablet with a Windows operating system (OS). It served as a user portal of all in-house services except the safety alarm system.

As I started to get to know the residents, I was invited to their homes. My initial questions to the residents were “Where do you keep your tablet?” and “Can you show me which services you are using on the tablet?” The majority of residents had put the tablet away in closet shelves and drawers because they only used the docking station during re-charging or, if it was plugged in, the screen in its early development often had the blue screen of death or an error message appeared. Thus it was often not operable for the users. It can be claimed that none of the users had the tablet ready at hand. However, there were some residents whom I experienced as super users that found the tablet useful, especially for reading online new papers. However, these users also had an additional computer in their homes, such as a laptop or stationary personal computer.

The docking station was installed close to the refrigerator and at standing height, therefore several users, especially those with mobility issues who were dependent on a walker to stand, found it troublesome to plug the tablet into its docking station. Moreover, for those who used a wheelchair it was even harder.

4.2.1 Logging breakdowns of welfare technology use

As my fieldwork went on, I experienced several user problems of operating the technical systems, even when not looking for them specifically. Thus, as the breakdowns kept occurring they became my main focus. Therefore, my data collection shifted from an open minded approach to a focused approach looking for problematic situations such as occurrences of socio-technical breakdowns[8] (Woll 2013). I logged these occurrences as notes taken during active and passive observations from formal and informal meetings with residents, in-house staff,

[8] I have to emphasize that the looking for failures exclude technical measures that worked well, thus I am aware of the attention to failures exclude the success stories.

project managers from the municipality of Oslo and the system providers of the welfare technology system. Several breakdowns of welfare technology were experienced and these were as follows.

1. Technology displays the blue screen of death (BSOD).
2. The safety alarm button is pushed, but the alert signal fails to go off.
3. The safety alarm reports an incorrect location in regards to the person who pushed the alarm button.
4. Technology is interrupted after a software update.
5. The technology fails to work because of a flat battery.
6. Takeaway orders are both handled by technology and manually list.
7. The safety alarm is not working as its battery is flat.
8. Apartments for couples are only equipped with one individual welfare technology “package”.
9. User fails to interact with a touch-based user interface.
10. Users misuse the safety alarm for other matters that are not critical situations, i.e., social needs.
11. Welfare services are not working due to unstable networks or failures in the network infrastructure.
12. The bathroom lighting is turned off when the elderly person use the shower curtains while showering because of smart house sensors for lightning do not detect the elderly person.
13. Poor Internet connection when using more Wi-Fi devices than the tablet.

This list shows that breakdowns vary in type and severity. They include socio-technical breakdowns that have occurred in user situations including well-known smart house technology, the info –assistant (the tablet), the in-house safety alarm system or the network infrastructure. I will present a brief summary of the identified breakdown situations as the study presented in Woll (2013) only investigates two of the breakdown situations because of the space limitations set by the journal editors.

The most common breakdown seen was the BSOD and this breakdown occurred for every resident. This breakdown was a result of unfinished software delivery from the vendor, who constantly had software releases that required a restart of every resident’s tablets. The restart had to be carried out manually and the users then had to log on with their personal username and password. The vendor generated the personal username and password for each resident and these were too long and complicated for the users to handle themselves. There were also breakdowns that could have

resulted in severe risks to the health of the users such as the breakdown listed at number 2: “The safety alarm button is pushed, but the alert signal fails to go off”. On one occasion, this was especially critical as one of the residents, “Martha”, was in need of assistance to get out of bed after a sudden illness. Martha was at that time 92 years old and she was a social individual who was lots of fun to be around: she always had a great story to tell and a big smile. However, she struggled with paralysis in her arm, mobility issues and she used a walker for support as a result of a past stroke some years ago. The breakdown of the personal safety alarm happen during the Christmas holidays and Martha had told her family who visited her often that she sometimes wanted time alone after several dinner gatherings to relax. Thus, when she went to bed that evening she thought she had a relaxing couples of days ahead, however as she woke up the next morning she noticed that her legs were swollen and cumbersome as a result of acute oedema. She was thus unable to get out of bed by herself. She, therefore, pushed her personal safety alarm button, however as the technology failed to send the alert to the in-house staff, the staff did not know that Martha had called for assistance. Martha did not have her phone on her bedside table and there was way for her to raise the alarm. Thus, Martha was bedridden for two days before she was assisted by her daughter who let herself in to Martha’s apartment for her planned visit the second day. The daughter further reported the breakdown to the in-house staff who then called the vendor. This breakdown of technology could have resulted in fatal outcome for Martha. However, she was lucky and after doctor supervision she recovered fine. Moreover, Martha later told me that she now always brings her phone with her when going to bed so that should the personal safety alarm not work, she has secondary support.

Breakdown number 3 is also connected to the use of the personal safety alarm as the staff experienced that the alarm response unit reported incorrect locations in regards to the person who pushed the alarm button. For example, the alarm response unit reports that a resident who is located at room 403 is calling for assistance when the resident is in room 303. The personal safety alarm is supposed to function outside the resident room to support the residents regardless of where they are in the care housing setting. However, the municipality of Oslo had decided that price was the criteria that most outweighed almost all other criteria, thus tenders sent by different providers were evaluated on their price after being evaluated on whether they met the system requirements. Thus, the vendor who won the public procurement competition had not

correctly calculated for the amount of position receivers that were needed in their tender and thus a more position receivers have to be spread around the building so that the safety alarm system worked accurately. However, there is no rule of thumb in regards to how many position receivers are needed, as it depends upon the design of the building and the construction material from which the building is made. Both of which greatly affect the ability of the receiver to pick up a signal. The care housing setting is complex in design as it is two buildings connected by an indoor pedestrian bridge. However, vendors are often required to do technical coverage tests, functions test and stress testing of technical systems before the system are formally delivered for ordinary use, e.g., to state formally that the system is working well enough to be an operative alarm system. However, despite the above, the vendor later got their contract with the municipality of Oslo expanded in order to increase the coverage of the safety alarm system. Following this, the error locations were minimised.

Breakdown number 4 was recorded as “Technology is interrupted after software update” and is connected to breakdown number 1. However, this breakdown is different in that the solution is not as easy as logging into the tablet again; it requires the user to fix recently installed software. As mentioned initially, the technology required repeated software updates that continued during the first year of system operation. Thus, the error messages on the screen confused the users as they did not know what to do about it, especially those users who did not use the tablet regularly. When the users turned the tablet on they would often, immediately, turn it if off again as they did not understand the error message and therefore the tablet could be out of order for an extended period.

Breakdown number 5 related to the fact that “the technology fails to work because of a flat battery” and was connected to the non-use of the tablet by the residents. Most residents were novice users of the procured technology and they saw the tablet as modern and unfamiliar. This was the case for a large amount of residence except the super users. Thus, the tablet was often put away in drawers and kitchen closets. It was also observed that the majority of elderly users were unfamiliar with the activity of re-charging batteries for the sake of maintaining usage. Moreover, the residents were unlikely to take their tablets with them as they moved around their home. More experienced users of technology are more likely to automatically take certain technological devices with them around their homes, for example, when moving from

the kitchen table to the living room apartment more regular user of technology, such as a mobile phone, may take it with them, whereas the inexperienced user would leave the device in a specific place, not seeing it as a mobile object. Due to this more experienced users of technology are more aware that the battery may need re-charging and are more likely to monitor the battery level. More experienced users will ensure that the battery is kept charged to make sure that the device is operational 24/7. This habit of re-charging and ensuring that devices are charged was not observed in the elderly residents during fieldwork. Thus, if critical health care services were supposed to be accessed by use of the tablet, they were required to learn the practice of recharging the battery. Moreover, this observation was also reported by the health care staff interviewed during joint care housing meetings arranged by the municipality. It was reported that the elderly people who used GPS for support when wandering outdoors also struggled with re-charging of the batteries of the devices they were using. These users were often reliant upon the home care services staff, which came for home visits, reminding them to re-charge the GPS. However, the staff experienced that the elderly people often took the plug of the battery charger out of the power socket before going to bed. This is common practice for many elderly people who view this as a safety measure to avoid fire. Thus, when the nurses arrived the next morning to make sure that the users had their GPS with them, before they went, the GPS had very low or flat battery.

Breakdown number 6 related to the fact that “takeaway food orders are both handled by the technology and manually list”. Whilst this is not necessarily a breakdown, the ordering of takeaway dinners via the tablet was one of the few services that required active use of the tablet and not all residents mastered the active use of the tablet. The in-house staffs were made aware of this issue and therefore developed an internal system to work around the issue and compensate for the lack of flexibility in the technology. Therefore, the in-house staff organised a manual dinner ordering system for the residents that they knew struggled using the services on the tablet. This system involved the residents ordering via oral communication with the in-house staff. The staff then gave the canteen personnel the manual order list. The takeaway dinner service was first and foremost for residents who had severe health care issues, which stopped them from going down to the first floor to eat dinner with the other residents in the canteen area. However, the in-house staffs were worried that the optional manual system was complicating the work of the canteen personnel – as the canteen

personnel worked shifts and thus were not always aware that there were two dinner ordering lists; the manual list and the digital list on the tablet. Additionally, the staff expressed concerns about residents who could fall in between the two ordering systems, but who could also benefit nutritionally from buying dinner from the canteen. This breakdown could be avoided if the technology was useable for all the residents or provided in a similar manner as it was for those with severe health care issues.

Breakdown number 7 related to the fact that "the safety alarm was not working as its battery was flat". This is a maintenance issue that is dependent on the user's safety alarm use. The life cycle of a safety alarm battery is estimated as 2 years before the battery needs to be changed; however frequent use of the alarm reduces its life cycle. Thus, users who use the safety alarm often need to replace the battery on a more regular basis than those who use the alarm on a seldom basis or for "normally" use (for emergency use only). Many safety alarm supporters have set up regular dates when every battery in the alarms is changed, whilst others are changing the batteries as when needed. Thus, this breakdown was a result of a user who used the alarm often causing the battery to run down and the sudden breakdown of the alarm.

Breakdown number 8 related to the fact that apartments for couples are only equipped with one individual welfare technology 'package'". As more residents moved into the care housing and it started to fill up during late autumn 2013, it was noted that the procured welfare technology package did not cover equipment for those apartments designed for couples, more precisely for two residents living together in an apartment. Thus, these residents had to share the use of the personal safety alarms and the tablet. This in turn made it difficult to place two takeaway dinners' orders, as well as supporting both persons safety when they were not in the same room.

Several users had trouble with breakdown number 9 which revolved around the "User failing to interact with a touch-based user interface". The tablet came with a pen that could be employed for interaction; however, the pen required a solid hand movement as well as the capacities of fine motor skills. Many elderly people did not receive this pen as part of the tablet delivery and in addition many of the seniors had issues with cold fingers which resulted in them finding the touch-based interaction with the tablet very challenging. This is not something that only affects elderly people, many younger people and other users who tried the tablets suffered from cold fingers or

motor skills that were not accurate enough for the tablet. Additionally the vendor's application worked as the tablet's dashboard and, for example, when reading the newspaper the users interface would shrink the online newspaper so it was hard to read or get an overview of the news. This thus added to the issue of scrolling up and down when having cold fingers. However, when the vendor's application was removed by holding the home button in for several second, the authentic Samsung system had a setting that could be used for reading newspapers which was easier to interact with. Therefore, it is possible to argue that the user issues with the touch-based interactions are in fact due to a vendor specific issue and not an issue with tablet use issue.

Breakdown listed as number 10 was "Users misuse the safety alarm for matters that are not critical situations i.e. social needs". The manager for the care housing reported that the staff had given some residents permission to "misuse" the alarms. The staff had allowed this due to the fact that the residents were end of life care users and want to stay in their homes. This resulted in users with permission using the safety alarm in a similar way to the nurse call system alarm, e.g., calling for assistance when they need help to go to the bathroom or when they needed a glass of water. However, it should be noted breakdown number 10 is in relation to the users who misuse the alarm for other reasons. These reasons included anxiety or social needs, however the users would express feelings of sudden illness or dizziness. Therefore the staff found these users are difficult to handle because they found it hard to reprimand the user for misuse or point out the misuse to the user. The manager at the care housing stated that it is important to take every resident seriously and that it could be dangerous or fatal to dismiss anyone or to not treat them with the upmost importance. Thus the staffs were left handling the misuse of the safety alarm in a manner that combined with their overall duty of care and work instructions. In cases of repeated misuse the staff might suggest the user book a doctor's visit to check their health, for example, to examine the cause of the experienced dizziness. This allowed them to discourage misuse without having to accuse the user of misuse. Moreover, in some user situation users should be taught to use the alarm according to its intended purpose as the staffs need the ability to correctly manage and prioritise their care giving. It was also evident that the residents were more likely to push the alarm button if they knew that the alarm was going to alert in-house staff, and in particular in-house staff that they knew well, rather than a remote safety alarm provider that every other elderly person

within the municipality of Oslo gets assistance from. It has thus been observed that seniors who use the public safety alarm provider often restrict their use of the safety alarm because they do not want to disturb the safety alarm provider unnecessarily. Moreover, they also find it hard to self-evaluate whether the situation is an emergency or not, thus they often do not use the alarm in cases where they absolutely should be using it e.g., after falls when they are not able to get up off the floor.

Breakdown number 11 revolved around the fact that “Welfare services were not working because of instability or failures in the network infrastructure”. An interesting aspect of the procured welfare technology package at the care housing was the downscaled Wi-Fi network. The residents are provided with Wi-Fi services in the common areas, such as in the lobby and canteen area. However, the apartments have poor Internet connection especially when using additional Wi-Fi devices other than the tablet. This is troublesome in cases of expanded use of other Wi-Fi devices such as a standalone fall alarm. Moreover, it is advised that users with additional devices should use their own Wi-Fi provider. However, as super users decided to get their own Wi-Fi providers, their systems began to disturb the signals of the Wi-Fi in-house. Thus, this affected the use of tablets that often struggled with low Wi-Fi coverage. It also affects the on-going study of the additional use of technical services, such as our telecare study, which is presented in sub-section 4.4 below.

Breakdown number 12 and 13 concern the use of motion sensors to turn lighting on and off in the bathroom and in the bedroom. This measure was introduced to save energy and to support users during night visits to the bathroom, however, the location of the sensors were not practical. They had a blind spot in the bathroom which was caused by residents using the shower curtains while showering. The bathroom is regarded as one of the riskiest places in the home for elderly users due to the risk of slippery floors, exposing the elderly to the possibility of a fall. Thus, the fact that the lighting went off when the residents used the shower curtains was certainly not supporting the user's safety. In addition to the above, the floor sensor, which was responsible for cutting off the power supply, was also sensitive to minor humidity. Several users experienced issues that resulted in the power source being cut off as a result of humidity forming on or close to the bathroom floor. This shows that it is impossible not to use the shower curtain as a way of avoiding the motion sensor disabling the lights. Moreover, the motion sensor that was intended to support

residents with automatic night lighting was installed in a position that also turned the lighting on when residents were moving in the bed, for example, turning around in the bed during their sleep. Thus, as the lighting was turned on the residents woke up. Several of the residents, therefore, had to cover up the sensors with gaffer tape to avoid unwanted lighting behaviour that either put them at risk, as was the case in the bathroom, or disturbed their sleep. The sensors used for motion detection and energy saving were later uninstalled (after 2 years of trial) as they did not support users as originally planned. This is an interesting observation as smart house installations are smart when seen as an isolated functionality, however, in real use, the smartness may fail as a human may act or move in a way that may not have been predicated by the technical installer. In order for welfare technology to support users the coverage of technical installation should be tested and the space should be mapped to ensure that there is nothing that would hinder or block the technologies intended use. Moreover, such installation should be “moveable”, e.g., furniture should not be put in a fixed place to fit the technology coverage.

4.3 Case study 2

The results recorded during case study 1 and in the field experiment, showed that the elderly people struggled to use the technology, not necessarily because of the technology itself, but rather as a result of the context in which it was being used or their health condition. This gave rise to the question of the use of welfare technology in nursing homes. It is fair to argue that those who live in nursing homes often have severe health care issues. One of the lighthouse projects of welfare technology use within nursing homes was conducted at Lyngbakken nursing home and was frequently referred to in the news. During this project the researchers from SINTEF spent an extended period of time assessing which technology was more appropriate for use within the setting. Furthermore they tailored their choice of technology based on the needs of both the elderly residents and the staff.

Lyngbakken nursing home has installed a state of the art nurse call system which involves the use of welfare technology and automation. The system is a silent system in that the traditional corridor displays have been removed and a nurse is notified of an active alarm call by a vibration on their mobile smartphones. This allows for the disposal of beeping and blinking room numbers. The nurse call system is therefore as

accurately described as a hidden system. The hidden and silent nature of the system led to a feeling of calm and decreased the sterile feeling of the nursing home. The system allowed the nursing home to step away from being an institution associated with care and allowed it to become a place that resembled a normal home environment. Lyngbakken nursing home also has a tactile garden, which has been proven to have positive effects on residents within homes. Tending to a garden has been shown to make people happy and simply sitting in a beautiful garden can lead to relaxation and comfort.

The residents in nursing homes receive around the clock in-patient care and are given daily support with activities such as eating, continence-related tasks including control and hygiene, bathing (personal hygiene and grooming), dressing and undressing, and transporting (movement and mobility) if needed. However, the residents who are able to self-care are motivated to continue doing so for as long as they can. The head nurse stated that informal care is also present within the nursing home and is administered by family and friends during their visits. The family members would support the residents by helping them to go outdoors and visit the tactile garden.

The nursing home had initially planned to install digital screens above the resident's beds so that they could make video conference calls to their families. However, they later decided not to install these screens as the residents in the nursing home were very elderly and many of them had severe health care issues that would make it impractical to use active technology. The head nurse stated that 80 percent of the residents had impaired cognitive capabilities and it was therefore estimated that approximately 30 percent of the residents had the ability to master the use of the personal safety alarm. To compensate for declining cognition passive use of technology was installed to reduce response time when assistance was needed, for example, in situations when resident's fall and are unable to call for help. The head nurse informed me that the most important requirement for any alarm system was to ensure that the residents felt safe. Many residents had spent a long time living alone in their own homes, longer than was justifiable, and so when they moved into a nursing home they tended to request that their doors were left open. This enabled the resident to hear others in the corridor outside their quarters and allowed them to feel more safe and comfortable.

Traditional nurse call systems are operated when the resident pulls a string which is connected to a wall panel above their bed in their rooms. Residents who needed access to an alarm when out of bed, when sitting in an armchair for example, need a more creative solution and have been known to extend the pull string alarm from the bedside to the chair. Typically the pull string alarm was extended by tying on an additional string that was either attached to the armchair or resident's clothes with a safety pin. There were several drawbacks to this solution including the fact that the string could disconnect and the residents would then have no alarm to pull and the fact that the alarm only worked in a set range depending on the pull string length.

Lyngbakken nursing home introduced mobile safety alarms in addition to various sensors including bed sensors to prevent falls, a camera that alerts the nurses when a resident falls, a camera for night supervision and door controllers to prevent patients from wandering. The door controllers had near field sensors that exchanged information with the residents personal safety alarm, so the doors would lock automatically when residents with pre-programmed restricted access approached the doors. This allowed the nurses to remotely control the residents' movements and prevent those residents with a tendency to wander from passing through selected doors during night or wintertime such as the main entrance door. This system is especially helpful when trying to prevent wanderers for getting lost or suffering from hypothermia should they venture outside without appropriate clothing. In addition to the above, technology is also used to promote the mobility and safety of the residents during the day. For example, GPS systems are employed to ensure that the resident can be tracked should they get lost and a personal safety alarm that works outside of the residents room can be provided to allow the resident to walk around the building and certain areas outside, such as the tactile garden. It is therefore arguable that the use of such technology is not simply for restrictive purposes, but also to motivate the resident to be active and mobile.

The nursing home also has a state of the art lift rail system that is integrated into the roof, which assists the staff to move immobile residents in a flexible and safe way from the bed to the bathroom. In addition to this, the nursing home has a spa room with fibre optic lighting which imitates the night's sky. This rooms is used by residents who need support when bathing, the lighting therefore increase the resident's comfort during this time.

The head nurse informed me that the introduction of the new technological solutions to in-patient care had altered the way in which the nurses welcomed resident's to the home. The use of technology to care for individuals requires the individual or their family to consent to such care. Consequently, when a new resident moves into the nursing home, the traditional routine of the nurse partaking in a housewarming conversation with the resident is transformed to include a conversation where the resident is informed about the technical solutions that exist in-house and where their needs are discussed. However, this is sometimes difficult as the staff need to get to know the residents and understand their needs in order to evaluate which welfare technology, if any, the resident may benefit from.

The head nurse also explained that the staff often struggled during initial implementation of the silent nurse call system, as they did not remember to take their mobile smartphones with them and as a result would miss the calls. In addition, the staff had to learn to understand the different alarms, some alarms were from the personal safety alarm, whilst others were informative alerts informing them that, for example, "Mrs Hanson is passing door 322". It therefore took some time before the staff learned to handle the new nurse call system. The nurse also informed me that the home had introduced the use of welfare technology in stages both for the employees and the residents in order to assist both parties as they became familiar with the new technology.

The mobile smartphones also received incoming alerts from the fire alarm system and the main entrance door phone. It is undeniable that new and additional technology creates additional alarms or alerts that need to be learned during practice. The work force in nursing homes is often made up of temporary staffs who take shifts in numerous differing homes to cover shortages. Therefore there are always new personal that need to be trained in the use of technology. In contrast to this there are also staff who are super users in that they take on the role of system administrator for the nurse call system software and measure the statistically data and communicate with the vendor when technology fails or is not working as planned. The super users can route the various alarms used by a resident to specific mobile smartphones and connect alarms in one department with others departments in the nursing home so that the night nurse, for example, can work between departments during the night shift.

4.3.1 Use of welfare technology in nursing homes as part of three innovative public procurements (as ICT advisor)

The welfare technology needed to support elderly care work in these projects is quite similar to the technology required and used in the nursing home presented in the above sub-section. Thus, Lyngbakken nursing home is seen as a lighthouse of innovation in elderly care and many other nursing homes use the technical solutions at Lyngbakken nursing home as a starting point when deciding which technology to procure for their home. The municipality also has an independent showroom where other municipalities view demonstrations of the technology and test it. However, all nursing homes have to make adjustments so that the technical solutions work with their local needs and for their residents. For example, the head nurse at Tjørsvågheimen nursing home requested that the nurse call system have two way communications in order to allow her nurses and residents to communicate. This allowed the nurses to tell the residents that they were on their way and would be there in 5 minutes if the cause for the alarm was a practical matter such as arranging a telephone conversation or it allowed the nurse to respond immediately in cases of an acute situation. The head nurse stated that the staffs were often occupied with caring for other residents when the alarms sounded and they had to interrupt these caring activities to respond to alarms, thus being able to communicate with the residents who were calling for assistance allowed the nurses to prioritise the situation and work more efficiently. Moreover, as one health care manager stated so perfectly “the more an employer is walking during a work day, the less time s/he is spending with the user”. Walk-reducing measures are important for employees in nursing homes, e.g., a handheld device for all types of interactions/communications is therefore seen an essential tool for support.

The most state of the art nurse call system is not a system that can be bought off the shelf and thus it is essential that innovative public procurement is utilised. There is an increased tendency for passive use of welfare technology and even if the sensors existed in other markets, the use of these sensors within a nurse call system is innovative. These sensors need to be integrated within the nurse call system in order to alert the nurses in a similar manner to the activation of a personal safety alarm.

As part of the innovative public procurement programme for the nurse call system, the local project group responsible for the purchasing the system (the municipal project leader, the head nurses, and two engineer advisors (including myself)) presented their user needs in a dialogue conference prior to requesting tenders. Then after the conference, the vendors who participated sent a brief draft of a possible technical solution to the project group. Afterwards, each vendor was invited to an individual meeting with the project group where they brought along technological devices to demonstrate selected components that they believed would form part of the nurse call system for the group to understand the technical attributes better. For example, one vendor brought several alternatives for personal safety alarms. Some of the alarms were for the ordinary user such as wrist alarms or around the neck safety alarms, while others alarms were intended to support individual user needs. For example, some alarms were aimed at residents that were more likely to press the alarm button. There were also voice activated alarm or monitors alarms for individuals with conditions such as epilepsy.

One of the vendors who participated in the dialogue meeting as part of the innovative public procurement programme informed the project group about the varying possibilities their solution could offer. He told us that not only did their information visualisation system identify and locate the residents who were wearing a personal safety alarm, but also identified and located the staff who wore a similar safety alarms for safety measures, e.g., in order to locate an employer who has activated the attack-alarm.

Several nursing homes have started to use staff personal attack alarms as some residents can get violent. In addition intruder could break into nursing homes looking for drugs. The alarms give the nurses the support they require when they need to call for assistance from other co-workers. Such solutions can also be used for different purposes, the vendor informed the team about a nursing home that used their nurse call system software to log the frequency of alarms and the staff responses to these alarms. Thus, their software logged each resident's active alarm and also which staff member responded to the alarm. This allowed the department to investigate the complaints made by the staff who reported that their residents had complex health care needs which resulted in increased workload and a need for additional manpower. However, as the manager analysed the amount of alarms and responses to these

alarms, he was able to conclude that this department had a lower workload in comparison to other departments within the nursing home. Thus, the manager in fact decided to move manpower from this department to another department with a higher workload. The ethical implications of monitoring workers are questionable, however using nurse call system software for statistical purposes and better resource allocation is beneficial. It allows a home to plan work shifts and share manpower across departments thus becoming more efficient.

We have chosen to exclude hospitals as a step in the elderly care trajectory, but we are aware that hospitalisation and repeated re-hospitalisation is an essential factor in the assessment of an individual's functional abilities. Moreover, most elderly people experience hospitalisation at the End of Life Care (EoLC) (Gabrielsen 2013).

4.4 Action research study

It was initially noted that most residents in the care housing were able to self-care with the support they got from the in-house staff, their relatives and the home care services. However, it was also noted that several residents suffered increasing health care issues as the study continued. Thus, more residents needed additional or complex home care services. It was observed that the in-house services that were accessible on the tablet were not health services related, thus the focus of the study shifted to the home care service and the question of how home care services could be technically connected to the care housing arose. Thus, collaboration with the head manager at the home care service in the old town of Oslo was initiated and the action research study together with Suhas Govind Joshi, a PhD research fellow, began.

4.4.1 Home care services

Home care services have developed enormously in the last five decades. The workload has increased and a broader range of user groups have evolved to assist with the vast variety of user needs and capacities. Home care services can vary from minor care tasks, such as assisting an individual to put on their stockings, supervising users when they are taking their medication and caring for wounds, to complex care tasks, such as provide users with extensive care services almost comparable to in-patient care including personal care and grooming. Many users in the old town of Oslo have extensive care needs, which make it difficult to transform current home

care services into technology-supported care services. For example, the home care service no longer partakes in the social supervision of their users. Thus this social supervision then falls into the remit of voluntary organisations like the Red Cross. The Red Cross offers users social interaction in the form of a visitor. This visitor befriends the user and calls or makes home visits to elevate the users' feelings of loneliness or lack social network. Voluntary resources have also taken on the role of assisting elderly people when they are running errands or visiting the doctor. Older people can also subscribe to various services like a multi-dose package of medication delivery from pharmacies. However, users report that this service is expensive, so those who cannot afford this service are supported by the home care nurses who put prescribed medication into a weekly pill/medication dispenser. In the past, home care services also helped users with their groceries shopping; however, this service is now delegated to online providers, such as directHome.no. Some of the elderly people have also applied for assistance in heating up pre-cooked food which is provided by the brand Fjordland. However, some municipalities offer elderly people with special needs to the ability to subscribe to the delivery of dinner to their homes, which is a service provided by both public and private companies. Practical assistance in the home for tasks such as cleaning can be provided by both private and public providers. This allows the user to decide which provider they prefer. Elderly people who live in their own homes must visit their General Practitioner (GP), the regularly assigned doctor in order to gain access to certain support. The technical aids centre also provides assistive technologies and various simplifying tools like arm grabbers. However, home care services have their own physiotherapist or occupational therapist that evaluates user needs and support users in applying for the different devices. Private or public providers provide services for well-being like hairdressing or foot care. Some home care providers' are able to assist elderly people with additional grooming such as helping elderly women to style their hair using rollers following a shower. This is a supplementary service and not included within a basic package of care. Others providers also provide foot care, but in the majority of cases these services are only offered by private providers. The residents in care housing have these well-being services in-house.

4.4.2 Collaborative group

Following the inclusion of the head manager at the home care service within the working group, a collaborative group formed and expanded with several stakeholders joining. The collaborative group consisted of several team members from the municipal home care service unit in the old town of Oslo including the head manager, head nurses of two home care units, head manager of practical assistance and a physiotherapist. Additional there were several nurses and assistant nurses who assisted with the selection process to find care receivers, living in the care housing, who could be asked to participated in the study. Moreover, twenty elderly care receivers were spoken to alongside residents that, for several reasons, did not receive home care services. They were asked about their perspective of home care service. Some of those questioned were later recruited for the usability study. The staff working in the care housing were also interviewed and asked to give their opinions on which residents to approach for participation. The reasoning behind this being, that the staff know the residents better than the home care nurses as they see the residents on a daily basis. Other stakeholders in the collaborative group were the project manager of the eSenior project working in Oslo city council and the one responsible for the procurement of welfare technology in the care housing. The vendor was also partly involved in the collaborative group as they also had interest in finding additional services that could be appropriate to include in their applications installed for in-house services on the tablet. Finally, Joshi and I who participated as the researchers in the action research study that was titled “The Collaborative Change Experiment”.

The action research cycle was adjusted to fit our needs of both action and research, and the various steps are described as follows.

4.4.3 Step 1: Preliminary field work

At the beginning of the experiment we were shadowing the nurses as they carried out their mobile work in the care housing, and in this manner, we came in contact with the elderly care receivers. Thus, we were able to observe both sides of home care by gathering both the nurses and the users’ perspective on the services. It was noted during fieldwork that those care receivers with complex health care needs were often prioritised during the morning shifts as these are the individuals who need support to

get out of bed and to get dressed. Moreover, the active ageing residents with minor care needs expressed that they felt ignored and left waiting for the home care staff to arrive for their visit. One of the residents said that he had stopped receiving home care services because the staff never arrived at the same time on any one day and he simply could not cope with having to wait for them all day. This was even the case when he required follow-up services after a temporary hospital admission. Another resident had additional concerns about the number of different nurses that came into her private home, which she found uncomfortable and intrusive.

The nurses estimate the time each home visit should take in accordance with the tasks the user should be supported with under their formal agreement. However, the nurses have to handle unexpected incidents during their visits that can prolong the time they spend with any one user. Thus, it is challenging to arrange a fixed time for each visit, so often the users have to wait for the nurses to arrive. This is especially troublesome for active ageing care receivers who are often not prioritised as those care receivers with complex health care needs are at the top of the list. It was also noted, however, that those with complex care needs also complained about being bedridden and waiting for the nurses to arrive. Technology cannot perform tasks such as personal care and grooming and so these tasks remain with the nurses. Thus, the research setting is focusing on home care services provided to active ageing users with a minor need for health care services. The home care service inform their users of a set time interval in which the users can expect the nursing staff to arrive for the home visit(s), for example, the user is told that the morning visit will take place between 9 to 12 o'clock. Thus, there is an agreement that the user has to be at home within this time range. Many users have severe health care issues and seldom leave their homes without assistance, while others, especially active ageing users, can find it troublesome to be stuck at home waiting for the nurse to arrive before they can get on with their daily activities.

Our objective during field work was to explore how we could transform selected home care services into services that could be delivered more efficiently and in a timely manner so that the user problems reported by the active ageing residents were addressed. This in turn would support the active residents in their wise to maintain an active life. The transformation of work practice study was limited to home care services provided to care users who lived in care housing. Our solution to the

problem was to test the delivery of home care services via telecare. Thus, there was also a practical reason for not recruiting care receivers who lived outside the care housing as they did not have Internet access in their homes. We emphasise that the use of telecare is not a new invention, but our research interests were to understand the problems with telecare within our fieldwork and find a solution to these problems. Thus, we were interested in the organisational processes of transforming work practices by introducing technology.

The choice of technology for telecare session

Initial tests were completed in order to ascertain the appropriateness of using the residents' tablets in order to carry out telecare session; however it was concluded that the tablet was not a suitable interface for remote care due to various occurrences of BSOD and flat batteries. It was also noted that it was problematic for the residents to hold the tablet in a way that enabled the person on the other side to see their face. In addition, the tablet had to be put down when the resident needed to perform a task (e.g., when they needed to take medication), thus the person on the other side of the camera could not see what the resident was doing. It was decided that a technology that required a constant power supply was needed in order to avoid the re-charge of battery issue. Previous studies have stated that it would be beneficial to build services on existing and familiar technology in the home as this will be easier for the users to operate. It was therefore decided that the television was an appropriate platform for video consultations. It was observed, while shadowing the nurses, that every care receiver in the care housing had relatively large and state of the art televisions (Figure 12).

Figure 12 shows the televisions in the private homes that were used for remote home care services during the action research study. Copyright: Joshi and Woll (2015a).

4.4.4 Step 2: Task elicitation

Task elicitation was a step that involved the selection of certain home care services that were suitable for remote delivery. The home care nurses provided a range of services to support their care receivers, however only certain tasks were evaluated to be practical and routine tasks that the users could do themselves. It was only these practical and routine tasks that were appropriate for telecare, for example reminders and supervision of user when taking medication. Tasks that required extensive home care support such as personal care and grooming were not suitable for telecare delivery. It was understood that task elicitation was only a starting point, and it was thus a requirement that each task was tested to see if it was suitable for remote delivery and if the participants mastery of the responsibility of self-care would ensure remote delivery was effective. Throughout the fieldwork, a difference of opinion was registered with regards to which tasks should be selected and delivered by use of telecare and which users could handle the responsibility of participating. This difference of opinion was even present between nurses working within the same team. Another challenge was that very few elderly care receivers were in receipt of a formal decision in regards to support for minor care tasks. The required level of need in order to obtain formal care services has become stricter due to the fact that the amount of care receivers with complex home care needs has grown. One decade ago elderly care receivers could obtain a formal decision that allowed them to receive a phone call or home visit for social reasons and supervision of their general condition. Supervision via phone or home visit would be suitable for telecare as the staff would also be able to see the condition of the users. Typically the main question from the staff when doing this care task was to ask how the person was doing. This would be followed by a conversation about the day during which the care receiver reported their own experience of their general condition. The main objective of this task was to check that the individual was home and how he/she saw their own well-being. If the nurses did not receive an answer when calling or the users were not opening the door when home visits had been arranged action had to be taken. Each care received had individual instructions for follow-up activities should the aforementioned occur, for example the nurse should call the user's family or call the safety alarm provider who had the key to the home. The nurse would then make a joint home visit to check everything was ok. These minor care tasks were of importance to the users who expressed a feeling of safety in the knowledge that someone would check in on them

every day and if something was out of the ordinary, the users knew that action would be taken. However, today these care tasks are delegated to voluntary organisations such as the Red Cross which has now taken over the phone calls and home visits. Thus, home care service tasks are increasingly fragmented.

Another challenge that arose was that several residents were originally from other districts in the municipality of Oslo. These residents often had formal decisions from their past residential district, and thus the former district was paying for the home care services delivered by the district of the old town of Oslo for these residents. These residents were therefore excluded from the action research study because the local district was paid to deliver traditional home care services. The reason being that the telecare visits were not initially counted as performed visit because the home care work instructions stated that only visits where the staff physically attended were counted as a visit, however, as the action research cycle unfold the telecare visits were counted as equal to home visits during diagnostic evaluation.

In order to conclude on which tasks should be selected for telecare delivery and to solve the different opinions on tasks and which users should be included in the action research study, we organised several meetings with the collaborative group. This gave us a forum in which all considerations could be taken in to account and the workshop yielded a list of tasks; see Figure 13.The figure displays tasks to be tested during the usability study and tasks to be tested for the diagnostic evaluation.

Tasks for usability testing	**Tasks for diagnostic evaluation**
1. Answersing a telecare call	1. Regular visit and examination of general condition
2. Registering calls at unsceduled times	2. Supervision while taking medication
3. Validating text size and readability	3. Self-care of physical wounds by remote supervision
4. Zooming in and out on the body	4. Put on aid stockings to prevent edema
5. Testing the sound level	5. Exercises by remote guidance by occupational therapist
6. Testing sound clairty during conversation	
7. Simultaneous movement	
8. Testing picture clairity during conversation	
9. Panning between feet and head	
10. Turn and move the camera	
11. Testing the light conditions	

Figure 13 gives an overview of task elicitation for usability testing and diagnostic evaluation (Joshi and Woll 2014).

The difficulty of recruiting participants

The home care nurses developed a list of users that could be approached and invited to participate, however several of the users were reluctant to participate. The elderly people gave several reasons for not wishing to participate including poor health, feeling untrained technically, a dislike for technology, feeling clumsy and unintelligent because they could not operate technology not wanting to be disturbed, preferring the nurse to attend, and that they were afraid of losing home care services. The main observation that was noted during the recruitment process was that the majority of the elderly people had low self-confidence when using modern technology. It took several weeks in the field before participatory consent was gained from five care receivers. Additionally, five participants, who were none receivers of home care services, were recruited for the usability testing. These five participants lived in the care housing and were evaluated to either be prior or prospective users of home care service. The participants were given oral and written information according to the regulation of the Norwegian Centre for Research Data (NSD), and they were required to sign a consent agreement to agree and participate formally.

4.4.5 Step 3: Usability study

After recruiting ten participants, a test suite was arranged. Each participant entered the test suite and individually tested the telecare solution in a demonstration apartment at the care housing, see Figure 14 for the setup.

Figure 14 shows pictures taken during the setup of the usability test. The home care nurse is pictured to the left and to the right are two elderly participants. Copyright: Joshi and Woll 2014.

The usability test was designed to simulate a real telecare session which involved the home care nurse, who was situated in the home care service office, and the elderly participant, who was sat in the living room in the demonstration apartment, conversing. Both users had similar telecare solutions: a 40-inch smart television and a high-density television camera to support wide-angle video conferencing. The wide angle camera was thought to be most appropriate as it allowed the nurse to see the participant sitting in the living room instead of the restrictive angle one would usual expect from a typical video conferencing device such as a personal computer.

Joshi and I were both participants and passive observers. Joshi observed the home care nurse whilst I observed the elderly participant during the training and the usability testing. This allowed us to conduct parallel observations of the users and any issues they encountered. We decided not to simulate either side of the interaction or conduct non-simultaneous observations as we wished to avoid minor circumstantial changes which could result biased measurements. Additionally, we provided the participants with user support during the testing. Our focus in the usability test was on tasks that were connected to the technical side of telecare; however, these tasks were believed to be important, as well as prerequisites for the users' experiences of quality care. For example, if the users experienced poor sound quality this would affect the ability of the nurses to deliver home care service from a remote location. The user experiences when performing the different usability tasks, such as those listed in Figure 13 are presented in the following paragraphs.

Answering a call

The users had to operate a basic remote control in order to use the video camera and answer a telecare call. Thus, initially, before the usability test started, we trained the users in operating the remote control. Several participants found the design of the remote control troublesome, especially in regards to the poor colour contrast between the black background and the off-white symbols representing the different buttons, see Figure 15. Despite this the users also learned how to use the controller relative quickly as it was simple and had few user options.

Figure 15 shows the telecare solution including the remote controller and the television camera.

Moreover, some participants stated that they found it difficult to understand if they had correctly pushed the button because there was poor feedback. It was noted that the participants, on both sides of the camera, pushed the buttons several times.

Registering calls at unscheduled times.

The elderly participants were tested in their ability to register telecare calls at unscheduled times, more precisely when they did not expect an incoming telecare call. The participants stated that the ringtone was too similar to other devices in the home, which resulted in confusion as they did not understand that the call was emanating from the "television" (video conference call). Some reported that the sound was similar to the fire alarm. Some participants preferred the low-frequency ringtone as an alternative. Moreover, the users experienced a long delay when the television was switching from television program mode to the telecare mode after they pushed the "OK" button to answer the call.

Validating text sizes and readability

Participants were asked to re-configure text size in the video conference settings to adjust the text to a format that was readable for them. Most participants did this task with ease; however, some struggled and changed the language instead of the text size.

Zooming in on the body

The participants were instructed to use the remote control to zoom the camera in so that the nurse could view a specific area of their body, for example, the leg. This allowed the nurse to support users who were treating their own wounds. The

participants found this task easy, however, whilst the camera picture enlarges an area when zooming in it does not make the picture any clearer which resulted in blurred images.

Testing the sound level and sound clarity

The participants tested the microphones during an ordinary conversation. The microphones displayed signs of hypersensitivity which resulted in a susceptibility to interference and noise. The sound was also impaired by the acoustics in the room and resultant reverberation. The deficient acoustic quality could have been a result of the sparsely equipped demonstration apartment. In addition to the aforementioned issues, fragmented sound occurred in a couple of the telecare testing sessions resulting in interruptions to the conversation.

Simultaneous movement and light conditions

When participants moved rapidly back and forth during the telecare session, the picture quality became unclear. Moreover, picture disturbance occurred when the lighting within the room was disrupted. The changes in the lighting required the camera to readjust its aperture and in doing so the picture was disrupted and the participants' movements became fragmented.

The video conference quality was tested in differing light conditions. The results to these test showed that the television camera was too sensitive to changes in the light conditions. Furthermore, it must be noted that the demonstration apartment did not have curtains or extra lighting installations and only had the basic lights that were integrated into the roof. Thus, it was difficult to regulate the lighting condition by, for example, shutting curtains or turning on an extra lamp. It was therefore anticipated that when telecare sessions were to take place in the living room during a sunny day, the partakers would have to use the curtains to avoid the sun affecting the quality of the video conferencing. Additionally, many elderly people are depending on several light sources such as reading lights and often have several lights installed around the television wall. Thus, when moving the video conference solution from the traditional video conference rooms into a private home these user differences would need to be compensated for and challenges would arise when trying to address the lighting issues to suit the users home.

Testing picture clarity

Several occasions were noted when the video conferencing solution suffered from an unclear picture. It was thought that t poor or unstable network capacity could be the cause of this.

For more information about the usability testing of telecare in a controlled environment, see Joshi and Woll 2014.

4.4.6 Step 4: Diagnostic evaluation

A critical step in the action research study was the transfer of the telecare sessions from the testing environment into a real life environment and the everyday life of the elderly participants. A television camera was installed into each of the participant homes. The differing televisions and installation of these televisions resulted in difficult in the installation of the camera. An example of this was the fact that one of the participant's televisions was positioned in a book shelf situated against a wall. The camera did not fit into the space available on the shelf and thus the television had to be moved forward in order to allow the camera to fit. This resulted in the television resting on the very edge of the shelf. In addition to this, the power outlet for this television was located behind the book shelf and so the shelf had to be de-assembled in parts in order to allow the plugs to be accessed, this involved removing five large drawers to allow the camera to be plugged into the outlet.

Another challenge that was faced was the locating of a free power outlet. Many of the participants had several electrical devices that interacted with and were connected to the television, such as the cable TV box and lights, and so power outlets were often occupied by these electrical devices. Extension leads were therefore required so that the camera could be successfully stored into the homes of two of the participants.

Further to the above the camera was connected to the television via a HDMI cable. The participants experienced difficulties when trying to switch the television from the cable TV Box HDMI channel to the camera's HDMI Channel using the remote control. Due to this, Joshi and I had less control, as facilitators, when testing the telecare in the real environment; in particular we experienced a lack of control over both practical and methodical issues. For example there was no way of knowing whether the participants were ready to answer the call. Furthermore, when the

participants did not respond to the call it was hard to know if it was because they were bedridden or because they were out of the home. No control could be taken over the infrastructure either and so it was impossible to control the network capacity or to check whether the camera was still connected to the television.

The participants also found it troublesome to respond to the telecare session within a set time range as a result of the need to shift between different HDMI sources. In order to answer a call the participants first had to locate the television remote control and then had to locate the video conferencing remote control. One of the participants lost the camera's remote control and so an additional remote control had to be acquired. On several occasions that participants misplaced the remote control and required assistance to locate it. The camera was not manually operational and had to be operated via a remote control and so it was not possible to answer incoming telecare calls without the remote control, for example. This is therefore a design issue that needs to be addressed as a redundant solution should be maintained, e.g., automatic connection from certain callers.

It was observed that the participants found the additional services and equipment installed for the operational use of the telecare system complicated the use of the television. Despite the aforementioned difficulties, the results appeared to be affected more by the users' everyday life than by isolated technical difficulties. For example, the timing of the call had a great impact on the user's ability to answer the call. The users' were required to incorporate ICT-supported care into their daily life activities and this was not always a smooth process. In addition it was noted that it was not a simple case of agreeing a time for the call, but a case of ensuring the user was ready to answer the call. When and if the user was ready at the agreed time to answer the call was dependent upon their day. This posed an interesting challenge in that nurses who make physical home visits are able to work around their users, for example, they could do the care tasks in different order. However, when the nurses delivered care via telecare the work around possibilities were severely reduced.

Several of the participants began to suffer from increasing levels of health care issues throughout the action research study and thus the level of care they received increased. For example, as one participant progressed through the study she began to need support to get up, put her aid stocking on and get dress. However, she was exceedingly enthusiastic about participating in the study and so it was decided that

she could continue if adjustments were made to accommodate for her. One of these adjustments included the provision of physical home care services to address the care that was now beyond the remit of the telecare system. These physical home care services were performed by me as I am a trained assistant nurse. For one week, I attended the participant's home every morning to assist her during her morning routine, following this she was able to partake in the telecare call. Coordination of care work needed to occur to ensure that the call could take place. For example, on some days she was ready to get up when I arrive, however on other days she preferred to remain in bed for longer and thus the telecare call would need to be rescheduled. The continual fluctuation of activity and inactivity in the participant's daily lives was a factor that impacted on the use of telecare which we had not foreseen before starting the study. In addition to the lady above, we also had a gentleman who slept on a sofa during the night and thus if he received a call when lying on the couch the camera would not capture his face and so we had to call him later. In addition to this, it was difficult to communicate with this participant via telecare as he had gotten into the habit of watching the television with the sound off, so when he received the telecare calls he did not hear the ringtone or the individual speaking and did not understand that he had to use the television remote control to turn the sound on and up. Thus, I had to pay him a visit to support him and inform him about the technical issue. Once these issues were resolved he was able to receive the telecare calls.

The home care nurses were supposed to call the participants as part of their ordinary work practice, however as the participant's health declined I was given the responsibility of performing the telecare calls and the additional home care services for five of the participant's for a week. The reason for my intervention was twofold: the participants needed additional home care services that could not be delivered by the sole use of telecare and/or the participant's general conditions altered on a daily basis resulting in the need to postpone or reschedule telecare sessions. The postponement of telecare sessions interrupted the nurses' workflow, so in order for me to successfully complete the diagnostic evaluation I had to take on the responsibility.

We planned to test five home care service tasks during the diagnostic evaluation. These were as follows (see Figure 13 above):

1. Regular visit and examination of general condition
2. Supervision while taking medication
3. Self-care of physical wounds by remote supervision
4. The putting on of an aid stocking to prevent oedema
5. Exercises with remote guidance from an occupational therapist

It was noted that task 1, “Regular visit and examination of general condition” and task 2 “Supervision while taking medication” were both suitable for delivery via the home telecare system. None of our recruited participants had wounds, so we were unable to test task 3. One of the participants used an aid stocking; however, whilst she was initially able to get her stocking on without any support later on in the study she required support to do so. Therefore, in the earlier stages of the study telecare supervision was an adequate care substitute as it allowed the nurse to check if she had remembered to take the stockings off. Task 5 was intended to be tested using the physiotherapist who was a part of the collaborative group, however the recruited participants had not been awarded care packages that included the receipt of physiotherapy thus it was not possible to test task 5 in practice.

During the course of the study we noticed that some of the participants appear to become very concerned with their own privacy. Two of participants asked if we were using the telecare system as 24/7 surveillance , whilst one of the other participants pulled out the HDMI cable as she did not want us to see her sitting in her bathrobe at the kitchen table, making it then impossible to operate telecare sessions with her. Joshi and I experienced that installing cameras into the homes of elderly people gave rise to both privacy and trust issues, thus it is essential that we as researchers are aware of this and fully inform the participants of how the technology works and what it does not do. It was also important to remember to show humility and respect when entering their homes.

For more information about the diagnostic evaluation in a real environment, see Joshi and Woll 2015a.

4.4.7 Step 5: Post – experiment evaluation

We completed our research cycle with a post evaluation session, bringing the collaborative group together and asking them to share both their positive and negative experiences from the action research study. Our main findings from the evaluation

were as follows. Firstly, the introduction of the telecare system was thought to be more contextually and organisational demanding than technologically challenging. However, we noted that the elderly people and the home care nurses experienced different organisational and technical issues. We believe this was a result of the fact that the elderly participants saw the delivery of telecare services as something individual to them, whilst the home care service staff had to incorporate telecare into their working day and deliver it to several care receivers. Secondly, our elderly participants were vulnerable to increased health care issues, which again affected their ability to us the telecare-provided in place of physical home care services. Telecare such as video conferencing is most suitable for active elderly people with minor health concerns due to the fact that telecare can never replace the physical care and grooming required by less active elderly people. Thirdly, telecare could assist in the timely delivery of services; however, this is in this setting referred to as a set time and to users that have the capacities of doing self-care. Both the elderly participants and the nurses stated that the timely delivery of services is an essential factor in the quality of the services received.

Fourthly, a key requirement for telecare-provided home care services is a stable and sufficient network connection on both sides. We learned during the action research study that the care housing had only planned to have free Wi-Fi in the Lobby area, thus, the residents experienced difficulty using their tablets in their homes due to poor Wi-Fi connection. We realised, as the study progressed, that users could elect to have their own Wi-Fi installed within their home, however we were unaware of this fact at the outset of the telecare study. This was arguably something that worked to our advantage however, in that the residents tended to use the tablet on an infrequent basis and so it would have hindered the use of telecare.

Finally, the head nurses expressed the fundamental need for extra work resources to enable them to take part in experiments such as this action research study to a larger degree, as well as to assist them in organising the implementation of assistive technology such as telecare-provided services. It was concluded and agreed that the transformation of home care services required to introduce assistive technology was much more time-consuming than initially thought.

For more information about the post-experiment evaluation, see Joshi and Woll 2015b.

5. Results

This section evaluates the results collated during my fieldwork, in which I explored the empirical use of technology via two case studies and an action research study. I have categorised the results with reference to my three main research aims and have evaluated them accordingly. By way of a reminder, my main research aims were as follows: (1) to study constraints and benefits of using welfare technology in elderly care, (2) to study elderly people's user barriers' to the adoption and use of welfare technology, (3) to study how technology-supported services better can be incorporated into the elderly care work.

5.1 RQ1: What are the key constraints and benefits of the current use of welfare technology in elderly care?

The results of RQ1 are can be extrapolated and further categorised into the following areas: the key constraints and benefits of the technology used in connection with the traditional care staircase; the fragmented nature of elderly care work; the lack of standardisation and infrastructure; and the ethical issues encountered. See Figure 16 for an overview of the identified constraints and benefits.

5.1.1 The care staircase

The primary limitation of the care staircase is the lack of recognition of the joint collaborative nature of care work which includes self-care, informal care and formal care. Thus, the staircase is constrained by its primary focus on formal care services and the lack of attention it gives to technology-supported services that all elderly people can actual use. For example, the widespread use of the traditional safety alarm is arguably also a constraint in that it requires the users to understand its use regardless of their cognitive and physical abilities. Furthermore, it requires the users to actually wear the alarm (See section 4). The results clearly show that elderly people and their families could benefit from an expansion in the use of technological aids for the performance of care activities (Woll and Bratteteig unpublished). For an elderly person to receive formal services they have to apply to the municipal application office (See section 4.1). Moreover, access to services depends upon the demand for services at the time of application and the workload or/and available

resources in a district. Therefore the ability to make a decision in relation to the elderly persons care is shifted from the user and her/his informal network to the municipality and the formal care providers. The decision on whether any elderly person should receive care becomes a formal matter and the responsibility of the state. All care users (except those users who require in-patient care) are expected to be part of a collaborative care work strategy that relies upon the care user's ability to continue with self-care activities alongside the introduction of formal care (Woll and Bratteteig unpublished). However, it is arguable that this joint collaborative work would benefit greatly from being more accurately addressed in meetings with formal care providers. The ability to remain autonomous and active as one ages should be paramount to any discussion or decision. More attention should be paid to the information that home care nurses share with their perspective users or the information provided on the municipal service website regarding elderly care services. Furthermore, it is evident from the results that elderly people should have access to more information in regards to their care options and the tools that would help them remain within their homes and continue to self-care but in a more efficient manner. This information should be available as soon as is practicable in order to reduce the need for formal services. The technical aids centre should provide an overview of the self-care tools that are available so that the elderly people can make informed decisions on their future care.

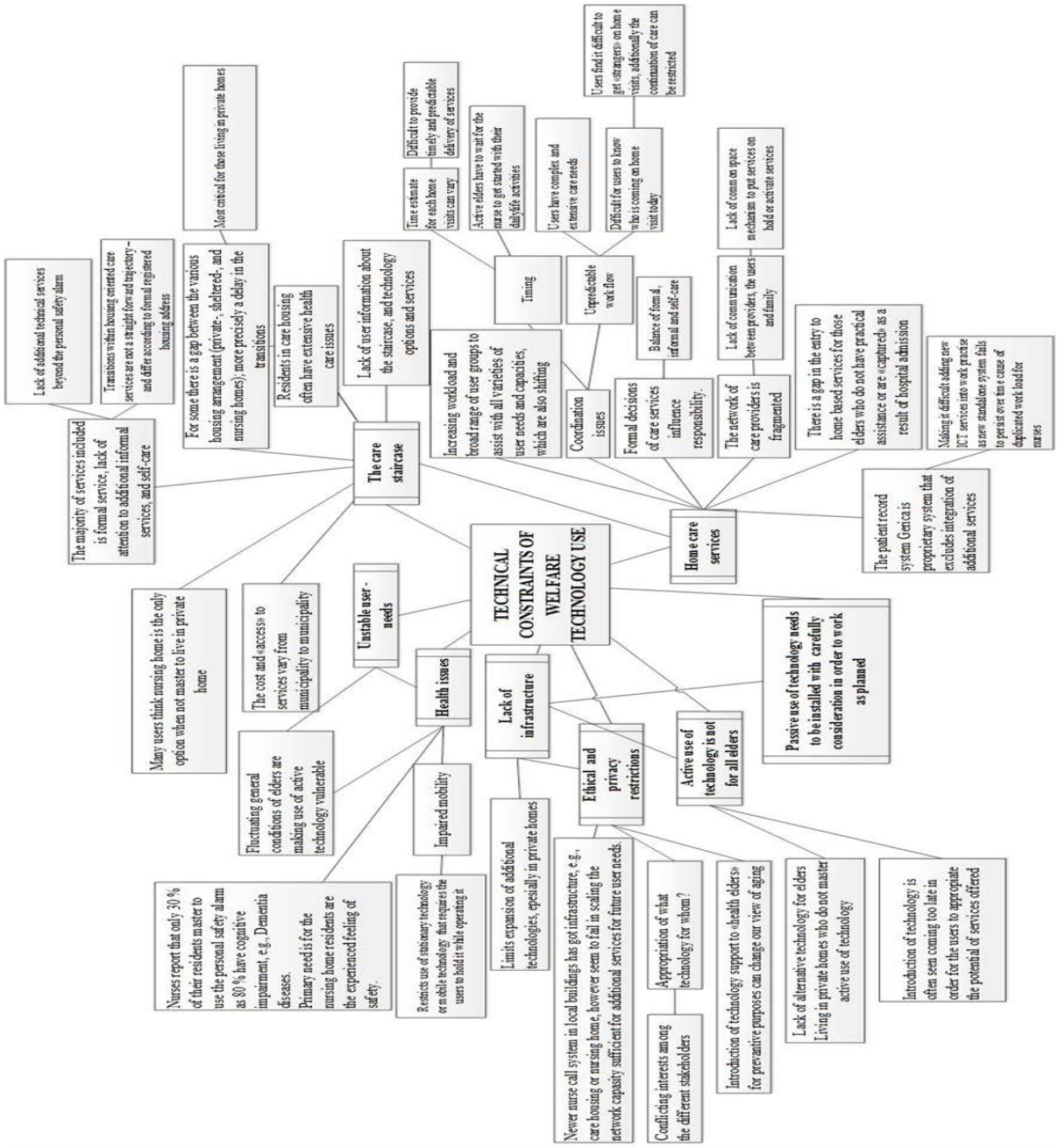

Figure 16 shows an overview of identified constraints of welfare technology use in elderly care.

The balance of work efforts made by the user, informal care provider, and formal care provider should be defined and formally documented. For example, there should be formal notes made on who is expected to carry out certain tasks and where and when these tasks should be complete. It is impossible to avoid the continued reports from users that there is a complete lack of information in regards to the staircase. One of the residents interviewed in care housing stated that they were “surprised by the fact it was possible for them to move into the housing they currently resided in.” They

believed that their only option was to move into a nursing home. It was evident throughout the study that many users believed that a nursing home was their only option when they no longer had the ability to live on their own. Moreover, users were afraid of moving into a nursing home, as one participant expressed “nursing home stays are the final destination. I am not ready to die… not yet”. Due to this fear and misunderstanding of the options available to them, users were often prepared for the worse scenario and were surprised when they receive information about other potential measures that could be adopted within their homes which would enable them to remain at home rather than requiring them to be transferred into assisted living. The users of the care staircase are provided with services at the lowest effective level of care (LEON), (see section 1.1), because formal care providers report that it is easier to add additional formal care services than it is to remove formal care services (e.g., in cases where the users do not need the services any longer). However, users report that there are a number of gaps within the care staircase. The pathway of the staircase is not a straightforward step-by-step progression, but rather an undertaking that required the user to walk up and down the stairs. The only users who did not experience this continual flux in care were those who had been awarded a formal decision that resulted in a long-term stay in nursing homes (a permanent solution). Moreover, users reported that they experienced a gap in the coordination of care when transferring from one step to another as there is no mechanism to ease this transfer or a shared information space for the different care providers to utilise. In practice, this resulted in services that should have been put on hold being continued. These gaps could occur when a person is suddenly transferred from their home into a nursing home for a short-term stay for example. These gaps resulted in services being provided to the users’ home whilst the user was not present. As a result, by the time this was realised and the services were stopped the user had often returned home and it took some time for the services to be reinstated. This therefore led to disruption in care.

It is also evident that the threshold at which one is allowed access to formal services has risen over the decades. This is especially evident when one compares current care receivers with care receivers two decades ago when several users received minor care tasks. Thus, users who have a need for care services receive these services later than they would have some years ago and the services they do receive are often not as extensive or effective as those previously offered to individuals with similar care

needs. It is arguable that technology could play an integral role as part of the shift between LEON to ADEL, by allowing some care practises to be delegated to users who no longer need services, see section 4.1.

There is also a potential use for technology-supported services in the care practise shift towards ADEL, see section 4.1. ADEL is the opposite of the care staircase strategy and includes the delivery of wide-ranging interdisciplinary services for a short period in the aim to get a person back on his/her feet. I have not observed any technology-supported care services as part of this shift of care practice. I recognise a need to maintain users' autonomy without compromising their safety and security by adding supporting measures, such as offering technology-supported self-care tools and formal care tools (Woll and Bratteteig unpublished). However, the self – care capacity a person has is hard to evaluate as seniors can experience fluctuating general conditions on a day-to-day basis, which make affect their ability to self-care, see section 5.2.3.

Some people also experience a gap in the transfer between the various housing arrangements: private, care, and nursing homes. More precisely they experience a delay in the transfer from one housing establishment to another. For example, several residents in the care housing had various medical issues that were restricting them from participating in social activities and from performing self-care. Some residents in the care housing had expanded privileges, awarded to them by the in-house staff, that allowed them to use the personal safety alarm similar the nurse call system's alarm, e.g., for practical matters and general care issue and not just for emergencies. These user privileges were given to the residents who had severe illness because they had expressed a strong desire to stay in the care housing during their end of life care. However, it should be noted that residents within care housing should ideally be able to self-care and operate independently to some extent. The lack of available beds in nursing homes is arguably one of the reasons that causes the application office to make formal decisions that result in individuals remaining in or being moved into care housing when in reality these individuals would have potentially c benefited from the in-patient care offered in the nursing home. The head nurse in case study 2 also reported a delay in the award of in-patient care or formal decisions for long-term stays in regards to her patients. She stated that "the primary need of the residents is the feeling of safety". She further expressed the belief that "…most residents prefer to

have the door to their rooms open, just to hear the staff or others walking in the corridor, as then they feel safe".

Work flow and timing of service delivery is a constraint in current elderly care. For example, several active ageing users with minor care needs have their home care visits late in the day as the elderly people with extensive care needs are often prioritised because they require assistance with personal care and grooming. It is understandable that the users who have the most complex care needs are prioritised as they depend upon the support of the nurse to get them out of bed. Without this support these users could remain bedridden all day. However, active elderly people need to be supported differently and be motivated to maintain an active daily life. However, a delay in their services often achieves the opposite affect and effectively prevents them from leaving their home whilst they wait for the home care visits, see section 4.3. Moreover, bedridden care receivers are reporting that they get help too late in the day. This is particularly disconcerting and upsetting for those who want to get up early in the morning.

5.1.2 Fragmented services

Today's home care services are becoming increasingly fragmented as the home care services that are available prior to in-patient care are delegated to private providers or voluntary resources, see section 4.1. There is a resultant gap in communication when services are transferred between a formal care provider and a private or voluntary care provider. Essential information is often held by different care providers and is rarely communicated into one information reserve. This results in an incoherent picture of the individual's general condition. This in turn means that several perspective or current care users are left in "a grey area" of the staircase. They do not fit into any specific step and are in a "transitional phase". They therefore need access to additional services to enable them to remain within their current home, or to move into housing that offers increased assistance. The residents receiving home care services at the care housing establishment had extensive home care service needs and so they did not qualify for our study. The fact that most care users in the care housing establishment had needs beyond those that were acceptable for participation within our study meant that there were not many candidates matching our inclusion criteria. The application office reports show that the two most common reasons for the request of formal home care services are either: a concern for the well-being of a care user

raised by the practical assistance staff or hospital staff requesting follow-up services when a patient returns home after a hospital admission, see section 4.1. Clearly, elderly people with no close family are liable to experience a delay in the formal elderly care system. This is a particular danger for people who are not receiving practical assistance or who have not been admitted to hospital. Using technology as a tool in transition phases are further discussed in Woll and Bratteteig (unpublished)

5.1.3 Infrastructure and standard for welfare technology

The lack of necessary infrastructure and an agreed standard for welfare technology hinders our ability to increase technology-support for elderly people living in ordinary homes. It is difficult for the municipalities to develop an efficient and standardised infrastructure for private homes because of the fact that the homes are located in many areas and are often some distance apart. It is therefore arguable that the implementation of the necessary infrastructure should be a national matter or, failing this, the government should, at least, develop a strategy on behalf of the municipality outlining the way in which they can implement the infrastructure. Several homes have no access to wired- or wireless network and mobile network connection quality can be poor. This means that many elderly persons have safety alarm system based on the analogue network. Moreover, the home care staff in the old town of Oslo report that relatively few care receivers have access to Internet services in their homes. Even the residents in the care housing have limited access to Internet services, which we as researchers experienced during our testing of additional technology use. The care housing offered Wi-Fi services for tablet use only and in addition to this technology requiring Wi-Fi services struggled when operated within private homes as the Wi-Fi signal was limited beyond the lobby area. Thus, those users who needed access to Internet their own quarters had to order and pay for the service themselves.

There is the possibility of expanding the use of Wi-Fi services so that it is connected to the established safety alarm system. The personal safety alarm system / response unit can then be developed into a type of call centre system, e.g., a central alarm response unit. This is especially beneficial for municipalities that already have a formal safety alarm provider such as the municipality of Oslo. However, those municipalities who have organised their safety alarm system differently, e.g., with the use of informal care providers will struggle to develop their services into a call centre

system. Thus, it is possible to argue that for the use of welfare technology to benefit all there first needs to be a standard infrastructure in place across all care establishments and municipalities. It was observed that it is easier to expand the use of technology-supported services in local buildings such as newer care houses and nursing homes, as the required infrastructure was already present and the staff were able to respond to the expanded alarm system.

The municipality of Oslo uses a proprietary system as their patient record management system (Gerica). This system initially struggled with the integration of additional welfare technology. For example, it often struggled when it was required to automatically log the activation of a person's fall alarm directly into the record system. However, the vendor developed a solution (Lifecare eSense) that addressed these issues and allowed the record system and standalone welfare technological solutions to collaborate. This integration of new welfare technology into an old proprietary system is not something that can be purchased off the shelf, but is a design that is individual to each system. However, without this necessary integration the nurses end up duplicating the work and increasing their workload, for example, they would have to manually enter the patient's names into the additional standalone systems. The interested of the vendors of the patient record system could also conflict with the interests of the users of the systems and the welfare technology vendor's interest. The system vendor's often worried about the privacy of their systems and this concern complicated the "open" nature of the elderly care setting. Tina Vedal, a master's student in Informatics, explored the use of a coordination tool to support the workflow of home care nurses. In this study, the home care nurses tested the use of a simple calendar system installed on the users' tablet, which sent the users reminders about their daily home visit, together with the name and a picture of the nurse who was scheduled to visit. However, the nurses failed to maintain the calendar's on a daily basis because they found it duplicated their workload due to the fact that the calendar system was not integrated into their patient record system.

5.1.4 Technology supporting beyond the formal work and shifting responsibility

Formal decisions in regards to care services influence the shift of responsibility between formal care, informal care and self-care. For example, a formal decision about a user's administration of medication could shift the responsibility from the

user (and concerned family members) to the formal care provider. However, the user still has to take his/her medication, but the formal care provider may be responsible for supervising the user in doing so. Thus, technology can also play a role in the division of elderly care work and be utilised as a tool to delegate work responsibility to elderly people, their informal care providers or their formal care providers (Woll 2016a). Health care workers report that it is difficult to "take back" formal decisions in regards to care services when the care receiver is no longer in need of those services. This is due to the fact that the users find it easier to continue with the services than to take on the responsibility of performing the tasks themselves again. I recognise elderly care work as work performed by of the contribution from primarily three different contributors: the elderly person her/himself (self-care work), in-house staff supporting users with practical matters, family members and volunteer resources (informal care) and paid health care workers providing care services to users who have been awarded formal decisions in regards to specific care tasks (formal care) (see Woll and Bratteteig unpublished). Elderly people who have the capacities to self-care when assisted by various tools are essential contributors in the transformation of elderly care. Strauss and co-authors (1982) were the first to recognise that patient work was of equal importance as formal work carried out by health care workers. Future elderly care arrangements are dependent on the ability of people to actively age and maintain the capacity to perform self-care work, this being an essential part of the collaborative care work. Thus, technology can be used in supporting the various types of trajectory work (Strauss et al. 1982, Woll and Bratteteig unpublished).

During my fieldwork, I experienced that technology was used to support all three work contributors; however the users were not aware that different tools were supporting different types of care work. Nevertheless, the work contributions were of equally importance to the overall elderly care work. For example, the use of the tablet was mainly for the purpose of supporting self – care activities (e.g., social activities, calendar function for reminders and ordering of take away dinners). The safety alarm was supporting informal care services as when activated it was the in-house staff who responded. The action research study introduced the videoconferencing solution by use of the participants' television and a plug and play TV-camera to support timely delivery of formal care services. In a similar manner, technology-supported services can play a role in re-distributing the responsibility of care tasks, e.g., by delegating a

current formal care task back to the elderly person, with or without backup support from informal or formal care providers.

For example, the elderly person can be delegated a specific task with the support of technology alone, e.g., the use of a toilet with wash and dry facilities to support a user's well-being and self-care in reference to personal hygiene. Moreover, technology can play a role by supporting individuals with parts of a care task, e.g., an automated medicine dispenser such as Pilly, which is an aid that reminds its users to take medication timely. Pilly is one example of how to transfer a formal decision back to the user by using technology in collaboration with an informal care provider and formal care provider. During my final fieldwork at the care housing setting, Pilly was tested in an on-going pilot study and the few participants I talked to expressed positive experiences. One user was so happy to finally take control over his everyday life that he stated: "before [Pilly] I had to wait for the home care nurse to come along, but now I just have to wait for Pilly, and then I can do whatever I like".

Thus, home care nurses pre-fill the medication dispenser weekly (formal care), the elderly person (user) is supported with reminders to self-administer daily medication (self-care), and family members are alerted if the medication is not taken within a set time interval (informal care).However, both examples illustrate that the use of technology is dependent on the elderly person capacities to complete self-care work[9]. Clearly, users are not expected to keep up with self-care activities during end of life care. Strauss et al. (1982) identified different types of patient work that could be categorised as self-care work and these are illustrated as follows.

• *Expecting* elderly people to work, e.g., maintaining daily life activities with the support of tools when they have the capacity to do so, sharing information about health conditions, drug use or reactions to drugs/treatment, being at home when the home care nurse is expected to visit.

[9] A limitation of the design is that users are able to take the pills out of the dispenser to make the signals to stop. They then later forget to actually take the pills. No technology can ensure that a user is, in fact, swallowing the pills. Thus, some users need physical supervision to take their medication and these users have to be provided with physical home visits or telecare and are not in the target group for using technologies like Pilly.

• *Demanding* elderly people to work, e.g., forcing reluctant elderly people to take an active role in their care: to take their medication or to eat and drink when they do not necessarily have an appetite.

• *Inviting* elderly people to work, e.g., self - monitoring or taking an active role during a procedure.

• *Negotiating* with elderly people in order to get them to work, e.g., asking elderly people to perform day to day activities that they would rather their caregivers perform for them.

• *Teaching* elderly people to work, e.g., instructing elderly about procedures such as proper nutrition, doing ADL with support of new tools, wound caring, drug use or self – monitoring.

These various types of self-care work should be carefully considered and include backup solutions in the form of informal or formal care.

See Woll and Bratteteig (unpublished, forthcoming 2017) for further findings about the conceptual proposal of the elderly care trajectory including layers supporting prolonging of a person's ability to self-care and increased use of automated services.

5.1.5 Ethics and privacy

It is hard to avoid the rise in questions of ethics and privacy when moving welfare technology into the homes of elderly people. During the action research study users expressed a concern that they believed they were being monitoring 24/7. This resulted in one participant regularly turning off and unplugging the TV camera during the diagnostic evaluation phase meaning that it did not work from one day to another (Joshi and Woll 2015b). Moreover, one participant thought he was being recorded and asked if I could replay the video from the TV camera so that he could prove that one of his friends had stolen his 1000 NKR. Another participant stated that she now got dressed before entering the living room as she did not want to be video-taped half-naked at the kitchen table. Clearly, the installation of cameras in the homes of the elderly people resulted in challenges arising in regards to the trust experienced between the researchers and participants. Hence, we as researchers needed to be aware of this and ensure that we talked to the participant's about their potential

privacy concerns and informed them of how the technology operated. We also needed to ensure that we showed humility and respect when entering their private homes. Moreover, this highlighted the fact that we should focus on designing for privacy and choosing solutions that support privacy. We could have, for example, used a camera with a “curtain” in front of the lens (when not in use) within the action research study. This would have allowed us to avoid the feelings of intrusion and surveillance that the end-users experienced. The data gathering of sensitive and personal information needs to be handled carefully, and according to formal regulations (including the Personal Data Act) and approved procedures for data storage must be applied.

It was noted that the late introduction of welfare technological services in fact hindered the users understanding of how the technology worked in practise. However, it is arguable that the early introduction of welfare technology could skew our view of ageing as the natural process of life (see Woll 2016b). Especially, in relation to situations where the technology is introduced to prevent and reduce individual risks, such as, in situations where technical efforts are made to support “healthy” elderly persons who have the potential of becoming wanderers or have the potential of developing increased instances of falling. This aspect of the use of welfare technology is further discussed in Woll (2016b).

5.2 RQ2: What are the elderly users’ barriers to the adoption and use of welfare technology?

Technology can be found throughout modern society so much so that it has merged into our everyday lives to such an extent that we no longer pay much attention to the use of it. Technologies that assist business sales, communication, education, buildings, transportation, banking, and healthcare have become somewhat intermingled into the daily operation of these areas. The Scandinavian notion of welfare technology seeks to aid at least four user functions within the elderly care domain 1) safety and security technology 2) compensation and wellbeing technology 3) technology for social contact and 4) technology for care and treatment. Thus, the use of welfare technology in elderly care is to support users within these areas so that they can increase their ability to live independently. These technologies also support health care workers during their working day by taking on routine nursing tasks,

supporting work flow, and helping to make the work more efficient and so on. The residents who lived within the care housing were supported by a variety of social-technological measures that all fell within the aforementioned welfare technology use subcategories. However, I believe that the housing's design and environment provided the residents with more support than any installed technology did. The overall environment (including universal design and adapted living arrangements) was supporting the residents beyond the ambition of what technology – supported services could offer. The housing design and associated in-house services were not only resulting in the residents taking part in social arrangements, but also helping the housing to feel cosy and be an inviting place to visit for the residents' families. This resulted in the families stating that they were looking forward to paying their relatives a visit. The in-house staffs were also valued as essential social resources as they had the ability to see each and every resident as an individual person, which meant that the residents felt that their presence actually mattered to the staff.

As elderly care progresses, fewer elderly people will be awarded the ability to rent an apartment in a care house. Thus, it is essential to learn from the social-technological measures employed in care housing and look at the use of technology in the overall care of the elderly. An important criterion for welfare technology is that it is able to replace a service normally provided by an individual or it is a more cost-effective delivery of a service. The main aim of technology-supported care services for elderly people living in ordinary homes is to transfer or delegate care generally fulfilled by care housing staff to the technology, allowing the elderly people to remain within their own homes. The safety and security of elderly people is always a paramount consideration when looking into the supportive measures employed and is an important evaluation criterion when making a formal decision regarding housing and formal care services. Therefore, if a person feels unsafe or insecure this would be of major importance when making a formal decision for an apartment in care housing. So how can we design technological solutions in order to actual support elderly people in experiencing the feeling of safety? It is fair to claim that today's offers of welfare technology are not always succeeding in matching the actual user capabilities of elderly people. Welfare technology is seen as a mix of beast, burden and blessing of the elderly people. In order to design and offer better welfare technology solutions, it is of importance to identify the user barriers of the elderly people. In the following sub-sections, I present the findings of the main user barriers as experienced during

my field work, moreover I reflect on alternative solutions to overcome the user barriers.

5.2.1 The mastering of technology

The personal safety alarm is the most widespread technology used in the elderly care. However, I have observed that many elderly people do not know how to use this alarm. There are a number of reasons why this is the case including the fact that the alarm requires the users to decide when it is appropriate to use it and then to take action by pushing the alarm button. In particularly, a frequent reported user problem was that the elderly people did not push the alarm button as they did not want to be a burden. In addition, certain elderly persons have impaired cognitive capabilities and thus have additional user challenges because they do not understand the actually use of the alarm. The nurses working at the nursing homes report that only 30% of their residents understood how to use the personal safety alarm see section 4.4. Furthermore, the personal safety alarm is restricted in that it only operates when the elderly person is indoors. This is with the exception of the GPS alarm. The GPS alarm requires users to recharge its battery regularly and most importantly it requires the users to actually remember to take the alarm with them when going outdoors. This issue is mirrored in the use of the personal safety alarm as users also have to remember to actually wear it. Typically, users hang the alarm on their walker or other convenient “hooks” when it is impractical to wear the alarm; however this often resulted in the alarms not being available for use when required. I asked one resident in the care housing if she had used her safety alarm to get help after she informed me that she had been hospitalized recently due to a fall. She stated that she did not have the alarm on as she fell when she was getting dressed and the alarm is always the last thing she puts on. Her answer is very typical as accidents often happen when users are not wearing the alarm when doing activities such as the morning bath, getting dressed, lying in bed, or other practical matters where the alarm seems to get in the way. This is especially the case for users wearing pendant alarms. Thus, whilst the use of the safety alarm technology is to provide users with a way of calling for assistance when they need help, it is clearly then that the personal safety alarm is not supporting its users as originally intended. There is therefore a need to find alternative solutions that actually support the users’ safety and security.

5.2.2 Active vs. passive use of welfare technology

The active use of technology requires user to interact with the technology for a particular purpose – a motivated human activity, e.g., self-monitoring of blood glucose or pushing the personal safety alarm button in cases of emergency. Moreover, navigating and reading the newspaper on a tablet. These activities require a level of familiarity on the behalf of the user so that they may to operate the technology correctly in order to utilise its function. Thus, the user must know how to perform the necessary steps and understand how to operate the technology accurately. It is hard to avoid the fact that the introduction of technology came too late for some people during case study 1 and the action research study. More precisely, “too late” for the users to be able learn and appropriate the services due to their decreasing functional and cognitive capabilities. Not only is the fact that the technology came “too late” a user constraint, but so is the elderly persons fluctuating general health which makes the active use of technology difficult. The possible solution for these users is the passive use of technology such as automated services which provide an increased layer of support when users finding it difficult to use technology actively, for example when they are struggling to understand the use of the personal safety alarm. Therefore, the use of welfare technology must be divided into active and passive use as certain technologies are designed with different levels of automation in mind and thus are able to support the diversity of users including users with minor or severe functional and cognitive disabilities.

Passive use of technology refers to instances when a person interacts with technology without necessarily knowing that they are doing so because the technology does not require any conscious input from the user, e.g., a sensor that automatically sends an alert through the safety alarm system when it detects that a user has fallen on the floor. In such cases, the user interacts with the technology without being aware of this interaction. Other examples of the passive use of technology include shower nozzles/water faucets that provide a constant water temperature when the user is bathing or showering; infrared water flow control, or sensors that log the opening and closing of the refrigerator door (Mao et al. 2014). Passive use of technology is particularly beneficial for users who cannot be expected to understand abstract or symbolic representations, e.g., users with cognitive impairments. For instance, in a situation where a person with cognitive impairment falls on the floor, s/he may not

understand that s/he can call for help by actively pushing the personal safety alarm button. Thus, implementation of various camera and sensor technologies can support users by increasing their safety and security by preventing risks such as fire and alerting nursing staff in the event of a fall or an individual wandering outdoors during night. I adjudge the benefit of the passive use of technology to be threefold: 1) as a preventive measure to avoid accidents; 2) to reduce the response time for assistance when accidents take place; or 3) solely for the purpose of delegating work load and freeing up nurses' time.

Most elderly people wish to live in their own homes for as long as possible, and increasing the safety and security measures within their homes can ensure that they are able to continue their life in the local community. Technology can play an important role for these elderly people and greatly assist them in their wish to remain at home. For example, the use of passive use of technology like extensive safety alarm devices. However, the passive use of technology requires careful consideration as people act in ways that one may not anticipate. For example, I presented in section 4 how the use of a motion sensor to turn on and off lighting failed to act as intended both in the bathroom and in the bedroom in a care housing setting. Several residents had to cover up their sensors with gaffer tape to avoid the lights turning on or off at inappropriate times such as the bathroom lights going off when they were showering, increasing the risk of falls, or the bedroom lights turning on during the night when users moved in their beds.

It is vital for one to understand the need for balance in the active and passive use of technology especially in accordance with the levels of automation (Cummings 2004). Cummings (2004) describes ten levels of automation from the lowest level, level 1 where the "human must take all decisions and actions" (p.2) to the highest level, level 10 where "the computer decides everything and acts autonomously" (p.2). Thus, when a user is actively pushing the safety alarm button, the user takes both the decision to call and action of calling for assistance. However, passive use of technology such as a sensor alerting on behalf of the user, e.g., a fall alarm acting autonomously by calling for help when a user is on the floor. Cummings (2004) lists differing levels of the human control between absolute control at level 1 to fully automated services at level 10. As you progress from level 1 to level 10 the technology takes increasing amounts of control.

The passive use of technology can be beneficial when looking at its functionality in isolation, however, in real life humans act or move in unpredictable ways that may not be obvious to those installing the technology. For welfare technology to support users there is an absolute necessity to test the coverage of the technical installation. Moreover, the technology must be designed so that it may be moved from one location to another and users' homes must be mapped out to ensure the technology will work as intended if installed in a specific location.

The idea of passive use technology is particularly interesting for users who are not able to understand the abstract or symbolic representations active technology requires one to, e.g., users with cognitive impairments. For instance, in a situation where a person with cognitive impairment falls on the floor s/he may not understand that s/he is able to call for help by actively pushing the personal safety alarm button. Users with stated cognitive impairments and increased health care challenges need to be offered alternatives to the active use of technology. The passive use of technology should not merely be limited to use within nursing homes, but should arguably be applied throughout the health care sector. Many elderly people suffering from cognitive impairments such as dementia are living in private homes or care housing. Thus, implementation of various sensor technologies can support users, increasing their safety and security by preventing fire; preventing a user from falling or alerting people when a user falls; alerting people if the user wanders outdoors during the night; or if the user becomes inactive, e.g., the technology may log when the refrigerator has been opened and in doing so show that the user is active and safe.

5.2.3 Unstable and shifting user needs

The use of technology in elderly care is challenged by elderly people's unpredictable and rapidly shifting user needs. Throughout the two year action research study I saw the participants develop numerous increased health care issues. For example, in the diagnostic evaluation study (Joshi and Woll 2015a), several participants were awarded additional home care services and were thus not longer part of the target group for the telecare participation. The participants' health care issues were, therefore, affecting the use of welfare technology. Clearly, the active use of technology in isolation is not a solution when trying to assist elderly persons. My experience is that is not a person's age, but rather his/her health condition that restricts the (active) use of technology. In reference to age, the most ardent

participant in my study was 93 years old and she expressed several times that she was a curious person and liked to test new things to maintain her cognitive abilities. Most residents in nursing homes are aged around 85 years old or older, however, these residents also have severe health issues and have often waited a long time to be awarded a long-term stay. The head nurses from case study 2 reported that approximately 30% of their residents understood the how to use a personal safety alarm. The nurses also report that on average the users' biggest concern during in-patient care was whether they felt safe. During an interview with a nurse in case study 2, I overheard residents shouting for help, thus it is plain to see that, even at a nursing home with extensive technology, the most instinctual way of calling for assistance is to shout for help. I also noted that the residents at the care housing setting experienced several issues with the active use of technology when using both the tablet and telecare. Moreover, persons with mobility issues struggled to use technology that was stationary due to the fact that they have to ensure they were able to access the technology, for example they had to ensure that they could move from the kitchen table to the television in time to reach a telecare call. The tablet was also installed at a height that was not operational for all residents, e.g., those using a walker or wheelchair. Technical regulations for buildings (TEK10) state that buildings for the public and business use have to be universally designed and these regulations should be taken into account when designing care housing. Whilst universal design regulations state that interactive panels should be installed within 0.8 – 1.1 meters above the finished floor for users to operate the screen at "sitting height", this is not the case for the care housing.

Moreover, the elderly care system has prioritised the objective of supporting users with personalised services to increase their quality of life. However, my experience during fieldwork was that the services provided are relatively similar and not that personalised. This is not to say that technology cannot play a role in achieving the personalisation of services to support fluctuating user needs however. Users must be provided with layers of support which result in back-up solutions that safeguard the user should another layer fail. The layering system would mean that users who do not have the capacity to self-care on a daily basis can receive increased support on those days when they are not feeling well. Consequently, it must be a priority to address this by expanded the use of technology or simplifying the tools used to support users in ADLs and in doing so, compensate for the minor lack of cognitive and physical

capabilities. By combing the active and passive use of technologies this may be achievable. ADLs require both cognitive and physical abilities and the technology aids used to support ADLs are more often than not physical solutions installed into the users home in the form of furniture or adaptations such as extended arm - grasping forceps, grab rails/handles, household aids, wheelchair, walkers, crutches and so onwards. In order to delegate some of the responsibilities and work that the in-house staff have in regards to the residents, elderly people living in ordinary home's should be supported with a personal safety alarm that can be supplemented with additional sensors supporting individual user needs. The sensors can capture and log normal activities in the home, such as the opening of the refrigerator, a tap being turned on or off, a light being turned on or off, or a sensor that captures whether the user is in bed or not.

Additionally, the active use of technology can support users in iADLs. For example, an automated medicine dispenser to assist in the taking of daily medication or the use of video conferencing or pre-recorded videos that allow the user to partake in daily exercise. Other examples of support in the home are as follows: technology used for communication, access to a booking system for Red Cross services, e.g., to book a companion for assistance during an upcoming doctor visit or support when running errands. Additionally, cleaning robots can be used to support users by vacuuming and cleaning the home as an additional supplement to practical assistance in the home.

5.2.4 Technology not working as planned

In user situations where introduced technology is not working as planned, the users get sceptical and lose trust in technology. Thus, technology not working as planned creates a user barrier "what the purpose of the use, when it fails to deliver what it promised". The transformation of health care services, including the increased use of technology, requires great responsibility and trust both on the parts of the humans involved and techniques employed to succeed in supporting elderly people 24/7. Consequently, it must be ensure that any active or passive use of technology support is well-tested prior to implementation to make sure that it works as planned and does not expose the users to malfunctions unnecessarily. In particular, technology used for safety and security measures must work as intended otherwise the elderly people will be given a "false" sense of security which could falter should the technology fail.

Trustworthy technology, robust solution, which can imply for the need of redundant solution is discussed further in Woll (2013) and Woll and Bratteteig (unpublished)

5.2.5 Everyday life and mobility issues

During the action research study (Joshi and Woll 2015a), we learned that also everyday life of elderly people is a user barrier to the adoption and the use of welfare technology. For example, building on other research findings, we chose the television as the platform for telecare. Prior research of Aaløkke Ballegard et al. (2006) shows that health care technologies can advantageously be an integrated part of the home environment, to avoid such technology to stand out as a helping aid that could stigmatise the resident (see e.g., Aaløkke Ballegard et al. photo illustration of a user hiding the tablet under a tablecloth decorated with a flower vase). However, we learned that the use of the television as a starting point for the delivery of telecare was not always that convenient in regard to the participants' schedule of watching television programs. Thus, the user then did not have time for telecare sessions as s/he was occupied watching a program, asking us to call back later. When replacing a personal home care visit with a technology-supported service, it seems easier for the user to postpone the service. Hence, it seems at ease to cancel or reschedule a remote service, then rescheduling a personal visit when a person is present and has made an effort in travelling distance. For further reflections and user challenges concerning the television as the platform for telecare, see Joshi and Woll (2015a). For example, we experienced that adding services and additional equipment to the familiar television platform increased the complexity of its use for the participants.

The fixed position of the television was also a user barrier for the participants' everyday life activities. Some days, the elderly participants were unexpected bedridden, either because they did not feel well, or because they wanted to stay longer in bed for various reasons. Moreover, some telecare sessions had to be postponed as the participants were occupied in doing their morning bath, getting dressed or eating breakfast in the kitchen. All the participants had various mobility issues, which resulted in them using extra time when moving from one place to another in the apartment. Thus, this was causing repeated unanswered telecare calls and worries of the participant's well-being. We had also learned from the initial step in the action research study (Joshi and Woll 2014) that the participants were mastering the use of telecare when studying the technological interaction as an

isolated activity. However, when introducing the technical solution into their social context, everyday life got in the way and complicated the use of technology. See Joshi and Woll (2015b) for additional discussion of this finding.

5.3 RQ3: How can use of technology-supported services better be incorporated into the elderly care work?

This sub-section presents two research studies that are proposals for how to go about to achieve a better incorporation of welfare technology in the elderly care work. The first is a practical approach, an action research study suggesting a stepwise transformation of existing working practices which results in technology-supported care practices. The second initiative is a conceptual proposal in regards to the overall re-designs of the elderly care trajectory staircase. The trajectory includes technology-supported services to a greater extent and emphasises the joint collaborative care work including formal, informal and self- care.

5.3.1 A stepwise approach to transforming health care practise

The proposed approach for transforming home care services is a stepwise generalisation in how to go about when initiating a change of work practise. The approach is an adjusted version of Susman's (2013) action research model. However, similar Susman's action research cycle, the approach is an effort to understand a problem and change it at the same time. It was necessary to adjust Susman's model to better fit our need in regards to our action and research enquiries during fieldwork (Joshi and Woll 2013). We also aimed to make the step increases specific and not generalised to better communicate the steps to the others in the collaborative group. Figure 11 presents the different steps involved in the change experiment. However, before starting the cycle it is important to establish a collaborative group, organise work delegation, set a time frame and develop a plan for regular meetings. Moreover, a financial plan is needed for equipment costs and staffs have to be available and not restricted by their day to day duties. The collaborative group can include stakeholders' such as health care staff; care receivers; health managers; interdisciplinary staff, like physiotherapist; and researchers.

The first step in the cycle as a researcher is to spend time in the field to understand the user context and potential issues that require the health care services to be

transformed. Home care staff and care receivers often have an opinion on what is working and what isn't, thus an essential part of the change process is capture the users' perspectives and understand existing work practice.

The second step is to perform task elicitation. Task elicitation involves selecting tasks that are part of the current working practice but that do not work appropriately or are causing specific problems. Thus, by arranging these tasks differently it may be possible to resolve the issues. The use of technology will depend on which working task needs to be changed. In our study (Joshi and Woll 2014), we wanted to use telecare as a means of delivering home care services to achieve increased timely delivery of the services to active elderly care receivers. We, therefore, found it constructive to build services on existing technology in the home thus we chose to use the receivers' television and the only additional technology used was a TV camera.

The third step is usability testing in a controlled environment (Joshi and Woll 2014). In order to teach users how they are to operate the new technology as part of the technology-supported care, user training and testing is essential. The usability testing helps to prepare users for real life use and users can address issues they find troublesome with the current setup of the technical solution. The collaborative group defines operations that need to be tested in order for the users to check the necessary interactions that enable them to use the technology according to its defined purpose (see for example selected usability tests in Joshi and Woll 2014). However, it is not until the technology is moved out of the laboratory and into the homes of the elderly people that the new practice is really "tested".

The fourth step is a diagnostic evaluation of the technology-supported care work in real life practice (Joshi and Woll 2015a), see Figure 11. This move is a critical part of the cycle where technology is moved into the homes of elderly people and tested outside the controlled environment. Users have to master the use of the technology before entering this step of the cycle. However, it was noted during our study that concerns regarding the ability to use the technology were less problematic than concerns in regards to the context in which the technology should or would be used. The collaborative group had to define tests and note other user aspects that influence the quality of care and delivery of services that collectively form the diagnostic evaluation.

The fifth step is the post – experiment evaluation (Joshi and Woll 2015b). This step is an evaluation of the step-wise cycle by the collaborative group. However, during the cycle, the collaborative group also held regular meetings to evaluate the experiment as it unfolded. Figure 11 shows that the outcome of the fifth step is threefold. The cycle can stop if the transformation of work practise is found to be satisfactory. However, often minor adjustments are required. Thus, alternative 1 is to re-do the step of diagnostic evaluation after practical or technical adjustments are implemented. However, sometimes transformation of the work practise fails to persist over time or the collaborative group has identified a new problem that requires them to re-do the evaluation or re-frame the issue. Nevertheless, the transformation of the work practise is both time and resource consuming. Thus, re-doing the cycle should be given careful consideration and one should fully evaluate whether the minor adjustment of the current setup would have a worthwhile impact on user satisfactory.

The study is presented stepwise elsewhere, see Joshi and Woll (2014, 2015a, 2015b), and other aspects of technology-supported home care is further discussed in Woll (2016b).

5.3.2 The conceptual proposal of an overall elderly care trajectory

We make a conceptual proposal of an overall elderly care trajectory in Woll and Bratteteig (unpublished). In doing so, we have applied Strauss and Corbin's trajectory model in order to overcome identified constraints in the traditional way of organising the municipal health care services. The suggested model includes the joint collaborative elderly care work consisting of self-care activities, informal and formal work activities see Woll and Bratteteig (unpublished). The aim of the proposed trajectory is to inform the design of a more seamless elderly care trajectory by connecting technology-provided services to every phase of the elderly care trajectory.

The study is presented in its entirety elsewhere, sees Woll and Bratteteig (unpublished), and is also further discussed in Woll and Bratteteig (forthcoming 2017).

6. Dicussion

In order to explore the use of welfare technology in practice, I have conducted two interpretive case studies and an action research study. These studies are the basis for answering the thesis's main research questions. The first research question addresses constraints and benefits of the use of welfare technology; the second addresses elderly people's user barriers to adoption and use of welfare technology; and the third addresses concerns around how welfare technology can be better incorporated into overall elderly care work. The results are discussed in the sub-sections that follow.

6.1 The critical need for the transformation of the current elderly care system

The elderly care system is a highly complex system that includes several stakeholders with conflicting motives in regards to the use of welfare technology. Thus, the use of welfare technology is not merely to benefit the end users, the formal care providers and the care receivers involved in the "people work" (Strauss 1982), e.g., to reduce the work nurses need to complete or to provide users with increased timely delivery of services. Use of welfare technology to improve the delivery of services or as an innovation in care is rather society's requirement: a necessity to develop services that are sustainable and can handle a growing elderly population and their need for assistance in the future. Until recently, the proportion of elderly people aged67 years of age and above had been relatively stable. In the year 2000 and 2010, this population was approximately 600,000 citizens (Statistics Norway 2014). However, in 2020, the population is expected to increase to 800,000 citizens, and in 2035, the population of citizens age 67 years of age and over is expected to increase to 1 million Norwegians (Statistics Norway 2014). Moreover, the age distribution within the population will have an impact on the need for care services because the number of elderly people over 90 years will also grow. In 2010, there were 38,500 elderly Norwegians over 90 years. In 2020, the oldest Norwegian population is expected to be 46,000 citizens. Moreover, in 2050, the number of elderly over the age of 90 years is expected to be 95,000 citizens (Statistics Norway 2014). Thus, when the Norwegian population has an uneven proportion of individuals contributing to tax revenues and retired people on pensions; welfare services have to be affected in one

way or another. Consequently, the current way of organising elderly care services has to be downscaled or develop in new ways to achieve a sustainable elderly care system. Thus, older people who do not have impaired cognition or physical capabilities have to take greater responsibility for self – caring and family and voluntary resources have to support elderly people to a greater extent than seen today.

Home care managers notice the pressure of delivering efficient services the most as they only have the ability to accept a maximum number of residents which is limited to the housing's rooms/apartments available. Home care managers are also noticing a general decline in their user's health with users being sicker on entry than users traversing the care staircase a decade ago. Thus, some current users are given home care services in an extensive manner almost comparable to in-patient care. Moreover, the managers of both care housing and nursing homes express that their users have increased health care issues compared to prior user groups. The entry to formal care services and housing is being postponed and elderly people have to be sicker to receive home care services or to be offered residence in care housing and nursing home. Human care has always been the most preferred way of looking after our elderly population. It is easy to note that access to services included in the care staircase has raised the threshold for users. Thus, the majority of formal care services provided are not replaceable with technology, e.g., the work of personal care and grooming cannot be delegated to technology. Scarce welfare resources and a growing elderly population restrict human care for everyone. Thus, current care arrangements have to be transformed so that elderly people needing human care services are guaranteed sufficient services in the future. But is it realistic to aim for technology-supported elderly care arrangements? I would argue yes. However, necessary assumptions have to be in place. I recommend that technology-supported services are introduced earlier than they are today, more precisely to younger people. Moreover, the delegation of selected care work to technology can only be justified by providing users with technical solutions that have technological or organisational capabilities because the introduction of technology as part of the care arrangements increases the complexity of the "people work". The move from "personal care" to "personal care *and* technology supported care" makes the service delivery more vulnerable to socio-technical failures or breakdowns. I saw during my fieldwork that the majority of elderly participants were novice technology users. The elderly participants had unstable and shifting user needs, which are challenging to support

with technology. The reason being that the way around a break down in technology is easier for human's to deal with than it is for the technology support to. Use of welfare technology is not seen as a concern for elderly users in isolation. It also requires the skills of formal and informal care providers. Health care workers are also not used to extensive technology use in their care work. Often the care providers are untrained users of welfare technology and they also have to learn the new practice of technology-supported care before becoming skilled users. Thus, the "main" participants in "people work" have to learn the new practice of care activities. Hence, elderly care services that have recently incorporated new technology face the potential for breakdowns , e.g., the distributed work arrangement is new and the activity's mediating relationships include subjects as novices and (sometimes novel) technology, e.g., neither people nor technology may act or respond as planned. Therefore, a breakdown in this context is more than merely a technical failure, it is also occurring as a result of socially constructed problems arising due to the use of new tools, e.g., welfare technology.

I argue that the observed breakdowns of socio-technical relationships are useful resources in the process of transforming care practice. Thus, breakdowns give new knowledge of socio – technical complexity and enable procurers to provide better procurement solutions in order to avoid them. Moreover, breakdowns are essential resources in the development of new work routines to prevent or minimise the outcome of breakdowns and recover from them. Similarly, I recognise Bardram's (1998) claim that understanding the socio-technical dynamics of the collaborative elderly care work is essential when introducing welfare technology in the hope of transforming current work practices. Especially, since the transformation of care practices is rather radical for the current generation of elderly people, as until recent time, elderly care has been performed primarily by human resources. Although the majority of old people seem highly motivated to self-care to avoid institutionalisation, I have experienced that they also find it challenging to handle the use of welfare technology as it requires them to manage, navigate, interact, configure and maintain technical devices. Moreover, I have experienced that active use of technology as the only form technical support is not sufficient or justifiable support. Thus, the understanding of collaborative breakdowns can be used to develop solutions that support users in situations where they have not mastered the active use of technology. The valuable nature of breakdowns is also recognised by Bardram (1998); "*Thus, the*

importance of understanding cooperative breakdowns, however, lies in the importance of supporting such breakdowns in the design of computer technology" (p.91).

The object of the provision elderly care such as home care is shared by a joint care effort; however, the collaborative nature differs from the collaborative activity of health care professionals in the surgery ward (Bardram 1996). First, the joint elderly care work is distributed in nature. The coordination of work in the care home setting is performed by the head nurse who delegates user lists to each team member ahead of their shift so that each team member knows which users they need to visit, when, where and what to do whilst there. The team members often chose to visit their users according to the pre-arranged order; however, they have the freedom to adjust their lists. For example, a nurse may find it helpful to re-arrange the list so that she/he can visit two users, who live in the same area consecutively, rather than visiting one user in the morning and then returning to visit the second user in the evening as per the list. Elderly care receivers are also performing co-ordinated work. However, their work tasks are related to their own everyday life activities. This work is of great importance for the formal care work sector. For example, findings from the action research study show that telecare session went smoothly on those days where the participants had performed their co-ordinated work ahead of the call, more precisely, when they had finished their morning care: had gotten dressed, eaten breakfast, and were prepared to take the incoming telecare call. In situations where the participants were unable to take the telecare call for various reasons, e.g., they were bedridden, the collaborative activity of telecare session failed. I experienced that participants did not have the capacity to recover from breakdown situations which appears to contrast Bardram's study of co-operative work in a surgery ward (Bardram 1996). Bardram reports findings of health care workers that make "*reflection on the means of work*" (p. 92) and work arrangements that may need to be re-established in cases of breakdowns (Bardram 1996). In the elderly care setting, it is the formal care providers that have the formal responsibility of the care work. And the formal care providers are doing their co-ordinated work with less or no involvement from the care receivers. Thus, in cases of breakdown of telecare sessions, the care receiver knows that the nurse will perform a home visit instead. However, sometimes the care receivers had just overslept, so if the nurse had repeated the call later during the day, the user would have been ready for the telecare session. To better support co-

operation, a tool to support communication could be a solution to this problem. For example, if the care receiver did not answer the telecare call, the nurse could check if the receiver was still in bed by use of a bed sensor. Moreover, the nurse could call the user to supervise the situation and the actual need for a home visit. Alternatively, the nurse could agree upon co-construction of the collaborative activity in cases where the user had serious illness, e.g., the care receiver could for a shorter period receive home visits as a replacement for telecare to recover properly.

6.2 Implication for welfare technology use

During my fieldwork, I have experience that new use of technology needs careful and close follow-up, at least initially, until new the practice is learned to avoid compromising the health and safety of elderly people. Moreover, my findings indicate that the current constraints of using welfare technology are more pronounced than its potential benefits. The identified key constraints are therefore seen as valuable knowledge in the process of transforming current care practice to support the elderly people better. However, I stress that only by overcoming the key constraints, can the potential benefits of technology-supported elderly care be accomplished.

6.2.1 Constraints of the current care staircase

The current pathway of municipal elderly care services is made up of the staircase of formal care services. The staircase is limited by its lack of attention to technology-supported services beyond the personal safety alarm and joint collaborative care work. Thus, the proposed care trajectory builds on the staircase (Woll and Bratteteig unpublished). In our trajectory design, we have tried to “translate” the formal staircase into a person-oriented seamless “journey” that also includes housing: ordinary homes, care homes and nursing homes. The main objective of designing the trajectory is to support users in getting a better overview of care services, thus making the care services more accessible to elderly people.

Elderly people, who have the capacity to self-care, are essential contributors in the future of elderly care. Those with minor care needs have to be content with technology-supported replacements or alternative ways of performing self-care as long as they are able to do so and so long as the quality of care is maintained. To accomplish this endeavour, the entry to technology-supported services has to start

early, pre-trajectory, to support users in self-care activities better, e.g., preventing accidents and helping them to stay active. Thus, the current care staircase has to expand and include technology-supported care services pre-trajectory. More precisely, a number of services have to be added before the initial step toward formal services is taken and actually needed. Thus, people performing self-care should be supported with technology that better supports their work, e.g., with aids from the technical aids centre. However, the various aids should be systemised and offered as pre-trajectory support under the elderly care system “umbrella”. Moreover, increased use of technology in elderly care can have positive outcomes because it allows users to receive smoother and timelier delivery of services that are tailored to their everyday lives.

Another finding is that elderly people lack the user habit of taking their mobile devices with them when moving around their apartment. For example, users of the tablet had either the tablet in the docking station or in another location which meant that they were unlikely to notice information sent to the tablet when not looking at it. Clearly, they could benefit from being supported by a flexible and adjustable stand for the tablet such as a tablet holder with a goose neck, long flexible arm or table clamp stand. Moreover, by offering a flexible tablet stand, the tablet is easier to operate and is more suitable for other services such as telecare sessions and online grocery shopping, as it was experienced that users struggled to hold and operate the tablet. Elderly people with fall tendencies or those who are not actively ageing should be instructed to wear the safety alarm around the arm 24/7 and not around the neck. Thus, small adjustments can support and safeguard users better in active use of technology.

During my fieldwork I observed that current elderly care could also benefit from becoming more people orientated. For example, the workflow of home care nurses should be supported by a coordination tool that includes accurate information of the users the nurse is about to visit so that the nurse is more able to provide timely delivery of services. Additionally, I have seen that certain care services can actually be transformed and delivered by technology, e.g., by the introduction of telecare. However, the transformation of elderly care is not done overnight and requires thorough user training, testing and exploration to ensure that the care work is more productive without compromising the user's dignity or security. One approach to a

stepwise change in work practice is presented as part of the action research study. The technological support needs to be in place before the health care issues get too severe: in time for them to appropriate habits and preferred ways of living. The trajectory can provide advice on when to introduce technology that may enhance abilities and potentially increase the range of possible activities. For example giving a dizzy and fragile person a walker supports walking and may (re-)introduce the ability for that person to go shopping, exercising, go for walks and visits that were difficult previously. In this way, the technology prolongs ability. A hearing aid or a wheelchair, for example, do more than support a weak ability, they enhance it and in doing so may increase the ability of an individual by replacing a function that is disabled (e.g. hearing, walking). Replacing obviously is stronger than supporting, but several reports show that training is necessary for the individual to actually be able to make use of new abilities, hence introducing hearing aids before a person becomes deaf or exercising using a wheelchair before a wheelchair is needed constantly introduces a higher threshold to technology support than merely supportive technologies do. There is a range of ethical dilemmas embedded in welfare technology. How long do people want to live independently in their home if they are totally dependent on technology; what does “independently” mean? The health authorities want most citizens to live in their home until the end of the trajectory, allowing the elderly to live and die within their own homes instead of a nursing home (Senior Report 2014). Currently, most elderly people die in nursing homes or during hospitalisation. Thus, only the sudden or unexpected deaths of elderly take place in the home. Death has, due to this, become alienated from the family. Elderly people who decide to stay in their homes after they have lost the ability to live independently are provided with extensive home care services, almost comparable to inpatient care, as a replacement for nursing home services. From an ethical perspective, the technology has to play a less important role during the final phase of the trajectory (e.g., expanded safety and security measures or for monitoring purposes only) since human care never can be replaced in the terminal phase.

The transitions and transfer from one service level to another is recognised as particularly important as they can be problematic for the elderly people. Hence, the transitions between the main phases are an essential and critical part of the trajectory. Smooth transitions can lower the threshold and increase the user experiences of traversing the elderly care trajectory because some users are in “grey phases” too

long and these users need to be supported earlier than they are today, either by increased support where they are located or by being transferred into housing that provides them with additional assistance.

Moreover, transitions are not necessarily a linear process, as they can be both horizontal (traversing the main phases) and vertical (traversing within a specific main phase) depending on the elderly person's general condition and the prospect of recovery (the user's capacities for rehabilitation). Thus, elderly people can experience shifting health conditions, but still be able to stay in the same phase of the trajectory if supported by increased formal and informal care in shorter or longer periods. In order to transform the current pathway of municipal elderly care services, it is recognised that it is constructive to add self-care and informal care into the proposed elderly care trajectory. This design attribute brings awareness to the joint collaborative care work that involves the care receivers, their relatives or voluntary networks, and formal care providers.

Additionally trajectory can be a means to help elderly people understand which health care services are available at various points in time (when they fulfil a set of requirements) and also enable them to navigate optional measures so that they can prevent or postpone the transfer to the next phase, e.g., by use of technology during the transition phase. The trajectory, therefore, needs to "speak to" the elderly people when planning present care needs and discussing their future (which involves potential illnesses and decline in abilities). More precisely, the trajectory design aims to support people in problematic transitions, in the decision-making when deciding if it is justifiable to live longer in an ordinary home, e.g., what are the alternative options for support in the home? Not surprisingly, the focus has to be on their mastery[10] of independent living. An important problem with technology designed to compensate for loss or decline in abilities is that people approach the technology too late for them to learn or utilise its potential.

Use of technology to support the joint collaborative work of formal care, informal care and self-care refers to how the public healthcare system responds to elderly people's declining cognitive- and physical capacities by means of providing users'

[10] The notion of mastery is defined as "a human response to difficult or stressful circumstances in which competency, control, and dominion have been gained over the experience of stress." (Younger 1991, p.76).

with various measures of assistive living such as housing, technologies and elderly care services. However, the lack of infrastructure that is necessary to support users with technology provided services in ordinary homes is a key constraint of current welfare technology use and prevents technology from being applied to its full potential. In ordinary homes, the users' ability to perform self-care is expected to be relatively high and supported by informal care providers according to individual user needs. However, the shifting general condition of the individual's health and sudden illnesses can cause the individual to be temporarily unable to perform self-care activities, e.g., when a person is hospitalised and needs assistance to recover.

The division of labour and amount of care work performed by the different stakeholders in the collaborative work group is seen as essential element in the trajectory design. Thus the amount of effort required from the formal and informal care workers depends upon the user's ability to perform self-care work. Use of technology is recognised as an important tool when supporting elderly people in prolonging a phase and in smoother transfer between phases. We, therefore, add technology-supported services throughout the trajectory. Our elderly care trajectory supports findings by Fitzpatrick and Ellingsen (2013), who argue that the move of technology into the home brings attention to self-care activities. The shift towards technology- supported care can reduce the number of home visits required and the benefits of technology-supported care are gained when technology replaces other tasks like one or several home visits. However, we argue that this shift will make the nurses prioritise home visits to those elderly care receivers that need them the most, e.g., elderly people that need support with personal grooming and care. Elderly people who have the capability to perform self-care are rewarded by slowing the decline of cognitive- and physical capacities.

The distributed collaborative nature of elderly care is also discussed by Petrakow (2007), who argues that home care work is more complex than hospital work as work activities in the home take place in a context that is difficult to change. One of the several advantages of living in care homes is that the architecture is designed for assistive living, which makes it easier for the care providers to carry out their work. However, universal design of an apartment does not compensate for the fragmented nature of the current elderly care infrastructure. Thus, there is a need to explore alternative infrastructures that include formal care services but also emphasise self-

care and informal care. The proposed trajectory gathers the varied caring resources and places them into an overall elderly care infrastructure. The trajectory design makes it easier to collaborate, generate understanding of who does what and where, and improve the coordination of work activities between different providers within the healthcare infrastructure.

Several researchers (Bratteteig and Wagner 2014, Piras and Zanutto 2010, Strauss et al. 1982) have called for tools that will support users during health care activities as the health care workers have shown a tendency to delegate the increasing responsibility of self-care to the patients. The authors argue that patients need tools to handle the increased responsibility and that they need solutions that are secondary to the tools forming a failsafe to secure their safety and security. The shift towards increasing the responsibility of elderly people who are able to take on the responsibility needs to be supported by backup solutions, such as the passive use of technology, to safeguard situations when the elderly person experiences acute illness or sudden decline in their health condition. Strauss (1982) and research contributions made by Strauss's patient work (Bratteteig and Wagner 2013) suggest that the increased focus on self-care work caused elderly care to develop into distributed collaborative work where the work effort of the care receivers' is just as important as other care providers. The elderly care design supports their findings and the increased focus on active ageing and successful ageing has brought a lot of pressure on elderly people to live in certain ways, maintain a healthy lifestyle, and actively take care of themselves. This is echoed by Proctor et al. (2014) who argued that successful ageing is socially accomplished by collaborative efforts of elderly people and their care network. They stress the importance of simple and easy customisation of technology to support individual needs. Thus, the use of technology can be a means of developing personalised elderly care services.

Aaløkke Ballegaard et al. (2006) reflected on the use of assistive technology and argued that such technologies are often introduced too late to elderly people, e.g., in acute phases when users have a severe or complex reason for increased care services. Their findings coincide with mine and Joshi's findings (Joshi and Woll 2014) as we observed that those with cognitive impairment struggled to use technology actively, especially unfamiliar technology such as a tablet or a personal safety alarm. However, my experiences are that old age alone is not restricting the active use of technology,

rather illness and health conditions combined with old age. This observation supports my argument for expanded use of automated services and passive technology.

6.2.2 Designing solutions supporting “unstable” user needs

Strauss (1991) understands the continuity of care as an illness trajectory. He recommends that current care needs and interventions should be designed with respect to “*past and future*” (p. 166) services. Strauss (1991) further states that the home (the home of persons with chronic illnesses) is the “*centre of care*” (p.166) and that hospital and rehabilitations units should be seen as backup resources.

First, throughout my fieldwork experience, I observed elderly people were not facilitated with wired- or wireless Internet. The care housing setting had procured welfare technology packages including safety alarm and a tablet, however, the Internet capacity in the residents’ private apartments wasn’t really sufficient for supporting the welfare technology package. Every elderly persons home should have wired and wireless Internet service as a minimum requirement so that the addition of technology-supported services is seamless.

In order to provide care services that can support fluctuating and shifting user needs and to recognise the home as the *centre of care* steps must be taken to arrange adequate Internet access. Many residents report that Internet services are costly for them and Internet services are therefore not affordable for some elderly people. I therefore recommend that seniors are offered a substitute to Internet services such as the technical aids centre providing its users with a wireless router.

Users with shifting general health conditions and health care issues should be given human care services when they lack the ability to self-care. However, I argue that in stable periods where symptoms are less pronounced, users can benefit from technology – supported services *if* the technical assistance has a built-in secondary functionality or back-up. It is important to maintain self-care activities to avoid deterioration. Additionally, the passive use of technology is an essential aspect to increasing the user’s safety and security both in stable and unstable user periods. Moreover, I call for the passive use of technology during the evaluation of the need for transfer: in the transition phase when elderly people are evaluated for transfer to another form of housing. Elderly people in the “grey areas” in the elderly care

trajectory (not fitting into any phase) can be monitored for a set time of two weeks, e.g., sensors could be used to log activities of daily life (ADLs), such as time spent in bed or absent from bed, the amount of opening and closing of the refrigerator door, t the use of tap water, passing the bathroom door or main entrance door, or turning the light on or off. Additionally, other activities that a user typically does during a day could also be logged to monitor their activities, e.g., watching television or sitting in a specific chair. Thus, after a two – week period the gathered data could be analysed to help tailor measures according to the user needs. In this manner, technology could be used to give home residents the same safeguard as those elderly people living in care housing who are observed on a daily basis. The care housing staffs would follow-up and intervene if they registered abnormal activity. For example, users who generally spend time in the lobby area would be checked upon if they were unexpectedly absent for a day.

6.2.3 Implication of welfare technology uses on the phenomenon of ageing

The use of technology as part of the health care delivery in the caring for elderly persons gives rise to a number of ethical dilemmas, especially in regards to protecting the elderly person's right to privacy. It is also important to emphasise that the use of assistive technology is not merely affecting the elderly person, but also bring the elderly peoples' families and public health care staff in to the sphere. For example, technologies that alert in a pre-defined situation require an infrastructure where "someone" responds to the alert or acts when information collected by the technology requires action. That "someone" could be a health care staff member or family member, which means that they would also need to familiarise themselves with the new technology. The motivation of the housing-oriented care system is to include the family to a greater extent in the care network as past institutionalisation of care services has resulted in the family being less involved in the practical matter of caring for their relatives (Daatland and Otnes 2014). The phenomenon of ageing has transformed into an increasingly disease focused area. Ageing is seen from the perspective of disease and the user's GP and municipal health care service make a formal decision of introducing assistive technology for the purpose of reducing the risks of potential accidents and diseases, e.g., a fall alarm. However, I also argue that there is an increased benefit in presenting welfare technology earlier in an elderly person's journey.

Thus, technology that controls or intervenes to prevent diseases and mortality can help to slow down age-related diseases and prevent risks for accidents with adverse outcomes. However, elderly people sometimes experience the introduction of assistive technology as an intrusion into their home and fear that technology is replacing social contact. Particularly in cases where technology is introduced in a top-down manner from the public health care system. Moreover, the introduction of technology could cause the elderly people to begin to experience the increased negative connotations of being ill or they may begin feel vulnerable to diseases and accidents as they believe these technological interventions must be for that reason. Thus, there appears to be an increased focus on disease in ageing with preventive measures being made in their homes to reduce the risks for additional diseases and accidents.

In order to discuss the phenomenon of ageing in the light of welfare technology use, an essential question to address is who is meant to benefit from the use of assistive technology? In the long run, who benefits the most from the increased ICT support in elderly care? Is it the community? Future generations? Health care system? Patient/user? Or their families? It is also apparent that there are potential conflicts of interest between these stakeholders. Society will benefit from the efficient use of scarce health resources and the use of technology in elderly care will generate a need for additional manpower, which again will reduce the workload of scarce health care resources. The health care sector is forced to develop a more cost-efficient elderly care system as increased safety measures in the home can help to reduce repeated hospital admissions and decrease the need for costly long-term stays in nursing homes. The plan to have a health watch call centre for more efficient treatment and safety system will require access to a shared patient health record systems at all levels of the health care services. Thus, all of the preventive measures are turning elderly people, who may not have any health care needs, into potential users or patients of a health watch call centre.

Family members caring for elderly persons can use public technology for remote visits and then feel less guilty for not actually attending the elderly person’s home. Despite this fact these interventions can be beneficial in reducing the risks of additional diseases and addressing society’s need to prolong the time elderly people can live in their ordinary homes. However, it is also gives rise to a dilemma in the

fact that society's scarce health resources are utilised on elderly persons who are considered non-users of the health care services in an attempt to prevent decline. The resources used on preventive measures can pay off in the long run if the elderly person has a reduced need for complex health care services. However, there is still a lack of research that explores the economic gains of implementing assistive technology into the overall elderly care. The understanding of disease and the relationship between disease, illness and sickness is changed when assistive technology is introduced as an incorporated part of the ICT-supported elderly care for preventive efforts when no other diseases are identified.

The reason being is that assistive technology is also introduced into the homes of an elderly person who has no health care needs, but is at risk of diseases or accidents that can have a fatal outcome. Thus, preventive measures made to control or intervene in the private homes of elderly people make the focus of ageing more disease focused, see Woll (2016b). However, this has to be separated from cases where assistive technology is introduced to support elderly people with additional diseases such as Alzheimer's diseases. The technology is then a treatment measure to support additional diseases and not ageing. Thus, it is important to recognise that there is a difference between ageing and assistive technology usage for preventive measures supporting "healthy" elderly persons and ageing and assistive technology usage in user situation where the elderly person has additional diseases that need to be controlled for safety reasons or treatment purposes. Moreover, finding a cure for Alzheimer's disease[11] or putting the effort into better prevention of hip fractures would release pressure on the health care needs of elderly people, thus, could be seen to "solve" the elderly care "crisis".

Hektoen (2014) has examined the cost for hip fractures among elderly people (above 70 years) living in an ordinary home by evaluating registry data for hip fracture surgery (n=378) at St. Olav's Hospital in Trondheim, Norway. I will not report on her costs, but rather on how the patients traverse the elderly care system after hospital admission. Hip fracture is a common injury among elderly people as a result of fall. Hip fracture is reported as the eighth most common death cause in Norway (GBD

[11] Alzheimer's diseases are the second most common cause of death in Norway. Various estimates of the prevalence of Alzheimer's diseases for the Norwegian population are presented and the most common number reported is 70,000 persons.

2013). Annually, 9 000 elderly Norwegians at an average age of 80 years are treated for a hip fracture. Daily, 24 elderly Norwegians are injured by hip fractures.

Hektoen (2014) reports that only 53 patients (14%) were sent directly home again after hospital admission. Prior to the hip fracture these were non-users of formal care services and so-called independent livers. However, they received home care services for follow-up care and interdisciplinary rehabilitation services after the hospital admission. She further states that 236 patients were transferred to rehabilitation stays after surgery. The average rehabilitation stay was 28 days. The patients moved back home after recovery and continued to receive home-based rehabilitation services. 30 of 236 patients who were sent to rehabilitation died during the first year. 89 patients were transferred directly to in-patient care at nursing home after surgery. In this group 19 patients died during the first year. Residents living in the nursing home are representative for 25 % of the annual hip fractures (Hektoen 2014). However, these patients were excluded from Hektoen's analysis as her inclusion criteria were hip fractures of elderly people living in ordinary homes only. Residents in nursing homes are the oldest of our population and those with most severe health care issues, however finding solutions to support or prevent hip fractures should be set as a priority both regarding the painful outcome of such fractures and its costs.

6.3 Implications for research

In order to understand the use of technology in the elderly care setting, I have focused on the joint collaborative elderly care work of self-care, informal care and formal care, so-called trajectory work. Moreover, I propose a way in which technology can support the various and distributed activities of the trajectory work. Relatively few CSCW studies have brought attention to this specific research topic. Thus there is a need for focus in this area and theories that allow researchers to examine the socio-technical complexity of elderly care work. Moreover, I have emphasised the importance of mixing active and passive use of technology to support elderly people better and to help them utilise their abilities to self-care. I recognise a need for secondary solutions that activate additional support when users fail to maintain self-care work by adding layers of increased technological and organisational measures. Thus, using technology as a means of providing care services also requires an ability to delegate work responsibility. In situations where users are unable to take this

responsibility, users need additional support to avoid socio-technical breakdowns that can harm their health and safety. This kind of computer-supported work is less addressed to CSCW.

Additionally, I emphasise that the elderly care trajectory should contribute to a standardised elderly care package similar to the current care staircase that provides users with access to information, services and user privileges. Moreover, the trajectory is also considered as a tool for elderly people during problematic transitions to support them in decision-making. The trajectory design challenges what social theories can offer, e.g., increased socio-technical complexity is hard to grasp by applying AT as the framework of analysis. I discuss the use of theories more below.

6.4 Use of theories

I have explored what AT can offer in informing the design of an elderly care trajectory, and mediating technologies supporting the joint collaborative care work from pre-trajectory to trajectory end. The theoretical study including reflections of the use of theories is presented in its entirety elsewhere; see Woll and Bratteteig (forthcoming 2017).

An interesting discussion in the light of the active and passive use of welfare technology is how AT can give new insights into activities where subjects are operating in the objective world by increased levels of automation (Cummings 2004). Moreover, the increasing use of automated services challenges AT's originally starting point of describing *human* activity. Cummings's first level seems to fit with the motivated human activity where a human "takes all decisions and actions" as the activity unfolds (Cummings 2004, p.2), e.g., the elderly person is actively pushing the personal safety alarm button. However, the increasing passive use of technology is supporting elderly people better regardless of their cognitive and physical fluctuating abilities. As a result, elderly people pass control to the automated instrument that is initially mediating the relationship of the subject and object. As levels of automation are added, the subject becomes increasingly an instrument rather than a subject and in fully automated activities; the instrument and the subject swap places in an activity system. When a human activity is completely controlled by automation "the computer decides everything and acts autonomously" (Cummings 2004 p.2). Fully automated

services in this setting use the elderly people as the instrument to act in pre-programmed setting, e.g., a person has fallen and the sensor is programmed to alert to a response system. Many elderly people are said to not have the capacity to understand active use of technology so the passive use of technology is increased for their safety. Moreover, the workload of the safety alarm response system will also increase, but the gain of allowing elderly people to feel safe compensates for the instrument taking control in the user settings where users are unable to make decisions or actions. Here different levels of complexity in human interaction with technology are added and this can be experienced as challenging for an elderly person to make decisions and actions if they are a novice technology user or are not feeling well. I presented earlier in the thesis an example of Pilly, the automated medication dispenser. Pilly alerts users to take medication and if the users have not taken the medication out of the slot within the set time period, Pilly alerts a pre-configured "someone", either a formal or informal care provider. I have evaluated this service to be part of the sixth level of automation: it "allows the human a restricted time to veto before automatic execution". Thus, every automated service in the real world is not fitting precisely into Cummings levels of automation.

I have met a few users of Pilly and they all are satisfied by the support they received because they are now self-dependent in regard to the administration of daily medication. However, those users who have shifting daily conditions are a challenge to the automated design of Pilly as Pilly cannot make sure that the users actually take the medication, even if they have taken the medication out of the dispenser. This is a struggle experienced by all of the levels from 2 to 5, those automated levels that are not giving full control to either the human or the machine. The reason being is that Cummings level 2 to level 5 includes collaboration between human and technology. Cummings referred to this as "the balance of automation and human control in decision and action selection" (p. 2). The balance that she refers to can often include rest-work or gaps in actions that are not done for various reasons, for example, users who have taken their medication out of Pilly, but who forget to take it are not supported any further. Pilly is pre-programmed to accomplish a specific task: ensure the user removes the medication from the dispenser within the set time range. Co-author and I argue, among others, that Engeström's activity system with its outcome often represents an ideal user situation and that the outcome of an activity is often various and not always predictable or successful (Woll and Bratteteig forthcoming

2017). Thus, in additional to the call for frameworks in CSCW that can offer researchers the macro view of socio – technical complexity of the unit of analysis, I argue that the increased use of automated services in the society can also challenge the application of AT as its fundamental origin is on the basis of the *human* activity, see Woll and Bratteteig (forthcoming 2017) for further aspects of this discussion.

7. Conclusion

In this thesis, I have identified constraints and benefits of the use of welfare technology in the elderly care. A key constraint of elderly care is the primary focus on solely formal care services and the lack of attention it brings to technology-supported services that all elderly people actually are mastering using. Technology-supported care services are often introduced too late and thus fail to support users in practice. Some users experience gaps when traversing the care staircase with its variety of care services connected to the different housings including ordinary homes, care housing, and nursing homes. The threshold to obtain access to formal care services has risen at all steps in the care staircase. In the future, the growing elderly population will put larger strain on the scarce welfare resources; this gives rise to a critical need for transformation of the elderly care. Thus, elderly people in general, including those with minor care needs and intact cognitive and physical capacities, have to be delegated the responsibility of self-care to a greater extent than is the case today and to operate technology – supported services. Moreover, the lack of infrastructure and standard for welfare technology is limiting the ability of users who wants to prolong independent living to do so. Moreover, it should be a formal demand- or benefit of elderly people to have, or to prepare for having, access to Internet services, which is the fundamental prerequisite for the use of digital welfare technological services.

During my fieldwork, I have experienced non-users of technology, reluctant non-users becoming users that can be characterises in all range from sceptical to enthusiastic technologists, and users becoming non-users again etc. Thus, I have sought to find the elderly users' barriers to the adoption and use of welfare technology. The mastering of welfare technology is diverse, nevertheless is it essential to design and offer elderly people technical solutions that are actual supporting their user needs and with a user interface that they actual can use. One of the most essential and critical functions of welfare technology is to support users with safety and security measures. The use of the traditional safety alarm is seen as limited as it requires users to understand its use regardless of cognitive and physical capabilities. I recognise a need for separating welfare technology into the active and passive use of technology, because welfare technologies should be designed with different levels of automation to support fluctuating user needs and the diversity of

users. I recognise elderly care as a collaborative effort including joint work contribution from elderly people (self-care), family and volunteers (informal care), and paid health care providers (formal care). By offering technological solutions supporting levels of automation, one allow technology to actually play a role in the division of elderly care work. Moreover, technology can then be a tool to delegate work responsibility back to the elderly people, thus, without backup support from informal and formal care providers.

The current elderly care model represented by the care staircase is experienced as a highly complex system, fragmented by its many stakeholders and the introduction of technology into this domain is increasing the socio-technical complexity of elderly care. The elderly care system is to some care receivers experienced as impersonal and it requires cooperative efforts across or within organisations to provide satisfactory health care delivery for the users. My findings indicate that the key constraints of using welfare technology are more pronounced than its potential benefits. The identified key constraints are therefore seen as important knowledge in the process of transforming elderly care. Thus, I argue that only by overcoming these, can the potential benefits of technology-supported elderly care be accomplished. Hence, the potential benefit of using welfare technology is the fact that it can be introduced to relative healthy users for the purpose of supporting them in preventive measures and in cases of shifting general conditions. Thus, the use of technology can be a means to prevent accidents or solely for back-up purposes. I suggest combining the active and passive use of welfare technology to a larger degree than seen today. This in order to support actual user needs of elderly people with fluctuating general conditions or those with extensive care needs. For example, elderly people can experience a sudden decline in general condition, thus, they need back-up solutions when they are not able to operate their personal safety alarm. Passive use of technology can also be a measure to prolong their current phase in the elderly care trajectory, thus, there is a requirement to increase the passive use of technology in elderly care.

The introduction of welfare technology as part of the elderly care delivery is experienced as challenging because the incorporation is highly context-sensitive. I present the action research study as one practical approach to transform conventional home care practice, e.g., by the use of telecare. Moreover, I call for a re-design of the current care staircase, to overcome the identified key constraints and the elderly

users' barriers to the adoption and use of welfare technology. Thus, the conceptual proposal is presented as the elderly care trajectory. The trajectory acknowledges the joint collaborative care work and makes assumptions for technology support throughout the various types of care work regardless of where the elderly person is located in the trajectory phases. The main objectives of the trajectory are as follow.

1. To introduce technology-supported services to younger elderly people so they can learn to use the services before they actually need them.
2. To connect technology-supported services to each of the different housing arrangements in elderly care.
3. To combine the active and passive use of technology for the importance of secondary back-up services and increase support to prolong the user's safety in each phase of the trajectory.
4. To increase passive use of technology to assist users better during transitions phases, e.g., for increased safety and security, and as a basis for documentation in problematic decision-making, e.g., decisions concerning the need for transfer to a care housing setting or nursing home.
5. To use technology as a tool to delegate increased responsibility to active ageing care receivers and their family. Thus, technology can be used to motivate users both in self-care- and informal care work.

I have also studied the potential benefits and limitation of activity theory as the theoretical framework for analysing technology-supported elderly care services. Leont'ev's hierarchical structure of an activity is proved useful for analysing how elderly people learn new technology-mediated care practices, and Engeström's activity system for studying the specific work context. In order to support elderly people who suffer from diseases and various declines, increased use of automation in technology-supported elderly care activities may be needed. Hence, my findings indicate how automated tools challenge the researcher in applying AT by discussing "instrumentality" versus motivated action of elderly people. I further suggest to combine the use of AT and TOA. Whereas TOA and Corbin and Strauss's trajectory model can supplement AT with a level of macro – analysis by adding time and transition as essential aspects of the elderly care trajectory. In addition, Strauss's concept of articulation work is recognised as particularly important for understanding the increased technology-supported elderly care work. Articulation work concerns both the making of arrangements, and the work to carry them through in a cooperative work setting. Gaps in the delivery of health care services can occur when,

e.g., elderly people experience sudden shifts in their capabilities of handling the technology-mediated object of activity. Articulation work is necessary to find and carry out a planned activity in an alternative way. In particularly, in user situations where work has to be re-delegated so that the subject and the object of activity is shifted.

Finally, I have discussed the different perspectives on disease in the light of aging to better understand aging and how our view of aging has implications for welfare technology design and use. Aging increases the risk for age-related disease(s) that can result in a decline of self-care abilities and long lasting needs for health care services. Aging combined with diseases is not a linear process: elderly people can have good and bad days, especially during phases of decline (transitional phases). Thus, in order to support elderly people's actually user needs, I recognise the elderly care trajectory as essential for the future development of technology-supported services including its suggested levels of automated services.

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PART II: PAPERS