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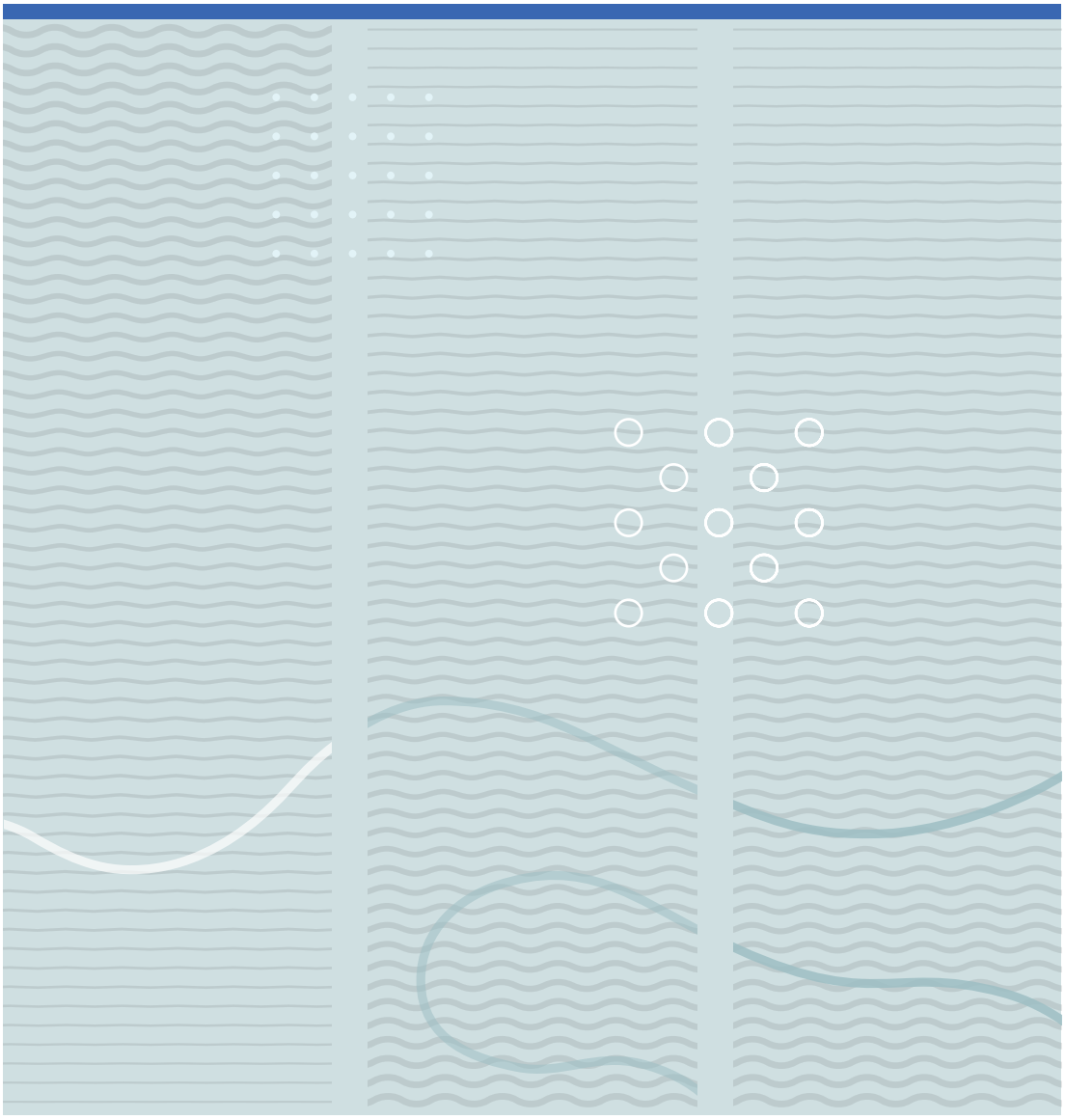
Janne Herholdt Dugstad

Co-creating digital transformation in care of older persons

A longitudinal mixed-methods study



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To my beloved family

Preface

Throughout my 25-year academic carrier, I have been strongly motivated by facilitating the development of health professionals' competence and clinical practices to the best interest of their patients and themselves, accustomed to the organizational context and infrastructure offered by the health organizations, as well as the larger healthcare system and professional communities to which they belong. I am a registered optometrist, and worked for 18 years within optometry and visual science, and also with lighting design. With the overall responsibility for bachelor-, master- and continuing educational programs, as well as research, I experienced the importance of close cooperation between the academic institution, the professional bodies, the industry, the consumer market and patient organizations, the Government and regulatory authorities, as well as corresponding international actors, in order to sustain a knowledge based link between education, research and professional practice.

Since 2006, I have belonged to a health innovation network in the Drammen-region. As my carrier later turned into the field of health innovation on full-time, I was fortunate to continue working in this ecosystem of healthcare organizations, vendors, researchers, third sector organizations and funding agencies, aiming at transforming the municipal care services by innovating and implementing welfare technology. As part of this, I had positions in the boards of the DRIV incubator and the Arena Health Innovation network. Since 2012, I have been the director of the Science Centre Health and Technology, which was accredited as an USN research centre in 2017. I had research leave in the period November 2017 - November 2019. In 2013-2017, I represented our institution in the steering group of the Digital Night Surveillance project included in the thesis. Since 2013, I have been involved in the "Digital and innovative health- and welfare services" master program, which I am currently coordinating. I have also been a member of the regional value creation team for clusters and networks since 2013.

These commitments have contributed to the foundation and progress of this thesis, which was initiated in 2013 and has been undertaken on part-time until submitted.

Acknowledgements

Undertaking this PhD has been extensive, innovative, very inspiring, but also demanding and complex work. I would like to thank all persons who participated in the research- and implementation projects included. You have been my foremost motivation.

I am grateful to all university units and leaders supportive of my work. The initiative to do a PhD was encouraged by Dean Heidi Kapstad and the Buskerud University College leadership. The University of South-Eastern Norway (USN) represents this institution today, and funded most of my work. Heidi is currently the Dean of Faculty of Health and Social Sciences at USN and still my supportive leader, as is Lise Gladhus, Head of Department of Nursing and Health Sciences, where I am employed. I am also grateful for partial funding of my research in the Digital Night Surveillance project from the Regional Research Fund in Norway (project number 234978), managed by the USN School of Business.

I belong to the Science Centre Health and Technology and am grateful for the discussions, support and feedback from the large research community there. I would especially like to thank my principal supervisor, Professor Hilde Eide, who is research director at the Science Centre Health and Technology, and my co-supervisor, Professor Etty Nilsen, who was project manager of the Digital Night Surveillance research project, for their advice and guidance, numerous discussions, and for their patience. Hilde, thank you for sharing your wisdom and innovativeness, and for pointing me in the right direction when I have felt lost. Also, thank you for taking on the full responsibility for managing the Science Centre Health and Technology, allowing me to concentrate on the research. Etty, thank you for inviting me into the process of writing the Resistance-paper, and steadily guiding me through all phases thereafter. Thank you also for establishing a fruitful partnership between the USN School of Business, where you worked, and the Faculty of Health and Social Sciences. It was an important measure for the realization of the Digital Night Surveillance project, and for your appointment as co-supervisor.

I would like to acknowledge the efforts of my other co-authors, Professor Tom Eide and Associate professor Monika Kundsen Gullslett at the Science Centre Health and Technology, and Associate professor Vibeke Sundling at the National Centre for Optics, Vision and Eye Care. Tom, thank you for dedicating so much of your time and expertise, and for co-creating texts with me. Monika, thank you for being theoretical whenever I am too practical. Vibeke, thank you for guiding me through statistical analyses and for believing in me when I did not. I would also like to thank Associate professor Kristin Bakke Lysdahl for her dedication and helpful advice in the last phase of writing up the thesis.

Working with the persons mentioned has been defining and of the greatest importance for me becoming a researcher. I am grateful for the interdisciplinary, scientific co-creation we have undertaken, and for what you all have taught me. These words of gratitude are also extended to the other members of the Digital Night Surveillance research team, my safe haven for four years: Associate professor Karen Stendal at USN, and Professor Tom Roar Eikebrokk, Professor Carl Erik Moe and Associate professor Torbjørg Træland Meum at the University of Agder. Thank you for making me feel as a significant contributor in our joint projects. I sincerely appreciate your friendship.

I feel privileged to have been part of the doctoral program in Person-Centred Healthcare, and would like to thank Professor Kirsti Skovdahl with colleagues in charge of the program, Professor Brendan McCormack and other inspirational lecturers, as well as my fellow PhD candidates. A special thank you to Linda Hafskjold, Espen Brembo and Vibeke Narverud Nyborg, for support and friendship.

The research has been closely intertwined with extensive innovation projects in "the real world". Many thanks to everyone who contributed, especially Hilde Holm, Petter Stølen, Jonas Haavik, Morten Moland, Henrik Aanesen and Kirsti Kierulf, who are vendors, and Kjersti Linneberg, Solfrid Nilsen, Ståle Sjaavaag, Lisbeth Bakken and Britt-Inger Kolset from municipal managements.

I am thankful for your cooperation, continuous support, for following up all my questions, and for facilitating good processes. You know co-creation!

I am grateful to all my colleagues in the Science Centre and other colleagues within the fields of nursing, radiography and optometry. I would like to mention Helle Falkenberg, Irene Langeggen and Bente Monica Aakre. A heartfelt thank you, to you and the rest of our large group of friends, for your support and encouragement.

I would like to thank my parents, Inger Herholdt and Fred Åge Berntsen, and my sister, Nina Herholdt Høyer, who always have had unshakable faith in me; my father's partner, my in-laws, sisters-in-law and brothers-in-law, and my wonderful nieces and nephews. I am so lucky to have you in my life! I was also fortunate to have my dear grandmother and stepfather as faithful supporters for some time into the PhD.

Dear Thor, Line, Eirik and Mats.
Without your facilitation and support, contributions and resistance, endurance and continuous love, this PhD could never have been accomplished. I am forever indebted to you and look forward to participating more actively in the most significant form of co-creation I know, with you.

Janne

Abstract

Norwegian authorities emphasize use of welfare technology in order to meet the increasing demand for healthcare services to the population of older persons. Implementation of welfare technology is considered beneficial to increase the quality of municipal care services, support the independence of persons receiving care services and improve the care providers' workflow. However, welfare technologies challenge established workflows and competence, as well as perceptions of good care. Furthermore, recommended implementation strategies such as co-creation of services and outcome measurements such as benefit - and value realization represent novelties in the care services. Digital transformation of the care services thus calls for innovative approaches, as well as research.

This thesis had a longitudinal mixed-methods design, and explored and evaluated implementation of digital monitoring services based on welfare technologies that promoted safety in municipal residential care facilities. The thesis belonged to a person-centred healthcare PhD program, and theories on innovation, implementation, co-creation, resistance and networks guided the research. Three sub-studies were included, presented by four research papers.

In the first sub-study, paper 1 aimed to identify and describe forms of resistance that emerged during the first year (2013-2014) of the digital monitoring implementation in five residential care facilities. Paper 2 aimed to identify the facilitators and barriers during the full four-year (2013-2017) implementation of digital monitoring in eight residential care facilities, and to explore co-creation as implementation strategy and practice. Both were longitudinal qualitative case studies where we observed and elicited the experiences of care providers, healthcare managers and vendors. Paper 2 also included managers and staff in information technology (IT) support services. Data analyses in paper 2 started with a deductive analysis based on a determinants of innovation framework, and both papers included inductive content analysis of interviews, process- and observation data.

Four main categories of resistance could be identified in paper 1: Organizational, cultural, technological and ethical. Each included several subcategories, which emerged as the participants perceived threats to stability and predictability in their workflow; to their role and group identity; and to their basic healthcare values. The resistance was primarily subtle, and changed over time. IT infrastructure and –support was identified as the most prominent resisting factor. Importantly, resistance contributed as a productive force during co-creation processes.

Paper 2 identified five categories of facilitators and barriers: Pre-implementation preparations, implementation strategy, technology stability and usability, building competence and organisational learning, and service transformation and quality management. Each category encompassed several subcategories that affected the early-, mid and late phases of the implementation to varying degrees. The implementation resulted in a sustained digital monitoring service in all the residential care facilities, indicating success. The co-creation methodology was in itself identified as the most prominent facilitator. The reluctance of the IT support service to contribute in the co-creation activities, in combination with persistent IT infrastructure instability, was the principle barrier.

In the second sub-study, paper 3 aimed to describe how a measurement instrument for determinants of innovation could be contextually adapted to evaluate welfare technology implementation in municipal care services. We performed an iterative evaluation of our adaptations of the instrument (questionnaire) during 2013-2019 and identified the chronological order of the most relevant informants and settings to adapt and verify the instrument. We described the operationalization of items detailing the 29 instrument determinants and linked the determinants to a sequence of welfare technology implementation strategies used in municipal care services.

In the third sub-study, paper 4 aimed to evaluate facilitators for and barriers to implementation of wireless nurse call systems as measured by the adapted determinant instrument. Paper 4 had a quantitative cross-sectional descriptive design and we collected questionnaire data from care providers (n=98) during the first year of wireless

nurse call system implementations in five residential care facilities (2017-2019). The greatest facilitators were the normative belief of unit managers and the care providers' perceptions of the nurse call systems contributing to prompter call responses and increased safety for residents and families. The care providers' lack of prior knowledge, and how they initially found the systems difficult to learn, constituted the most prominent barriers, rapidly solved through training and skill acquisition.

The major finding of the thesis is that digital transformation in the form of successful implementation of digital monitoring is a complex, resource intensive and time-consuming process in municipal residential care facilities, and more so when it represents radical innovation with respect to technology novelty, disruption of care relationships and workflows, moral values, and the need for competency. All the implementations studied were successful in establishing new services that are still sustained, even though the implementations represented a high degree of complexity. Alignment of actors and agencies' self-efficacy, their trust in the technology, and in other actors' competence and support represented a tipping-point in the implementation processes, where the resistance decreased and safe, person-centred practices were established. Co-creation had a strong facilitating effect on resource-integration between actors, as well as on the development of competency and new workflows. However, both the implementations and co-creation represented novelty and depended on facilitation. The findings point to the importance of how the implementation of digital monitoring was conceptualized; as a straightforward "just do it" process, or as a complex and innovative endeavor.

The thesis contributed with substantial empirical evidence for digital monitoring implementations, including resistance, co-creation, facilitators and barriers, implementation strategies, complexity, conceptualization of digital monitoring implementation, and development of competency, capacity and capability for digital monitoring in residential care facilities. Further, it contributed methodologically with detailed descriptions of co-creation practices for dual implementation and research

projects, as well as an adapted version of a measurement instrument for determinants of innovation for welfare technology implementation.

Clinical implications are in line with the major findings: Digital monitoring implementation will be safer if conceptualized as digital transformation, rather than incremental change. The implementations benefit from good planning and persistent management focus. The prior level of digital competency among care managers and care providers needs to be addressed appropriately. Practical training and co-creation processes facilitate implementation efforts and contribute to competence building and an implementation climate characterized by benevolence. The measurement instrument offers valuable means to evaluate welfare technology implementation. Moreover, digital transformation of care services challenges the current silo organization of municipal IT support services. This is ultimately a threat to patient safety and will need to change over time. More research is needed into patients' perspectives, safety aspects and organizational capacity building as more welfare technologies are introduced into the care services, either as new entities or as new parts and functionalities expanding such innovative digital systems as described in this thesis. A compilation of welfare technology implementation strategies has been suggested, and more research is needed into the differentiation and cause effect relationship between barriers, facilitators, implementation strategies, intermediate implementation outcomes and long term service- and patient outcomes, in order to realize benefits and a sustainable digital care service.

Keywords: co-creation, digital transformation, welfare technology, digital monitoring, innovation, implementation, facilitators, barriers, service design, residential care, patient safety, competency building, resource integration, ethical resistance, complexity

List of papers

Paper 1

Nilsen ER, **Dugstad J**, Eide H, Gullslett MK, Eide T (2016). Exploring resistance to implementation of welfare technology in municipal healthcare services – a longitudinal case study. BMC Health Services Research doi: 10.1186/s12913-016-1913-5

Paper 2

Dugstad J, Eide T, Nilsen ER, Eide H (2019). Towards successful digital transformation through co-creation: A longitudinal study of a four-year implementation of digital monitoring technology in residential care for persons with dementia. BMC Health Services Research doi: 10.1186/s12913-019-4191-1

Paper 3

Dugstad J, Sundling V, Nilsen ER, Eide H (2019). Evaluating and Tailoring Welfare Technology Implementation Processes. Adapting the MIDI Questionnaire to Welfare Technology Implementation in Municipal Care Services. *Proceedings from The 17th Scandinavian Conference on Health Informatics 2019 Oslo, Norway, November 12-13, 2019; Linköping University Electronic Press*

Paper 4

Dugstad J, Sundling V, Nilsen ER, Eide H (2019). Facilitators and barriers during implementation of wireless nurse call systems in residential care. A cross-sectional study. (Re-submitted after revision).

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Appendix 7	NSD approval no. 918960

Abbreviations

These abbreviations are used in the manuscript. Abbreviations used in tables, figures or textboxes are explained in their respective legends.

D1-29	Determinant 1 – Determinant 29
D&I	Dissemination & Innovation
GDPR	General Data Protection Regulation
IT	Information Technology
MIDI	Measurement Instrument of Determinants of innovation
MIDI-WT	MIDI adapted for Welfare Technology
NSD	Norwegian Data Service for Social Sciences
PCHC	Person-Centred Healthcare
UiA	University of Agder
UK	United Kingdom
US	United States (of America)
USN	University of South-Eastern Norway
WHO	World Health Organization

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1 Introduction

Digital transformation of healthcare services entails a series of processes where implementation of digital technology facilitates radical changes in the resource integration within and between the service offered and the persons receiving the service. I regard the very act of providing healthcare as a process of co-creation between persons and systems involved. Digital transformation influences this co-creation, and affects actors directly involved, such as patients and healthcare professionals, but also actors and agencies indirectly involved. Digital transformation of healthcare services includes changes in organizational and business processes and structures within the healthcare service, in the distribution of knowledge and power, and in workflows and procedures (Benjamin & Potts, 2018; Matt, Hess, & Benlian, 2015).

This thesis was initiated as Norwegian municipalities embarked on digital transformation of their care services. The research started in 2013, as vendors, municipal care services and researchers joined forces to co-create increased patient safety by developing and introducing novel monitoring technology in the care services. The technology had the potential to replace rather than support established care procedures, indicating the need to design digital monitoring workflows and possibly organizational re-structuring. The care providers constituted the primary users of the technology, and the details of the technology, partnership, co-creation and research will be accounted for throughout the thesis. Based on four research papers reporting from three studies, the thesis explores and evaluates innovative processes in the period 2013-2019, related to the co-creation and successful implementation of digital monitoring of persons with multi-morbidities, including dementia, and resulting in transformed residential care services.

1.1 A welfare technology imperative

1.1.1 The need for digital transformation

The Norwegian as well as the global population is increasingly characterized by ageing in the years to come (United Nations, 2017). The group of persons aged 60 or over constituted 13% of the global population, 25% of the European and 22% of the Norwegian population in 2017. This age group is projected to double by 2050 and triple by 2100, whereas the number of persons aged 80 or above is expected to triple by 2050 and have a sevenfold increment by 2100 (United Nations, 2017). The relative ageing of the population represents increased numbers of old inhabitants with a higher degree of morbidity, including dementia and multi-morbidities (Mura, Dartigues, & Berr, 2010; Rechel et al., 2013), in combination with shortage of care-providers, challenged economies and no tolerance for poorer quality of care (Statistics Eurostat, 2015; United Nations, 2017; Wachter, 2016). Projections of the healthcare workforce predict a substantial shortage of health workers by 2030 and beyond (Liu, Goryakin, Maeda, Bruckner, & Scheffler, 2017; Marć, Bartosiewicz, Burzyńska, Chmiel, & Januszewicz, 2018). This has fuelled the search for policies and measures to transform the health services, long-term care, and welfare systems. Technological advances in health systems have traditionally shifted demands on the workforce (May et al., 2001; Nicolini, 2007; World Health Organization, 2006), and rapidly developing technologies potentially relieve some of the care burden related to the growing segment of old inhabitants.

1.1.2 Welfare technology

"Welfare technology refers first and foremost to technological assistance that contributes to increased safety, security, social participation, mobility, and physical and cultural activity, and strengthens the individual's ability to cope with everyday life despite illness and social, mental or physical impairment. Welfare technology can also act as technological support for relatives and otherwise contribute to improve accessibility, resource utilization and quality of service provision. Welfare technological solutions can in many cases prevent the need for services or admission in institutions" (Norwegian Official Report, 2011, p. 99).

The Government assigned most of the responsibility for the long-term, increasing demand for health and care services to the municipalities through the coordination reform (Ministry of Health and Care Services, 2009). In parallel, the need for service innovation, design based methodology and participatory approaches in the care sector was emphasized (Ministry of Trade and Industry, 2008). The "Innovation in the Care Services" green paper was thus initiated, kicking off the Norwegian welfare technology initiative (Norwegian Official Report, 2011). The Directorate of Health categorised welfare technology as: 1) technologies for security in everyday life that enable persons to reside safely in their own homes, such as social alarms and fall detectors. 2) Coping technologies that enable persons to better manage their own health, such as medication dispensers and digital calendars. 3) Assessment and treatment technologies that enable advanced medical examination and treatment at home, such as biomedical sensors and telehealth. 4) Wellness technologies that support persons in everyday activities, such as smart house technology and social robots (Melting & Frantzen, 2015). Internationally, intelligent assistive technologies (Bharucha et al., 2009) and ambient assisted living (Huch et al., 2012) are corresponding terms to welfare technology.

Welfare technology represented novelty in many ways. First, the technology was new to care providers, residents and other users. Second, neither the use of the technology, integration into care processes, the care organizations nor the care infrastructure had been explored. Third, technologies anticipated to be effective were not commercially available, and new vendors (were) mobilized. Fourth, legal issues were unclear, technological standards were not decided and funding schemes were not established. Fifth, implementation processes and outcomes were hard to predict. These gaps of knowledge indicated the need for research in order to bridge policies and practices. Even so, the welfare technology imperative was recurrently reinforced, seemingly based on an understanding that welfare technologies had an inherent value, but without giving directions for how to facilitate, achieve and manage outcomes (Corneliussen & Dyb, 2017; Garmann-Johnsen & Eikebrokk, 2017). This thesis contributes with scientific evidence of and methods for successful implementation of welfare technology.

1.1.3 Digital innovation in residential care

Residential care facilities, also known as long-term care settings or nursing homes, are complex settings (see section 1.2.1). Implementation processes in residential care are expected to be affected by the physical environment and infrastructure, availability of time and resources, availability of staff training, availability of support, receptiveness of organizational culture, involvement of all actors, demonstrable benefits of the change and empowering leadership (Birken et al., 2015; Cammer et al., 2013; Ko, Wagner, & Spetz, 2018; Masso, McCarthy, & Kitson, 2014). As welfare technologies were introduced, technologies had traditionally supported residents' independency, as well as care procedures performed by the nursing staff. The care organizations were experienced implementers of administrative information technology (IT) systems and electronic health records, which were used in 60% of the nursing homes in 2005 (Norsk Senter for Elektronisk Pasientjournal [Norwegian Centre for Electronic Patient Journal], 2008), increasing to more than 80% in 2010 (Norsk Senter for Elektronisk Pasientjournal, 2010). However, these were not integrated in care procedures and workflows involving residents. Few studies had documented the efficacy, effectiveness or efficiency of welfare technology in real-world settings (Hofmann, 2013).

The thesis is thus an innovation study. Greenhalgh, Robert, Macfarlane, Bate, and Kyriakidou (2004) defined innovations in health service delivery and organisation as "a novel set of behaviours, routines, and ways of working that are directed at improving health outcomes, administrative efficiency, cost effectiveness, or users' experience and that are implemented by planned and coordinated actions". This definition reflects a series of processes involving actors and contexts, and their mutual interactions, aimed at producing outcomes. Such processes and interactions can be facilitated through co-creation, where actors jointly define and produce mutually valued outcomes through iterative processes including value propositions, resource integration and learning (Payne, Storbacka, & Frow, 2008; C. K. Prahalad & V. Ramaswamy, 2004; C.K. Prahalad & V. Ramaswamy, 2004; Vargo & Lusch, 2004). Co-creation is a central concept in the research undertaken in this thesis.

1.1.4 Implementation of evidence based practices

The research has been influenced by pragmatic dissemination and implementation (D&I) science, where "pragmatic" reflects that the research is conducted under real world conditions (Battaglia & Glasgow, 2018). Implementation science is a fairly young field, which studies how routine healthcare service and practice systematically translate knowledge in the form of research findings, evidence-based practices and -interventions (i.e. healthcare known to be effective) by adoption, implementation and maintenance (i.e. healthcare delivered), in order to improve quality and effectiveness (Bauer, Damschroder, Hagedorn, Smith, & Kilbourne, 2015; Eccles & Mittman, 2006; Holtrop, Rabin, & Glasgow, 2018). An evidence-based practice is characterized by the integration of individual clinical expertise with patients' choices and the best available external clinical evidence, preferably from systematic research (Evidence-Based Medicine Working Group, 1992; Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996).

Theories, frameworks and models have been introduced to promote successful dissemination and implementation of evidence-based practice (P. Nilsen, 2015). Most of these are influenced by the seminal "Diffusion of Innovations" theory by Everett Rogers (2003). According to Skolarus et al. (2017), the most frequently cited theory within D&I literature is the "Diffusion of Innovations in Health Service Organizations" by Greenhalgh et al. (2004). Through an extensive review, they identified the lack of research on processes contributing to implementation and sustained use of specific innovations in specific contexts of health service delivery and organization, as well as their impact, to be the most serious gap in the literature. Since then, implementation theories have primarily been used to identify key constructs that may serve as facilitators for and barriers to specific implementations (Birken, 2017). These studies dominated D&I research as this thesis was initiated (e.g. Barnett, Vasileiou, Djemil, Brooks, & Young, 2011; Lluch, 2011; McKenna, Ashton, & Keeney, 2004). There was an emerging focus on implementation outcomes, initiated by Proctor and colleagues (E. Proctor et al., 2011), who recommended that implementation strategies needed to be more specifically described in order for other researchers to learn what works where and why (E. K. Proctor, Powell, & McMillen, 2013). A large body of D&I research founded

on the Consolidated Framework for Implementation Research (Damschroder et al., 2009) and conducted by the Society for Implementation Research Collaboration in the US, have later focused on implementation strategies and their inter-connectedness (Powell et al., 2015; E. K. Proctor et al., 2013; Waltz et al., 2015), moving towards research that aims to establish cause-effect relationships for implementation of evidence-based practices (Powell et al., 2019).

A much cited paper by Balas and Boren (2000) discusses how only 14% of research evidence progresses to implementation, and that it takes 17 years in average before the evidence reaches clinical practice. Taking this into account, two issues are raised in the context of this thesis: The first issue concerns the need to speed up implementation of digital evidence-based practices; Within 17 years, digital technology will evolve through more than one "generation" (Shahmarichatghieh, Härkönen, & Tolonen, 2016), indicating the need for rapidly updated practices. Pragmatic approaches and mixed methods have been suggested to accelerate translation of research and evidence into practice and policy (Glasgow, 2013; Mazzucca et al., 2018). The other issue is how to approach implementation of novel technologies and practices, which are innovative rather than evidence based. The first sub-study in the thesis started from "scratch", with little evidence to draw on, indicating high risk, but also the potential to establish evidence.

1.1.5 Implementation of innovative technologies and novel practices

Rigorously designed research, like randomized controlled trials of technology efficacy and cost-effectiveness, has been called for in evidence-based practice, education, healthcare quality, and patient outcomes related to contexts and participants as those included in this thesis (Melnyk, 2012). However, the high level of uncertainty, combined with the need to establish evidence in a near to non-existing market, limited the possibilities for large-scale implementations. Alternative research strategies had to be pursued as welfare technology was introduced. Norwegian researchers solved this challenge by studying early development, piloting implementation and scaling of various welfare technologies through a diversity of theories and methodologies, including, but

not limited to, socio-technical system studies of established care technology (Stokke, 2016, 2017; Thygesen, 2009); realist evaluation of telecare (Berge, 2016, 2017); cross-sectional study of adoption (Øyen, Sunde, Solheim, Moricz, & Ytrehus, 2018); case study of medical dispensers (Nakrem, Solbjør, Pettersen, & Kleiven, 2018); co-design of technology study (Holbø, Bøthun, & Dahl, 2013); studies of technology usability (Gerdes, Trinugroho, Næss, & Fensli, 2015; Smaradottir, Gerdes, Fensli, & Martinez, 2015) and feasibility (Holthe, Casagrande, Halvorsrud, & Lund, 2018); phenomenological studies and ethnographies (Barken, Söderhamn, & Thygesen; Barken, Thygesen, & Söderhamn, 2018) as well as evaluations of telemedicine (Gerdes, Gallefoss, & Fensli, 2019; Smaradottir, Gerdes, Martinez, & Fensli, 2016); and of users' attitudes (Veralia, Anker-Hansen, Taylor, & Eilertsen, 2019). Publications also include care ethic perspectives (Moser & Thygesen, 2015), theory development (Wiig et al., 2019), transformative services research based on the service-dominant logic (Rai, 2018), large-scale information infrastructure research (Mikalsen, Farshchian, & Dahl, 2018). As detailed in the papers and throughout the thesis, we pursued another approach. We relied on theory and validated methods, and applied an approach to constantly seek the best evidence available with strong emphasize on co-creation, in order to align the research efforts with the needs of the actors involved in our settings.

1.1.6 Digital monitoring

As our research was initiated, research on assistive technologies, including sensor technology and remote monitoring as studied in this thesis, had evolved through technical design studies, experimental design studies and patient experience qualitative studies (Greenhalgh, Shaw, et al., 2016). Monitoring technologies included smart homes technologies (Weiser, 1991) and ambient intelligence (Shadbolt, 2003), a precursor to Internet of Things technology; intelligent assistive technologies, which compensated for physical or cognitive deficits by sensing and responding to user needs through changing situations, and ubiquitous or pervasive technologies, which provided real-time monitoring of daily (or nightly) activities by computational devices embedded in the close surroundings (Bharucha et al., 2009). These interventions were regarded as

promising in home-based care, with the potential for a more independent lifestyle, affordable care and prevention of elopements (Arcelus, Jones, Goubran, & Knoefel, 2007; Franco, Gallay, Berenguer, Mourrain, & Couturier, 2008; M. Rowe, Lane, & Phipps, 2007; M. A. Rowe et al., 2009). However, if and how smart technologies supported people in their homes were not known (Martin, Kelly, Kernohan, McCreight, & Nugent, 2008). Inconclusive effects of monitoring technology interventions in nursing homes were also reported (Holmes et al., 2007). User participation in the design processes of pervasive systems generally tended to be subjective, limited in time, and undertaken in unrealistic contexts, thus resulting in solutions with limited validity (Mulder et al., 2009). A review of intelligent cognitive devices, sensors and advanced integrated sensor networks in dementia care found that nearly no systems originally had been developed for older users or researched in clinical setting involving persons with dementia (Bharucha et al., 2009).

Implementation of monitoring technologies potentially reduces staff burdens and enhances safety, increases resident freedom and prevents elopements and wandering behaviour in persons with dementia (Brims & Oliver, 2018; Carswell et al., 2009; Collins, 2018; Hall, Wilson, Stanmore, & Todd, 2017; Lin, Zhang, Chen, Ni, & Zhou, 2014; Niemeijer et al., 2010; Rashidi & Mihailidis, 2013; Zwijsen, Depla, Niemeijer, Francke, & Hertogh, 2012). Wandering behaviour is closely related to dementia, has severe implications (Gurwitz, Sanchez-Cross, Eckler, & Matulis, 1994; Rapp, Becker, Cameron, König, & Büchele, 2012; Volicer, 2007), and constitutes a major reason for nursing home admission (Cipriani, Lucetti, Nuti, & Danti, 2014; Halek & Bartholomeyczik, 2012; Lai & Arthur, 2003). The provision of care for these residents is challenged by night wandering, sleep disturbances and night time agitation (Andrews, 2017; Cipriani et al., 2014; Lai & Arthur, 2003), at a time where the care service has the lowest levels of staffing. Carswell and colleagues reviewed the role of assistive technology for people with dementia in the hours of darkness. They called for more research situated in the care context during night, using participatory design and adhering to ethical standards, and preferably involving a multidisciplinary research team (Carswell et al., 2009).

The third sub-study in the thesis included implementation of nurse call systems, frequently referred to as call-, light call-, patient call- paging- or care communication systems (In Norwegian: *sykesignalanlegg, pasientvarslingsanlegg, eller alarmsystem*). Nurse call systems are well accepted technologies with long-standing traditions within the care services (Andersson Marchesoni, Axelsson, Fältholm, & Lindberg, 2017). Following the introduction of the mechanical nurse bell system by Florence Nightingale in the 1850s hospital care (Nightingale, 1990), the systems have evolved in line with current developments of technology as well as healthcare services. Nurse call systems traditionally allow patients to summon assistance for routine or emergency needs, and thus support patient safety, provide patients with means of control and reduce staff burden (Deitrick, Bokovoy, Stern, & Panik, 2006; Hall et al., 2017). Modern technology offer new affordances for persons unable to actively engage with the system, including detection of unattended events and hazardous situations, prevention and timely treatment, which reduce injury and harm (Detweiler & Hindriks, 2016; Kaur & Kaur, 2017; Manoj & Thyagaraju, 2018). Currently, wireless nurse call systems encompass a number of functionalities and integrated technologies, of which many are offered as stand-alone welfare technology. This includes digital monitoring by sensor technology and/or cameras, social alarms (bracelets or pendants), tracking by a global positioning system or an indoor system, fall-sensors, and medicine-dispensing robots. The increased number of appliances integrated in the wireless nurse call systems could potentially add to the number of alarms constantly interrupting the nursing staff's work, and compromise the caring relationship with patients (Andersson Marchesoni et al., 2017; Klemets, Evjemo, & Kristiansen, 2013). The greater scope of affordances implies that novel functionalities are introduced, and the well-known nurse call system is transformed into something quite new and unknown. These technological advances called for studies of monitoring technologies situated in the organizational, social, political and policy contexts into which they were implemented (Greenhalgh, Shaw, et al., 2016).

1.1.7 Ethical and legal implications

According to Korhonen, Nordman, and Eriksson (2015), nursing and caring technologies are conceptualized as devices and products; as processes and methods integrated in the caring relationship between patients and care providers; and as a service in which care is produced by technology. In their review of the literature on ethical aspects of IT based technology, advanced device technology, simple tool technology, and assistive technology, they found that ethical issues were mainly discussed as benefits, risks, or unsolved problems. In 2017, the Norwegian Directorate of Health recommended municipalities to implement digital monitoring technology and wireless nurse call systems, based on benefit realization assessments undertaken in the national welfare technology program (Melting, 2017) (the program is further described in section 1.2.2). Internationally, the introduction of monitoring technology in residential care facilities for persons with dementia had generated considerable ethical debate. The debate focused on 1) Institutional aims, including functional efficacy, safety and risk, and staff burden; 2) Care relation, including duty of care vs autonomy; substitution of care, and person-centred care; 3) Resident concerns, including freedom and consent, privacy, and dignity/stigma (Niemeijer et al., 2010). Hofmann (2013) pointed to the risk of breaching confidentiality and privacy when third-party actors are involved; the need to ensure equal access and just distribution; and to handle conflicts between instrumental rationality, dignity and vulnerability. Ethical dilemmas primarily arose if there were conflicting goals between stakeholders, such as care institutions and residents (Hofmann, 2013; Niemeijer et al., 2010).

Ethics have been thoroughly discussed related to the design processes of technology, emphasizing the need to regard technology and society as mutually defining (Kiran, 2012), and to let ethical considerations accompany the development and implementation of technologies 'from within' (Kiran, Oudshoorn, & Verbeek, 2015, p. 10). Detweiler and Hindriks (2016) found ethical implications of pervasive computing technologies for elderly care to affect human values, such as well-being, autonomy and privacy, and suggested a taxonomy for value sensitive design. Several literature reviews have provided recommendations to the ethical design and development of (intelligent)

assistive technologies and related services. Ienca, Wangmo, Jotterand, Kressig, and Elger (2018) recommended ethical considerations of autonomy, privacy, beneficence, non-maleficence, interdependence, and justice. Users should be involved in the product development, use should be based on informed consent, and care should be taken to enforce data security (Novitzky et al., 2015). Issues regarding ethical implications are further explored in the thesis.

Legally, the technologies studied in this thesis are defined as notification and localization technology, regulated by § 4-6a in the Patients' Rights Act in Norway. According to § 4-6a, which was amended in June 2013, health and care services may make decisions on the use of technical solutions for notification and localization as part of health and care services to patients or users over the age of 18 who do not have capacity to consent (Pasient- og brukerrettighetsloven [The Patient and User Rights Act], 1999). The assessment of the patients' or users' capacity to consent is regulated in § 4-1 to § 4-3. The measure (i.e. technology) must be necessary to prevent or limit the risk of injury to the patient or user and should be in the interest of the patient or user. The decision should build on an assessment of whether the measure is in reasonable proportion to the relevant risk, whether the measure appears to be the least invasive option, and whether it is likely that the patient or user would have given permission for the measure. Where possible, information from the closest relatives should be obtained about what the patient or user would have wanted. The provision does not apply if the patient or user opposes the measure (Pasient- og brukerrettighetsloven [The Patient and User Rights Act], 1999).

There is no legal requirement to implement nurse call systems in Norwegian care facilities. However, according to recommendation HB 8.C.8 by The Norwegian State Housing Bank (2012), technical infrastructure for a nurse call system and welfare technology is required when a municipality applies for public funding in order to build, purchase, rebuild, improve or rent nursing homes or sheltered accommodation. In reality, most municipalities that build or refurbish care facilities rely on funding from the Housing Bank, and have accommodated this recommendation since 2012.

1.2 Responses to the welfare technology imperative

The monitoring technologies studied in this thesis were implemented in municipal residential care facilities. In the following, the Norwegian healthcare service is introduced and the national initiatives that framed the implementation activities undertaken are summarized. Finally, the regional network that formed the foundation for the implementation projects is introduced.

1.2.1 Residential care and round-the-clock-services

In Norway, the health and welfare services are taxation-based with a universal and automatic coverage for all residents. Whereas the specialized health services (secondary and tertiary levels) are the responsibility of the Government, the municipalities are responsible for providing primary health services where people live. Approximately 365 000 people of the 5.3 million Norwegian population receive at least one care-related service from their municipality (The Norwegian Directorate of Health). Around 30% of the care-service users reside either in care institutions or in a variety of sheltered housing, the latter legally defined as a private home. The authorities recently recommended the use of the term “round-the-clock-services” for services provided by municipal care services in private homes, sheltered care housing or institutions during the day, evening and night, on all days of the week, by means of technology or by other parties on behalf of the municipality (Ministry of Health and Care Services and The Norwegian Association of Local and Regional Authorities, 2017). According to statutory requirements, round-the-clock-services are based on written routines and ensure satisfactory fulfilling of the needs of service users concerning independence and control, dignity, predictability and respect in all aspects of their lives (Kvalitetsforskrift for pleie- og omsorgstjenestene [Quality regulations for nursing and care services], 2003). The service is to be adapted to the progression of diseases and deteriorating health and cognitive status, such as dementia and difficulties in expressing oneself; more than 80% of Norwegian nursing home residents are diagnosed with moderate to severe dementia (Helvik, Engedal, Benth, & Selbæk, 2015). The care service organizations participating in the studies included in this thesis, provided round-the-clock services to residents in

municipal nursing homes and extra care sheltered housing owned by the municipalities, in this thesis referred to as residential care facilities or residential care, for short.

1.2.2 National welfare technology measures

Following the introduction of welfare technology in 2011, the most prominent measure was the establishment of a national program for development and implementation of welfare technology in municipal care services (2013-2020), with priority of technology supporting safety in the initial phase (i.e. 2013-2016). The Government reinforced objectives and policies in the Report No. 29 (2012-2013) to the Storting "Future Care" (Ministry of Health and Care Services, 2012) and the "Care Plan 2020", with supportive recommendations from the Directorate of Health (Helsedirektoratet [The Directorate of Health], 2013). In 2012, the principle telecom company in Norway, Telenor, announced their intentions to replace the telecommunication network with mobile and IP telephony networks, pushing the transformation from analogue to digital systems. In close cooperation with the Norwegian Association of Local and Regional Authorities, the Directorate of Health later launched a roadmap for service innovation in 2015. The roadmap introduced co-creation and service design methodologies to assist municipalities during their implementation efforts (KS [Norwegian Association of Local and Regional Authorities], 2015). Further, an educational program was introduced in 2016, and benefit realization reports with recommendations of specific welfare technologies in 2016 and 2017 (Melting, 2017; Melting & Frantzen, 2015). Welfare technology was later included in the "National eHealth Strategy 2017-2022", following the establishment of the Directorate of eHealth in 2016, where the term eHealth corresponds to the use of IT to improve quality, security and efficiency in the health and care services.

1.2.3 A regional health innovation initiative

In 2005-2006, Buskerud University College (currently the University of South-Eastern Norway), municipalities, the county administration, the local hospital, funding agencies and third sector- and private sector organizations, formed a health innovation network,

Figure 1-1. Through foresight methodology (Popper, 2008), they (we) decided on implementation of digital technology in the care sector as a shared strategic field for regional development of health services, education, research, innovation, entrepreneurship, and businesses. The network was formalized as the Arena Health Innovation network, inspired by the triple-helix system theory (Etzkowitz, 2003) and funded by the Innovation Norway's cluster program (2009-2013). Papirbredden Innovation office managed the network and DRIV Incubator supported start-up companies, with funding from Buskerud County and the SIVA agency.

Figure 1-1 A regional ecosystem for health innovation 2005-2013

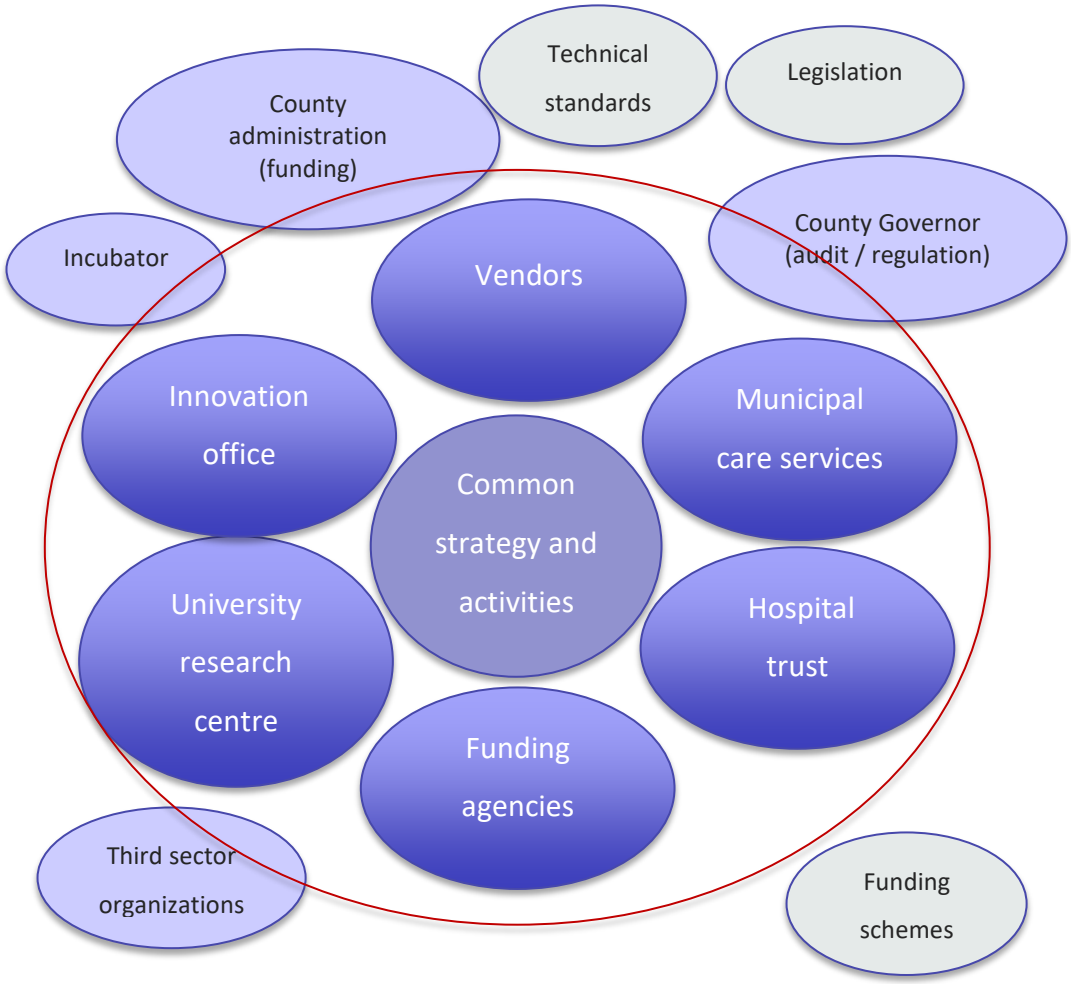

Figure 1-1 illustrates the actors participating in the Arena Health Innovation network (inside the red circle), the adjunct actors collaborating with and influencing the network (light purple ovals) and the instruments or schemes influencing network activities and strategies (grey ovals). In total, this constituted a regional ecosystem for health innovation.

Abbreviations used in the following are explained in Textbox 1-1. Network cooperation and co-creation activities received VRI funding from the Research Council of Norway and Buskerud County (2009-2016). Municipal infrastructure investments were funded via the Norwegian State Housing Bank from 2012. A series of R&D contracts with Innovation Norway funded technological innovation through co-creation between vendors from 15 small-and–medium-sized-enterprises, care providers and managers from municipal care services, and researchers. A range of welfare technologies were developed by the Arena Health Innovation network, of which many were prototyped, some were piloted and a few were commercialized. The digital monitoring technology system studied in this thesis belongs to the latter category. It was implemented as digital night monitoring in the first sub-study and further developed to a wireless nurse call system implemented in the third sub-study. An overview of the Norwegian Government's funding agencies and funding schemes used in the innovation, implementation and research included in this thesis is provided in Textbox 1-1.

Textbox 1-1 Funding agencies and funding schemes related to the implementation and research projects

Overview of the Norwegian Government's funding agencies and funding schemes used in the innovation, implementation and research included in the thesis

Innovation Norway (IN) supports innovation and development of Norwegian enterprises and industry in order to develop their competitive advantage and enhance innovation. **OFU** (*Offentlig forskning og utviklingsavtale)* is a public research and development (R&D) contract.

SIVA *(Selskapet for indrustrivekst)* is a real estate company that invests in, develops and builds co-localization environments. SIVA forms partnerships with industry and innovation clusters throughout Norway, and coordinates and funds a **national incubator program**.

The Research Council of Norway (RCN) invests in research and innovation to build knowledge for a sustainable future and meet major societal challenges. RCN's key target group is research organizations. RCN offers a variety of funding instruments that promote renewal and innovation in the public sector, as well as value-creation in Norwegian trade and industry. **VRI** (*Virkemidler for regional innovasjon*) was until 2016 RCN's main support mechanism for regional research and innovation, encouraging innovation, knowledge development, and added value through regional cooperation.

The Regional Research Funds (RRF) strengthen research for regional innovation and development within a region's prioritised focus areas. RRFs provide funding for shorter pilot projects, as well as extensive research programs. The research studies included in this thesis were funded by both types of programs, the latter being a joint call involving three RRFs.

1.3 Research positioning and aims

The thesis is situated within a person-centred healthcare (PCHC) PhD program, and influenced by the principles of PCHC delivery and research. I find the definition of person-centredness suggested by McCormack & McCance to reflect principles for being a healthcare professional and providing a healthcare service that correspond with my own values: "Person-centredness is an approach to practice established through the formation and fostering of healthful relationships between all care providers, service users and others significant to them in their lives. It is underpinned by values of respect for persons (personhood), individual right to self-determination, mutual respect and understanding. It is enabled by cultures of empowerment that foster continuous approaches to practice development" (McCormack & McCance, 2016, p. 3). I was trained to become a healthcare professional according to these principles, first as an optometrist's assistant while still in school, and later through my professional training as an optometrist in Norway, the UK (full-time BSc(hons) program) and the US (part-time clinical MSc program). The person-centred framework for nursing and healthcare by McCormack and McCance includes attributes of the care provider, such as professional competence, interpersonal skills, work commitment, and clarified values; attributes of the care context, such as appropriate skill mix, shared decision making, effective relationships, and potential for innovation (including risk); and attributes of the care processes, as detailed below (McCormack & McCance, 2016; McCormack & McCance, 2006).

Person-centredness is in line with current healthcare policy. "The patients' healthcare service" is a core concept in Norwegian healthcare, introduced by Bent Høie and integrated in policies thereafter: "*My project as Minister of Health and Care is to create the patient's health service. The patient should be placed in the centre, waiting times should be reduced and the quality should be improved*" (Helse- og omsorgsdepartementet [Ministry of Health and Care services], 2014). While patient-centred care is a model of biomedical care supporting function, reducing symptoms and suffering, and contributing to a functional life, person-centred care is a humanistic care

model, adding well-being to the goals of functionality and contributing to a meaningful life (Eklund et al., 2019). People-centred care, as conceptualized by WHO (World Health Organization, 2016), relates to this latter definition. Patient- and person-centred care processes have many similarities, supporting empathy, respect, engagement, communication, shared decision-making (partnership), a holistic view and individualized focus in the care relationship between healthcare professionals and patients, as well as coordinated care (Constand, MacDermid, Dal Bello-Haas, & Law, 2014; Eklund et al., 2019). Importantly, in person-centred care, these principles apply to the relationship between all persons within the healthcare system: patients, families, care providers, managers, support staff, and administration. Values to support and take into account respect for personhood of all persons, and virtues that support people to flourish and be the best they can in any given situation are emphasized (Buetow, 2016). According to Cardiff, McCormack, and McCance (2018), person-centred care is best supported by person-centred leadership, which is a complex, dynamic, relational and contextualized practice.

Person-centred healthcare research is based on the same values as PCHC, including respect, reciprocity, mutuality and self-determination (McCormack, van Dulmen, Eide, Skovdahl, & Eide, 2017). The degree of connectivity, whether the research is for, on or with the persons involved, is of importance. As a researcher, I aim to include the persons involved in the research settings in every stage of the research process. Moreover, I aim to be attentive, promote dialogue, support participation leading to empowerment, and to apply critical reflexivity, in line with the principles for person-centred research outlined by Jacobs, van Lieshout, Borg, and Ness (2017).

Person-centredness gives epistemic priority to individual persons and their unique contexts, and can be applied to individual, organizational and system levels. The complexity of persons (actors), agencies and system levels involved in innovative processes characterized the nature of the social reality explored in this thesis. Most likely, a number of causal factors would produce the outcomes of the processes, influenced by the multitude of persons, their biases, perceptions, actions, interactions,

relations, as well as events and contexts. Hence, the research strived to take into account as many perspectives and causes that contribute to the outcomes as possible. This called for the application of a variety of scientific methods and different theoretical perspectives.

I see myself as a person-centred, pragmatic researcher. Within the pragmatic worldview described by Maxwell (2012), different kinds of knowledge can be applied as uses, purposes and contexts vary. Pragmatism values both objective and subjective knowledge (Morgan, 2007), and represents a practical rationality that attends to learning, problem solving, habit, experience, skill, creativity communication and iterative action (Ansell & Geyer, 2017). According to Creswell, Klassen, Plano Clark, and Smith (2011), pragmatism provides a philosophical foundation for mixed methods evaluation, with integration of a variety of theoretical perspectives from social sciences, behavioural sciences and applied sciences, in the different phases of the study.

1.3.1 Research aims

The overall aim of this thesis was to explore and evaluate innovative processes with a special focus on facilitators for and barriers to the implementation of welfare technology-based monitoring services in municipal residential care facilities.

Aim 1 was to explore resistance during the first year of implementation of digital monitoring in long-term residential care for persons with dementia who were night wanderers (paper 1). As detailed in the conceptual framework, resistance is a reaction to change (see section 2.1.3). Resistance may inhibit change processes such as implementation, but need not.

Aim 2 was to identify facilitators and barriers during a four-year implementation of digital monitoring in long-term residential care for persons with dementia who were night wanderers (paper 2). Factors described as facilitators promote implementation, while barriers inhibit implementation (see section 2.1.2).

Aim 3 was to explore co-creation practices as an innovation strategy during a four-year implementation of digital monitoring in long-term residential care for persons with dementia who were night wanderers (paper 2).

Aim 4 was to describe how a measurement instrument for determinants of innovations could be contextually adapted to welfare technology implementation in municipal care services (paper 3).

Aim 5 was to explore facilitators for and barriers to implementation of wireless nurse call systems in residential care facilities, as evaluated by the care providers (paper 4).

1.3.2 The outline of the thesis

Chapter 1 introduced the welfare technology imperative and the Norwegian Government's initiatives to support digital transformation in municipal care services. The chapter accounted for the monitoring technology research status as the three sub-studies included in the thesis were initiated, and introduced dilemmas related to how to approach an innovative field founded on little evidence. The aims of the research were outlined.

Chapter 2 introduces the conceptual framework, including theories, frameworks and models that can be used to explore the variables and inter-relationships presumed to account for the resistance, facilitators, barriers, co-creation practices and outcomes explored and evaluated, in line with the aims of the thesis.

Chapter 3 introduces the research design and methodology used in the sub-studies, more extensively described and detailed than in papers 1-4.

Chapter 4 provides a brief summary of the results of the sub-studies, with less detail than the results reported in papers 1-4.

Chapter 5 discusses the summarised findings of the thesis, binding the results of the four papers together. The strengths and limitations of the design, methodology and specific methods are also discussed, and a statement of reflexivity is provided.

Chapter 6 presents the conclusions, contributions and suggestions for further research.

The four research papers are then included, followed by appendices related to the papers.

2 Conceptual framework

The conceptual framework introduces theories that can explain and predict, and frameworks that can be used to explore the variables and inter-relationships presumed to account for the resistance, facilitators, barriers, co-creation practices and outcomes that are explored and evaluated according to the aims of the thesis. The conceptual framework also includes models that can be used to guide these processes.

2.1.1 Innovation

Innovation has been defined in many ways, and even if the definition by Greenhalgh et al. (2004) (cited in section 1.1.3) has guided the research in the sub-studies and papers included in this thesis, other definitions add useful perspectives. Rogers' seminal theory for diffusion of innovation among individuals in a social system over time defines innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (E. Rogers, 2003). Inspired by Schumpeter (2017), the Norwegian government defines innovation as "a new product, a new service, a new production process, application or form of organization that is launched in the market or put into use in production in order to create economic value" (Ministry of Trade and Industry, 2008). The vendors used this definition. In the "Future Care" white paper (Ministry of Health and Care Services, 2012), innovation is conceptualized as known or new knowledge combined with a new method or use in a new context; as ideas converted to better practice that creates added value; as enterprising, daring and experimental in form; as a way of approaching tasks; as a culture; and finally, as a process whose result is unknown in advance. For practical purposes, the Norwegian Association of Local and Regional Authorities defines innovation as something "unique, useful and utilized" (in Norwegian: *nytt, nyttig, nyttiggjort*). This was the definition used by the municipal care services.

Innovative processes are most frequently described in relation to the innovation, such as a technology (product) or a service (process; organization) and their outcomes, and to the implementation of the innovation, the strategies applied during implementation

and the outcomes obtained (Fixsen, Naoom, Blase, & Friedman, 2005). Service innovations are usually categorised according to the degree of change (incremental or radical), type of change (product or process), novelty (new to the organization or new to the world) and means of provision (by technology or by organization) (Snyder, Witell, Gustafsson, Fombelle, & Kristensson, 2016). Innovations in public services are generally incremental, but disruptive, with the potential to cause improvement (Hartley, 2005; Hartley & Rashman, 2018). Radical or transformative innovations usually refer to products, such as breakthrough technologies, perceived as novel, disruptive and hard to adopt, disturbing prevailing habits and behaviour (Markides, 2006). Most technological innovations reconfigure known technologies (Schoenmakers & Duysters, 2010), whereas radical technology is characterized by novelty, uniqueness and impact on future inventions and practices (Dahlin & Behrens, 2005), with affordances that meet user needs better than existing products (Chandy & Tellis, 2000). According to Norman and Verganti (2014), radical innovations rely on a series of incremental innovations to be fitted into a system in a form that is acceptable to the actors involved.

Gallouj and Weinstein (1997) proposed that two mechanisms are involved in the provision of a technology-based, innovative service: the tangible (e.g. equipment) and intangible (e.g. legal or financial) parts of the technology, which are based on competences, and the direct mobilisation of competences (e.g. clinical procedures). The transformative nature of innovation underpins the need development of new knowledge and competencies, and for learning as an organisation implements an innovation (e.g. Greenhalgh et al., 2004; Hartley & Rashman, 2018). The more radical the innovation, the more necessary it is to instruct the users how to adopt and use it (Gallouj & Weinstein, 1997). Experiential learning strategies can be managed and facilitated within an organization (Moon, 2013), promoting development of skills from novice to expert, as described by Dreyfus and Dreyfus (1980). Kolb (1984) described experiential learning as a cyclic process encompassing concrete learning, reflective observation, abstract conceptualization and active experimentation. An organisation's capabilities for problem solving and learning new knowledge generated externally, as well as technological infrastructure, leadership, internal knowledge sharing and

relational capability, contribute to the absorptive capacity of the organization (Cohen & Levinthal, 2000; Zahra & George, 2002; Zou, Ertug, & George, 2018). Absorptive capacity is an antecedent and strong predictor for innovation and knowledge transfer (Greenhalgh et al., 2004; Zou et al., 2018). The absorptive capacity builds cumulatively on the existing base of skills and knowledge (Cohen & Levinthal, 2000; Hartley & Rashman, 2018), including tacit knowledge (Nonaka, 1994).

2.1.2 Implementation

E. Rogers (2003) also studied the diffusion of an innovation introduced in a market by a planned approach, and the characterizing stages are often referred to as dissemination (learn about the innovation), adoption (decide to use the innovation), implementation (put the innovation to use in the organization) and continuation (sustained use of the innovation). Just as innovation, implementation is a core concept in all the research included in this thesis. Implementation strategies represent the 'how to' in introducing and making use of an innovation in a healthcare service (E. K. Proctor et al., 2013); the actions needed to make an innovation fit the organization and services provided, and to enable the organization, the service providers and patients to use the innovation. Implementation outcomes are the intermediate process results that influence the later production of what Fixsen et al. (2005) described as intervention outcomes, and E. Proctor et al. (2011) detailed as service outcomes, such as increased efficiency, safety and patient centredness, and patient outcomes, as increased patient satisfaction and function. The implementation of evidence is influenced by the uncertainty, emergence and unpredictability that characterize healthcare services and the persons intertwined with the systems and processes that constitutes the context (Braithwaite, Churruca, Long, Ellis, & Herkes, 2018; May, Johnson, & Finch, 2016; McCormack et al., 2002). Hence, D&I research pays attention to external rather than internal validity, in order to ensure transferability to other contexts and populations (Brown et al., 2017).

Implementation researchers use a number of theories, primarily according to the analytic levels provided (e.g. individual-, organizational-, and system levels), and most frequently in order to explore determinants of implementation (Birken et al., 2017).

Determinants are the factors that act as facilitators for or barriers to the achievement of desired outcomes of the implementation strategies, which means that measuring determinants provides means to adjust the implementation strategies (Fleuren, Wiefferink, & Paulussen, 2004; Lewis et al., 2018; P. Nilsen, 2015; Tabak, Khoong, Chambers, & Brownson, 2012). Theoretical determinant frameworks can be applied to study how human, organizational, technical and other contextual factors or implementation strategies affect the implementation processes (P. Nilsen, 2015). There are many similarities between these theoretical approaches, including the implementation of an innovation (evidence) by implementation strategies (e.g. training) into a context, where it will be used by actors (Lynch et al., 2018).

The Measurement Instrument for Determinants of Innovations (MIDI) is a multi-dimensional determinant framework that has informed all sub-studied included in this thesis. MIDI focuses on individual healthcare professionals' use of an innovation, while working in an organization that is embedded in a wider societal context. The theoretical underpinnings of the MIDI framework were derived from theories and empirical findings related to healthcare innovation implementation reported in the literature. These were refined through Delphi studies involving implementation experts with broad empirical experience, as well as empirical studies of implementation of evidence-based innovations (Fleuren, Paulussen, Van Dommelen, & Van Buuren, 2014b; Fleuren et al., 2004).

2.1.3 Resistance

Implementation of innovative technology within complex systems, such as healthcare, involves various cycles of iteration as technological, social and organisational dimensions gradually align (or not) over time (Cresswell & Sheikh, 2013). Both lack of alignment and the time factor may be due to resistance, which is a phenomenon researched across many disciplines, most frequently related to what Coch and French Jr (1948) described as "changes in methods and jobs" in their seminal resistance study. Change involves alterations to the status quo; to let go of something familiar, including some form of loss, and to embark on something unknown, which might be threatening.

In recent research within information systems, user resistance is defined as the behavioural expression of a user's opposition to change(s) associated with health information technology implementation (Alohali, O'Connor, & Carton, 2018). The definition is in line with traditional definitions from other disciplines (e.g. Coghlan, 1993).

Lapointe and Rivard (2005) proposed a multi-level model of resistance to information technology implementation, to explain triggers, expressions, progression, and culmination of resistance, regardless of whether resistance is seen as a barrier to be removed or an expression of workers' discomfort with flaws in the system. The model encompasses the major components of resistance: object of resistance (e.g. an innovation), initial conditions (status quo), interaction (the way the innovation affects status quo), perceived threats (unacceptable factors of interference), resistance behaviors like apathy, passive resistance, active resistance, aggressive resistance (Coetsee, 1993), and subject of resistance (individual workers or groups) (Lapointe & Rivard, 2005).

Klein and Sorra (1996) saw resistance, avoidance, compliance and commitment as implementation outcomes They proposed that implementation effectiveness, i.e. the quality and consistency of workers' use of an innovation is a function of the implementation climate and workers' perception of how the innovation fits to their values. Whereas the latter corresponds to theories already mentioned, implementation climate needs further explanation. The implementation climate reflects how an organization ensures workers' skills in using the innovation; supports use of the innovation and responds if the innovation is not used; and how obstacles to innovation use are removed (Klein & Sorra, 1996).

Whereas resistance theories and the framework by Lapointe and Rivard informed paper 1 in the first sub-study, implementation climate theory informed paper 2.

2.1.4 Co-creation

Co-creation describes an interaction where actors jointly produce a mutually valued outcome based on their assessments of the risks and benefits of the proposed courses of action, and decisions based on dialogue, access to information and resources, as well as transparency (C. K. Prahalad & V. Ramaswamy, 2004). Co-creation is used and researched across a multitude of disciplines, and is believed to increase research impact, as knowledge generated through co-creation between researchers and other actors represents a joint knowledge production rather than knowledge translation (Greenhalgh, Jackson, Shaw, & Janamian, 2016). Co-creation encompass participatory design processes, traditionally used in IT design (Bratteteig & Wagner, 2016), and service design processes aiming to develop services that are useful, usable and desirable from the service users' perspective (Mager, 2008).

Co-creation theory and methodology inform all the research included in this thesis. However, co-creation may very well be applied in developmental or innovative processes without an integrated research component. According to Patrício, Fisk, Falcão e Cunha, and Constantine (2011) service design in complex systems such as healthcare involves co-creation of the user experience by involvement and understanding of users, contexts, service providers and social practices, and translation of this understanding into design of the service concept through design of the service system and service encounter.

Public sector services are suitable for co-creation because they are discreet and intangible, focusing on the users consuming the service as it is produced or delivered (Osborne, Radnor, & Nasi, 2013). Co-creation takes different forms depending on the service process, including the phases of ideation, evaluation, design, test, launch, production and consumption, as well as the complexity of contextual factors and actors involved (Oertzen, Odekerken-Schröder, Brax, & Mager, 2018, p. 567; Steen, Manschot, & De Koning, 2011). According to the service-dominant logic theory (Vargo & Lusch, 2004; Vargo, Maglio, & Akaka, 2008) and other theoretical contributions (Galvagno & Dalli, 2014; Oertzen et al., 2018; Payne et al., 2008; C.K. Prahalad & V. Ramaswamy,

2004; Ramaswamy & Ozcan, 2018; Vargo et al., 2008), central concepts of co-creation include the joint efforts of a service provider organization and other actors in the definition and creation of value; the value propositions of the organization and co-creation actors; the resource integration between actors and contexts; and learning processes. Resources (e.g. knowledge and skills) can be accessed from other actors through absorption, acquisition, sharing and resource co-creation (Rusanen, Halinen, & Jaakkola, 2014). Structures and practices within the service context form the foundation for how the actors integrate resources to co-create value (Edvardsson, Skålén, & Tronvoll, 2012).

Co-creation processes often involve an element of facilitation, which is defined as the process of supporting and enabling practitioners to improve practice by implementation of evidence, as well as the role of being a facilitator (Dogherty, Harrison, & Graham, 2010; Harvey et al., 2002). According to Carl Rogers, who developed the philosophical basis for person-centred care, facilitation of significant learning relies on attitudinal qualities in the relationship between the facilitator and the learner. Essential attitudes include realness, prizing the learner, acceptance and trust, sensitive awareness and empathic understanding (C. Rogers, 2002). The facilitator role includes activities as analysing issues, learning from experience, and working as a team to draw conclusions. Facilitation can be applied on all levels within a complex system such as a healthcare organization or an ecosystem for health innovation, as studied in this thesis. Facilitation on the network level can be described as orchestration, including management og knowledge mobility, innovation feasibility, network stability and network health (Gausdal & Nilsen, 2011).

2.1.5 Triple-helix

The triple-helix system theory was the innovation strategy recommended by the funding agencies and a prerequisite for the funding schemes used in the Digital Night Surveillance Project (the first sub-study). The triple-helix describes how public sector organisations, private sector companies and research institutions forms a clustered or networked system in order to collaborate and co-create mutual beneficial outcomes

(Etzkowitz, 2003; Etzkowitz & Leydesdorff, 2000). Triple-helix-systems generates new knowledge and innovation, which is diffused and put in use through activities which stimulate local, regional and national knowledge development in the "knowledge space"; the development of local innovative companies, regional competitive advantage and public entrepreneurship in the "innovation space"; and, consolidating and adjusting proposals for further advancement through collaboration leadership and conflict moderation in the "consensus space" (Ranga & Etzkowitz, 2013). The triple-helix strategy allows the intended users of outcomes to be involved in design and development of products, processes and services, and such involvement is likely to improve adoption and post-implementation satisfaction (Greenhalgh et al., 2004; Huryk, 2010).

3 Research design and methodology

Chapter 1 of the thesis introduced digital transformation, the welfare technology imperative and initiatives, monitoring technology research status and the dilemma of how to approach an innovative field founded on little evidence, as well as the aim of the research. Chapter 2 introduced the conceptual framework, including theories, frameworks and models to explore and evaluate the variables and inter-relationships presumed to account for the resistance, facilitators, barriers, co-creation practices and outcomes. In this chapter, the research design and methodology will be presented.

The thesis represents a study with an exploratory, sequential mixed methods design, consisting of two sub-studies. Mixed methods methodology is philosophically founded in pragmatism and appropriate when the research aims call for real-life contextual understandings and multi-level perspectives (Creswell et al., 2011). The approach was emergent, with an initial plan to undertake the research included in the first sub-study and intentions to apply the determinants of innovation framework, and with the papers emerging as the innovative, empirical field evolved. We thus applied an exploratory sequential design (Creswell & Clark, 2011; Onwuegbuzie, Bustamante, & Nelson, 2010), by employing rigorous qualitative research to explore the meaning and understanding of constructs such as facilitators and barriers, followed by quantitative research to assess magnitude and frequency of those constructs. Multiple methods were included and integrated in a connecting data approach, where the analyses of the first dataset informed the subsequent data collection (Creswell et al., 2011), Figure 3-1. The design could also be classified as multilevel, with inclusion of data from individual micro level and organizational meso level, and influences from the societal macro level (e.g. Government), corresponding to multiple levels of realities or ontologies (Tashakkori & Teddlie, 2010). An overview of the four research papers, including designs, settings, innovations, samples, data and methods, is presented in Table 3-1.

The healthcare providers were the actual users of the monitoring technology. Neither the thesis nor the sub-studies collected data directly from end-users of the technology-based service, such as service recipients, residents/patients or their families.

Table 3-1 Overview of the sub-studies and papers, including designs, settings, innovations, samples, data and methods

	Sub-study 1		**Sub-study 2**	**Sub-study 3**
	Paper 1	**Paper 2**	**Paper 3**	**Paper 4**
	Resistance	**Co-creation**	**MIDI adaptation**	**Cross-sectional**
Design	A one-year longitudinal, case study design with elements of action research	A four-year longitudinal case study design with elements of action research	An iterative evaluation design	A cross-sectional study design
Care setting	Five residential care facilities (#1-5) in five municipalities.	Eight residential care facilities (#1-8) in eight municipalities	Thirteen residential care facilities (#1-13) in nine municipalities.	Five residential care facilities (#9-13) in four municipalities.
Technology	Digital night monitoring installed in 34 resident rooms	Digital night monitoring installed in 67 resident rooms	Digital night monitoring and wireless nurse call systems	Wireless nurse call systems installed in all resident rooms
Sample	Care providers Care managers Vendors Researchers	Care providers Care managers Vendors IT service staff Researchers	Care providers Care managers Vendors IT service staff Researchers	Care providers Care managers
Data collection	June 2013 – May 2014	June 2013 – September 2018	June 2013 – February 2019	September 2017 – February 2019
Methods	9 individual interviews 3 focus group interviews Process data from 3 work-shops (n= 50) Observations	21 individual interviews 2 focus group interviews Process data from 7 work-shops (n=172) Observations Documents	All data from papers 1 and 2. Survey data from pilot testing of MIDI. Data from contextual adaptation of MIDI in paper 4	MIDI questionnaire data from n=98 respondents
Analysis	Inductive content analysis of interviews Analysis and interpretation of data from interviews and observations by a bricolage approach Triangulation	Deductive and inductive content analysis of interviews. Interpretation and integration of data from interviews, observations and document analysis by a phenomeno-logical hermeneutical approach Triangulation	Iterative evaluation of MIDI adaptations	Descriptive statistics of participant characteristics and MIDI scores

Figure 3-1 Overview of the three sub-studies, with research activities, inter-relationships and a timeline

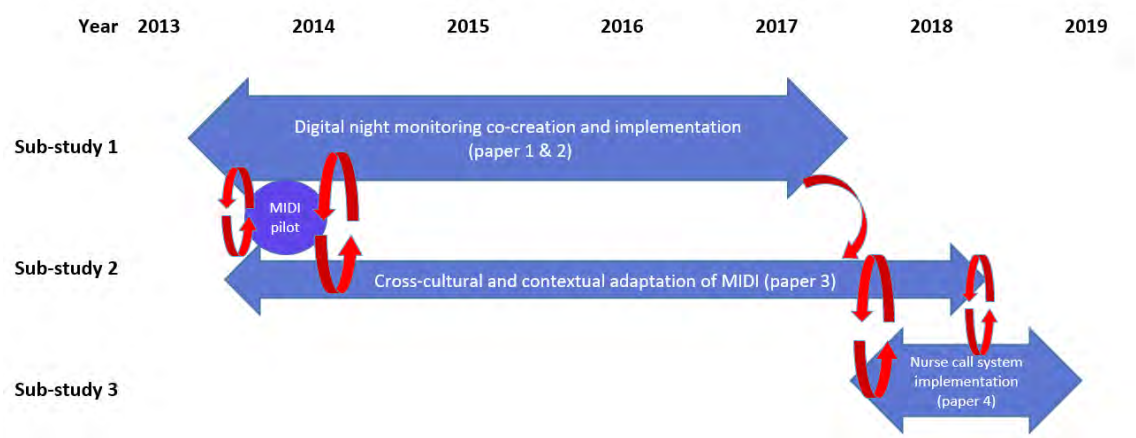

Figure 3-1 provides an overview of the research activities and their inter-relationships, with a timeline. The blue arrows indicate research sub-studies. The red arrow indicate how a research activity informed later research. Circular red arrows indicate iterative process of mutual information between research studies.

3.1 The Digital Night Monitoring Study (paper 1 and 2)

3.1.1 Research design, settings and samples

The first sub-study had a longitudinal case study design (Yin, 2018) with elements of participatory action research (Baum, MacDougall, & Smith, 2006). Case study design is appropriate for developing a detailed understanding of a system, in line with complexity theory concepts (Walton, 2014).

A needs-assessment in the municipal care services that participated in the Arena Health Innovation network (introduced in section 1.2.3) had revealed a higher rate of adverse events at night, involving persons with dementia and wandering behavior. In order to attend to medical or personal needs and to support safety, nursing staff routinely entered residents' rooms e.g. three times during the night shift, in order to see if the residents were in bed and asleep, or in need of any assistance. In spite of the manual surveillance routine, falls and wandering were recurrently reported, and elopements had occurred.

The network decided to pursue development and implementation of digital night monitoring in the care for persons with dementia and wandering behavior, with the intention to progress to implement full-scale wireless nurse call systems. Vendors from the Arena Health Innovation network initiated the Digital Night Surveillance Project (2013-2014), in cooperation with five municipalities and a team of five researchers from the Science Centre Health and Technology, USN.

Textbox 3-1 Terminology explained: monitoring and surveillance

Terminology explained: monitoring and surveillance

The first sub-study was based on a project with the Norwegian title "Digitalt nattilsyn". As the implementation project protocol and research protocol for the Digital Night Surveillance Project were developed, the consortium decided to use the term surveillance as the English translation of the Norwegian term "tilsyn". Supervision and monitoring were other translations discussed. The title of the research project to which my thesis contributed, was "Implementation of welfare technology. Digital surveillance in municipalities and its impact on innovation of services and organization".

However, in this thesis, I have used "monitoring" as the English translation of "tilsyn", as I have found it to be more in line with the functions of the technology based services under study. According to www.encyclopedia.com, *surveillance* refers to targeted monitoring carried out in covert ways and with legal authority, whereas *monitoring* is a general term that refers to the systematic, continual observation of e.g. persons and processes.

The Digital Night Surveillance project had a dual implementation and research design, where technologies and services where innovated, implemented and researched simultaneously through an iterative, co-creation approach. The strategies related to innovation and implementation are outlined in Figure 3-2. The blue boxes describe activities and the blue arrows indicate the order of activities, starting from the left. The circular red arrows indicate the iterative approach, where the activities were repeated over time. The research encompassed all activities and is detailed later.

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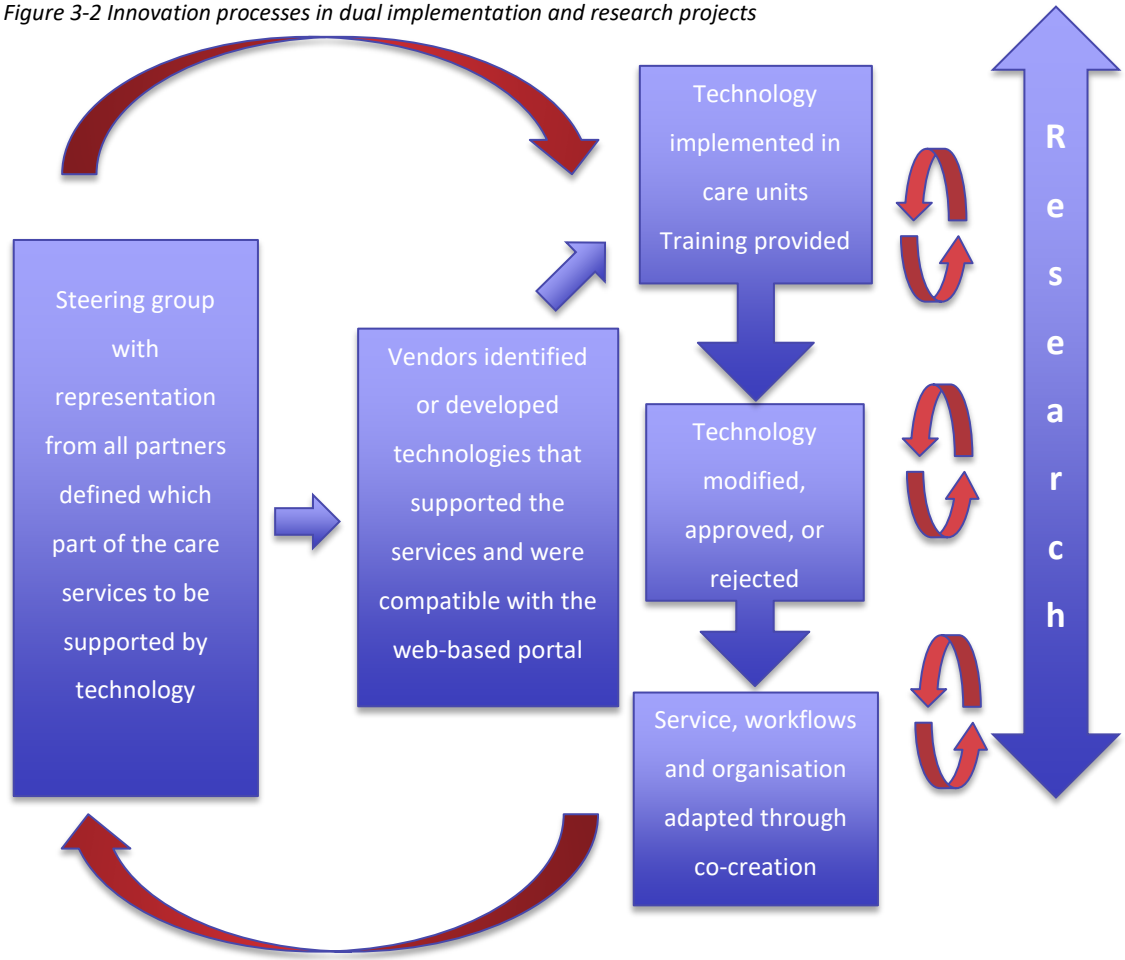
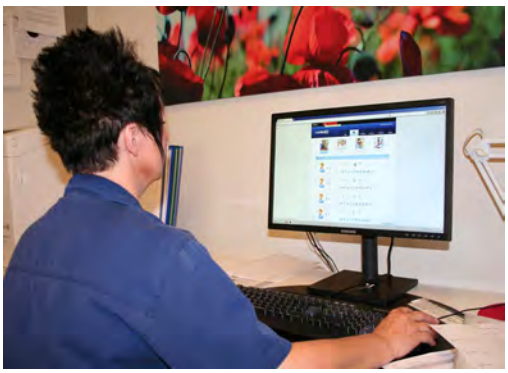
Figure 3-2 Innovation processes in dual implementation and research projects



This first project formed the empirical foundation for paper 1 and was included in paper 2. A formal consortium of eight municipalities, two technology companies and a group of three researchers from the University of Agder and six from USN, was consecutively established for the next step, the "Implementation of welfare technology. Digital surveillance in municipalities and its impact on innovation of services and organization" project (2014 – 2017). The Norwegian Research Council funded both projects. The second project continued the dual implementation and research design (Figure 3-2), and formed the remaining empirical foundation for paper 2. It also framed the initial cross-cultural and contextual adaptation of the determinant of innovation instrument reported in paper 3.

Picture 3-2 Sensor technology for digital monitoring included bed-sensor and beam-sensor mounted on bedframe

Picture 3-3 Smartphone for care providers, connected to web-based portal for digital monitoring, used in an early phase



Picture 3-4 A care provider is operating a preliminary version of the web-based portal for digital monitoring (paper 1, 2 and 3), which was later developed into a full-scale wireless nurse call system (paper 3 and 4)

Picture 3-1 Sensor technology for digital monitoring included door-sensors

The digital monitoring system in the first sub-study (Picture 3-2, Picture 3-3, Picture 3-4 and Picture 3-1) provided passive notification of residents' movements, passing, absence from bed or falls. These were detected by ambient sensors, mediated as an alert or alarm by digital means via a web-based portal to a smart phone carried by a care provider.

3.1.2 Recruitment

The sampling to the first sub-study was purposeful (Creswell & Clark, 2011; Palinkas et al., 2015), meaning that persons and groups considered to be knowledgeable and experienced with the digital monitoring were deliberately selected. Participation in the implementation activities was included as ordinary job tasks for the care providers. As more persons in each care facility were involved in the implementation, they could be included in the sample by a snowballing procedure. The invitation to participate in the research activities was presented at each event and activity (appendix 1a and b). The opportunity to provide or withdraw consent to participate was reinforced at each occasion. The samples are described in relation to the research methods applied.

3.1.3 Interview samples

Paper 1 included nine individual interviews and three focus group interviews (n=14), of whom four participants were interviewed twice (Table 3-2). All interviews but one focus-group interview were also included in paper 2. Paper 2 included 21 individual interviews and two focus group interviews (n=13) of totally 22 participants, of whom nine were interviewed twice. The sample composition reflected all groups of actors and agencies actively participating in the implementations, in line with recommendations by Palinkas et al. (2015): project managers, managers, super users, night shift staff, registered nurses, healthcare workers, vendors, information technology manager, and also the network orchestrator. The participants in paper 1 represented all involved groups except the IT services.

3.1.4 Interviews

According to Kvale (1996), interviews are conversations between persons with inter-change of views regarding a specific theme, which may produce scientific knowledge through intellectual understanding when caution is made to the methodological approach in the question being asked, to the dynamics between the participants in the conversation and attention is given to what is said. Focus group interviews add the dimension of interaction in the interview situation (Webb & Kevern, 2001), where participants can confirm, reinforce or contradict each other's opinions. The individual interviews were conducted by members of the research team at a place chosen by the participants, usually where they worked. An interviewer and an assistant from the research team conducted the focus group interviews, which were done when a larger group was gathered during co-creation activities. Notes were taken during the interviews, which also were recorded and transcribed verbatim. I conducted 10 individual and two focus group interviews, one as an assistant, and transcribed three interviews.

The interviews were semi-structured and followed an interview-guide (appendix 2). The interviews started with open-ended questions to elicit the participants' perception of the implementation and their own participation in the project.

Table 3-2 Overview of interviews included in paper 1 and 2 (the first sub-study)

							Paper 1		Paper 2	
ID	**G**	**PM**	**MA**	**SU**	**NS**	**P**	**II**	**FG**	**II**	**FG**
1	F	x	x			RN	1		2	
2	F	x				RN	1		2	
3	M	x				RN	1		2	
4	F		x			RN	1	1	1	1
5	F		x			RN			2	
6	F		x			RN	1	1	1	1
7	F	x		x		RN	1	1	2	1
8	F			x	x	RN		1		1
9	F			x	x	RN	1		1	
10	F			x	x	HCW		1	1	1
11	F			x	x	HCW	1	1	1	1
12	F				x	HCW	1		1	
13	F				x	RN		1		1
14	F				x	RN			1	
15	F				x	RN		1		1
16	F				x	RN		1		1
17	M					V		1	1	1
18	M					V		1	1	1
19	M					V		1		1
20	M					V		1		1
21	M					IT			1	
22	F					O			1	
23	F		x			RN		1		
24	F		x	x		HCW		1		
25	F					RN		1		

ID = participant number; G = gender; F = female; M = male; PM = project manager; MA = Manager; SU = super user; NS = night shift; P = profession; RN = registered nurse; HCW = healthcare worker; V = Vendor; IT = Information technology manager; O = Orchestrator; II = individual interview; FG = Focus group interview

We assumed the monitoring technology to require some kind of new competence in order to be used, and that the use of technology would affect the workflow, care practices and possibly the distribution of assignments and responsibilities within the nursing staff. Hence, two main topics were discussed during the interviews: 1) if any need for new competence had emerged and how it had been dealt with, and 2) if there had been changes to the job situation or organisation of care providers.

As they were sharing their experiences during the interviews, the participants were encouraged to elaborate and critically reflect on the resistance, facilitators, barriers and co-creation processes that they reported. In the later interviews in paper 2, the participants were encouraged to reflect on the development they had experienced during the implementation. Care was taken to assure that the participants could reflect and speak freely. Hence, the focus groups encompassed either vendors or nursing staff, and all participants were encouraged to contribute in the discussions. We changed topics when the participants were reluctant to elaborate, in order to respect their privacy.

3.1.5 Action research elements

In line with the dual implementation and research design based on an iterative and integrative approach, the research was inspired by participatory action research, which has been found useful to improve nursing care (Glasson, Chang, & Bidewell, 2008). During the participatory action research cycle, researchers and participants jointly gather and analyze data, and decide on an action. The results of the action are then observed and reflected on, and decisions are made as to continue or refine (Wadsworth, 1993). Importantly, the participants are actively engaged in these steps and power is distributed between the researcher(s) and other participants (Baum et al., 2006). The methods applied in the participatory action research cycle are detailed in following sections.

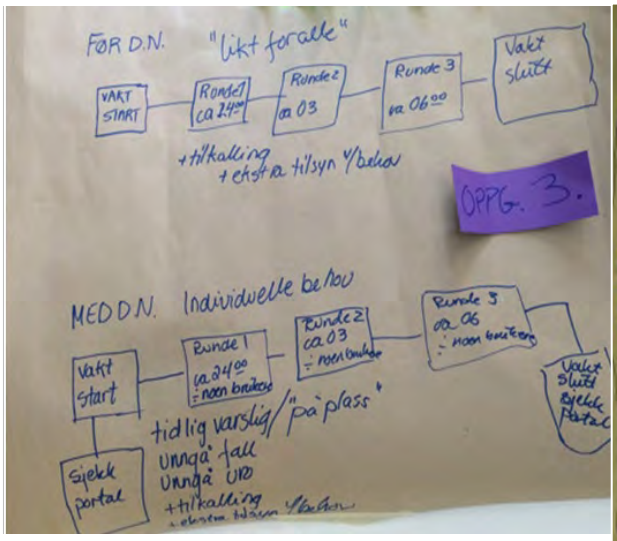
Action research elements included my own and other researchers' participation in:

- planning of and preparations for co-creation activities
- participation in and facilitation of co-creation activities
- participation in and facilitation of knowledge-sharing and reflection processes during workshops and meetings
- presentation of preliminary research findings to the steering group and during workshops
- writing the minutes of 10 steering group meetings, and taking notes of observations and reflections during 25 meetings (steering-group meetings, staff meetings, meetings between municipal project managers, vendors and the consortium orchestrator, and meeting in the research team), seven workshops and approximately 20 hours of observation of training and clinical practice. (The numbers refer to activities that I have undertaken).
- using interview settings to collect data, and also to stimulate critical reflection

3.1.6 Co-creation methodology

Workshops constituted a prominent arena for the dual task of participatory action research and co-creation of digital monitoring, and were attended by approximately 50 participants during the first year (paper 1) and 170 in total (paper 2). The workshops primarily addressed service innovations, not technology innovation; see paper 2 for further details. Even so, the workshops included updates, information and discussions about technology improvements, about data security and privacy, and about infrastructure and IT support. Further, co-creation of communication strategies, of individual and collective (organizational) learning, of learning strategies, and of routines, new workflows, functions and work organization. Workshops also included discussions of patient selection criteria and of ethical dilemmas. All workshops included lectures based on theory and evidence-based practices related to the topic of each workshop.

In the early stages, we used low-key tools for visualization of the co-creation activities, as seen in Picture 3-6, Picture 3-5 and Picture 3-7. In the later stages, we used methods and tools for visualizations developed in the national Roadmap for Service Innovations (KS [Norwegian Association of Local and Regional Authorities], 2015). During the course of the implementations, we aggregated data related to each topic and carefully prepared the next co-creation activity, to avoid double work and to ensure progression in the development of e.g. clinical practices and new workflows.



Picture 3-6 Service blueprint of monitoring by rounds (before) and by technology (after), based on a time-schedule for the night shift

Picture 3-5 Stakeholder mapping

During the workshops, we used a number of methods in order to facilitate co-creation. Some were known from the management literature and some from service design.

These included:

- service blueprint and patient journey mapping (Bitner, Ostrom, & Morgan, 2008) (Picture 3-6), including touchpoints, interactions and user experiences prior to, during and after the implementation
- stakeholder mapping (Picture 3-5) (Stickdorn & Schneider, 2011)
- future recall (Picture 3-7)
- participatory co-design of technology (Bratteteig & Wagner, 2016)
- process simulations
- personas (Miaskiewicz & Kozar, 2011; Pruitt & Grudin, 2003)
- co-development of clinical procedures methods and routines (Lee et al., 2018)
- Individual-Group-Plenary reflections and discussions

Picture 3-7 Future recall; statements that potentially could be made in 2025 regarding digital monitoring

I shared responsibility for dissemination of preliminary research results and/or co-creation activities in all workshops in the Digital Night Monitoring projects (2013-2017). An invitation to participate in the research activities was extended to the participants present at each workshop, and the opportunity to provide or withdraw consent to participate was reinforced. Reporting research results to the participants or steering group required careful considerations related to confidentiality and to the possible consequences for the participants (Kvale, 1996). Some results pointed to groups with few participants, who easily could be identified. If such results were considered negative or unfavorable, e.g. revealing a low level of competency, they were not reported until more data was aggregated over time and confidentiality could be assured. However, if the results were considered positive, they were seen as examples that others would follow. They were assumed to have a facilitating effect and tended to be reported back to the participants.

3.1.7 Participatory observation

Participatory observations were undertaken during the data collection for all papers. Table 3-3 details the settings and samples, as well as their interactions and the researcher's role as both a participator and an observer in research activities included in the Digital Night Monitoring projects, which were reported in paper 1, 2 and 3. I generally focused on the task of observing rather than "participating" in settings where I was not responsible for the activity (like co-creation workshops). However, even if participant observation as described by Kawulich (2005) was intended in some situations, like staff meetings and training sessions, I usually was given a minor facilitating role by e.g. being asked to share and discuss information or to assist with practical issues, in addition to making observations. An invitation to participate in the research activities was extended to the participants present at every observation, and the opportunity to provide or withdraw consent to participate was reinforced.

Table 3-3 Settings, participants and interactions included in participatory observation in Digital Night Monitoring

Observation settings and participants	Objects of observation	Researcher's (my) role
Steering group meetings (n=10)	• Action of and interaction between participants, including steering group leader (municipal director), eight municipal project managers, two vendors, two university representatives, the orchestrator and the research project manager	• Observed communication and other interactions • Wrote minutes of meetings • Presented results of co-creation • Presented current policies and research • Wrote reflections
Meetings between project managers, vendors and orchestrator (n=4)	• Action of and interaction between participants, including eight project managers, four vendors and the orchestrator	• Shared information • Observed communication and other interactions • Wrote reflections
Staff meetings in residential care units (n=3)	• Action of and interaction between participants, including local project manager, unit manager, nursing staff belonging to shifts (n=30-50) and vendors	• Shared information • Observed communication and other interactions • Wrote reflections
Training sessions (n=6)	• Action of and interaction between the vendor, project manager or super user who was responsible for the training session and the care providers attending the training (n=1-10) • Interactions between technology and persons	• Assisted in the training, if needed • Observed communication and other interactions • Wrote reflections
Co-creation workshops	• Action of and interaction between participants (n=17-57), including project managers, managers, super users, nursing staff, IT staff, vendors, researchers, external experts, funding agency advisors	• Planned and facilitated co-creation activities • Disseminated preliminary research results • Observed communication and other interactions • Wrote reflections
Clinical practices during the night shift (no observations of residents)	• Action of and interaction between three care providers, a super user and the project manager • Interactions between technology and persons	• Observed communication and other interactions • Wrote reflections

3.1.8 Document analysis

Document analysis is a systematic procedure for reviewing or evaluating documents, primarily applied as a complement to other research methods (Bowen, 2009). Reviewing and interpreting documents into current contexts was included in the triangulation of data during analyses reported in the papers, as well as in the progress of the implementation projects and the thesis, as detailed in Table 3-4.

The document analysis was done in the form of reading white papers or grey literature, as well as following social media, taking notes and including the information in presentations, or just learning from reading such documents, adding to the personal knowledge and understanding. More extensive approaches included collecting information from such documents and combining it with written material such as reflection notes or previous co-creation process data, into thematic packages of information which were used for further co-creation; or included in traditional research activities.

3.1.9 Data analyses

Data from multiple sources (Table 3-1) were converged in the analyses in paper 1 and 2, and thus contributed to the exploration of the facilitators and barriers, co-creation practices and resistance (Baxter & Jack, 2008).

In paper 1, the transcribed interviews were initially read through in a naïve manner by several researchers, ERN, MKG and JD (Kvale, 1996). They were then explored inductively using content analysis to generate categories of resistance and explanations (Pope, Ziebland, & Mays, 2000), such as sources of resistance. The first author, ERN, led the analyses. Units and themes were derived through analyses and discussions in the research team. As part of this, I deductively analysed resistance based on the model by Lapointe and Rivard (2005), including object of resistance, initial conditions, interaction, perceived threats, resistance behaviors and subject of resistance. This analysis was integrated into the larger analysis and can be found in the paper in the form of text rather than a table format.

Table 3-4 Documents influencing the implementation of digital monitoring and wireless nurse call technologies, as well as research activities

Document type	Influences of document review and interpretation
White papers, green papers, and national policy papers, recommendations and strategies	• Enforced the municipalities' choice to implement digital monitoring and wireless nurse call technologies (all papers) • Constantly influenced choices made by the steering group of digital monitoring (papers 1-2) • Constantly influenced co-creation of digital monitoring (paper 1-2) • Framed the PhD thesis and constantly influenced research activities (all papers)
Laws, regulations, GDPR	• Constantly influenced choices made by the steering group of digital monitoring (papers 1-2). • Constantly influenced technological development with regards to data security and privacy (papers 1-2) • Constantly influenced the development of clinical practices (all papers) • GDPR influenced research ethics (paper 3-4)
Municipal policy papers and strategies	• Informed the municipalities' choice to implement welfare technology (all papers)
Minutes of steering group meetings	• Mutual influence on co-creation of digital monitoring (paper 1-2) • Informed the data analyses in paper 1 and 2
Personal reflection notes	• Informed the co-creation of digital monitoring (paper 1-2) • Informed all research activities (all papers)
Process documents from co-creation activities	• Constantly influenced choices made by the steering group of digital monitoring (papers 1-2) • Constantly influenced the development of digital monitoring technology and workflows (paper 1-2) • Informed the co-creation of digital monitoring (paper 1-2) • Informed the data analyses in paper 1, 2 and 3
Information from municipalities to nursing staff, residents, families and media	• Informed the co-creation of digital monitoring (paper 1-2)
Technical documentation	• Informed the MIDI questionnaire (papers 3-4) and data analyses in all papers
Clinical procedures and checklists	• Informed the MIDI questionnaire (papers 3-4) and data analyses in all papers
Reports from concurrent implementations	• Informed decisions made by the steering group of digital monitoring (papers 1-2)
Published research	• Informed the co-creation of digital monitoring (paper 1-2) • Framed the PhD thesis and constantly influenced research activities (all papers)
Social media (Facebook groups)	• Provided back-ground information, primarily about the socio-political context

The early versions of the manuscript of paper 1 included the results of the MIDI pilot (see Figure 3-3). The cross-sectional questionnaire data thus informed the process of analysis, even if the MIDI data were taken out of the manuscript before finalizing paper 1.

In paper 2, I analysed the data from qualitative interviews by content analysis, including deductive qualitative analysis and mapping of the transcribed interviews (Elo & Kyngäs, 2008), against the 29 constructs in the MIDI framework (Fleuren et al., 2014b). Even though all constructs could be identified as categories in the material, the analysis resulted in categories that apparently were not included in the instrument. Training, which had been discussed in all interviews, constituted such a category. Training was originally included as a determinant in the research underpinning the development of MIDI (Fleuren et al., 2004), but had been left out during the process of finalizing the measurement instrument. As the content analysis did not fulfil the aim of the study, the deductive analysis was put aside and an inductive, phenomenological hermeneutical analysis inspired by Lindseth and Norberg (2004) was initiated. This was a complex analysis based on a vast material, in which I first coded the transcribed individual and focus group interviews inductively in N-Vivo, and then condensed the data excerpts. In order to keep track of contextual factors, the data were kept as more extensive excerpts than suggested by e.g. Graneheim and Lundman (2004) throughout the analysis. Another researcher, TE, joined the next step, where we manually performed a preliminary categorization. Data from co-creation processes, participatory observations and documents were then examined to further inform the analysis. The refined categories formed the basis for a text (in English), which by a phenomenological hermeneutical approach (Lindseth & Norberg, 2004) was iteratively interpreted, critiqued, condensed and re-written between the two researchers. Through this process of writing, we abstracted the data to form subcategories of factors, processes and actions that were found to facilitate the implementation when completed or impede the implementation when not, as well as a timeline. We re-examined the original data sources when we did not agree on the interpretation. All quotes included were kept in

the original language (i.e. Norwegian) until the full paper manuscript was produced, in line with the principle of low-inference descriptors (Johnson, 1997).

In paper 1 and 2, threats to validity and reliability were met by close cooperation within the research team in all phases of the research. The research team was interdisciplinary, and all nine researchers were responsible for different research perspectives in the Digital Night Monitoring projects (Dugstad, Nilsen, Gullslett, Eide, & Eide, 2015; E. R. Nilsen et al., 2017). The researchers' expert knowledge within the research fields, as well as deep knowledge of the local and larger contexts, participants and implementations, facilitated open discussions in a series of planned research meetings. The researcher triangulation as well as method triangulation strengthened reliability. Discussions and reflexivity about the interpretation of data were further stimulated through dissemination of preliminary results to and discussions with the participants in the consortium. Detailed descriptions of the research approach were included in the papers to meet further threats to reliability.

3.2 The contextual adaptation of MIDI study (paper 3)

The second sub-study (2013-2019) introduced an instrument for evaluation of implementations not previously used in Norway, the measurement instrument of determinants for innovations, MIDI (Fleuren, Paulussen, Van Dommelen, & Van Buuren, 2014a). MIDI encompasses the innovation process and strategy, and captures four broad categories of essential determinants, as evaluated by healthcare professionals, who are considered to be the adopting users during the implementation of innovations in larger healthcare organisations (Fleuren et al., 2014b). The innovation category consists of seven determinants: procedural clarity (D1), correctness (D2), completeness (D3), complexity (D4), compatibility (D5), observability (D6) and relevance for the patient/resident (D7). The adopting user category captures 11 determinants associated with the care provider who is using the innovation: personal benefits and drawbacks (D8), outcome expectations (D9), professional obligation (D10), resident satisfaction (D11), resident cooperation (D12), social support (D13), descriptive norm (D14), subjective norm (D15), self-efficacy (D16), knowledge (D17) and awareness of content

of innovation (D18). The organization category consists of ten determinants associated with the care unit implementing the innovation. This category includes formal ratification by management (D19), replacement when staff leave (D20), staff capacity (D21), financial resources (D22), time available (D23), material resources and facilities (D24), coordinator (D25), unsettled organization (D26), information accessible about use of innovation (D27) and performance feedback (D28). The socio-political context determinant (D29) in the fourth category is related to legislation and regulations.

3.2.1 Research design, settings and samples

Paper 3 was designed as an iterative evaluation of the processes of contextually adapting MIDI, of adapted versions of the MIDI, of outcomes of piloting the MIDI during the Digital Night Monitoring study (the first sub-study) and of applying the MIDI in the cross-sectional study of the implementations of wireless nurse call systems (the third sub-study), which thus constituted the settings. The data collected in paper 1, 2 and 4 informed paper 3. Hence, the sample in paper 3 overlap with those of paper 1, 2 and 4. Aiming to describe how MIDI could be contextually adapted to welfare technology implementation in Norwegian municipal care services, the research questions was: Which welfare technology related items should be included to cover the determinants in MIDI-WT?

As detailed in the next sections, the iterations included: 1) a cross-cultural and contextual adaptation of MIDI to the digital night monitoring, including piloting MIDI for digital night monitoring, and 2) the contextual adaptation to and cross-sectional study of wireless nurse call system implementations.

3.2.2 Cross-cultural and contextual adaptation of MIDI to the digital night monitoring implementation (Iteration 1)

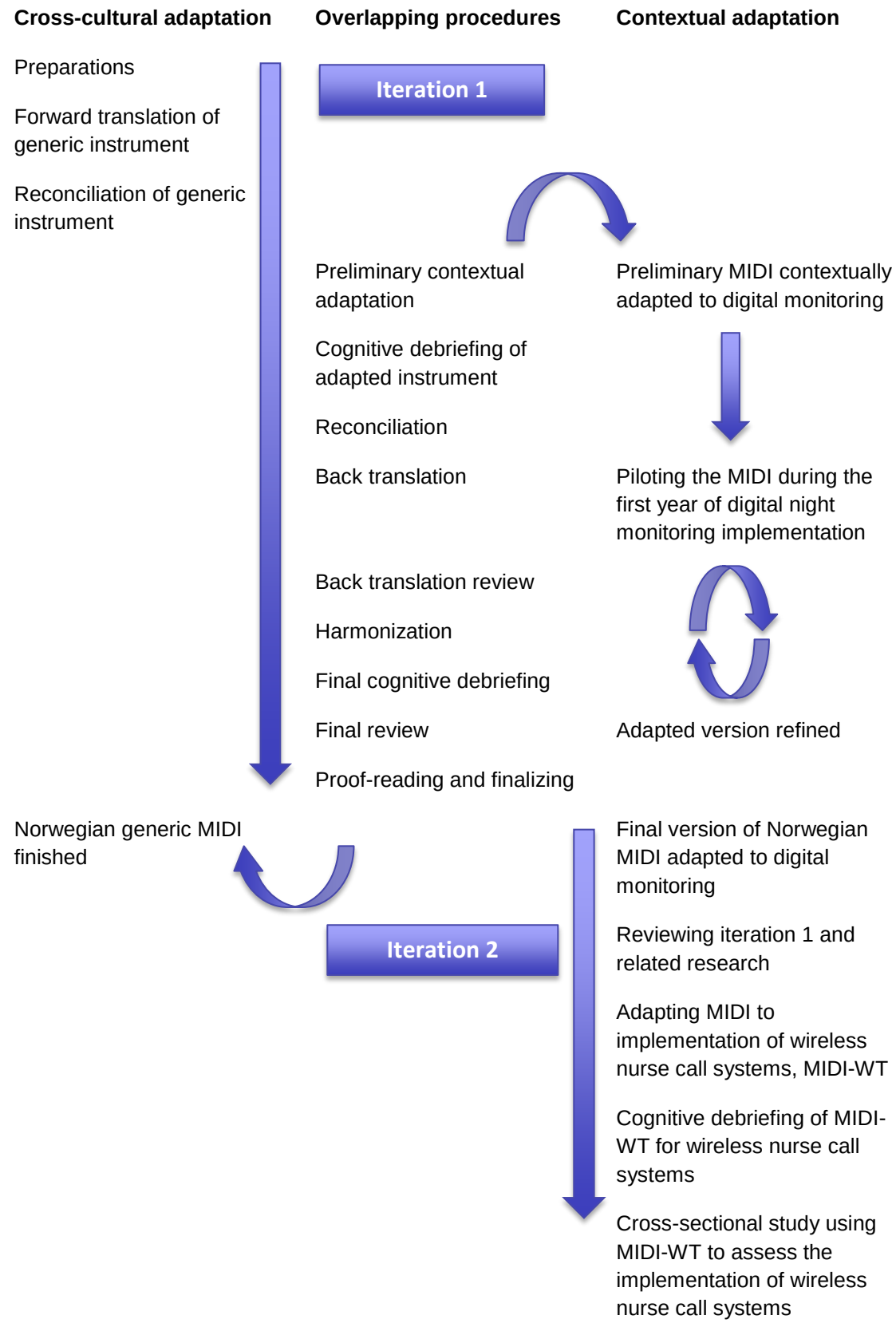
The contextual adaptation of MIDI partly overlapped with a preceding cross-cultural adaptation, which has been referred to by Dugstad and colleagues (Dugstad, Nilsen, & Eide, 2014), but not fully documented in any paper. The two processes and how they were related are explained in Figure 3-3, and detailed in the following.

A cross-cultural adaptation involves linguistically translation and cultural adaption, in order to maintain content validity of a research instrument at a conceptual level (Beaton, Bombardier, Guillemin, & Ferraz, 2001). The cross-cultural adaptation included a preliminary contextual adaptation and was performed in accordance with the "Translation and Cultural Adaptation of Patient Reported Outcomes Measures—Principles of Good Practice" (Wild et al., 2005), with the following steps:

1. **Preparations:** The MIDI was identified in the research literature by JD. Permission to do a cross-cultural adaptation was granted from the instrument developers in the Netherlands, and two developers agreed to participate in the process.
2. **Forward translation of generic instrument**: JD translated MIDI from English (published source language) and HE from Dutch (original source language), into the target language, Norwegian. The translators were bilingual, each with in-depth experience in the culture of the source language, as well as the target language**.**
3. **Reconciliation of generic instrument**: The two translations were compared item by item in order to establish semantic equivalence and content equivalence. Any differences were discussed until consensus was reached.
    a. **Preliminary contextual adaptation**: In order to check the relevance of MIDI, JD adapted it to the digital monitoring implementation.
    b. **Cognitive debriefing of adopted instrument**: MIDI was then piloted by a group of care providers (n=16) in the digital monitoring implementation. The respondents were invited to write down comments as they responded, and then to discuss each item, the alternatives and their reflections in a group discussion facilitated by JD.
    c. **Reconciliation**: The two translators (HE & JD) and two other researchers (ERN & TRE) who knew the implementation, but was not familiar with MIDI, observed the group discussion and then discussed the feedback from the cognitive debriefing, including the scores and comments of each item. Changes were made accordingly and new, adapted version was produced.

4. **Back translation:** The adapted MIDI was back-translated blindly to the source language (English), by a professional translator who was unfamiliar with the instrument, the samples and the researchers.
5. **Back translation review:** JD reviewed the back-translated version and commented discrepancies between the original version and the back-translation, item by item. A table format was used, and the Norwegian version was also included to visualize and exemplify the comments.
6. **Harmonization:** Several iterations of harmonization were done between JD, HE & ERN and the Dutch developers, based on the review-table. References were made to the original Dutch version (Fleuren, Paulussen, Van Dommelen, & Van Buuren, 2013; Fleuren et al., 2014b) and the theoretical framework underpinning the MIDI instrument (Fleuren et al., 2004). The developers also drew on their experiences from the initial translating process from Dutch to English before publishing the instrument, assuring a consistent approach to translation issues. A harmonized, adapted version was thus produced.
7. **Final cognitive debriefing of cross-culturally adopted and contextually adapted instrument:** Care providers, a local project manager and an IT service manager (n=7), and researchers (n=5) tested the instrument. They evaluated the wording of the items and responses, as well as the contextual adaptations to the digital monitoring implementation, in order to check comprehension, interpretation, and cultural relevance.
8. **Final review of cognitive debriefing results:** A new comparison was made of the respondents' interpretation of the translation with the original version to highlight and amend discrepancies. The two translators and the developers then discussed issues that had been raised and suggestions made during the debriefing, in relation to both cross-cultural and contextual adaptations. A new, adapted version was produced.

Figure 3-3 Cross-cultural and contextual adaptation of the MIDI to welfare technology implementations



9. **Proofreading and finalizing of generic instrument:** A final review of the translated and contextually adapted MIDI was done to highlight and correct any typographic, grammatical or other errors. Following the finalization of MIDI for digital monitoring, a final, generic Norwegian version of MIDI was produced.

3.2.3 Contextual adaptation of MIDI to the wireless nurse call system implementations (Iteration 2)

Iteration 2 (Figure 3-3) started with a review of the documentation from iteration 1 and discussions of the research question within the research team. The analysis of facilitators and barriers in the digital night monitoring implementations (Dugstad, Eide, Nilsen, & Eide, 2019) informed this discussion, see Figure 4-1. The contextual adaptation of MIDI to the wireless nurse call system implementations was planned accordingly, bearing in mind that implementations call for flexibility and local adaptations to each care setting. The adaptation relied on contributions from actors involved in the implementation, and as part of the iterative evaluation approach, we developed a procedure for adapting the MIDI to implementations that represented novelty for the researchers, with regards to welfare technology and/or contexts. The procedure was detailed in paper 3 and consisted of the following steps: 1) Interview with healthcare top management; 2) Interview with care unit management team; 3) Interview with vendors and/or IT service; 4) Co-creating the adaptation of MIDI items with a super user; 5) Additional sources of information (see section 3.1.8 about document analysis); and 6) Verification of MIDI-WT.

The steps of the contextual adaptation per determinant were further described in paper 3. The MIDI adapted to wireless nurse call system implementation was then used in the cross-sectional study reported in paper 4, where I observed some of the care providers as they responded to the questionnaire. Following the analysis of the cross-sectional data, some adjustments were made before the final MIDI-WT was recommended, as detailed in paper 3.

During the course of the iterative evaluation, quite a few changes could be traced in the MIDI versions adapted to welfare technologies. Table 3-5 provides an example of the iterative development by detailing how the list of important social referent persons changed over time. Social referent persons, important to the care provider who responds to the questionnaire, are listed in determinant 13 social support and determinant 15 subjective norm in the MIDI questionnaire.

Table 3-5 Development over time in list of important social referent persons included in MIDI determinants 13 and 15

Initial stakeholder mapping	Iteration 1, digital monitoring	Iteration 2, wireless nurse call	Final recommendation
• the manager • the implementation project manager • a super user • the union representative • the primary contact nurse • a nurse • a healthcare worker • other care professionals • the IT service • the janitor • the vendors • municipal politicians • municipal top management • the residents • the families	• the manager • the implementation project manager • a super user • the union representative • a nurse • a healthcare worker • the IT service • the janitor • the vendors • municipal politicians • municipal top management • the residents • the families	• the manager • a super user • the union representative • a nurse • a healthcare worker • the IT service • the janitor • the vendors • the residents • the families	• the manager • a super user • a nurse • a healthcare worker • the IT service • the vendors • the residents • the families

3.3 The wireless nurse call determinant study (paper 4)

Updated versions of the digital monitoring technology platform in the first sub-study were implemented as full-scale digital (wireless) nurse call systems in two of the five implementations in the third sub-study, reported in paper 4. Similar systems were implemented in the other care facilities.

3.3.1 Research design, setting and sample

Paper 4 had a cross-sectional design and examined facilitators for and barriers to the implementation of wireless nurse call systems, as measured by the contextually adapted MIDI at one single time point during the first year of implementation. A cross-sectional design represents an observational study for the collection of quantitative data connected to two or more variables at a single point in time (M. D. Carlson & Morrison, 2009). The sample population included care providers (n=98) working in five residential care facilities in South-Eastern Norway. The participants were recruited via the municipal care organizations by two approaches to probability sampling (see section 3.1.2). In four residential care facilities, the care providers were informed about the survey in staff meetings and simultaneously received a written invitation to participate, a consent form and a MIDI questionnaire (appendix 3, 4 and 5). The participants were offered a lottery ticket (value: NOK 10) upon returning the questionnaire. One care facility had a tradition of competitions between units, and the staff in one unit challenged their colleagues to obtain the highest response rate. I provided cakes for a staff meeting in the winning unit. I visited all the care facilities within the first two weeks after distributing the MIDI questionnaire in order to answer questions and encourage the care providers to respond to the questionnaire. In one residential care facility, care providers were informed by the manager in staff meetings and then via a text message, which also included a link to a digital version of MIDI. They received a friendly reminder via SMS after one week. Consent to participate was considered as provided as the participants responded to the digital questionnaire.

The MIDI was contextually adapted by a procedure detailed in paper 3 with the following steps: 1) Interview with healthcare top management; 2) Interview with care unit management team; 3) Interview with vendors and/or IT service; 4) Co-creating the adaptation of MIDI items with a super user; 5) Additional sources of information (see section 3.1.8); and 6) Verification of MIDI-WT. The digital version of the adapted MIDI was provided by the University of Oslo's research survey platform Nettskjema (University of Oslo). It was piloted through several iterations before it opened for

respondents, in order to develop the most appropriate technical and visual layout of the determinants for the smart-phone interface.

3.3.2 Statistical analysis

The Statistical Package for Social Sciences 21.0 was used for data analysis, performed by JD and reviewed by VS. Participant characteristics and MIDI scores were analysed by descriptive statistics (mean, standard deviation, median, range and percentage). Facilitators for implementation were defined as items to which ≥80% of participants responded 'agree/totally agree' and barriers to implementation as MIDI items to which ≥20% of participants responded 'totally disagree/disagree' (Verberne et al., 2018). The Kruskal Wallis test was used to explore differences between groups, with p-value ≤ .05 considered statistically significant. Internal consistency of the MIDI questionnaire was assessed by Cronbach's coefficient α (alpha) (Tavakol & Dennick, 2011). The research followed the Standards for Reporting Implementation Studies (StaRI) checklist (Pinnock et al., 2017) and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (Von Elm et al., 2007).

3.4 Research ethics

The research was in line with the central principles for research in health sciences as stated in the Helsinki declaration (World Medical Association, 2013). Approval from the Regional Committee for Medical and Health Research Ethics was not necessary, as the research was not regulated by The Health Research Act, and did not include patients or data collected in patient settings. However, the research was approved by the Norwegian Data Service for Social Sciences (NSD) through approval no. 34831 (Digital Night Surveillance project) and a separate approval for the PhD project, no. 36230 (appendix 6), which was upgraded in accordance with the General Data Protection Regulation (GDPR), to no. 918960 (appendix 7). Reading the guidelines and filling out the notification forms for the NSD assessments of how personal data would be processed in the research, with additional inquiry and discussions over the phone, served as useful input to ethical reflections about the stages in the research.

4 Results

Chapter 1 of the thesis introduced digital transformation, the welfare technology imperative and initiatives, monitoring technology research status and the dilemma of how to approach an innovative field founded on little evidence, as well as the aim of the research. Chapter 2 introduced the conceptual framework, including theories, frameworks and models to explore and evaluate the variables and inter-relationships presumed to account for the resistance, facilitators, barriers, co-creation practices and outcomes, in line with the aims of the thesis. Chapter 3 detailed the exploratory, sequential mixed methods design, including the four papers based on three sub-studies. This chapter will present a short summary of the main findings from the four papers. A brief reminder of the aim of each paper is introduced before the results. The research design, setting, technology, sample, data and methods of each paper were summarized in Table 3-1. The results are extensively elaborated in the papers.

4.1 Main results of paper 1

The aim of paper 1 was to describe the resistance that emerged during the first year of the digital night monitoring implementation. Through inductive analyses of interviews, observations and co-creation activities in four workshops we found four main categories of resistance with several subcategories, during the first year of the same implementation as studied in paper 2. Organizational resistance included care providers' resistance to change in established routines and to necessary competence building; systemic resistance to communication across groups and professions; and management resistance to participatory processes. Cultural resistance were due to language differences and a clash of professional cultures; and also included resistance against the role as co-creator. Technological resistance included care providers' resistance to technology and IT support staff's resistance to innovative practice; as well as persistent resistance represented by IT infrastructure. In fact, the IT-related resistance was the most dominating of all factors. Ethical resistance was due to patient safety issues; concern for the quality of care; patient privacy and dignity issues; and due to issues of justice. The resistance emerged from perceived threats to a) stability and predictability

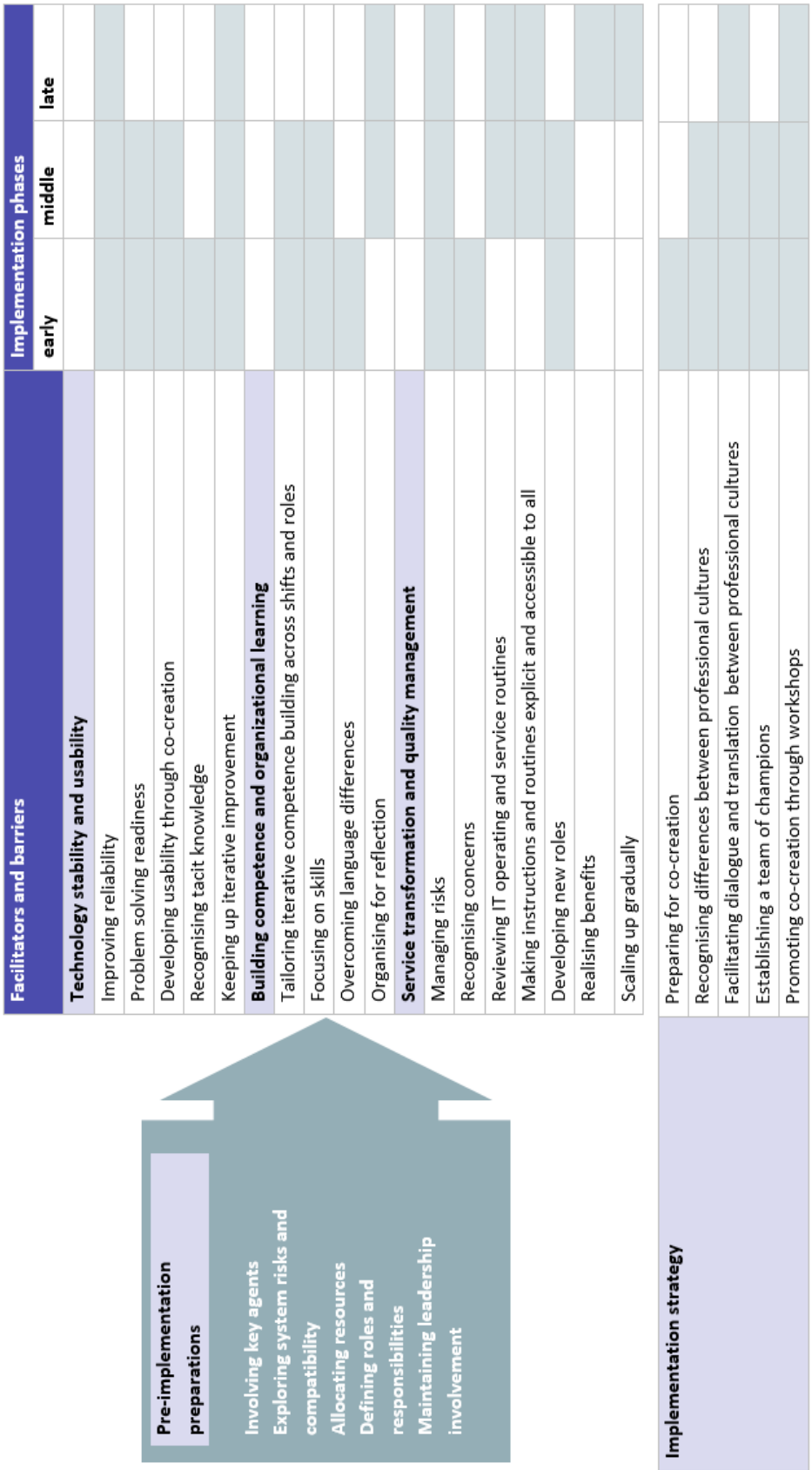
(fear of change), b) role and group identity (fear of losing power or control) and to c) basic healthcare values (fear of losing moral or professional integrity). Resistance to implementation and to co-creation was found in all groups of actors. The resistance fluctuated over time and between groups, primarily in a subtle form. Importantly, resistance acted as a productive force in the co-creation activities and facilitated improvements to the digital monitoring.

4.2 Main results of paper 2

Paper 2 aimed to identify facilitators and barriers, and explore co-creation during the digital monitoring implementation. We identified five major categories with subcategories of facilitators for and barriers to the implementation through the extensive inductive analysis of interviews, observations, documents and co-creation activities. The major categories were: 1) Pre-implementation preparations; 2) Implementation strategy; 3) Technology stability and usability; 4) Building competence and organisational learning; and 5) Service transformation and quality management. The factors, processes and actions included were facilitators for the implementation when completed and barriers to the implementation when not. The co-creation methodology was the most prominent facilitator, and the combination of IT infrastructure instability with the reluctance of the IT support service to contribute in the co-creation of values was the most persistent barrier throughout the implementation. From a temporal perspective, the implementation moved through characteristic pre-implementation, early, middle and late phases. In the initial deductive analysis of the interviews, we identified all the determinants of the MIDI framework. The implementation was considered successful, as it resulted in a sustained digital monitoring technology service in all the residential care facilities.

Figure 4-1 visualises the pre-implementation preparations, the implementation project's strategies, and facilitators and barriers through the early, middle and late phases of the implementation.

Figure 4-1 The life-span of the implementation of digital monitoring



4.3 Main results of paper 3

The aim of paper 3 was to describe how the MIDI questionnaire could be contextually adapted to measure welfare technology implementation. The iterative evaluation of previous contextual adaptations of the MIDI in line with an optimized procedure involving key informants and settings (see section 3.2.3), resulted in a thorough description of the welfare technology items detailing the 29 MIDI determinants. The determinants were related to the sequence of implementation strategies identified in paper 4, listed in Table 4-1.

4.4 Main results of paper 4

Paper 4 aimed to evaluate nurse call system implementations by measuring facilitators and barriers with the MIDI adapted for welfare technology. Statistical analysis of the MIDI questionnaire data from care providers (n=98) in the five residential care facilities identified far more facilitators (n=22) for than barriers (n=6) to the implementation. The implementation was strongly facilitated by the fact that nearly all (98%) care providers expected that use of wireless nurse call systems would lead to shorter response time and increased safety, were firmly influenced and supported by the manager, and also by fellow healthcare professionals (93%). The two most prominent barriers, reported by 37% of the care providers, occurred at the outset of the implementation. They did not find their level of prior knowledge sufficient, and found the systems difficult to learn. However, the barriers had been addressed by training and practicing technological skills and at the time of the cross-sectional measurement, 90% of the care providers used the nurse call systems and reported a competence level that facilitated implementation, including knowledge and a number of skills. Most facilitators and barriers were related to the adopting user. Only one barrier was identified in the organisation category, related to availability of equipment. No features of the technology itself nor of the socio-political context were identified as facilitators for or barriers to the implementation.

A sequence of implementation strategies used by the residential care facilities during the implementation of wireless nurse call systems was identified, as outlined in Table 4-1.

Table 4-1 Wireless nurse call system implementation strategies in residential care facilities

No	Implementation strategy
1	WNCS adopted as part of strategic development of RCF/care unit
2	WNCS purchased according to procedures for public procurement, including negotiation of long-term service and support agreements with vendors
3	Risk and safety assessments undertaken of WNCS in relation to existing building structure, infrastructure and care services, in order to prepare implementation
4	Implementation planned, roles and responsibilities defines, and resources allocated
5	Implementation coordination team is established: unit manager, WNCS super users, IT service, digital transformation facilitator and vendors
6	Information meetings for care providers and for residents/families
7	WNCS installed and tested before integrated in care workflows and routines
8	Unit manager actively involved in the implementation and can operate WNCS devices and applications
9	WNCS manuals and written clinical procedures made available to care providers
10	Training sessions offered to care providers, focusing on practical handling of NCS devices and applications
11	Supervision and support offered to care providers, focusing on practical handling of WNCS devices and applications
12	Care providers integrate WNCS devices and applications in care workflows and routines
13	Care providers instruct residents/families about WNCS devices
14	Implementation updates, technological-, clinical- and ethical issues discussed in coordination team meetings
15	Implementation updates, technological-, clinical- and ethical issues discussed in coordination team meetings

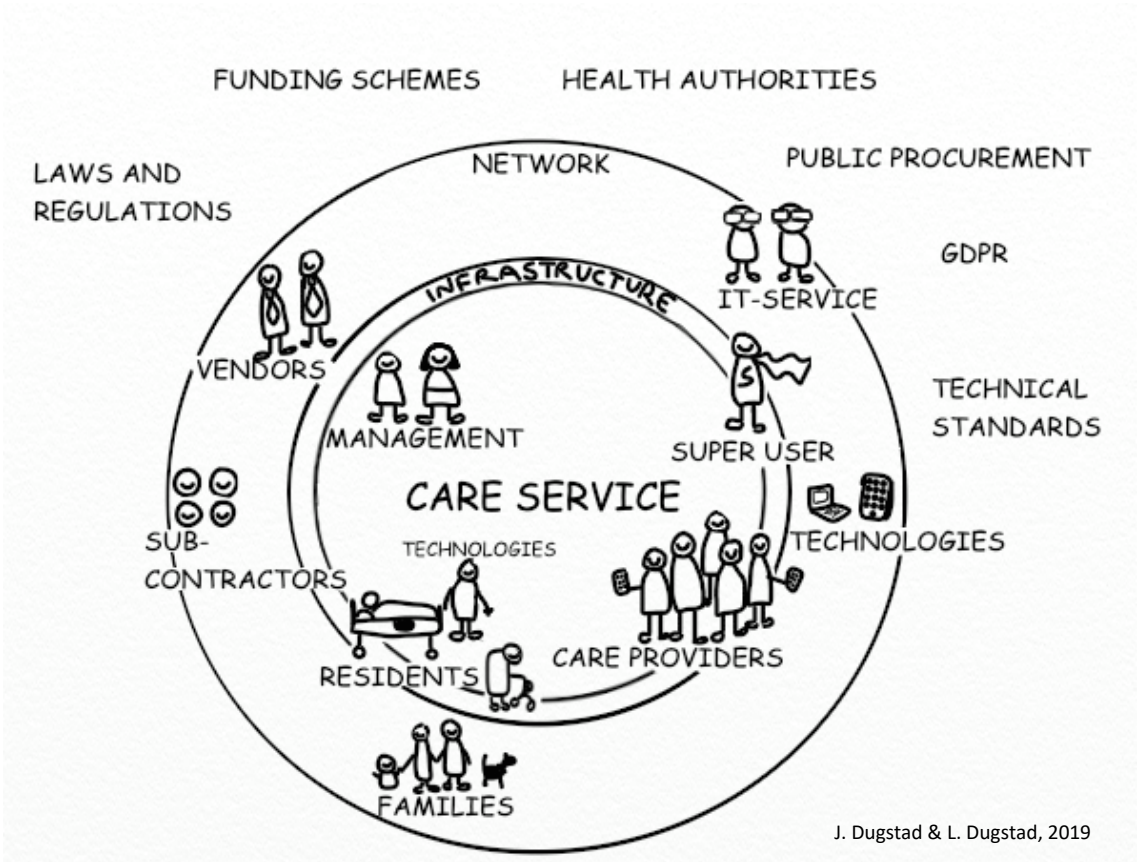
Abbreviations: WNCS; wireless nurse call system, RCF; residential care facility.

5 Discussion

The research included in this thesis has explored and evaluated innovative processes with a special focus on facilitators for and barriers to the implementation of welfare technology-based monitoring services in municipal residential care facilities. The first sub-study was an early implementation and co-creation of a highly innovative, digital night monitoring service customized for a small group of vulnerable residents. The second sub-study was a contextual adaptation of a measurement instrument for determinants of innovation, to welfare technology implementation in municipal care services. The third sub-study was a later full-scale implementation of a digital, wireless version of a well-known technology, the nurse call system, installed in nearly all rooms within the care facility, intended for all residents and used by the entire nursing staff.

The discussion will take a merging approach (Creswell et al., 2011), and will compare and contrast the three sub-studies to underscore the findings of the four papers.

Figure 5-1 Actors, agencies and system levels involved in digital monitoring implementation



5.1 Digital transformation of residential care

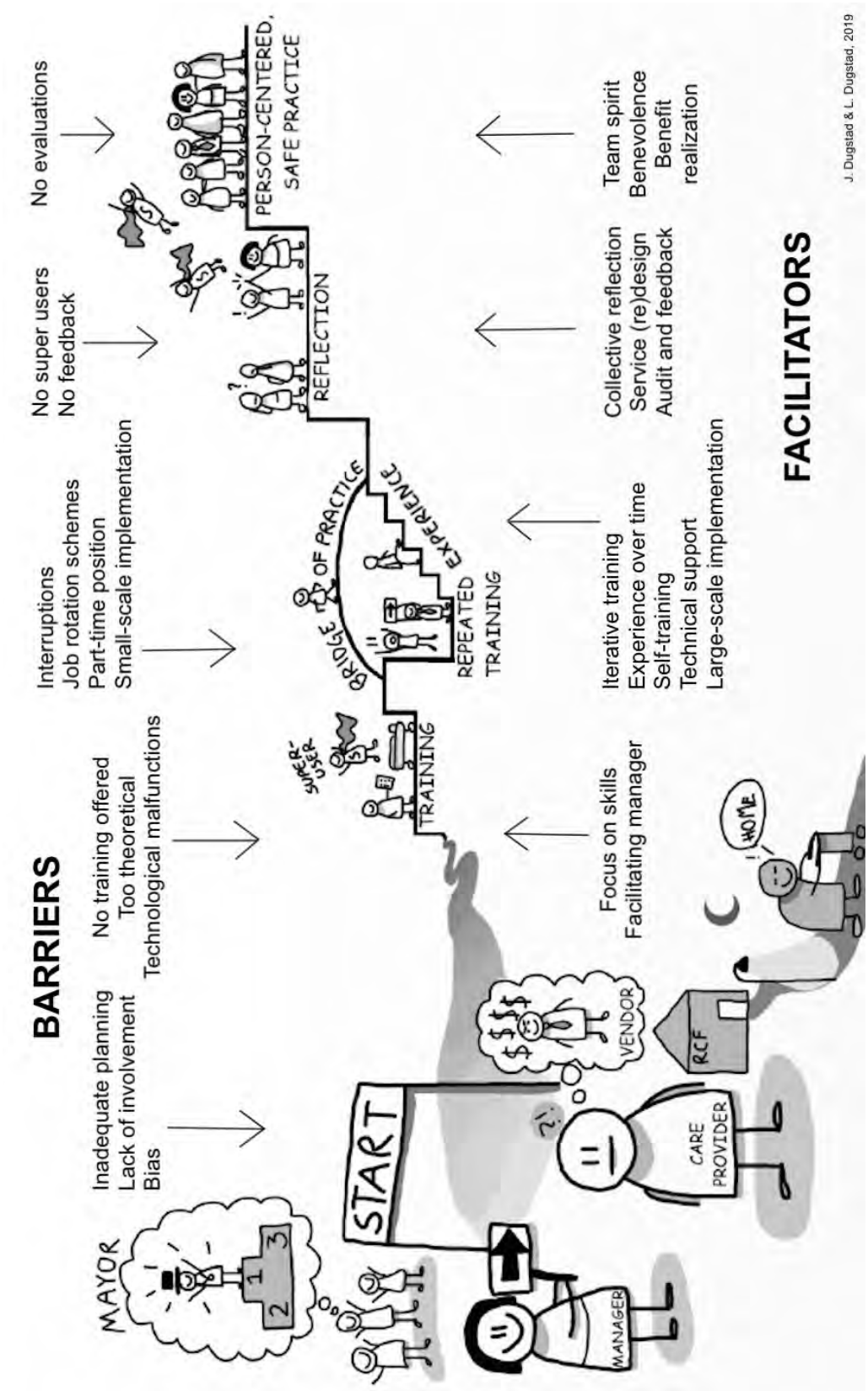
5.1.1 Overall findings

The major finding is that digital transformation based on successful implementation of digital monitoring is a complex, resource intensive and time-consuming process in municipal residential care facilities, and more so when it represents radical innovation with respect to technology novelty, disruption of care relationships and workflows, moral values, and the need for competency. Remarkably, all the implementations studied were successful in establishing new services that are still sustained. However, the implementations represented a high degree of complexity and the road to success was certainly no highway.

The progress of implementation processes depended on iterative and continuous involvement of and inter-dependencies between actors and system levels, influenced by facilitators, barriers and resistance within the micro care unit level, the in-between infrastructure level, the meso implementation network level, and the macro welfare technology governance level, as outlined in Figure 5-1 and Figure 5-2. Alignment of actors and agencies' self-efficacy, their trust in the technology and in other actors' competence and support seemed to represent a tipping-point in the implementation processes. Co-creation had a strong facilitating effect on resource-integration between actors and development of competency, capacity and capability. However, just as the implementations, co-creation represented novelty in itself, and depended on facilitation. The findings point to the importance of how the implementation of digital monitoring was conceptualized; as a straightforward "just do it" process, or as a complex and innovative endeavour.

The main aim of implementing digital monitoring in residential care facilities was to increase patient safety. Importantly, patient safety seemed proportional with the overall level of digital technology competency, quite low at start and increasing throughout the implementation. Founded in professional care ethics (Slote, 2007) and

Figure 5-2 A visualisation of the development of competency, capacity and capability over time



the essential constituents of person-centred care (McCormack & McCance, 2016), any factor perceived to compromise patient safety was in breech with the care providers' moral standards and treated as a barrier or cause of resistance. Safety was inversely related to risk, which again was linked to trust within and between individual actors, groups and system levels.

5.1.2 Competency, capacity and capability

Individual actors' competency and the availability of skills and competencies within the care units and the systems they belonged to strongly influenced the progression of the implementations. Inspired by the design-based approaches used in the first sub-study and integrating the results from all papers, Figure 5-2 presents a visualisation of the development of competency, capacity and capability over time on an individual level and within the care unit.

Competency was expressed in many ways. Thick knowledge boundaries (Carlile, 2002) between the groups of actors expressed through differences in language, interpretation and motivation characterized the early phase of all the implementations. Competency building included the development of a language to describe and discuss both the technology and the use of the technology in the context. It included a set of skills to operate the technology. It included practice over time, for the use of technology to become integrated in the range of professional strategies of the individual care provider (Dreyfus & Dreyfus, 1980), including the ability to initiate tasks that can be described as "hidden work" (Procter, Wherton, & Greenhalgh, 2018). It included an understanding of how to apply the new technology into the established service and of the changes that had to be made in order to use the technology efficiently. It also included the collective building of capacity and capability for emergence, problem solving and upscaling.

The development of competency, capacity and capability relied on a number of implementation strategies and was influenced by facilitators and barriers. Facilitators are presented as forces (arrows) that pushes the levels up, whereas barriers are forces that flatten the otherwise increasing levels. At the start of the implementation, Figure

5-2 shows a resident escaping the residential care facility at night (which triggered the implementation in the first sub-study), as well as some of the actors' motivation for the implementation and bias towards other actors. Starting the development of competency, strategies of experiential learning (Dreyfus & Dreyfus, 1980; Kolb, 1984; Moon, 2013) managed and facilitated by super users and unit managers focused on skill-acquisition. The provision of training was an important initial step, but contrary to a common belief in the municipal organizations, it was not enough. The next stage introduces "the bridge of practice". Care providers who were not granted continuous practice over time needed repeated training and/or support and supervision in order to operate the technology. When they could handle the technology, they were capable of contributing in the design of the new service. At this stage, the roles of the manager and super users developed to facilitating reflections on ethical and practical issues, as well as the design of new procedures and workflows. The care organisations' systems for audit and feedback measured the new performances. This stage included an alignment of self-efficacy, trust in the technology and in the colleagues, and represented a tipping-point in the implementations. Steadily reinforcement of these activities and the availability of technical support contributed to a safe monitoring service, provided by a skilled care-team working in a unit characterized by benevolence and person-centred practice.

5.1.3 Time, timing and temporality

Implementation constitutes a phase in the innovation process (E. Rogers, 2003), and even if the digital monitoring implementation was characterized by iterations and emergence, it also consisted of phases that took time and depended on timing. A phase of preparations preceded implementation, which encompassed transformation through three phases before the new monitoring service could be sustained. The first phase was characterised by installing the technology and getting it to play by local adaptations, or even what Rogers described as re-inventions (E. Rogers, 2003). The latter, more extensive adjustments were primarily triggered by mismatches between somewhat patch worked IT infrastructure and new monitoring technology. The second phase was

characterised by learning to use the technology and start changing the care procedures and workflows. The third phase was characterised by a more stable, reflective and safe monitoring service, with capacity and initiatives for upscaling, and then a gradual transformation into a sustained service. Each phase was influenced by factors and activities that had a flipped-coin effect, and that came to play as facilitators for implementation if applied and barriers if not. Once initiated, most of the characteristic activities of each phase were sustained and further developed in the subsequent phase(s), as seen in Figure 4-1. The identification of phases is in line with implementation theory (e.g. Moullin, Sabater-Hernández, Fernandez-Llimos, & Benrimoj, 2015; P. Nilsen, 2015; E. Rogers, 2003). The phases, as well as the facilitators and barriers, provided guidance to the order of implementation strategies that contributed towards successful implementation of digital monitoring, as presented in Table 4-1. Hence, time, timing and temporality were important determinants of implementation, because the processes involved in dealing with innovativeness, embarking on change processes and building competency and capacity were time-consuming, and the order of events seemed to be predictive of outcomes.

Whereas the small-scale night monitoring implementation (the first sub-study) was slow and time-consuming, the full-scale nurse call implementation (the third sub-study) was more rapid and time-efficient. A number of factors accounted for this, including the difference in technological novelty, perceived complexity, disruption of existing practice, and what Kiran et al. (2015) described as a changed moral landscape. The combination of time and the common level of technological proficiency most likely influenced these factors. As the first sub-study included in this thesis was planned in 2012/2013, it was hard to imagine how we in 2019 would become constantly connected and interconnected. During this period, welfare technology generally became more (morally) accepted. Smart phones and use of applications required resources for training and practice in the night monitoring implementation, but were easily adopted as the wireless nurse call systems were implemented, primarily due to the high proliferation in the private smart phone market (Øyen et al., 2018).

5.1.4 Conceptualizing welfare technology and digital monitoring

As the Government launched the welfare technology imperative without guidance as to how the municipal care services could facilitate, achieve and manage outcomes (Corneliussen & Dyb, 2017; Garmann-Johnsen & Eikebrokk, 2017), municipal managements welcomed the first report on welfare technology by the Directorate of Health in 2012. In this report, welfare technology was classified as a type of eHealth (Helsedirektoratet [The Directorate of Health], 2013). The municipal care services were experienced implementers of eHealth, such as electronic health records, and could be expected to recognize the need for infrastructure, IT competence, and risk assessments. In the report, the Directorate of Health also emphasized the need for innovation in order to develop, implement and sustain welfare technology services (Helsedirektoratet [The Directorate of Health], 2013). Indeed, the implementations studied in this thesis encompassed a series of innovations. Based on the classification by Hartley (2005), the digital monitoring technology represented product innovation; the new clinical routines and workflows represented process innovation; the new functionalities and re-structuring of responsibilities represented organization innovation; the vendors' entry into a new market represented position innovation; the municipalities' decision to implement welfare technology represented strategic innovation; the Government's imperative represented governance innovation, and the introduction of new concepts and terminology represented rhetorical innovation.

However, a quote on the cover of the welfare technology report by Nis Peter Nissen, the Director of the Danish Alzheimer Association, gained far more impact than the guidance provided between the covers: *"welfare technology is not about technology, but about human beings"* (Nissen, 2011). As discussed by Corneliussen and Dyb (in Norwegian), the notion that welfare technology is not about technology, which repeatedly has been and still is emphasized by the authorities, collides with the experiences of care providers working in the municipalities. In line with the findings of papers 1, 2 and 4 in this thesis, Corneliussen and Dyb (2017) have found care providers to see welfare technology as complicated and to be frustrated by their own lack of competency.

Given the level of innovativeness and the consequent risk of failing, a reflection on how actors or agencies within the system conceptualized the digital monitoring implementation may explain the emergence of resistance, barriers and facilitators reported in this thesis, as well as the choice of implementation strategies applied and those left out. Conceptualizing is in this context an expression for how a group of actors envisioned and enacted on the implementation, included processes, resources and involvement needed, and how they envisioned and enacted on the digital monitoring, including technology, clinical routines and organization; Or whatever the group through socially negotiated meanings included in those concepts (Hjørland, 2009). This understanding is in line with Moullin et al. (2015), who described implementation concepts to include the process of implementation through phases, influenced by groups and system levels, as well as by facilitators and barriers, implementation strategies and evaluation. The apparent conceptualizing by the majority in each group of actors in the first and third sub-studies is discussed in the following. Conceptualizing was introduced in paper 4. It was partly discussed as differences in language, interpretation and motivation between the actors in paper 2. Here, the discussion is developed to encompass the consequent actions and priorities of the different groups of actors.

5.1.4.1 The night monitoring co-creation and implementation (the first sub-study)

The municipal managements prepared and secured the formal entry into the night monitoring implementation project through a consortium contract and a research protocol, which both received extensive funding. Even so, the night monitoring was conceptualized as a small-scale, incremental innovation by all levels of management, including the locally appointed project managers. This was in line with traditional thinking of public innovation (Hartley, 2005; Hartley & Rashman, 2018), and probably influenced by how the Government had conceptualized welfare technology (Corneliussen & Dyb, 2017; Garmann-Johnsen & Eikebrokk, 2017). Thus, the managements failed to prepare the implementation sufficiently. Most remarkable was the failure to see the monitoring technology as eHealth (or as an IT system), and the consequent omission to involve the IT services.

Top managers, as well as middle managers, such as the care facility managers and their sub-ordinate care unit managers, can be expected to play a key role in overcoming challenges of implementation (Birken, Lee, & Weiner, 2012; Klein, Conn, & Sorra, 2001). The managements' persistent reluctance to involve themselves in spite of acknowledging that their efforts were needed, expressed passive resistance (Coetsee, 1993) and was symptomatic of system inertia, which is an organization's failure to achieve a sustained change in behavior, despite clear evidence that change is essential (Coiera, 2011).

The care providers initially conceptualized the implementation as difficult to accomplish and more importantly, as unethical, which caused substantial resistance. Remarkably, their conceptualizing reversed during the first year of implementation. This relied on the building of competency and capacity over time, and co-creation strongly facilitated this change.

The IT support service conceptualized the implementation of night monitoring as a high-risk endeavour, for which they were reluctant to bear responsibility. The top management did not seek their advice when preparing the implementation. When the IT services later were involved, they worried about incompatibility between the existing infrastructure and the novel technology, about the healthcare managers' and nursing staff's lack of competence, and ultimately, about the patients' safety. Their attitude was perceived as undue, active resistance (Coetsee, 1993), and cooperation became hard to achieve.

The vendors conceptualized the implementation as a co-creation exercise of hard work, and were prepared to offer a high degree of service and efforts in order to be successful. Their ultimate goal was to commercialize the technology and establish themselves in a profitable market. Their extensive integration of resources with all the other actors and system levels contributed towards emergence and flexibility within the consortium. This was done by filling the gap of IT competence when the IT service was unavailable, working during night to support the night shift, cooperating closely with each of the local project managers, and installing security measures until the care service had matured

and could audit the technology. In this way, the vendors reduced complexity and contributed to balance the networked system, allowing the implementation processes to move forward.

The researchers initially conceptualized the night monitoring implementation as traditional research, but soon took the roles as knowledge brokers and facilitators of co-creation as they (we) collected data and disseminated preliminary results. They also contributed towards emergence and flexibility, by taking on more responsibility for facilitation when the network orchestrator left the network.

5.1.4.2 The nurse call implementation (the third sub-study)

The management took quite another approach to the nurse call implementations. These were conceptualized as expensive and extensive public procurement projects by the municipal top management, directed by international procurement regulations and formal agreements with the vendors. Being sensitive to the new recommendations from the national welfare technology program (Melting, 2017; Melting & Frantzen, 2015), the municipal management was concerned about benefit (value) realization, understood as increased quality of care, saved time, and/or avoided costs (Melting & Frantzen, 2015). These principles seemed to trump previous recommendations by the same authorities, as none of the wireless nurse call implementations used co-creation as an implementation strategy.

A notable improvement, compared to the night monitoring implementation, was the managements' extensive pre-implementation preparations, including risk assessment. In one care facility, the technical installation initially failed. The implementation was thus postponed for 6 months, as opposed to the night monitoring implementation, where the implementation progressed in similar situations, posing risk to patient safety and to implementation success.

According to Birken et al. (2015), top managers may increase middle managers' commitment by giving the implementation organizational priority, allocating resources and performance reviews, and encouraging middle managers to do the same. The care

unit managers involvement and high degree of commitment was one of the major facilitators of the full-scale nurse call implementations. Whether this was due to the economic scope of the implementation and contract obligations, the top managements' involvement, the full-scale involvement of all residents and staff, or a higher level of digital health competency, was not explored. Importantly, their commitment contributed to a positive implementation climate (Klein & Sorra, 1996), with a high degree of resource integration within the nursing staff; also across shifts and professional backgrounds, as opposed to the night monitoring implementation. These findings are in line with reviews of the literature, which have found middle managers to facilitate implementation by diffusing and synthesizing information, mediating between strategy and day-to-day activities, selling the implementation and shaping a positive implementation climate (Birken et al., 2018; Birken et al., 2012).

The wireless nurse call systems offered a series of new functionalities, including night monitoring, which potentially would disrupt established workflows. However, the management decided to implement less advanced functionalities based on risk assessment. In this way, the complexity was reduced and the new system mimicked the nurse call systems previously used. This allowed one care facility manager to conceptualize the nurse call system as an upgrading of the former system, in line with previous upgrades at regular intervals. Consequently, it was decided that no training was needed, and no super users were appointed. The other four care facility managements conceptualized the nurse call systems as novel systems that needed training, availability of support and relied on the efforts of the nursing staff. These contrary ways to conceptualize the implementations became apparent in the preparations to the cross-sectional study (paper 4), but could not be evaluated statistically. However, the majority of care providers evaluated their prior knowledge as the most profound barrier and initially found the wireless nurse call system difficult to learn. They currently rated their self-efficacy and their colleagues' use of the nurse call system to be so competent that it facilitated the implementation. Bearing in mind that a cross-sectional study can not establish causality (M. D. Carlson & Morrison, 2009),

implementation strategies involving training and support most likely contributed to these outcomes and the rapid change in competency.

The IT support services conceptualized the nurse call implementation based on previous experience. They mobilized from the initiation of the procurement processes and were prepared to be more involved during the implementations. Remarkably, all the municipalities included a facilitator of digital transformation in the management of the implementation. One was an external consultant, whereas the others belonged to internal agencies for digital transformation within the wider municipal organizations. The digital transformation facilitators held positions in the implementation teams, facilitating the cooperation between agencies, including the IT service.

The vendors conceptualized the implementation according to their obligations in the contractual agreements. As these implementations did not rely on co-creation, both the IT service and the vendors were hardly included in resource integration with care providers, resulting in more distance and lack of a common language, which impeded the care provides' ability to learn from and communicate with the vendors.

5.1.4.3 Conceptualizing digital monitoring implementation as digital transformation of residential care

I have chosen the term digital transformation to describe how the processes included in the digital monitoring implementations represents a substantial change in the resource integration within the care service and between care providers and residents. The change was radical in the night monitoring implementation, but less radical in the nurse call implementation. However, the full potential of the nurse call systems is yet to be realized. The evaluation has revealed a mismatch between how the implementations were conceptualized and what we have found them to encompass. A number of factors contributing to the complexity have been identified. A characteristic example is that even in the most organized and managed implementations included in the thesis, the wireless nurse call system implementations, no single informant in any of the municipalities could provide all information required to prepare the questionnaire used

to evaluate the implementations. The nursing home context is in itself a complex adaptive system, as discussed by Anderson, Issel, and McDaniel (2003). The number of actors, agencies and system levels involved in the implementation and the consequent use of the monitoring technology, as seen in Figure 5-1, and their interconnected and interdependent actions represented implementation complexity. The thick knowledge boundaries between them, severely impeding communication, added to this complexity. As did persistent infrastructure instability, the novelty of the technology, as well as the novelty of the co-creation methodology. Emergence and iterations characterized the implementations, but even so, patterns, relationships and regularities were established, resulting in relative permanence of structures over time, as discussed by Stacey (2005).

A shift in focus from agencies to the inclusion of local interaction of and relationships between actors, transforms the triple-helix network, as included in the first and second sub-studies, into a complex adaptive system (Grant, Meyer, & Kuusisto, 2014). Rogers' diffusion of innovation theory (E. Rogers, 2003) has overlapping features with complexity theory, including how diffusion processes within complex systems move through observable, transformative phases which might be facilitated, leading to more rapid adoption and emergence, and resulting in outcomes like improved systems, products or services (E. Rogers, Medin, Rivera, & Wiley, 2005). Several research groups have proposed complexity science as a frame for implementation of health technologies, including Braithwaite and colleagues in Australia (Braithwaite et al., 2018; Rapport et al., 2018). In an EU project, Pfadenhauer et al. (2017) recently introduced the Context and Implementation of Complex Interventions framework. In parallel, Greenhalgh et al. (2017) introduced the "Non-adoption or Abandonment of technology by individuals and difficulties achieving Scale-up, Spread and Sustainability" framework in the UK. These frameworks can be used for further research of digital transformation through welfare technology implementation in municipal care services. In complexity research, it is essential to replace the principle of reduction with a principle of exploring the relation of the whole-part mutual implication. This thesis has shown that tendencies to reduce complexity by conceptualizing digital monitoring implementation too simple,

causes resistance and barriers. It is not possible to decompose such a complex system into elements, modify one element, produce a system outcome and then conclude that the isolated change agent caused the system change (Braithwaite et al., 2017; Byrne & Callaghan, 2013; Cutler, 2002).

Within the conceptual framework used in this thesis, the innovativeness, as well as the complexity of the digital monitoring implementation can be conceptualized by adapting the definition of innovation in healthcare organizations and delivery proposed by Greenhalgh et al. (2004), as stated in textbox 5-1.

Textbox 5-1 Conceptualizing digital monitoring implementation as digital transformation of residential care

Conceptualizing digital monitoring implementation as

digital transformation of residential care

Digital monitoring in residential care facilities includes a transformation of technology and behaviours, routines and ways of working perceived as novel to care providers and of which there is a growing base of evidence and guidance to draw on.

Digital transformation by digital monitoring implementation is directed at improving health outcomes, primarily by increasing residents' safety and supporting communication between residents and care providers in situations where residents are in need of assistance. Further, by boosting cost effectiveness and users' experience, including care providers experience of providing and residents' experiences of living in and receiving a safer service, with strong care relationships and increased person-centredness. Digital monitoring implementation is facilitated by actions that are co-created, coordinated and planned in an emergent manner, with allocation of resources, strong management involvement and facilitated strategies for learning and resource integration between nursing staff and IT- and technology competent agencies, such as the IT support service and vendors.

As digital transformation through digital monitoring implementation represent innovative practices, challenges raised by complexity, risk and (dis)trust can be supported by financial incentives as well as resource integration within a larger network consisting of similar organizations, vendors and researchers.

5.2 Methodological strengths and limitations

5.2.1 Strengths of the research design

This thesis addresses a highly relevant topic, which lacked a sound body of evidence. As advised by Brownson and Jones (2009), the research has pursued the best evidence available, and paid close attention to relevance, validity and reflexivity (Malterud, 2001). Practice-based evidence can be drawn from clinical practice and individual actors' personal knowledge and experience, which might be tacit and intuitive and need to be made explicit, disseminated, critiqued and developed for consensual validation and verification (Rycroft-Malone et al., 2004). Evidence from contexts and environment can be based on audit and performance data, knowledge about organizational culture, social and professional networks, feedback from a broad range of actors and agencies, and local and national policy (Rycroft-Malone et al., 2004). These principles have informed the design of the research, and thus form the basis for the contributions of the thesis.

Initially, the research intended to take a care provider perspective. As the implementations progressed, a constant flow of influences originated from the residents, families and the care unit on the micro level; from the in-between infrastructure level; from the municipal healthcare service, the overall municipal organization, the IT support services, vendors or other actors on the meso level; or from the Government, the national welfare technology program or other actors on the macro level. As reflected in the papers, the design of the study allowed for flexibility and adaptations to emerging influences.

According to Creswell and Clark (2011), mixed methods allow for a more complex understanding of phenomena that can not be achieved by a single method. Furthermore, mixed methods may include a bridging of philosophical perspectives (Greene, 2007). In this thesis this is exemplified by the application of interpretive hermeneutics and case studies, both belonging to the constructivist interpretive (phenomenological) paradigm, and the cross-sectional study belonging to the post-positivistic paradigm. Transparency was ensured through thorough descriptions of both

the methods and the mixing of methods. The five purposes for designing evaluations as mixed method studies proposed by Greene, Caracelli, and Graham (1989) have been applied as follows: First, triangulation supported convergence and correspondence of results from different methods. Second, complementarity ensured elaboration, enhancement and clarification of the results, where qualitative and quantitative methods were applied to measure overlapping but also different facets of phenomena. Third, results from one method informed the next method, resulting in development over time. Fourth, initiation allowed us to look for paradox, contradiction and new perspectives by mixing methods in an iterative approach. Fifth, the application of different methods for different components of the research expanded the breadth and range of inquiry.

In order to grasp the complexity of the context and the innovative processes, the research was conducted by a multidisciplinary team, as recommended by Aarons, Reeder, Miller, and Stadnick (2019), where each of the ten researchers represented an unique professional background and/or scientific discipline that contributed to an informed selection of methods and theories. These included the scientific fields of leadership, management and organizational studies, service innovation, process orientation, nursing, optometry, psychology, sociology, information systems, health informatics, health communication research, literature and ethics. By an investigator triangulation approach (Johnson, 1997), several researchers contributed in the collection and all contributed in the analyses of data in papers 1-4. Triangulation contributed to increased understanding of complex phenomena (Malterud, 2001).

The research was informed by a range of theories in order to capture the complexity of processes, actors and system levels. Thus, the base of theory constituting the conceptual framework evolved with the progression of the research, in line with the inclusion of new aims, contexts and methods. This theory triangulation (Johnson, 1997) corresponded with the overall, emergent mixed methods design of the research.

5.2.2 Strengths of the qualitative methods

The first sub-study had a longitudinal case study design with thick descriptions of how implementation was successful in spite of uncertainties and barriers, which is appropriate for research on complex systems (Greenhalgh & Russell, 2010). The strength of evidence has been reinforced through thick descriptions of multi-actor co-creation activities in real-world settings. In the first sub-study, the technology as well as the clinical practices were innovated as they were implemented, with input from the realities of the specific care setting, including healthcare management, care providers, IT support, vendors, residents and families, infrastructure, organizations, resources and strategies, and further balanced with theory from the peer-reviewed literature and member checking by the researchers. Hence, the process aimed to include triangulation of evidence with complementary information from different sources (Brownson & Jones, 2009). The research was also reported back to the participants on a regular basis during the first sub-study, in steering group meetings and in workshops, constantly informing the implementation processes. This was also a form of member checking (J. A. Carlson, 2010), where the participants were invited to provide feedback to the researchers' interpretations of data. There is a limitation in this method, as the quick feedback can compromise research rigor (Kislov, 2019).

The first sub-study encompassed extended fieldwork over a long period, resulting in trust between researchers and participants, and thorough knowledge of the culture (Creswell & Poth, 2017; Johnson, 1997). Low-inference descriptors, close to the participants' own accounts and researchers' field notes, also contributed towards validity (Johnson, 1997). These measures contribute towards a strong external validity, which is emphasized for clinical studies of "real-world" consequences of health innovations (Khorsan & Crawford, 2014).

Reliability was ensured during the coding processes, by mutually agreed code definitions between the researchers involved in the coding. Codes and themes were subjected to thorough discussions and refinements in the research team.

5.2.3 Strengths of the quantitative method

The MIDI instrument encompassed four relevant categories of determinants and allowed for adaption of items that reflected the complexity of implementing digital monitoring in residential care facilities. The strengths of MIDI included:

1. MIDI can be adapted to the specific innovation and context at hand; Most determinant frameworks are generic and hence provide limited "how-to" support for carrying out an implementation (P. Nilsen, 2015), whereas the adapted MIDI has the potential to guide an implementation process (Fleuren et al., 2014a).
2. MIDI is designed to elicit the perceptions and opinions of individual care providers as users of the innovation, in line with the digital monitoring systems under study.
3. MIDI corresponds with major constructs and attributes of the person-centred healthcare framework, as defined by McCormack and McCance (McCormack & McCance, 2016).
4. MIDI includes determinants that correspond with constructs, items and underpinning theories included in other generic determinant instruments for evaluation of implementations by care providers, such as the Normalization Process Theory instrument NoMAD (Finch et al., 2015) and the Theoretical Domains Framework (TDF) questionnaire (Huijg et al., 2014). NoMAD, on the other hand, does not include items related to patients and the TDF questionnaire does not include items to evaluate the innovation.

5.2.4 Limitations

All methodologies reduce the amount of information in order to contain the problem explored. The first sub-study encompassed a vast data material, and one of the consequences of these simplifications was that the residents and their families were not directly included in the research activities, which was in line with the research protocol. However, as active participants in the co-creation of the care itself, and the care relationship, they influenced the digital monitoring innovation and implementation activities. These interactions were reported by the care providers and vendors, as well as managers, through interviews and co-creation activities within the network. In a

similar manner, the MIDI questionnaire in the second sub-study took the perspective of the care provider, meaning that the perspectives of the administration and management, the support agencies, the vendors, as well as residents and families were indirectly reported.

Even if the first sub-study collected a lot of data, we were not successful in collecting descriptive quantitative data, like the number of residents who used the digital night monitoring during the course of the project. As the implementations ran in parallel to routine care from the very beginning, a large number of staff handled the residents and the technological installations without being directly involved in the research project. The quality of the registrations was too poor to be reported, and the routine was discarded. Similarly, patient outcomes, like the reduced number of elopements, falls and medicines, were not measured in all municipalities and were thus not quantified.

In the third sub-study, the response rate to the questionnaire was low. A large number of potential respondents who received the digital invitation or were given the envelope with information and the MIDI questionnaire in information meetings did not participate in the survey, even if a number of strategies were applied in order to motivate them. I observed some of the care providers as they worked their way through the questionnaire, and it was obvious that some struggled with the Norwegian language and that many respondents found the questionnaire to be long. The response time varied from 10 to 40 minutes on the paper version. However, the lowest response rate was related to the digital survey. A closer analysis showed that nearly all the responses were initiated within a couple of minutes after the SMS with the link to the survey was sent from the residential care facility manager to the nursing staff, which was done twice. The care providers who were busy at the time, probably forgot about the invitation, or lost it in the line of messages.

Nearly 20% of the respondents were super users, and had received more extensive training, which represented a bias. We do not know whether the characteristics of non-responders differ from responders. The low response rate may have given a bias of the measures of outcome. We were not able to investigate whether the time from the

outset of implementation to the administration of the survey (e.g. 0-3 months, 4-6 months, 7-9 months, or 10-12 months) affected the results. No comparisons of the MIDI scores between professional groups or the residential care facilities could be reported, even if it would be very interesting to explore how the different implementation strategies influenced the outcomes.

The cross-sectional study design assesses the exposure and outcome simultaneously. There is generally no evidence of a temporal relationship between exposure and outcome, in the sense that even if there is an association between an exposure and an outcome, there is generally no evidence that the exposure caused the outcome (M. D. Carlson & Morrison, 2009).

Finally, the transferability of the findings in this thesis to other welfare technologies or care contexts can not be predicted, but the thick descriptions will enable readers to determine transferability to their contexts (Creswell & Poth, 2017).

5.2.5 Statement of reflexivity

The research undertaken in this thesis is influenced by the close proximity between myself, the participants and the implementations included in the first sub-study over a long period of time, as well as the formal positions I had before and during the implementation project (as detailed in the preface of the thesis and the method chapter). This proximity contributed to deep knowledge of the innovations, participants, contexts and their inter-relationships, as well as their development since the first network activities described in the introduction of the thesis. The formal position in the steering group represented power and an opportunity to influence the implementation processes, in line with the other members of the group. In practical terms, the network orchestrator prepared and recommended strategies for discussions in the steering group, and then the municipal representatives made the strategic decisions. The formal position in the steering group also represented responsibility for achieving the aims of both the implementation project and the research project, by fulfilling the expectations of the funding agencies, the partnership and the university, which I represented. The

formal responsibility was shared with the research project manager and a researcher representing another university, whereas the other researchers did not bear the same responsibility. This highlights how the co-creation approach resembled, but differed from traditional action research. It certainly influenced my motivation and efforts as a researcher and an enthusiastic facilitator of implementation, even if it challenged the balance between becoming embedded in the context and implementation processes and maintaining the critical distance expected in research. Kislov (2019) described this conflicting identity as "being 'too academic' for practitioners and 'not academic enough' for fellow researchers".

I was introduced to the residential care institution context through the first sub-study, initially as an observer of vendors instructing care providers to use smart phones and applications. Situations soon arose where language differences and thick knowledge boundaries (Carlile, 2002) between the vendors and the care providers brought me into the role of a facilitator as well as a researcher. Intervening in these small group settings, primarily to provide information and solve misunderstandings, contributed to a better flow of activities. However, possessing more information than other participants might have influenced the power-balance between us. I have sought to manage this position with consciousness and respect. My role as facilitator of co-creation activities during workshops in large group settings was planned as part of the research design. It was never my or any other person's sole responsibility to decide, prepare or facilitate the activities; it was always the joint effort and responsibility of actors representing different partners in the network, including the network orchestrator, municipal project managers and fellow researchers.

I have consciously applied a set of strategies to approach the issues of bias. I have participated in all previously described activities undertaken by the team of researchers in order to promote reliability and validity. The research team reflected on issues of bias during regular meetings and in the joint efforts of analysing and writing up the research. Another strategy I have used, is reflexive journaling (J. A. Carlson, 2010). I have continuously made "notes to self" during observations, interviews, meetings, while

reading literature, and while doing analyses. These notes concerns issues for further exploration, questions to ask certain people, perceptions to check with certain people, reflections to discuss with supervisors or the research team, or perceptions for myself to reflect on. In order to follow up these notes and reflections, I have recurrently reviewed them, and I have pursued a proactive approach of seeking information and asking questions in order to explore issues in more depth. If I have not understood or been provoked by the answers, I have made an effort to ask more questions.

I have encountered participants that have had their own agenda, who wanted the research to prove their case. They invited me in to document issues they were not in a position to influence by themselves, but which they expected the research or the researcher would. In these cases, I have listened to them and then have sought to balance the information by exploring the perspectives of other actors. This is an example of situations where I have pursued to maintain my own voice while truthfully reflecting the voices of the different actors, even when they have been conflicting.

In addition to member checking within the network, I have applied a similar strategy involving external informants. The research has been conducted within a timeframe that has been characterized by progress in all system levels, agencies and actors, the market, technical standards, legislation, funding schemes, tools for implementation, national recommendations, education and research. In order to stay informed and keep up with this progress, I have given about 150 presentations of our research and related topics for user organizations, care providers, professional associations, municipal managers, politicians on local, regional, national and Nordic levels, funding agencies, vendors, students, corresponding networks, health cluster organizations, and researchers. A few presentations have been in research conferences, some have been in national or international seminars, and the majority have been in settings that are more informal. I have also presented for and discussed with the bodies responsible for the national welfare technology program, the Directorate of Health, the Directorate of eHealth, and the Norwegian Association of Local and Regional Authorities. I have visited Sweden and Japan to explore welfare technology implementation in corresponding care systems.

These strategies have provided wonderful opportunities to discuss, reflect, learn more, connect, and to disseminate the research. They have contributed to my general knowledge of welfare technology and service transformation through digital health, and have been reflected back to the research.

6 Conclusion, contributions, and further research

The overall aim of this thesis was to explore and evaluate innovative processes with a special focus on facilitators for and barriers to the implementation of welfare technology-based monitoring services in municipal residential care facilities. The specific aims were to 1) explore resistance, 2) identify facilitators and barriers, and 3) explore co-creation practices as an innovation strategy during the first sub-study, the implementation of digital night monitoring of persons with dementia who were night wanderers. Further, the thesis aimed to 4) describe how a measurement instrument for determinants of innovations could be contextually adapted to welfare technology implementation in municipal care services, in the second sub-study. Finally, the thesis aimed to 5) explore facilitators for and barriers to implementation of wireless nurse call systems in residential care facilities, which constituted the third sub-study.

In conclusion, digital transformation in the form of successful implementation of digital monitoring represented a complex, resource intensive and time-consuming process in municipal residential care facilities. The more novel the technology and the more radical the disruption of care relationships and workflows, the more they challenged the moral values of the care providers, resulting in resistance, as seen in paper 1. As the technology was perceived to improve safety, allowing the care providers to attend to the residents' needs more promptly and supporting person-centredness, it became a strong facilitator for implementation, as seen in papers 1, 2 and 4. Low levels of technological competency among care providers and care managers generally impeded digital monitoring implementation and the potential for digital transformation, and even threatened patient safety, as seen in papers 2 and 4. The implementations were influenced by iterative and continuous involvement of and inter-dependencies between actors and agencies on the micro care unit level, the in-between infrastructure level, the meso implementation network level (papers 1 and 2) or coordination level (paper 4), and the macro welfare technology governance level (all papers). Social support within the care unit had a facilitating effect on the implementation, according to the care providers in paper 4. Similar support was provided within the network studied in paper

1 and 2. Planning and preparations, sustained leadership and the application of a series of implementation strategies facilitated the implementation processes through three characteristic phases, which took time and required timing (papers 1, 2 and 4). Co-creation had a strong facilitating effect on the resource integration between actors and the development of competence, capacity and capability, involving the micro- and meso-levels, as seen in paper 2. The macro-level initiatives were both facilitators for and barriers to the implementations. The late introduction of guidelines and recommendations, as well as the introduction of GDPR impeded the implementations, whereas funding schemes and the increasing availability of guidance were facilitating contributions, as discussed in papers 1-4.

6.1 Methodological contributions

The research in the first sub-study represented a variant of action research based on the participation from several groups of actors in the formulation of research aims and in the decision of progress and activities in the dual design of research and practical implementation. Both the implementation activities and research activities have been thoroughly described and analysed, and can serve as a method in further research.

The method for collecting information about welfare technology implementation in municipal care services in the second sub-study, including the informants, their order and the data collection (see section 3.2.3 and further details in paper 3), was found to be appropriate for preparing the MIDI questionnaire. The procedure is most likely appropriate as a backdrop for other research designs aiming to explore welfare technology implementations.

The MIDI questionnaire in the second and third sub-studies was cross-culturally adapted to Norwegian and contextually adapted to welfare technology in municipal care services, and may be adapted to other technologies and implementations.

6.2 Empirical contributions

"If We Want More Evidence-based Practice, We Need More Practice-based Evidence", according to Green (2006). This thesis contributes with substantial empirical evidence, including evidence that supports co-creation practices and service design methodology, as well as digital monitoring implementation, which are methodologies and technology recommended by Norwegian authorities (KS [Norwegian Association of Local and Regional Authorities], 2015; Melting, 2017).

Paper 1 contributed the identification of organizational, cultural, technological and ethical resistance, in research on novel technology in a context sparsely studied in relation to resistance. The concept of ethical resistance, with the sub-categories of resistance due to patient safety issues, concern for the quality of care, patient privacy and dignity issues, and issues of justice, was the main contribution. Yet another contribution was the exploration of the productive role of resistance during implementations organized as co-creation processes.

Paper 2 contributed with the identification of a number of factors, which acted as facilitators for implementation of digital night monitoring if applied and barriers to the implementation if not. The determinants were categorized as pre-implementation preparations, implementation strategy, technical stability and usability, building competence and organizational learning, and service transformation and quality management. The categories were related to characteristic phases over time, as seen in Figure 4-1.

Paper 2 also contributed with detailed explorations of which, when and how co-creation strategies, including participatory design and service design, were efficient facilitators in the implementation processes. This provided an empirical backdrop for the co-creation activities recommended by Norwegian authorities.

Paper 4 contributed with the identification of facilitators and barriers during full-scale implementation of a wireless (digital) nurse call system in residential care facilities and

the identification of a series of implementation strategies used during digital monitoring implementation.

Finally, the thesis contributed with a visualisation of the development of competency, capacity and capability for digital monitoring in residential care facilities, including facilitators and barriers (Figure 5-2) and a proposed conceptualization of digital monitoring implementation as digital transformation of residential care.

6.3 Implications for practice

The clinical implications are in line with the major findings: Digital monitoring implementation represents a complexity that should be conceptualized as digital transformation, rather than incremental change. The implementations benefit from good planning and persistent management focus. The prior level of digital competency among care managers and care providers needs to be addressed. Practical training, experience over time and co-creation processes facilitate implementation efforts and contribute to competence building and an implementation climate characterized by benevolence. Facilitation of dialogue between actors and agencies, and of development of competency, capacity and capability, is a measure that contributes to reduce the complexity of transformative processes. The MIDI questionnaire offers valuable means to evaluate welfare technology implementation.

The complexity of distributed responsibility for technical components in the building structures, infrastructure, digital monitoring technologies and integrated applications seems more challenging, and invokes the need for close attention. Finally, digital transformation of care services challenges the current silo organization of municipal care services and IT support services. This is ultimately a threat to patient safety and will need to change over time.

6.4 Suggestions for further research

This thesis found care providers' prior levels of digital competency to be low and to compromise patient safety. The relationship between care providers' digital competency and patient safety during welfare technology implementation should be further researched.

More research into the perspectives of residents who receive a digital monitoring service, as well as their families, would provide valuable information for the sustained use of monitoring services.

The research undertaken in the thesis reports from early stages of digital monitoring services. More research into organizational capacity building over time is needed as more welfare technologies are introduced into the care services, either as new entities or as new parts and functionalities expanding such innovative digital systems as described in this thesis.

A compilation of welfare technology implementation strategies has been identified, and more research is needed into the differentiation and cause effect relationship between barriers, facilitators, implementation strategies, intermediate implementation outcomes and long term service- and patient outcomes, in order to realize benefits and a sustainable digital care service. Complexity theory and frameworks may be applied.

Digital transformation of care services rely on integration of competency related to IT, digitalization and technology that challenges the current silo organization of municipal IT support services. This is ultimately a threat to patient safety and will need to change over time. It seems relevant to explore the role of the digital transformation facilitators with respect to the role and responsibility of the IT support service.

Finally, this thesis proposes the need for research into the municipal adoption processes and their subsequent conceptualizing of welfare technology implementation.

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Paper 1

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Exploring resistance to implementation of welfare technology in municipal healthcare services – a longitudinal case study

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Abstract

Background: Industrialized and welfare societies are faced with vast challenges in the field of healthcare in the years to come. New technological opportunities and implementation of welfare technology through co-creation are considered part of the solution to this challenge. Resistance to new technology and resistance to change is, however, assumed to rise from employees, care receivers and next of kin. The purpose of this article is to identify and describe forms of resistance that emerged in five municipalities during a technology implementation project as part of the care for older people.

Methods: This is a longitudinal, single-embedded case study with elements of action research, following an implementation of welfare technology in the municipal healthcare services. Participants included staff from the municipalities, a network of technology developers and a group of researchers. Data from interviews, focus groups and participatory observation were analysed.

Results: Resistance to co-creation and implementation was found in all groups of stakeholders, mirroring the complexity of the municipal context. Four main forms of resistance were identified: 1) organizational resistance, 2) cultural resistance, 3) technological resistance and 4) ethical resistance, each including several subforms. The resistance emerges from a variety of perceived threats, partly parallel to, partly across the four main forms of resistance, such as a) threats to stability and predictability (fear of change), b) threats to role and group identity (fear of losing power or control) and c) threats to basic healthcare values (fear of losing moral or professional integrity).

Conclusion: The study refines the categorization of resistance to the implementation of welfare technology in healthcare settings. It identifies resistance categories, how resistance changes over time and suggests that resistance may play a productive role when the implementation is organized as a co-creation process. This indicates that the importance of organizational translation between professional cultures should not be underestimated, and supports research indicating that focus on co-initiation in the initial phase of implementation projects may help prevent different forms of resistance in complex co-creation processes.

Keywords: Ethical resistance, Welfare technology, Innovation, Co-creation, Municipal healthcare

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Background

Healthcare services face vast challenges that will increase in the years to come, partly due to demographic changes including ageing populations [1, 2]. Welfare technology is viewed as one important means to meet these challenges. Implementation of digital night surveillance technologies in nursing homes and home care services has emerged as a potentially efficient way of meeting the need for monitoring persons for healthcare and safety reasons. This is an alternative to calling in on, for example, patients with dementia or intellectual disabilities, and potentially waking them up at night. However, the application and use of digital surveillance technologies in the care for vulnerable individuals generates considerable ethical debate [3–5]. Implementation of welfare technology also implies innovation and organizational change, which is often met by different kinds of resistance. Resistance can be found on individual, organizational, and institutional levels, and these levels are often inter-connected [6–8]. This paper explores if and how resistance occurs on different levels in the initial phase of digital surveillance technology implementation in municipal nursing homes and home care services.

Implementation of innovation

Innovation has been defined as "the intentional introduction and application within a role, group, or organization, of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, or wider society" [9, 10]. This definition has become widely accepted among researchers [11, 12]. It captures many aspects of the innovation process under study, as it aims at implementing new technologies and developing new ways of working in order to benefit the individual service user and the healthcare organization. Implementation is seen as one of the four stages of innovation: dissemination, adoption, implementation and continuation [13]. The implementation stage is according to Rogers "that which occurs when an individual puts an innovation into use" ([14]:474).

Implementation of technology initiates a change process and has the potential to alter the way we work, how we organize work and the power relations in an organization. However, a large number of change initiatives fail due to unfocused and insecure management and lack of systematic project management [15, 16] or are slow to be implemented (e.g. [17–19]). The implementation phase is increasingly becoming a phase where the technology developers and the customers cooperate closely, and in the business literature it is coined as co-development of the product [20] or co-creation of value [21]. The concept of co-creation implies close and continuous interaction in the implementation phase between the innovators and developers of the technology and the customers. The technology developers may lack knowledge about the market and the users, while customers often also lack familiarity of technological language and technology proficiency. In the implementation phase of, for example, welfare technology, several knowledge spheres or epistemic cultures meet [22].

Resistance to technology implementation

Resistance is inherent to organizational life [23, 24], and the literature on resistance stretches across several disciplines [25]. According to a recent review of research on resistance to healthcare information technologies, resistance is under-researched and multifaceted, and relatively little attention has been paid in understanding it [26]. Resistance to change has mainly been seen as an effort to maintain status quo and research has traditionally seen resistance as a negative force that must be overcome [23], and as a restraining force "that leads employees away from supporting changes proposed by managers" [27:784]. Resistance to technology implementation is 'expected' and can be seen as the flip side of success factors for innovation which has been emphasized in research on technology implementation in the Information Systems (IS) field (see for instance [26, 28]).

Change processes like the implementation of technology are met by several types of resistance. Resistance is found at individual, organizational and institutional levels [6–8], and these levels are inter-connected. Previous research has for instance shown that traditional organizational constellations may change as a result of technology implementation [29, 30]. Increased use of technology may change the work pattern, the division of labour and the interaction pattern. Previous research also indicates that the implementation is complicated by a lack of training and lack of interest from employees [31, 32].

Within the IS field, research on resistance concentrates on the negative paradigm, focusing on subordinates' unwillingness to implement decisions made by the management [33, 34]. Resistance occurs if threats are perceived from the interaction between the object of resistance and initial conditions [33]. Resistance creates friction, which has negative connotations and may complicate the implementation process. Friction is however also an antecedent to change [35]. As the implementation process proceeds, the users are likely to make moderations to the set of initial conditions or the subject of resistance, based on their experience with the technology. Hence the nature of the resistance will change through the implementation process [33], and resistance is not considered as purely harmful. A further example is the notion of productive resistance [23]. Productive resistance builds on the notion of resistance as a way of coproducing change and "refers to those forms of protest that develop outside of institutional channels" [23:801].

In this study, we investigate how resisters think, how they understand their own resistance and what resisters do "rather than seeing resistance as fixed opposition between irreconcilable adversaries" [23:801]. This resistance behaviour is categorized by Coetsee [36] as apathy, passive resistance, active resistance and aggressive resistance.

Resistance to technology implementation in healthcare

Resistance to increased use of technology in healthcare is still considered to be under-researched [26, 29]. Lluch states in a review article on health information technologies (HIT) that "more information is needed regarding organizational change, incentives, liability issues, end-users' HIT competences and skills, structure and work process issues involved in realizing the benefits from HIT" [31:849].

Furthermore, the healthcare field is not *one* field, and healthcare technology consists of a wide range of technology. Within the healthcare field, hospitals have often been the preferred empirical setting (see for example [33, 37, 38]), and physicians are the preferred actors under study (see for example [18, 37]). The municipal healthcare setting differs from that of a hospital, especially due to the organizational and structural elements of the municipality itself. The municipality is more complex and consists of several organizations, weakly tied and embedded in the larger municipal organization. Still, the levels and the various actors and units within the greater municipal organization are linked through the tasks and the users of the services. Further, the focus on patients' interests in healthcare in general and concerning the increased use of technology, in particular, has led to focus on the groups who need to collaborate in order to implement technology [39].

Based on their studies of the implementation of information technology (IT) in hospital settings, Lapointe and Rivard [33] identified five basic components of resistance: Resistance behaviours (from passive uncooperative to aggressive), the object of resistance (the content of what is being resisted), perceived threats (negative consequences that are expected implications of the change), initial conditions (such as established distributions of power or established routines) and finally the subject of resistance (the entity, individual or group, that adopts resistance behaviours). They propose a dynamic explanation for resistance to the implementation of technology. The resistance behaviours result from the nature of perceived threats on various points in the implementation process. Depending on what triggers the resistance behaviours, new threats and consequently, new resistance behaviour emerges. The perceived threats and the resistance behaviour can be found at an individual and group level. In this article, we recognize the five basic components of resistance identified by Lapointe and Rivard, and define resistance descriptively as behaviours (attitudes, acts and omissions) that obstruct or interfere with the process of co-creation and organizational change.

The case of Digital Night Surveillance

The innovation project at hand is called "Digital Night Surveillance", which is a government funded project where five municipalities, both rural and urban, work with a network of technology developers to develop and implement the use of sensors and digital communication in nursing homes and home care services.

The project entailed service development and technology development in a co-creation process [21, 40] within a triple-helix inspired network [41], consisting of (1) a network of small- and medium-size technology enterprises (SMEs), (2) municipal health and care services, and (3) a university research group [42]. The overall aim was to develop and implement the best possible solution to the challenges of night surveillance, in order to enhance security and quality of care for the service users within the municipalities' limited resources [29, 43]. The co-creation and implementation process was facilitated by a professional manager or "orchestrator" [42].

The technology to be implemented included sensors on doors and in electronic security blankets (on mattresses) used during the night. A web-based portal facilitated communication via traditional PCs as well as mobile devices, such as tablet computers and smartphones. Most of the municipal services already had some welfare technology installed, such as alarm systems. The novelty of the new system was tied to the web-based portal into which different technological applications could be connected and administered. In this way, technology in different categories and from different producers could function together and be programmed and adjusted to the individual patients' needs. Alterations could be made based on for instance variations in needs during the day or due to the progression of a disease. An alarm went off when an incident happened. The system was programmed to send alarm messages to dedicated personnel, and they received the alarm on either a smartphone, pad or PC, or a combination of these. They 'signed out' the alarm as they checked on the patient.

The implementation project involved a large number of stakeholders, and the study of resistance involved exploring some of these. Data in this study comes mainly from the healthcare providers on the night shift, managers on various levels in the municipalities and healthcare institutions, and the technology developers, who also installed the equipment and trained the healthcare providers. Furthermore, the following stakeholders were involved and/or affected by the project: IT service staff, patients and families.

The home care services and the nursing homes included in the project had primary users in need of night supervision. The residents of the nursing homes suffered from dementia, and tended to get up at night and wander around, which has been described as one of the most challenging behaviours to manage [44]. Night surveillance in one form or another (face-to-face or technology based) was necessary to detect "night wanderers" and guide them back to bed in order to avoid confusion and anxiety, avoid the risk of falling and injuries, and protect other residents from being disturbed and frightened at night. In the Digital Night Surveillance project, sensors in blankets and on doors detected and sent a signal if the patient left the room. The patients did not actively use the technology; rather the users were the healthcare providers.

The participating municipalities identified a need for innovation in order to ensure safety at night for the service users. Then entered into a contract with a network orchestrator, a network of technological SMEs and a science centre for health and technology in a university, in order to run an implementation project, which included both municipal home care services and nursing homes. The initiative came from the empirical field itself.

Methods

Aim and study design

The aim of this study was to explore resistance to implementation of welfare technology in five municipalities in Norway. The design was explorative and draws on a longitudinal single-embedded case study [45] with elements of action research. The study was carried out during 2013 and 2014.

A case study is suitable for an explorative, in-depth study of contemporary events in its real-life context [45]. The case was a project, organized with sub-projects in each of the municipalities, with a local project manager on site. The research took a multi-stakeholder perspective as both the technology developers in the business network, who also install the technology and train the healthcare providers, and the healthcare providers, on various levels of the homecare services and nursing homes, were included in the study. The healthcare providers are the actual users of the technology and are defined as the users in our study. The study does not include data from the end-users.

Three main action research elements were applied: 1) researcher participation in the project design and planning activities, 2) researcher participation in (and by occasion also facilitation of) knowledge sharing and reflection processes during workshops and meetings, including presentation of preliminary research findings, and 3) using focus group interviews not only to collect data but also to stimulate critical reflection on the co-creation and implementation process [46, 47].

Table 1 gives an overview of the longitudinal design, the timeline, the technology, the users and the data collection methods.

Table 1 Design and data collection methods – an overview

Stake-holders	Technology	Research activities			
		Q3 2013	Q4 2013	Q1 2014	Q2 2014
Municipality 1	Sensor technology Alarm system Web-based portal Installations: 8	EP WS PO FG	WS PO II	WS PO	WS PO
Municipality 2	Sensor technology Alarm system Web-based portal Installations: 11	EP WS PO FG	WS PO II	WS II PO	WS PO
Municipality 3	Sensor technology Alarm system Web-based portal Installations: 9	EP WS PO FG	WS PO II	WS PO	WS PO
Municipality 4	Sensor technology Alarm system Web-based portal Installations: 4	EP	WS PO	WS PO	WS PO
Municipality 5	Sensor technology Alarm system Web-based portal Installations: 2		EP WS PO	WS PO	WS PO
Suppliers		FG WS	WS	FG WS	WS
Participants in each workshop		24	33	17	32

Abbreviations: *EP* Entered the project, *II* Individual interviews; *FG* Focus group interviews; *PO*: Participatory observation; *WS* Workshops

Data collected

The main sources of qualitative data were semi-structured interviews, both individual and focus group interviews, and observations in workshops and meetings. Altogether, data were collected through nine individual interviews, three focus group interviews and observations on site and in four workshops. In all, about 50 individuals (including the five researchers) took part in the workshops and meetings. The researchers facilitated some of the workshops in order to stimulate co-creation and the production of process data. Twenty-one individuals were interviewed, both healthcare providers (from all five municipalities) and technology developers. All interviewed informants participated in two or more of the workshops. Some of the participants in the focus groups were also interviewed in-depth individually. All participants consented to participation in the research study.

The selection of informants from the municipalities for the individual interviews was aided by the project managers. The inclusion criteria were employees working as either project manager, middle manager or night healthcare provider. Eight women and one man were interviewed in the period from September 2013 to November 2014. Four technology developers, all male, participated in a focus group interview in January 2014. The focus group method was in line with the methodology used in the project itself, which used the workshops as an arena for orchestrated interaction, collective reflection, knowledge sharing and innovation of services [42], thereby the interviews were an arena for co-creation in themselves [48]. The in-depth interviews followed a semi-structured interview guide (Additional file 1) [49, 50] and were carried out as conversations. An interview guide was used as a checklist at the end of the interview to ensure that all planned topics were included. The first two focus group interviews with healthcare providers from three of the municipalities were performed as part of a workshop arranged early in the implementation phase, and were conducted by four of the researchers. The third focus group interview was conducted by two of the researchers with central representatives from the network of technology companies. The focus group interviews were conducted face-to-face and lasted for about 90 min each. Both the in-depth interviews and the focus group interview were digitally recorded and transcribed verbatim.

Data analysis

Data from the interviews and observations were analysed and interpreted as inspired by Kvale's description of the bricolage approach to data analysis [49]. Analysing data based on bricolage involves the use of various techniques and concepts during the process. We also used researcher triangulation [51], which meant that the whole research team with members from various fields such as organization and innovation studies, sociology, psychology, nursing, healthcare research and ethics, took part in the analysis and interpretation process. The main reason for choosing a researcher triangulation approach was the need for different perspectives to understand the complexity of the innovation and co-creation process, involving five different municipalities, including different professional roles, service designs, IT systems, and local decision-making procedures.

As a first step, following the description of analysis by Kvale and Brinkmann [49], the transcribed texts from the interviews were systematically read through in a naïve manner. A reflexive, open-minded and inductive reading was pursued, as well as grasping the intuitive meaning of the text as a whole and to interpret the participants' experience and descriptions of the implementation of welfare technology. The themes in the analysis arose in an iterative process between reading and interpreting by several researchers, in order to find meaningful units and then themes according to the research question [49, 52].

Threats to validity were met by cooperating within the research team in all phases of the research project, which ensured an open discussion as well as deep knowledge of the context. The reliability of the study was strengthened through researcher triangulation and continuous contact with the network. Threats to reliability have further been met by describing the research approach in detail.

Results

At the outset, there were few signs of resistance among the participants. As the process moved on, various forms of resistant behaviour emerged, from scepticism of the usefulness and the functionality and safety of the technology, to both passive and more active uncooperative attitudes towards the change of initial conditions, such as established routines, practices and technological infrastructure. The perceived threats were often communicated indirectly, and not always easy to identify, but in many cases, they were associated with technological instability, feelings of uncertainty and concerns for the quality of care. Resistance was found in different groups of participants and on different levels of the municipal organization. Four categories of resistance with several subcategories were identified, as laid out in Table 2.

In the following, the findings will be presented in more detail and exemplified, starting with organizational issues.

Organizational resistance

Resistance to change in established routines

The surveillance technology was primarily introduced on the night shift, and only the night shift personnel were trained to use it. Usually, the employees worked either only night shifts or only day/evening shifts, and there was only brief contact between the shifts. The use of the

Table 2 Categories of resistance

Main categories	Subcategories
Organizational resistance	• Resistance to change in established routines • Resistance to necessary competence building • Systemic resistance to communication across groups and professions • Management resistance to participatory processes
Cultural resistance	• Resistance due to language differences • Resistance due to a clash of professional cultures • Resistance against the role as co-creator
Technological resistance	• Healthcare providers' resistance to technology • Resistance represented by IT infrastructure • IT support staff's resistance to innovative practice
Ethical resistance	• Resistance due to patient safety issues • Resistance due to concern for the quality of care • Resistance due to patient privacy and dignity issues • Resistance due to issues of justice

technology appeared to demand a closer cooperation between the shifts. For instance, there was a need for the evening shift to prepare the technology while the patients were still awake. A night shift worker said: *"We need to have good cooperation with them, so that the mattresses are placed correctly in the evening and that they are switched on the way they are supposed to."* Another night shift worker put it this way:

> *The day shift must make sure that things work, do things well, so that I can do a good job. I cannot ask the patients to wake up and get out of bed so that I can check that everything is OK in bed. That would be stupid.*

The needs for adjusted routines and better communication and cooperation between day/evening and night shifts were soon recognized. However, both project managers and healthcare personnel experienced a lack of interest and support from the responsible middle managers and unit leaders or ward nurses. As one of the project managers answered when asked whether the unit leader had taken an active role in the project*: "No, she has barely participated and does not take the role. And she feels it is fine that I have that role".*

This lack of managerial interest and omission to make the necessary adjustments to established routines (which was beyond the authority of the project leaders) may be interpreted as a passive form of organizational resistance to change, which interfered with, and to some degree obstructed, the process of co-creation and implementation.

Resistance to necessary competence building

The day shift did not receive any training in how to prepare and use the technology, and would hear about the project only through information in staff meetings. The need for training of the day shift personnel was soon recognized by the project leaders and the other participants, but the responsible unit leaders did not arrange for such. The lack of interest from the management in competence building across shifts resulted in a poor understanding of the project and the technology on the part of the day shift. One of the personnel working night shift declared:

> *I feel that they do not understand any of this. It is a «night-shift-thing». (…) and I do not think they follow up, because it is never talked about. So I hoped we could have a more thorough conversation about this, not just two minutes in the staff meeting.*

Systemic resistance to communication across groups and professions

In addition to the lack of communication and cooperation between shifts, a more general issue emerged concerning communication, knowledge transfer and organizational learning. Communication channels across organizational levels, units and groups of professions within the complex municipal system were scarce. Those involved in the implementation of the surveillance technology lacked sufficient information about, for example, potential risks. Accordingly, this was an issue in workshops and inter-municipal meetings. However, not everybody involved could attend the workshops, and some groups – such as the cleaning staff – were not thought of as having a role in the implementation process. An example of an unforeseen risk, which proved to be a problem, was that cleaning personnel – not being sufficiently informed – on occasions moved electronic plugs and equipment in order to clean behind desks and in the corners. Breaking the electrical circuit might have the effect that sensors or communication devices shut down, and the error had to be detected before the system could be made functional again. The lack of communication channels across groups, levels and professions may represent an organizational resistance that made it difficult to prepare for unexpected errors that might obstruct or interfere with a successful implementation and use. During the workshops, it became clear that the procedures and written instructions had to include more groups than initially thought of.

Management resistance to participatory processes

Little by little it became clear that neither the steering group nor the responsible municipal leaders or their central IT support departments had taken sufficient measures to ensure that the necessary infrastructure was in place to serve the participating homecare units and nursing homes. It appeared that the municipalities' IT support departments had not been included in the initial phase of the project. This was in spite of the well-known fact that the innovation technology in question required

a stable technological infrastructure in order to work. If the IT support department was included, this happened at a late stage in the planning process or in the implementation process itself. Since the initiation of the implementation usually was run on the administrative level, and the crucial role of the municipal IT infrastructure would have been easy to foresee, the omission to involve the IT departments may be interpreted as a passive form of leadership resistance to collaborative and participatory processes, putting the project at considerable risk.

Cultural resistance

The nature of the implementation project required close collaboration and interaction between different groups coming from different organizational cultures, such as the technology developers, the healthcare providers and the municipal IT staff. This collaboration was a field for learning for all parties, but also a source of resistance, that challenged established in-crowd language, professional roles, administrative routines, distribution of power and decision-making responsibilities.

Resistance due to language differences

There was a noticeable difference in vocabulary between the technology developers and the healthcare personnel. One healthcare provider put it this way: *"I feel they miss out on the language that they use – or what do you call it? Terminology?"*. The language gap was recognized also by the technology developers, but hard to bridge. One of them explained it as a question of awareness:

> *We still have a tendency to use words and concepts from our world that we use on a daily basis, that we are actually not aware of that we use, but we can see that their eyes become glassy. And if they do not understand, they do not say so. It is a challenge.*

Resistance due to a clash of professional cultures

Communication problems between the technology developers and the healthcare providers went deeper than language only. Trained in different professional fields and focusing delivery of very different services (technological solutions vs care for vulnerable people), the cultural differences were considerable. This was observed during the first workshops. Both groups often used us–them language when speaking about each other, and initially there was some resistance on both sides to take the perspective of the other and actively enter into cooperation. An example is the technology developers' reluctance to meet the healthcare providers' needs for more written material on the technological procedures. This was clearly communicated from the outset, without being recognized. Instead, the developers adopted a passive uncooperative attitude, omitting to create the material needed. As one of the technology developers expressed: *"At the outset we hardly had any material at all. Because we perceived that this was intuitive and straightforward".*

Resistance against the role as co-creator

Like the technology developers, it took a while before the healthcare providers understood their role as co-creators. The imperfections of the technology were a constant source of concern to them. For instance, alarms would go off when they should not, and vice versa. Most healthcare providers considered technological errors to be the developers' problem, not a shared responsibility. Co-creation was perceived as foreign to them and to some degree also as a threat to their professional identity. However, some providers tried to encourage cooperation and to bridge the gap between them and the developers:

> *It is a pilot project, and as I said to NN [technology developer], everyone has not understood that. That we should not have a negative attitude towards everything that we are testing out. We can be negative when the project is over, if nothing works.*

This clash of professional cultures was to some degree anticipated by the orchestrator, designing the workshops partly with the aim of two-way cultural translation and learning. It was a steep learning curve for both parties. The technology developers learned a lot about healthcare and started using some of the healthcare vocabulary. Likewise, the healthcare providers became more familiar with the technology and the developers' way of thinking: "*When I am with them now I understand more what they mean and what they are talking about, because I am more into the system…*"

The communication and mutual understanding improved in the course of the project. New material was developed, the vocabulary changed, more procedures were included, and material was also customized to each municipality and to different groups of users (healthcare personnel, patients and relatives). However, this was primarily done by the local municipal project managers. They had expected the technologists to take more responsibility for improving and customizing the material. From their point of view, elements of passive resistance behaviours among the developers did not diminish.

Technological resistance

Under the heading "Technological resistance", we group both the resistance to the technology and the resistance represented by the technology itself.

Healthcare providers' resistance to technology

To some of the healthcare providers the technology was in itself threatening. It challenged their sense of predictability, professionality and competence, which influenced their motivation to use the technology negatively. A main source of resistance was fear of not coping with the new technology. To some this was due to lack of familiarity with sensor technology and/or digital communication devices, and to others due to negative experiences with technology in the past. An example of the latter was a healthcare provider who for weeks had dreaded participation in a training session and even considered asking for a sick leave. She remembered her negative experience with the implementation of electronic patient records some years prior, when she ended up with a frozen shoulder. As the healthcare providers' experience with the technology and the understanding of its prospects increased, however, the resistance decreased and the attitude became increasingly positive and enthusiastic. One of them expressed it this way: *"On our team, we have a positive attitude towards this. I believe many of them find this exciting."*

Resistance represented by the IT infrastructure

Perhaps the most resistant subject of resistance, interfering with and to some degree obstructing a successful co-creation and implementation process, was the municipal IT infrastructure itself. In several of the municipalities, the technological infrastructure was in its infancy, and in some institutions, internet was not installed. If it was installed, it was often very unstable. As one of the healthcare providers said:

> *And the fact that our network is down a lot, and the system in the whole municipality is very difficult to handle, as NN* [technology developer] *and they have said, it is very hard to handle. And that has made it very difficult for the technology developers and us. Well, it did not matter that much for us, but as the project was going to be terminated soon they needed to have it running, and it was very difficult. I did feel a bit sorry for them.*

The technology developers described it like this:

> *We knew that there were differences, but when you really get out there you see how it works and a lot of things fall in place. And there are large differences in the infrastructure, some places they do not have a network at all, and do not use it for anything, no technology. Other places they use a lot.*

According to both the healthcare providers and the technology developers, the technological platform and the infrastructure did not provide the necessary stability for digital surveillance at night.

IT support staff's resistance to innovative practice

The co-creation and implementation of technology in the making also required close cooperation with the central IT department and the support staff in the municipalities. The developers could experience resistance from the support staff in the form of reluctance or sometimes uncooperative attitudes, making implementation difficult. The developers themselves explained this by pointing to a contradiction in logics between the IT support whose focus was an efficient system maintenance, safety and predictability, and an innovative practice, implying co-creation and implementation of new technology:

> *From a technological point of view, it is very difficult to innovate in a sector that… where there is a contradiction between running efficiently and innovation. Because… IT in the municipalities have stability as their main goal, and innovation leads to instability, at least when you want to try out brand new technology.*

One example of resistance to innovative practice was the reluctance to change established IT system routines. In most of the municipalities, there were routines for running the system updates during the night. This is incompatible with the use of digital night surveillance within the same system, because it represents a threat to the security of the patients when the system is shut down in order to run updates. The healthcare providers became aware of this routine only after they started using the new technology. A healthcare provider explained how this routine interfered with successful digital night surveillance:

> *They run updates once a week, and at that time we cannot register and write reports. And when I entered to turn off the alarms, the system was down. So I could not get them turned off, so they just continued to go off. And all that was hopeless. And then my whole tool* [technology] *is wasted. And time and again they ran the updates during the night.*

Ethical resistance

From the very beginning, healthcare providers, even individuals with a generally positive attitude towards technology and innovation, expressed moral concerns. One such concern was whether the motivation behind the project was morally good or not, if it was initiated in order to enhance the quality of care or to lower the cost. *"I find it [welfare technology] the right way to go. But the ethical part of it, that I'm concerned with. Not to do it to*

save money. That would be quite wrong." The implicitly perceived threat seemed to be an imagined future where implementation of welfare technology is a means of budget control at the expense of competent healthcare.

Resistance due to patient safety issues

Resistance among healthcare providers emerged also from a concern for patient safety and from fearing that the implementation of an unstable surveillance technology might cause adverse events and harm to patients. As the stability of the technology increased, however, this attitude of scepticism and resistance changed during the project period. A member of the staff put it this way:

> *Thus, it [the technology] really makes the night shift feel safe. You can just watch the smartphones and see that the patient is sleeping, and we have had on-call staff at night who were very impressed.*

Resistance due to concern for the quality of care

Concern for the quality of care was evident from the start. Some perceived the surveillance technology as a threat to preconditions for maintaining a high professional standard, like face-to-face communication, attentive observation, tacit knowledge and professional judgement. When, for example, the healthcare providers no longer needed to enter the patient's room at night unless the alarm on her smartphone went off, she felt like she was missing important information that she would have got if she had been physically present in the room. This included smelling and seeing the whole picture and, at times, communicating with the patient. As one informant expressed it:

> *but there is something about, as I am saying, when I enter a patient room then there is something about what I see and smell and find out how things are as a whole, plus he* [the patient] *might say that today I would like to watch TV a bit longer… for example.*

Resistance due to patient privacy and dignity issues

There was also a concern for patient privacy and dignity and how this would be ensured. Was not surveillance an invasion of patient privacy, and a threat to privacy at work? These questions were subject to moral deliberations from the start:

> *I have no problem displaying what I do at work. I rather think of the user, of … Where did the privacy go? I enter and leave the room and do my job, and am supposed to be professional. But the users shall feel that they have a private life when they enter their flat, that they are not going to be under surveillance, 'cause that is unnatural.*

In the beginning, some of the healthcare providers held the view that digital night surveillance was a threat to patient privacy and dignity. This view seemed to change, however, and the resistance that emerged to this perceived threat seemed to convert into a moral argument in favour of digital night surveillance. As the experience with the technology grew, a critical view on previous practice emerged. The argument was that ordinary, regular night visits, including observation while the patient was asleep, might represent a far more serious invasion of privacy and violation of dignity than a digital signal on the nurses' phone when assistance was needed. Digital night surveillance made it possible not to disturb the person in question unnecessarily, for instance, avoid waking him or her up at night in order to perform intimate actions, like adult diaper checks.

Resistance due to issues of justice

A final moral issue that was raised among healthcare providers that gave rise to some resistance to the project was the question of equal access to and just distribution of the technology. In this project the technology was not implemented on a large scale and accessible to all. Not all patients that could have benefitted from the technology had access to it, and some patients moved into nursing facilities where the technology was installed, without using it. This was sometimes hard to explain to relatives, but did not interfere with the innovation and implementation process.

In general, there was a change during the project period from scepticism and resistance, to a broader acceptance, and to some degree even enthusiasm, on moral grounds among healthcare personnel. One of the technology developers also made this observation:

> *It has quite clearly been a change here, and the best example is that some years ago we were fighting against the perception that it was unethical to use technology here, that this was all about the warm hands (…) whereas now the norm is that it is unethical to not use the technology.*

Discussion

Four main forms of resistance – and perceived threats

This exploration of resistance to an implementation of welfare technology in municipal healthcare services has displayed a series of resistance behaviours, mostly passive and uncooperative, among different groups of agents – management, IT management, support staff, technology developers and healthcare providers. Four main categories of resistance were identified: 1) *organizational resistance*, including management resistance to participatory processes and necessary competence building, 2) *cultural resistance*, including resistance to cooperation and co-

creation across professional groups, 3) *technological resistance*, including resistance represented by the municipal IT infrastructure itself, and 4) *ethical resistance*, including healthcare providers' resistance to implementing the new technology. The resistance seemed to emerge from a variety of perceived threats, partly parallel to and partly across the four categories of resistance: a) threats to stability and predictability (fear of change), b) threats to role and group identity (fear of losing power or control), and c) threats to basic healthcare values (fear of losing moral or professional integrity).

Implementation ambivalence

Summing up these findings, it might seem that there was a massive resistance to technology implementation. This was not the case. Except for the quite strong and persistent resistance represented by the IT infrastructure, most of the identified forms of resistance were passive more often than active, weak rather than strong, subtle rather than outspoken. Some of the initial scepticism and resistance even became the opposite, such as resistance due to moral concerns, which to some degree transformed into moral motivation and arguments for applying the new technology when the concerns were met and the technology worked safely. In addition, parallel to the variety of resistance, there were also considerable positive interest, energy and enthusiasm among the participants. In other words, the exploration of resistance to co-creation and/or implementation also unveiled that the variety of forms of resistance most often were intertwined with the opposite, a motivation to co-create and implement the technology. To various degrees throughout the project period, such implementation ambivalence characterized most of the participants, both developers, IT personnel, healthcare providers, projects leaders and municipal managers.

Productive resistance

It seems like both resistance and ambivalence were productive as sources of creativity and co-creation. For example, the resistance that emerged from the threat of technological instability, unpredictability and lack of safety also triggered healthcare providers' and developers' creativity and cooperation to improve the technology and service. The healthcare providers helped co-create the technology through resisting the use of a technology that was not fully developed. Likewise, the technology developers helped co-create new service routines through resisting the acceptance of a non-technological practice. This may be characterized as 'productive resistance' [23]. In this project, productive resistance emerged from two elements: a technology or practice that failed and a co-creation process design that aimed to develop unfinished products or services [23]. The resistance became a constructive force that pushed the innovation process forward. The main reasons why much of the identified resistance in this project seemed to turn productive were probably 1) the use of an orchestrator, external to both of the participating 'camps', and 2) a workshop design, functioning as a learning network where all parties could meet regularly, share experiences and reflect openly together [53, 54]. Orchestrating the workshops as processes of 'translation' between the different professional cultures [55] was key to developing trust, enhancing knowledge of each other's perspectives and making resistance turn productive.

Organizational resistance

The classical theoretical approach to resistance in organizations has a negative outlook on resistance, seeing resistance mainly as a counter-force to power and control mechanisms [24, 27]. The active resistance acted by the municipal IT support department as well as a more passive resistance from the management in the healthcare institutions may have been motivated by the fear of losing power. This was intertwined with the "struggle" between stability, safety and predictability on one hand, and co-creation on the other. Participation in a pilot project evoked a certain resistance in itself, since the technology was under development and in need of improvement. This was the exact purpose of the project, but included nonetheless an element of dynamism and insecurity that was contrary to the services' need for control and stability. The IT support departments, in particular, appeared to have a low degree of tolerance towards insecurity and loss of control.

Cultural resistance

Cultural resistance refers to both the communication problems between healthcare providers and technology developers, as well as the resistance that emerged from the implementation of the project's feature as a co-creation project [21]. Even though the innovators contributed to "promulgation and spread of novelties" [29:1], the communication difficulties appeared to be based in both the lack of shared vocabulary and in a mutual prejudice of the other sphere (technological vs healthcare). These cultural tensions as well as a mutual foreignness to co-creation [20], evoked resistance to the role of co-creator in both 'camps'. Cultural differences and lack of redundant knowledge are challenging barriers to overcome in the implementation of technology [56], and the orchestrator who designed a translation process in both directions proved to be justified [42, 55].

Technological resistance

Concerning technological resistance, there were two surprising findings. The first was that the municipal IT

infrastructure in itself represented a serious resistance to the implementation process. From our material, the IT infrastructure emerged as perhaps the most uncooperative entity of all, a subject of resistance in its own right. This might seem strange, considering that subjects of resistance normally are individuals, groups of persons or organizations. However, the observation that an artefact can serve as a social-relational function is not new. The Actor Network Theory provides a corrective to the usual social scientific focus upon human beings by "directing attention to the significance of nonhumans in social life" ([57]:109) – in this case the IT infrastructure, obstructing the process of co-creation and innovation.

The second surprising finding was the passive resistance represented by the fact that nothing was done on the management level of the municipalities to include the IT departments at an initial stage, in order to prepare the IT system and support staff for the co-creation and implementation process. This is even more surprising considering the well-known fact that the municipal IT infrastructure would play a crucial role, and that implementation of welfare technologies is high on the political agenda. We have interpreted this omission as passive management resistance to participative processes. This finding is in line with research on collaborative innovation projects in the public sector, identifying co-initiation as a success factor, suggesting that public leaders and managers may be reluctant to co-initiation because of fear of losing power [58]. We can only speculate as to what, in this case, the perceived threat might have been – fear of losing power, financial consequences or something else. Whatever the reason might be, the finding suggests that more attention should be drawn to the importance of *co-initiation* and participative processes at an initial stage when planning complex municipal innovation and implementation projects.

The resistance from the IT support staff can be characterized as active resistance and was at times perceived by other stakeholders (healthcare providers and technologists) as aggressive [36]. For the managers, it appeared to be due to a poor understanding of their role in the implementation process [59]. The management did not take an active interest in the implementation, and their lack of interest can be categorized as a passive resistance that manifested in practice [33, 36].

Ethical resistance

Ethical resistance refers to resistance emerging from reflection on perceived threats to basic healthcare values and professional ethics [60, 61]. Four main perceived threats were identified: 1) threats to patient safety, 2) threats to the quality of care, 3) threats to patient privacy and dignity, and 4) threats to equal access and just distribution. These findings are consistent with previous research with regard to the development and use of welfare technologies [3, 5, 62, 63]. Indirectly these moral concerns seem to represent arguments that may be found in healthcare (organizational and clinical) ethics. These are based on ethical theories, like the moral obligations to secure patients' safety and rights (duty ethics), to consider moral implications, such as possible harm to patients' privacy, dignity, autonomy and integrity (consequentialism), and to protect one's integrity as a morally mindful, caring and professional healthcare worker (virtue ethics) [64, 65].

Ethical resistance concerns the core of the healthcare providers' professional practice, including how she uses her knowledge, skills and senses when she sees, touches, smells and speaks to the patient. Changing circumstances in the form of increased use of technology is perceived to alter and discipline the professional work [66], and professionals face new threats that have to be managed. These can be fear of not being a good healthcare provider or a caring institution and a threat to their identity as healthcare providers. Due to the changing circumstances, the content of the professionalism is contested.

The concept of ethical resistance might help leaders to recognize that this kind of resistance represents cues to moral concerns that have to be identified and solved in order to prevent adverse events and to help transform staff resistance into motivation. The concept might also help leaders avoid the psychologization fallacy, to confuse the ethical resistance of putting values at risk with the psychological resistance of change as a negative force that has to be overcome. It might also help leaders develop their ethical leadership skills [67], by using ethical resistance as a golden opportunity of detecting and managing moral risk and improving the moral quality of both the implementation process and final result [67].

In concluding the discussion, according to the informants, the initial resistance and scepticism of the new technology was replaced to a certain degree by a positive attitude towards implementation of the technology. We see three partly overlapping explanations for this. One might be adaptation, meaning that the healthcare providers got used to the technology and learned that it was helpful, not harmful [33, 68]. Another explanation might be ethical reflection upon the experience that the surveillance technology proved to enhance patient safety and reduce intrusions of privacy at night. A third explanation might be the facilitated interaction and knowledge sharing, including ethical reflection, during workshops and other meetings. This might have contributed both to adaptation, solutions to moral problems and a feeling of connectedness, competence and coping, factors associated with motivation [69, 70].

Implications for practice

In planning the implementation of welfare technology in municipal organizations one should consider a) the IT infrastructure, b) co-initiation, c) translation spaces and d) use of an external orchestrator.

Managers should consider ethical resistance as productive, and promote co-creation between care personnel and technologists in order to meet the moral concerns.

Issues for further research

In studies as the one at hand, many factors influence the context. In order to reduce complexity, we have omitted several factors. Central and important stakeholders like the patients and next of kin have not been included in the study. This is because we wanted to focus on the employees, but at the same time, we recognize the patient and his/her family as the real end user of the welfare technology. Focus on the patient and families will need to be included in future studies.

Conclusion

This study identifies forms of resistance that appear to slow down the implementation of technology in a healthcare setting, especially resistance to participate in collaborative processes, resistance connected to the IT infrastructure and resistance arising from ethical concerns. It contributes to the body of literature on resistance to technology in a municipal healthcare setting, since the majority of extant research on resistance in healthcare has been performed in hospitals. Furthermore, the technology in question is sensor technology in combination with a web-based portal, which is also atypical for studies within the field.

Contrary to what might be expected from previous findings (e.g. [8]), we found that resistance to surveillance technology on a general note was not significant, and the healthcare providers perceived the new technology as a threat only to a low extent. In the long term, this could be explained by involvement in the co-creation process and motivated by a perception that a positive attitude towards this technology is appropriate and "modern", rather than seeing technology in itself as a threat. The healthcare providers also appear to conceive the advantages and the future use of welfare technology.

Theoretically, the study contributes by identifying resistance categories, coining the concept of ethical resistance and focusing on productive resistance. Resistance appears to play a productive role when the implementation is organized as a co-creation process. The study has shown that resistance changes character over time and that it is not solely a negative phenomenon, as it contributes to development and innovation through the friction it creates.

Additional file

Additional file 1: Interview guide for semi structured focus and individual interviews. (DOCX 14 kb)

Abbreviations

EP: Entered the project; FG: Focus group interviews; HIT: Health information technologies; II: Individual interviews; IS: Information systems; IT: Information technology; PO: Participatory observation; SME: Small and medium-sized enterprises; WF: Welfare technology; WS: Workshops

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Availability of data and materials

An interview guide is available (Additional file 1). The data collected for this study consists of transcribed interviews and field notes. These qualitative data will not be made available for privacy reasons.

Authors' contributions

All authors made significant contributions to the manuscript. The study was conceived by ERN, and was drafted in close cooperation with JD, HE and MKG. ERN, JD, HE, MKG and TE collected data and contributed to the analysis. The manuscript was written by ERN, JD, HE, MKG and TE. All authors read and approved of the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable.

Ethics approval and consent to participate

The project has been approved by the NSD, the Norwegian Data Service for Social Sciences (ethical approval no. 34831). The participants signed an informed consent form. The data are anonymized in the presentations.

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Paper 2

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Towards successful digital transformation through co-creation: a longitudinal study of a four-year implementation of digital monitoring technology in residential care for persons with dementia

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Abstract

Background: Implementation of digital monitoring technology systems is considered beneficial for increasing the safety and quality of care for residents in nursing homes and simultaneously improving care providers' workflow. Co-creation is a suitable approach for developing and implementing digital technologies and transforming the service accordingly. This study aimed to identify the facilitators and barriers for implementation of digital monitoring technology in residential care for persons with dementia and wandering behaviour, and explore co-creation as an implementation strategy and practice.

Methods: In this longitudinal case study, we observed and elicited the experiences of care providers and healthcare managers in eight nursing homes, in addition to those of the information technology (IT) support services and technology vendors, during a four-year implementation process. We were guided by theories on innovation, implementation and learning, as well as co-creation and design. The data were analysed deductively using a determinants of innovation framework, followed by an inductive content analysis of interview and observation data.

Results: The implementation represented radical innovation and required far more resources than the incremental changes anticipated by the participants. Five categories of facilitators and barriers were identified, including several subcategories for each category: 1) Pre-implementation preparations; 2) Implementation strategy; 3) Technology stability and usability; 4) Building competence and organisational learning; and 5) Service transformation and quality management. The combination of IT infrastructure instability and the reluctance of the IT support service to contribute in co-creating value with the healthcare services was the most persistent barrier. Overall, the co-creation methodology was the most prominent facilitator, resulting in a safer night monitoring service.

Conclusion: Successful implementation of novel digital monitoring technologies in the care service is a complex and time-consuming process and even more so when the technology allows care providers to radically transform clinical practices at the point of care, which offers new affordances in the co-creation of value with their residents. From a long-term perspective, the digital transformation of municipal healthcare services requires more advanced IT competence to be integrated directly into the management and provision of healthcare and value co-creation with service users and their relatives.

Keywords: Service design, Absorptive capacity, Risk, Triple helix, Workflow, Radical innovation

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Background

Digital monitoring has become an increasingly important application among the health information technologies (IT) in long-term care, such as residential care facilities for persons with dementia [1, 2]. Implementation of monitoring technologies potentially reduces staff burdens and enhances safety, increases resident freedom and prevents elopements and wandering behaviour in persons with dementia [3–9]. This includes persons referred to as night wanderers. Sleep disturbances and wandering upon awakenings in combination with nighttime agitation pose severe challenges in caring for these persons [10–12].

The research literature provides recommendations as to how implementation of monitoring technologies can be facilitated (e.g. [4, 13, 14]). However, many healthcare professionals (HCPs) and service organisations are reluctant to introduce such technologies [2, 15]. There are multiple causes for this reluctance, including ethical considerations, fear that technology will cause attenuation of the care relationship, lack of appropriate infrastructure, and a general lack of knowledge and skills in relation to digital health [3, 16–21]. In a recent literature review, Granja et al. [22] found quality of healthcare to be the major facilitator and shortage of finance the major barrier in the implementation of eHealth interventions, including monitoring technologies. The intervention's influence on existing workflow was the single most important factor to predict success or failure. There is a need for further identification of facilitators and barriers to ensure that all factors are considered when defining the development and implementation strategy of specific eHealth interventions [22].

Intelligent assistive technologies (IATs) [23] are monitoring technologies with computation capability and the ability to communicate information through a network. These are complex technologies that require new skill sets and perspectives, and their development must be responsive to the needs of their users and simultaneously be commercially viable [24]. A high number of the more recently introduced IATs lack clinical validation; i.e. technical feasibility and usability have predominately been tested through simulations [15]. Therefore, study designs involving multiple stakeholders in technology development processes are recommended [4, 16, 24, 25]. New technologies transform services, including contexts, service provision and experiences with respect to organisations, employees and users. Therefore, there is a need for research into service innovation by leveraging service design and understanding value creation in this context [26]. These are time-consuming processes, but most implementation studies report retrospectively from early phases and there are few innovations studies in the field that cover long periods of time [27].

The current article is a longitudinal case study of the implementation of digital monitoring technology over a four-year period. The article explores the barriers and facilitators during the implementation and the strategic role of co-creation processes to overcome resistance, improve functionality and ensure quality of care. In a previous article from the first year of these processes, four main forms of resistance to the implementation were identified: i.e. organisational, cultural, technological and ethical resistance [20]. Resistance was triggered by perceived threats to stability and predictability, role and group identities and basic healthcare values.

Conceptual framework: innovation and implementation through co-creation

Innovation in health service delivery and organisation has been defined as "a novel set of behaviors, routines, and ways of working that are directed at improving health outcomes, administrative efficiency, cost effectiveness, or users' experience and that are implemented by planned and coordinated actions" [28]. This definition captures many aspects of the innovation processes under study, as novel technologies and new ways of working were developed and implemented to benefit service users and healthcare organisations. Service innovations are usually categorised according to the degree of change, type of change, novelty and means of provision [29]. Most innovations in the public sector are incremental, but still disruptive, i.e. they are changes that potentially cause improvement [27, 30]. Radical innovations usually refer to products, such as breakthrough technologies, that their intended users perceive as novel, disruptive and hard to adopt, disturbing prevailing habits and behaviour [31]. Radical innovations rely on a series of incremental innovations to be fitted into a system or context in a form that is acceptable to the intended users [32]. Regarding the type of change, discussions of product and process innovations are predominant in the literature. Other types include position, strategic, governance and rhetorical innovation [30].

The innovation process is traditionally described by the stages of dissemination, adoption, implementation and continuation [33]. The transformative nature underpins the need for learning and development of new knowledge as an organisation implements an innovation e.g. [27, 28]. The more radical the innovation, the more necessary it is to teach the users how to adopt and use it [34]. The organisation's absorptive capacity includes capabilities for problem solving and learning new knowledge generated externally, as well as technological infrastructure, leadership, internal knowledge sharing and relational capability [35–37]. The absorptive capacity builds cumulatively on the existing base of skills and knowledge [27, 35], including tacit knowledge [38].

Absorptive capacity is an antecedent and strong predictor for innovation and knowledge transfer [28, 37].

Implementation of innovative technology within complex organisational systems, such as healthcare, involves various cycles of iteration as technological, social and organisational dimensions gradually align (or not) over time [18]. Interacting influences known as determinants of innovations [39] and determinants of healthcare professional practice [40] contribute to the multidimensionality of the innovation process, and enable or prevent the improvement, or change, in the specific context or practice. Information about such barriers and facilitators is useful for controlling the implementation strategy and a determinant of innovation framework helps to focus this study on the essential processes of behavioural change, which are complex in clinical settings [41, 42].

The triple-helix model [43] is an innovation strategy where public sector organisations, private sector companies and academia collaborate and co-create. This strategy allows its intended users to be involved in design and development processes of products, processes and services, and involvement is likely to improve adoption and post-implementation satisfaction [28, 44]. Resources can be accessed from other actors through absorption, acquisition, sharing and resource co-creation [45].

Co-creation is an interaction where actors jointly produce a mutually valued outcome based on assessments of the risks and benefits of proposed courses of action and decisions based on dialogue, access to information and transparency [46]. Cutting through a broad variety of concepts and theories regarding co-creation [47–52], its central elements include defining and creating value through iterative processes including value propositions, resource integration and learning processes. Public sector services are suitable for co-creation because they are discreet and intangible, focusing on the users consuming the service as it is produced or delivered [53]. Traditionally, the value-creation process is said to occur as the user consumes or uses a product or service [54]. According to Oertzen et al. [49], co-creation in services "manifests itself in different forms depending on the phases of the service process (co-ideation, co-valuation, co-design, co-test, co-launch, co-production and co-consumption) and is influenced by a contextual, multi-actor network". Co-creation includes creative collaboration connected to design processes as well as the usage or delivery of a service [55]. Actively involving intended users through participatory design processes has traditionally been emphasised in IT design [56]. Service design processes aim to develop services that are useful, usable and desirable from the service users' perspective [57]. Service design applies to all parts of a service, including planning and organising people, infrastructure, communication and material components [55].

Methods

Aim and study design

The overall aims of this article are a) to identify facilitators and barriers, and b) to explore co-creation practices as an innovation strategy during four years of implementation of a digital monitoring technology in long-term residential care for persons with dementia who were night wanderers. The study had a longitudinal case study design [58] with elements of transformational action research [59]. Action research elements included researcher participation in the project design and planning activities, participation in and facilitation of knowledge-sharing and reflection processes during workshops and meetings, and presentation of preliminary research findings to the steering group and during workshops, which informed the iterative innovation activities.

The case: a digital night surveillance intervention

The present study is based on the Digital Night Surveillance Innovation Project, which was a combined innovation and research project initiated by a triple-helix-inspired network that developed digital technologies for municipal healthcare services. Between 2009 and 2012, vendors from a small-sized enterprise had developed a distributed IAT system, i.e. the digital monitoring technology system used in this study, which potentially offered increased safety for persons with dementia who were night wanderers. To access the immature market of municipal healthcare organisations, the vendors organised a project for implementation utilising public sector-sponsored incentive programs to minimise economic risk for the municipalities. Based on their access to funding, the vendors and three municipalities initiated the implementation in 2013, and successively recruited more partners and established a formal consortium of eight municipalities and two technology companies for the main project from 2014 to 2017. A group of nine researchers from two universities, including the authors of this paper, participated in the consortium.

The implementation strategy encompassed a variety of co-creation activities combining human-centred and service designs, as well as participatory design methodologies. Workshops constituted a major arena for co-creation during the implementation, as detailed below. An orchestrator managed the implementation project in co-operation with a project group comprised of the local project managers and vendors. Within the municipalities, local politicians made formal decisions to enter the project based on preparations by municipal top management. The organisational units of adoption, one per municipality, were dementia care wards in nursing homes within the municipal healthcare organisations. Healthcare workers and registered nurses, i.e. care providers, working on the night shift were anticipated to be the

main group of users to adopt the monitoring technology.

Sixty-seven installations of the monitoring technology system were implemented. The system consisted of an Internet-based portal built on a platform solution that included novel Internet-of-Things (IOT) middleware, which could handle and unify data from multiple hardware protocols and allowed integration of e.g. bed-exit or door sensors from different manufacturers. Thus, the system offered a unique feature where the care providers could operate multiple technologies simultaneously via a personal computer (PC), tablet or smartphone of their choice. A short message service (SMS)-mediated alarm alerted care providers when predefined scenarios occurred, such as a resident leaving their bed. The portal allowed adjustments of settings at any time to match the needs, behaviour and progression of dementia of individual residents, including the sequence and timing of input from a variety of sensors. No other monitoring technology systems available on the market at the time offered these affordances. Upon installation, the final stages of designing user interfaces on the applications and operating systems chosen by each municipality, as well as integration of suitable sensor technology, would take place. The monitoring technology was in compliance with regulations of data protection and privacy, as well as the legal framework for monitoring persons with dementia using sensors. According to the Norwegian Patients Rights' Act, municipal health and care services may decide on the use of technology for notification and localization as part of services to patients over the age of 18 who do not have capacity to consent. The measure must prevent or limit the risk of injury to the patient, be in reasonable proportion to the relevant risk and appear to be the least invasive option. It should be likely that the patient would have given permission for the measure. The provision does not apply if the patient opposes the measure.

Participants and data

Data collection took place between June 2013 and September 2018. The data included 23 interviews, strategic documents, participatory observations and process data from seven workshops, as well as observations of local training sessions and numerous meetings. The meetings were steering group meetings, project group meetings, local staff meetings, information meetings for residents and relatives, meetings between vendors and single municipalities, and meetings between IT and healthcare services. Data was not collected in care settings, and not from residents or relatives. All participants in research settings consented to participation in the research study. The study complied with the tenets of the Declaration of Helsinki.

Workshops

Data from workshops were collected between November 2014 and September 2016. The workshops (not including the final dissemination seminar) were attended by participants ($n = 172$) from municipal healthcare service staff ($n = 89$) and IT service staff (n = 8), vendors ($n = 30$), research institutions ($n = 14$), non-governmental organisations (n = 3), other public sector organisations ($n = 5$), innovation and funding agencies ($n = 20$) and external experts (n = 3).

The orchestrator and researchers facilitated workshops, where the researchers and other experts initially would introduce a theme predetermined by the project group. Then all participants engaged in co-creational activities related to the theme and thus contributed to the progress of the implementation. The researchers documented the results of such activities and made them available to the participants in a reasonable time. In addition, the vendors and the local project managers presented updates during workshops and the researchers presented preliminary research results. There were opportunities for generating and prioritising ideas, discussions and exchanges of experiences. The workshops usually lasted for two days, from lunch to lunch, with a social event during the evening. Workshop locations were close to the participating municipalities and one took place in Sweden in co-operation with a corresponding triple-helix network.

Interviews

The sample consisted of 21 individual interviews ($n = 16$) and two focus group interviews, i.e. one with HCPs ($n = 9$) and one with the vendors ($n = 4$) (Table 1). Fifteen interviews were performed between August 2013 and April 2016, and informants were interviewed up to three times. Individual interviews were performed at a place of the informants' choice, normally at their workplace. The focus group interviews took place in co-creation activity settings. The interviews started with a "grand tour" question (around the table if in a focus group) to elicit the informants' perception of the implementation and their own participation in the project. Two main topics were then discussed with the informants: i.e. if any need for new competence had emerged and how it had been dealt with; and if there had been changes to the job situation or organisation of HCPs. The interviews were semi-structured, recorded and transcribed verbatim. Please c.f. Nilsen et al. [20] for the interview guide. Purposeful selection assured inclusion of informants representing the enterprises ($n = 4$) as well as the initial three municipalities ($n_1 = 6$, $n_2 = 5$ and $n_3 = 6$) that participated throughout the entire project period from 2013 to 2017. As a validation of information regarding the municipal planning and preparation process,

Table 1 Overview of interviews and informant characteristics

Informant	PM	Manager	Superuser	Nightshift	Profession	II	FG
1	x	x			RN	2	
2	x				RN	2	
3	x				RN	2	
4		x			RN	1	1
5		x			RN	2	
6		x			RN	1	1
7	x		x		RN	2	1
8			x	x	RN		1
9			x	x	RN	1	
10			x	x	HCW	1	1
11			x	x	HCW	1	1
12				x	HCW	1	
13				x	RN		1
14				x	RN	1	
15				x	RN		1
16				x	RN		1
17					T	1	1
18					T	1	1
19					T		1
20					T		1
21					IT	1	
22					O	1	

Abbreviations: *FG* Focus Group Interview, *HCW* Healthcare Worker, *II* Individual Interviews, *ITM* Information Technology Manager, *O* Orchestrator, *PM* Project Manager, *RN* Registered Nurse, *T* Technologist

JD interviewed the orchestrator, three local project managers and two vendors over the phone in April–September 2018. These interviews lasted for 10 to 45 min and were documented by notes.

Data analyses

Data from qualitative interviews were analysed by content analysis [60], followed by an inductive phenomenological hermeneutical analysis inspired by Lindseth and Norberg [61]. The first step consisted of deductive qualitative analysis and mapping of the transcribed interviews [60] against the constructs in the measurement instrument for determinants of innovation (MIDI) framework [62]. JD and HE did the analysis. The MIDI framework [62] encompasses the innovation process and strategy, and captures four broad categories of essential determinants, as evaluated by healthcare professionals, who are considered to be the adopting users during the implementation of innovations in larger healthcare organisations. The category associated with the innovation includes determinants such as correctness, complexity and compatibility. The adopting user category encompasses benefits, professional obligations, knowledge and perceived satisfaction of patients. The category for organisational attributes includes determinants such as management involvement, staff capacity, resources, and information and performance feedback. Legislation and regulations constitute the final socio-political category.

The second step consisted of an inductive analysis of the same material by putting the MIDI framework in parenthesis to grasp the essence of the meanings of the informants' expressions of their experiences of the innovation processes. JD and TE performed several iterations of the inductive exploration, the latter without any knowledge of the results of step 1. The aim was to group facilitators and barriers into themes. JD performed the initial inductive coding and then condensed the data excerpts. The data were complex; therefore, physical organising and structuring was needed. Thus, the data excerpts were printed and cut into separate units. JD and TE sorted and reorganised the data and this analysis resulted in the main structure of themes.

In the third and final step, observational data, process data and strategic documents were examined to enrich the exploration of processes that were found to be essential during implementation. Therefore, the data from interviews, observations and text analysis were integrated. Utilising a phenomenological hermeneutical approach [61], JD and TE interpreted the data excerpts in an iterative manner by reading and critiquing each other's texts. We abstracted the data to form subcategories in the form of facilitators and barriers. The subcategories were then further condensed into categories and reviewed in a timeline perspective. JD, TE, HE and EN contributed in finalising the themes, categories and timeline.

Threats to validity were met by co-operating within the research team in all phases of the research project, which ensured open discussion and deep knowledge of the context. The reliability of the study was strengthened through researcher triangulation. A further layer of discussion and reflexivity about the data and their interpretation with consortium members complemented the interdisciplinary reflections and discussions. Detailed descriptions of the research approach were included to meet threats to reliability.

Results

Through the deductive analysis of the interviews, we were able to identify all of the determinants of the MIDI framework. The analysis provided deeper insights, but the MIDI framework did not cover the entire material. In the following, the results of the inductive analysis (step 2 and 3) will be presented. Five major categories of barriers and facilitators of innovation were identified, including subcategories for each category: i.e. factors, processes and actions that proved to facilitate the

implementation when completed or impede the implementation when not. The presentation of categories and subcategories include descriptions of how facilitators and barriers were experienced and dealt with through co-creational processes to ensure progression and eventually successful implementation. Finally, the results will be presented in Fig. 1, showing the development through the four-year implementation period.

Pre-implementation preparations

Involving key actors

During the planning process, the municipal top managements appointed a local project manager and involved the healthcare services and the vendors. However, contrary to internal guidelines, the municipal IT management staff were not involved until the formal decision-making was finished, which caused a series of problems and slowed down the implementation.

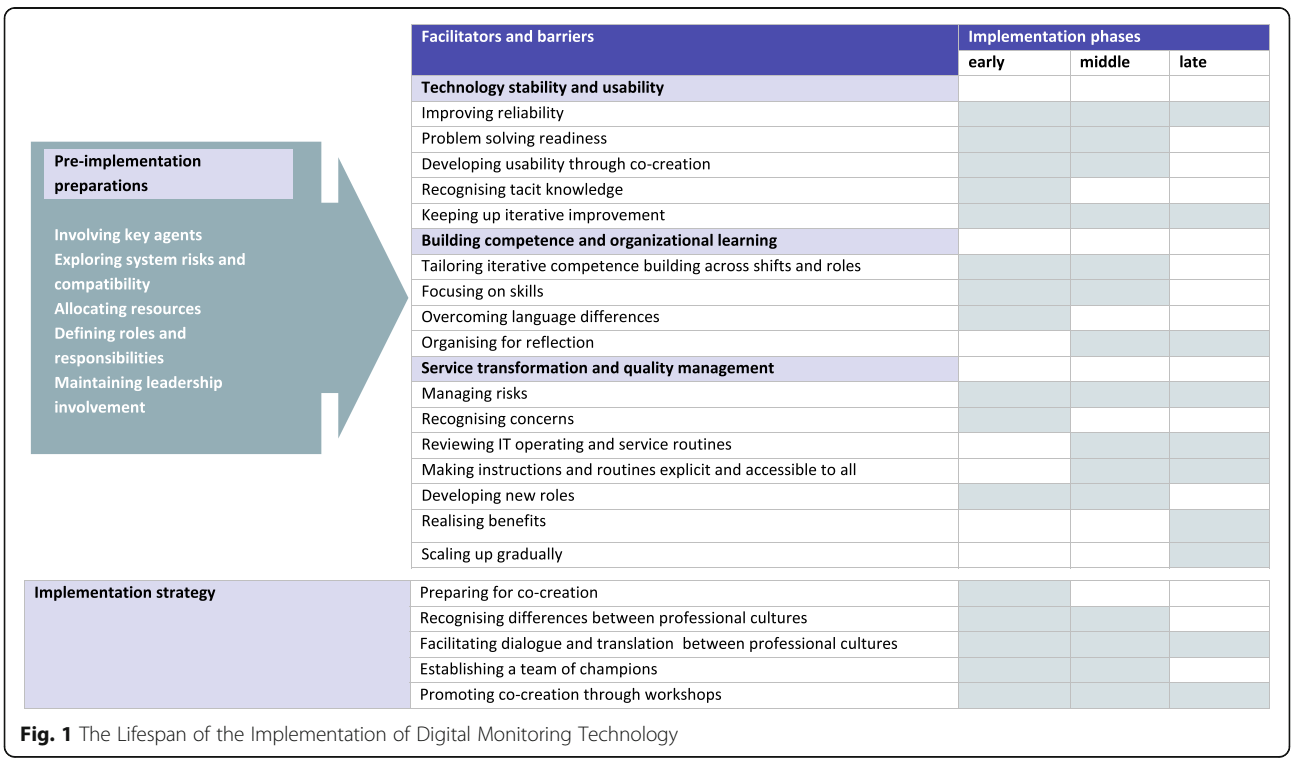
The municipalities anticipated small-scale projects affecting the night-shift staff and the residents being monitored. "*It seemed manageable. Just at night. Few people*" (Project manager). However, the implementation involved large parts of the organisation. The IT support service and management dealt with the vendors as the monitoring technology was installed into existing IT systems and infrastructure. The healthcare managers were responsible for developing new routines, roles and responsibilities. The care providers who worked day and evening shifts had to check and prepare the technology for the night. Janitors, cleaning staff and substitute personnel needed information and tailored training to accommodate the technology into their routines. The initial failure to recognise actor complexity was followed by a consecutive involvement of all involved actors and groups over time, which facilitated the implementation.

Exploring system risks and compatibility

Initial risk assessments of the technology and patient safety were missing in seven of the eight municipalities. As the IT management was not involved from the very beginning, in-depth explorations of compatibility between existing and new technology did not take place until instability and errors occurred, which compromised the residents' security and caused frustration among care providers. Instability and errors occurred in the functionality of the digital monitoring technology, but more so in the municipal system's infrastructure and deliveries from third-party suppliers, and because of building constructions obstructing digital signal transmissions. As a quality measure, the old systems and routines operated in parallel to the new monitoring technology until stability was ensured.

Allocating resources

At the macro level of the healthcare system, the political expectation was that implementing digital technologies would save time and resources and be a part of the long-term solution for future resource problems.



Facilitators and barriers	Implementation phases		
	early	middle	late
Technology stability and usability			
Improving reliability			
Problem solving readiness			
Developing usability through co-creation			
Recognising tacit knowledge			
Keeping up iterative improvement			
Building competence and organizational learning			
Tailoring iterative competence building across shifts and roles			
Focusing on skills			
Overcoming language differences			
Organising for reflection			
Service transformation and quality management			
Managing risks			
Recognising concerns			
Reviewing IT operating and service routines			
Making instructions and routines explicit and accessible to all			
Developing new roles			
Realising benefits			
Scaling up gradually			
Preparing for co-creation			
Recognising differences between professional cultures			
Facilitating dialogue and translation between professional cultures			
Establishing a team of champions			
Promoting co-creation through workshops			

Fig. 1 The Lifespan of the Implementation of Digital Monitoring Technology

Potential cost reductions motivated the meso level of the municipal top management to initiate this implementation and was also evident at the micro level of the nursing home management. However, healthcare and IT management and staff had a dual role during the implementation because they needed to run the services as usual and simultaneously contribute to the implementation, which required extra effort and increased resources. Allocating sufficient time and resources across roles and professions for workshops and other implementation strategies proved to be a facilitator.

Defining roles and responsibilities

Identification and redistribution of roles and responsibilities emerged as a necessary facilitator early on and most profoundly between the IT and healthcare services. Contrary to the beliefs of the healthcare management, some IT services had not been delegated the responsibility for specific healthcare-related IT systems and support. "*The professional responsibility for applications and development related to specific needs of the municipal service sectors is delegated to the respective [healthcare] service, i.e. to a line function*" (IT manager). This was not considered by municipal top management during planning and strongly affected the co-operative climate during the early phase.

Maintaining leadership involvement

The mangers' priority was operating the 24/7 healthcare service. They anticipated their own involvement to be a success factor for the implementation, but were insufficiently prepared and unable to make implementation a priority.

> *I have chosen not to go into details, because I have felt that I do not … If this is something that we really want to get into, with motivated staff, I should probably get involved at some point* (Healthcare manager).

This mismatch resulted in a misalignment between the authorial structure of the organisation and the decision design architecture for the implementation, which repeatedly impeded their ability to solve unforeseen challenges.

Implementation strategy

Preparing for co-creation

Unpreparedness for co-creation, which was a new way of working for most of the actors, represented a barrier during the early phase. The vendors faced a great variety of municipal practices and routines; therefore, there were no fixed solutions for their deliveries. The vendors needed the care providers' user experience and co-operation to meet the needs of the care services and the co-operation of each municipal IT service to make the technology work in the specific settings. As the project started, the healthcare managers and staff expected the vendors to provide a tailored technology including a toolkit of new routines. When this proved not to be the case, it took time and effort for the actors to understand the concept of co-creation and contribute in a meaningful way.

Recognising differences between professional cultures

Cultural differences were experienced by healthcare managers and staff on the one hand and the vendors and IT staff on the other. Initially, representatives of all parties understood the basic problem to be a lack of insight or competence of the other parties. The care providers reported that neither the vendors nor IT staff understood what care for persons with dementia required. Similarly, a vendor stated that the care providers lacked interest in building their technological skills and competence. The project managers were caught in the middle and constantly needed to explain and enforce the implementation: "*There is just a … how shall I put it … a persistent feeling that I need to translate all the time*" (Project manager). Recognising these differences facilitated bridging the gap between the two cultures.

Facilitating dialogue and translation between professional cultures

Regular workshops were part of the innovation strategy and proved to be the prominent arena for dialogue between the two cultures (Table 2), which steadily supported progression in the implementation. The workshops became meeting places for sharing knowledge, experiences and material, as well as for common development of knowledge, new routines and distribution of responsibilities. They also led to formation of informal groups and networks such as "fast-working, self-dissolving task-teams", where actors joined forces across organisational boundaries to solve a common problem. The team dissolved once it had identified and proposed a solution.

Establishing a team of champions

The project managers recruited care providers on the night shift and professional practice advisors as superusers of the monitoring technology. In co-operation with the vendors, they formed local implementation teams that provided technological support and training to colleagues and filled the role of implementation champions. Late appointment of superusers proved to be a barrier. In the middle phase, the teams were reorganised as a quality measure, which ensured that one superuser always was on duty to provide support around the clock.

Table 2 Overview of the timing, themes, topics for co-creation activities and workshop participants in the Digital Night Surveillance Project

Date	Theme	Topics for co-creation	Participants				
			HCP	IT	T	R	Other
Nov 2014	Service innovation	Visualising the night service before and after implementation	23	3	5	6	7
		Stakeholder mapping					
		Stakeholders' responsibilities					
		Communication between shifts					
		Need specification of new routines					
		Potential new user groups and services					
Feb 2015	Communication	Individual communication Organisational communication	27	3	4	5	1
		Communication strategies for implementation (media, public, politicians, relatives, patients, employees)					
May 2015	Service design	Future recall	28	4	4	7	5
		Patient journey, touchpoints, interactions and user experiences					
		Development of new routines					
Sept 2015	Information security and privacy	Technology improvements	10	4	2	7	2
		Requirements to infrastructure					
		Legal and regulatory issues					
Nov 2015	Routines, documentation and technology	Documentation into existing systems	21	2	4	5	
		Optimising routine descriptions, work lists, check lists. Etc					
		Optimising the technology					
		Routines and responsibilities for support					
		Patient privacy and safety					
April 2016	Service innovations and ethics	Practical familiarisation with tools in the national roadmap for welfare technology implementation and service design	17	2	3	5	2
		Ethical dilemmas when implementing monitoring technology in dementia care					
Sept 2016[a]	Implementation issues in digital surveillance technology	From pilot-testing to continuation	20	2	12	7	16
		Best practices, Norway and Sweden					
		Management challenges					
		Involvement of IT services					
		Developing clinical expertise					
		Benefit realisation					
May 2017	Results and dissemination	Final seminar	46	2	5	11	7
		Summing up experiences					
		Presenting research and project reports					

Abbreviations: *HCP* Healthcare Professionals, *IT* Information Technologists, *R* Researchers, *T* Technologists. [a]Workshop located in Sweden

Coaching colleagues had a bonding effect between different shifts and professions, and promoted the implementation: "*I think it ties us together across professional groups*" (Night-shift nurse). Through their team efforts, they explored the other actors and reinforced the principles of co-creation to buffer frustrations and solve problems. As the mangers did not involve themselves much, the implementation teams supported each other through the consortium.

Technology stability and usability

Improving reliability

Reliability of the technology was crucial to the care providers. IT infrastructure and mobile network instability was the major and persistent technological barrier: "*We had data problems from day one. That was our biggest challenge*" (Healthcare manager). Some challenges were resolved, such as re-negotiation of agreements between municipalities and mobile operators to ensure priority of

SMS at night, but infrastructure instability remained a challenge until the end of the implementation. In contrast, the instability in the monitoring technology portal and integrated sensor technologies was solved during the early and middle phases of the implementation.

Problem-solving readiness

Rapid problem solving and quick deliveries were essential to the progress of the implementation. Immediacy was hard to achieve during the early phase because of the complex distribution of responsibilities and the multitude of suppliers. Whereas the healthcare services purchased the portal directly from the vendors, third-party suppliers delivered sensor technology. The vendors and subcontractors were responsible for installing the technology. The municipal IT service and their third-party suppliers were responsible for the existing infrastructure, such as Internet and mobile networks. The IT service purchased and installed smartphones and computers, or had subcontractors doing the installation. Installation of the monitoring technology in residents' rooms required tight coordination between the care service and all other parties. Equipment that did not work, was not delivered or installed in time caused numerous delays during the early phase, compromising safe practice as well as efficient training.

> *Suddenly they* [the vendors] *were there, and then we did not have ... They did not come, and then they should install something, and … in a way we did not have a sufficient dialogue with those supposed to make the delivery. They were expected on a Friday, and suddenly they did not appear, and I had to address it, and they had not received the parts, and then they turned up on Monday … It has been a bit messy, really* (Project manager).

To solve problems more rapidly, the vendors and local project managers established a routine of daily feedback on the functionality of the technology. As the implementation progressed, the feedback was maintained with less-frequent interactions.

Recognising tacit knowledge

Recognising tacit knowledge and tasks and types of work embedded in such knowledge was a facilitator for implementation. Tacit knowledge guided the care practices of observation by seeing, listening, smelling and feeling, and the responding clinical tasks, tailored to the needs and behaviour of the individual residents, varying from one night to another and following the progression of dementia and comorbidities over time. To adapt the technology to the care settings, the vendors had to identify the multitude of aspects of the work performed by night-shift care providers. It took time to unlock these complex and variable clinical practices through deep explorations, thorough observations of the actual work and broad discussions with the care providers.

Developing usability through co-creation

Involving night-shift care providers, vendors and the IT service in the systematic development of the usability of the technology proved to facilitate implementation. However, there were initially major barriers to overcome because the vendors assumed that their technology was intuitive, whereas most of the care providers found the technology all but easy to use. In addition to trial-and-error use of a variety of sensors, the complicated integration into the existing IT infrastructure increased frustration: "*You need to carry a whole notebook to remember things. And then there are all the new usernames and passwords*" (Night-shift nurse).

Maintaining iterative improvement

The development of the final technological solutions required considerable efforts over time from the vendors and care providers in each nursing home and within the consortium. These processes nurtured the development of mutual trust and a constructive dialogue, and vice versa. As adequate sensor technologies were installed and the technological stability and functionality improved during the middle phase of the implementation, the care providers could instantly assist the residents when needed and started to change their routines accordingly. "*It works much better now. There are few false alarms, and we tap directly into the smartphone and it simplifies a lot. It is just awesome*" (Professional development advisor nurse). The vendors also updated the technology in line with current regulations of data protection and privacy, during the course of the implementation project.

Building competence & organisational learning

Tailoring iterative competence building across shifts and roles

Building competence proved to be important and necessary, but was hard to organise systematically because of the complexity of the healthcare service and the multitude of actors. Training sessions that were organised just before the shift started worked well for the night-shift workers, whereas sessions during the day were appropriate for other groups that needed training.

The project workshops facilitated iterative competence building, as did staff meetings and training sessions addressing specific needs of groups and shifts. Some needed repeated sessions and learned one task at a time. Mastering the new skills integrated into new routines required continuous practice over time for all involved

care providers. Job rotation schemes, part-time positions and frequent use of substitute and on-call personnel proved to be barriers because the care providers were not sufficiently exposed to the technology. "*I need to practice [new skills] when I am working. We alternate between many wards. I only have two nights there during a six-week rotation*" (Night-shift nurse).

Focusing on skills

Initial training sessions were more theoretically oriented, but the care providers soon asked for instructions in the practical handling of the technology. "*Showing in practice how things work, not just telling and using words. Then we would not understand that much. We all need this for it to become second nature!*" (Night-shift healthcare worker). Skill acquisition started with learning the swiping hand movements and multi-touch gestures to handle the smartphone app and then combining the practical handling with operating the software commands before introducing the app into care settings. Until their skills were proficient, care providers perceived the technology as obstructing and stealing their focus from the residents: "*When it's busy it feels silly to carry that phone around. We sometimes feel that we carry the phone more than actually dealing with residents*" (Night-shift nurse).

Overcoming language differences

In the early phase, language differences between technology and healthcare represented a barrier to learning, motivation and progress in the implementation process.

> *We were speaking two different languages. They were talking about "the platform" and explained all these things about gadgets and cables and stuff, using words and phrases we didn't understand* (Healthcare manager).

Through experience and co-operation, the vendors gradually adapted a language more understandable to the care providers. Similarly, project managers iteratively modified user manuals and written instructions into a more understandable format. Exchange of material within the consortium further facilitated competence building and implementation.

Organising for reflection

Some of the municipalities focused on ethical reflection, which proved to be a facilitator. Many informants appreciated face-to-face meetings to discuss dilemmas and practices. Not prioritising reflections proved to be a barrier in the later phases, undermining motivation and slowing down the implementation process.

> *I can't put my hand on my heart and claim that everybody is compliant. I don't believe it, because it's never discussed. I was hoping for a broader conversation and not just two minutes in a staff meeting to be informed that 'it's up and running'* (Night-shift healthcare worker).

Service transformation & quality management

Managing risks

A series of unforeseen risks emerged in the care service during the early phase of implementation. Daytime personnel occasionally forgot to check on bed-exit sensors before residents went to bed, turned motion detectors towards the wall and moved residents in need of monitoring into rooms without sensor technology. "*Some staff working the day shift do not even know that there is a system, tugging on the cables without knowing what happens*" (Vendor). Likewise, the cleaning staff inattentively moved sensors or disconnected cables when cleaning the rooms. These incidents were communicated among the project managers, enabling them to learn from each other. As the implementation progressed, the care providers on all shifts and the support staff became more skilled and the new routines and practices reduced the risk of compromising patient safety.

Recognising concerns

For some actors, employment security was an important factor, especially during the early phase. Generally, older care providers seemed less technologically proficient and expressed more anxiety than younger care providers. Some actors feared that the technology would replace their roles. Others felt challenged and even embarrassed by their own poor technical proficiency. Most participants were waiting until they had received more training. A few were highly motivated from the very beginning and constituted an asset in the implementation. Professional obligation was identified as a motivating factor: "*I think it's a part of my job as a nurse to take responsibility for it*" (Night-shift nurse). Some actors, such as care assistants, felt professionally relieved from such an obligation. Feeling responsible was linked to whether one was working on the night shift, especially early on when the implementation still was considered a night-shift issue. Plans for dissemination of information and competence building contributed to relieve the concerns and deal with issues that arose as did the co-creation activities.

There were a few incidents of unfortunate patient–technology interactions, such as residents thinking the bed-exit sensor was causing them to wet their bed during the night. These incidents were solved by removing the sensors. The care providers focused on the safety

aspects of the technology in their communication with relatives, who initially feared that the technology would replace human care. As the implementation proceeded, however, the relatives tended to ask for more technology.

Reviewing IT operating and service routines

The existing IT system operating routines not being in line with the needs and requirements of the healthcare services impeded the implementation. "*For us there are only bits and bytes. We don't go into the context. That is the basis for how we operate*" (IT manager). Thus, the IT service workhours represented a barrier. In most of the municipalities, IT support was available during daytime on weekdays, whereas the monitoring technology was operated at night all year. When the system failed at night or during the weekend, the lack of immediate support put patients at risk. It also caused considerable distress among the night-shift staff who needed to find solutions and reorganise their care for the residents. The same thing happened when the monitoring system went down at night due to automatic IT updating routines, which resulted in alarms that did not get through to the care providers and no access to the systems. The consortium organised separate workshops focusing on IT to address these challenges. In addition, a couple of the IT managers stepped up and contributed to the project and steering groups for the benefit of healthcare services from municipalities with less involvement from their own IT services.

Making instructions and routines explicit and accessible to all

The lack of written night-shift instructions and explicit routines represented a barrier to service innovation. New routines for resident selection and for continuous assessments of residents' needs (including discontinuation of digital monitoring) were gradually developed and documented into the administrative systems of the care services as were routines for maintenance of the equipment on a daily (e.g. charging), weekly (e.g. cleaning) or monthly basis (e.g. testing), and routines for reporting to and communicating with the vendors and the IT services. General awareness of the technology was integrated into existing routines, regularly commented on during staff meetings and during the handover between shifts. However, not all the work related to the technology could be included in checklists or written instructions. The superusers took responsibility for checking on sensors and wiring, sorting out issues with the phones and so on.

> *It is a lot of itty-gritty things that you do that is not visible, you know. There are many things that you just drop by to check and.... I'm lying under the beds to check on the hose in port 1.... and you become.... You should have shared it with more people, but the night shift is only available at night* (Professional development advisor nurse).

Developing new procedures for the handover between night and day shifts was necessary because the technology required efforts from all of the shift workers to function as intended. This also affected the amount and content of information shared during the handover before and after the night shift. The new routines informed managers and colleagues about the residents' behaviour during the night and they became more aware of the work of the night shift. "*It is more referred to the experiences of the night shift than before. You know, their observations are passed on to the doctor during rounds and so on*" (Healthcare manager).

Developing new roles

As new routines were developed, there was a need for new roles and responsibilities. In line with vendors' recommendations, superusers were appointed among professional development advisors and night-shift care providers during the early phase. Specially trained staff administered alarm settings and patient data. This required deep knowledge about the individual residents and the task initially belonged to the primary contact nurses responsible for the residents. However, because they worked only on the day shift, the residents' primary contact nurses did not know about their residents' nocturnal behaviours. The alarm settings were suboptimal until the role of setting parameters was transferred to the night-shift care providers.

Realising benefits

New insights into the nocturnal behaviour of residents was a strong motivating factor that drove the implementation forward. The general assumption was that residents were in bed sleeping unless otherwise observed. The digital monitoring revealed that the night wanderers were far more awake during the night than previously known, even by the experienced night-shift care providers.

> *The ones who seemingly were calm during the night are far more awake and wandering. I see that for some it's normal to go to the bathroom or stretch their legs. And they do it much more often than I realised* (Night-shift healthcare worker).

Assisting the residents sooner resulted in less wandering and no elopements, in addition to more hours of sleep during night and less during the day. Ceasing the

routinely rounds resulted in fewer entries into residents' rooms. Some residents started to sleep through the night and others did not need sleep medication anymore. The care providers could co-operate and assist each other in new ways during the night shift. They saw all these benefits as increased quality of care, enhanced privacy for the residents and more efficient services, which motivated them through the final stage of implementation: "*I feel I can do an even better job, in a way, for now I can see things. So, for me, it [the implementation] has been merely positive*". (Night-shift healthcare worker). When asked about the main outcome of the implementation, a healthcare manager answered: "*In capital letters: SAFETY, both to residents, relatives and care providers*". During a workshop in the last phase of the implementation, the participants were asked how the innovation project would be evaluated in 2030. "*Digital monitoring at night saves lives*", a healthcare worker answered, "*It already has*".

Upscaling gradually

Beneficial experiences triggered care providers to experiment and suggest upscaling to encompass more residents: "*They think it's working well during the night and have asked if more residents could have it*" (Healthcare manager). Towards the end of the implementation, the monitoring technology was utilised for other indications than night wandering in all the nursing homes. The technology was found to be beneficial for residents with fall tendencies, infections and during rehabilitation following hip fracture.

The lifespan of the implementation project

From a temporal perspective, the implementation moved through characteristic phases as shown in Fig. 1. The municipal organisation represented by the management adopted the technology during the pre-implementation planning phase. The IT services, nursing home staff, residents and relatives adopted the technology during the early phase of implementation upon installation. Co-creating the adaptive elements of the monitoring technology system and instability in infrastructure characterised the early phase, with simultaneous resistance to and motivation for change. The main phase was characterised by practical experience and co-creation of service innovations. The safe and new monitoring practice, skilled care providers and realisation of benefits characterised the last phase. Following the implementation, the new, technology-based monitoring service continued. The monitoring system and the transformed services were still running in all participating nursing homes in the eight municipalities one and a half year after the completion of the implementation period (i.e., at the end of this study).

Figure 1 visualises the pre-implementation preparations, the innovation strategy and facilitators and barriers through the early, middle and late phases of the implementation.

Discussion

This article aims to identify facilitators and barriers, and explore co-creation practices as an innovation strategy during a four-year implementation of digital monitoring technology in long-term residential care for persons with dementia who are night wanderers. The study shows that the implementation of monitoring technology in nursing homes implies radical innovation and digital transformation. The main finding – which is not previously identified – is that the complex process of digital transformation of healthcare services can be successfully facilitated by recognizing the inherent slowness of radical change and by applying co-creation methodology across roles and professions. This will be discussed in the following.

Factors that proved to facilitate the implementation when completed or impede the implementation when not completed can be categorised as: 1) Pre-implementation preparations; 2) Implementation strategy; 3) Technology stability and usability; 4) Building competence and organisational learning; and 5) Service transformation and quality management. The co-creational methodology was the most prominent facilitator and the combination of IT infrastructure instability and the reluctance of the IT support service to contribute in the co-creation of values was the most persistent barrier throughout the implementation. In combination with the project initiation followed by the pre-implementation activities, identification of three phases during implementation is in line with the five-stage model of innovation processes in organisations proposed by Rogers [33].

The foundation for digital transformation

The implementation represented a radical and transformative innovation process in contrast to the incremental changes that all levels of management and the IT and healthcare services were prepared for. The political decision to kick-start a digital transformation of the healthcare services by implementing monitoring technology in nursing homes formed the foundation for radical innovation. The decision was in itself a strategic innovation in line with Hartley's [30] description of long-term perspectives for restructuring responsibilities between the public care sector, the population and the private sector. The municipal managements' initiative to enter a project with a set timeframe and a formal consortium based on the triple-helix network structure was essential. The interactions within the consortium added value to the implementation processes almost regardless of settings, participants and activities, which supports

the proposition by Sørensen and Torfing [63], i.e. cross-disciplinary collaboration enriches the generation, selection and implementation of ideas, in addition to the dissemination of new practices.

Co-producing radically new technology

The monitoring technology fulfilled the three criteria defining technological radicalness according to Dahlin and Behrens [64], i.e. novelty, uniqueness and impact on future inventions and practices, as well as the definition proposed by Chandy and Tellis [65], which includes incorporation of substantially different technology that can fulfil key customer needs better than existing products. In contrast to most technological innovations that reconfigure known technologies [66], this system was unique because it included novel IOT middleware that allowed one application to operate a variety of technologies based on different technical protocols. The care providers had experience with and could easily manage some of the sensor technologies in line with the findings of Hall et al. [4], whereas smartphones had not yet been adopted by the majority of intended users.

Norman and Verganti [32] suggested that advances in technology and change in the meaning of existing products instead of human-centred design drove radical product innovation. In this case, the vendors had entered a not-yet-existing market, which can be considered as position innovation [30] and relied on close interaction with the care providers, that took the position as the lead users [67] of the novel technology. The vendors developed deep knowledge of the services, residents and care providers through dialogue, translation and co-creation, thus minimising the potential clash described by Coiera [68] between anticipations forming the basis for software coding and the real clinical practices. These final stages of the product innovation [30] represented a paradox. The adaptability of the technology was found attractive by the care providers and managers and is considered a promoting factor in implementation [27, 69, 70], whereas the lack of completeness, which truly frustrated the care providers, is a known barrier [39] that had to be overcome. The vendors aligned their processes with those of the care services (i.e. their customers) through the co-creation activities [52] and actively planned, tested, prototyped and implemented value co-creation opportunities. The gap in competence and difference in terminology between vendors and care providers was dealt with by translation by project managers and co-creational methodology as visualisation and prototyping, in line with the recommendations by Ünsal et al. [71]. Furthermore, the vendors explored potential technological solutions and then presented a moderate number of options, which enabled the managers, project managers and care providers to make decisions, as discussed by Bratteteig and Wagner [56].

Knowledge conversion as a mediator for service innovations

Care providers acquired skills and adopted routines that initially were perceived as incompatible and inconsistent with existing workflows. This breach is traditionally considered to be a major barrier to implementation [22, 39]. In contrast to the incremental improvements of existing practices, most of the service and process innovations represented new ways of structuring and performing tasks and responsibilities, which supports the notion of radical innovation described by Norman and Verganti [32]. The service design methodology engaged all actors during the workshops by offering them a voice in the co-creation processes and lending them an ear during the collective prioritisation of recommendations. Co-creation efforts included sharing experiences, integrating resources and learning, and resulted in mutual betterment [72]. The methodology facilitated conversion of tacit knowledge to explicit knowledge through externalisation [38], initially in the form of critiques and concerns. Little by little, the externalisation processes resulted in written material, routines and organisational learning. Organisational learning also included recognition of all the efforts and smaller tasks constantly performed without prior mentioning in written routines. This "hidden work" [73], relied on an expert level of competence because they required a trained eye and overview to be recognised and dealt with.

Building capacities for digital transformation

The implementation brought together groups of actors with strong internal uniformity in their knowledge base, but with thick knowledge boundaries [74] between the groups, as expressed by differences in language, interpretation and motivation. Digital transformation represented a novel domain to care providers, with a prediction that learning would be more difficult and expertise would develop incrementally [35]. An array of strategies and practices promoted competence building that was radical in the sense that it elevated most care providers from expressing almost no technological knowledge to becoming experts in intuitively using the technology, which allowed them to focus on their residents. The first learning strategy was skill acquisition, which is in line with the model introduced by Dreyfus and Dreyfus [75]. The care providers' problem-solving capability developed through the high availability of support from and interaction with the vendors. Other learning strategies included access to training, supervision, practical experience over time and collective reflections, which are known to facilitate a positive implementation

climate [76]. Discontinuity in practicing newly acquired skills inhibited the development of competence, in line with the perpetual novice syndrome described by Wilson et al. [77].

Orchestration and translation was essential for the development of absorptive capacity, including communication with external organisations, between actors in the consortium and within internal subunits [35]. As HCPs, the middle managers are expected to be able to take key roles in the implementation [78], with the capability to mediate between the innovation strategy and day-to-day activities, and translate and facilitate implementation processes [77]. Their delegation of responsibility for implementation activities to project managers and professional practice advisors without delegation of authority over the nursing staff impeded the problem-solving capacity at times when it was difficult to maintain momentum during the implementation [28]. Further, it complicated the coordination between the implementation and other organisational priorities, which is a known barrier to implementation [18, 39]. Transformational leadership has been found to support innovation and readiness for change in residential aged care settings [79]. From a long-term perspective, the nursing homes lost essential leadership competence related to digital transformation upon completion of the implementation because the project managers had held temporary positions and returned to the larger municipal healthcare organisations after the implementation completed.

In a co-creation of value perspective, the interaction between service systems such as the healthcare and IT services should optimally be based on a relationship that promoted integration of mutually beneficial resources [51]. The support and services from the IT service was an integrated part of the healthcare service ecosystem [80] because the services provided by the healthcare service (i.e. their value propositions) strongly relied on deliveries from the IT service. However, in line with traditional bureaucratic silos [63], the established practices and routines of the IT services were to a large extent ignorant of the essential traits and needs of the healthcare services. During implementation, the IT services were reluctant to participate in co-creation activities and contribute to internal knowledge transfer [35], which diminished the absorptive capacity of the municipal organisations that relied on their expertise. This recurrent infrastructure instability, which is a substantial barrier in implementations of e-health applications [19, 81], impeded the implementation during all phases. The reluctance to change IT operating routines [82] and unwillingness to solve system slowdown and downtimes, which are among the major causes for negative attitudes toward health IT among nurses [44], compromised the provision of care and had a negative reinforcing effect. As most IT support staff did not actively involve themselves in the implementation, the nursing staff and vendors joined forces as a compensating measure. Consequently, the vendors filled the supporting role [83] and thus contributed to a trustful implementation climate conducive to change and characterised by benevolence.

Trust, risk and safety across the colliding worlds of health and technology

Trust in the monitoring technology, the infrastructure, their colleagues and their own safe use of the technology was crucial for the care providers, which supports the concept that a trustful working environment contributes to the care providers' basis for providing quality care [17] and specifically to their confidence in caring for residents with dementia [84]. Trust expresses relative security and includes the possibility for negative consequences; therefore, both trust and risk are incorporated in the decision-making [85].

The care providers' perception of the technology having risks for residents impeded the implementation [86]. The reports of risky situations during implementation of IATs [87] emphasise how the care service managers and staff are experienced risk assessors who continuously mitigated risk with promotion of the independence of persons with dementia and reduction of the care burden. To a large degree, however, the care providers and their managers did not have the competence to assess risks created by the digital monitoring technology [88], which inhibited balancing of implementation decisions [18] so that the technology did not impose threats to patient safety. In the early phase of implementation, their low technological competence combined with poor strategies for problem solving was a striking phenomenon, which was expressed through an inability to discriminate causes of technological malfunctions. The vendors established control measures that the nursing homes adapted as the implementation proceeded. Competence building and frequent reflections fostered a collective awareness of safety issues [89] and supported the development of a safety culture [90] over time.

The inherent slowness of radical change

A four-year implementation of any technology might seem excessive, and time and resources could probably have been saved if the planning and preparations had been more thorough. However, as the implementation represented radical innovation, a sequence of time-consuming strategies, such as competence building and establishing new routines through continuous co-creation, dialogue and translation, had to take place to enable the care providers to integrate the new monitoring service in their clinical practice and realise the benefits and co-create value with their residents. From a

value perspective, the benefits are weighed towards the costs. Despite the barriers, individual and organisational interactions, resource integration and learning within and between the actors in the consortium steadily supported the endurance of the inherent slowness of radical change. The care providers became experienced innovators [27] through these efforts. Towards the end of the implementation, they took calculated risks and experimented with the technology in contrast to previous reports from implementation of monitoring technology in residential care [e.g. 16].

Implications for practice

The key findings of this study can be summarised into three points representing the main facilitators of digital transformation and recommendations when planning innovation and implementation processes: a) involving key actors from the very start; b) organising for dialogue and co-creation throughout the implementation period; and c) planning for competence building and iterative improvement of technologies and clinical practices.

Further research

According to this study, both the meso and micro levels of the existing healthcare ecosystems [91] will need to change to accommodate digital transformation by integrating IT competency and possibly also IT support into the healthcare organisation and service provision to benefit the value co-creation within the ecosystem and with service users. Future research into how this can be done is recommended. A quantitative study evaluating the benefits of the digital transformation, in terms of both cost savings and outcome measures related to the effectiveness of the system, is also recommended.

Strengths and limitations

This study covers the full duration of an implementation process involving a relatively high number of participants and technical installations. The interdisciplinary research team represents a research strength with their high levels of competence within economic and organisational studies, leadership and ethics, innovation management and healthcare professional practices in psychology and nursing. The study limitations are related to the vast material, which implies that all actors affected by the implementation were not directly involved in the data collection. The residents and their families were merely passive actors in the co-creation activities of the study and the research data involving them were primarily provided by other actors. Further, more descriptive, quantitative information related to the uptake of the technology would be useful. Because this is a case study, transferability may be difficult in other situations, although the rich descriptions of the settings and participants may enable readers to determine transferability [92].

Contributions

This study contributes to the implementation literature by identification of factors facilitating implementation of IATs in residential care services, which can be defined as radical innovation. The longitudinal nature of the study and the close research interaction with thick descriptions of the co-creation activities and facilitating factors that developed across groups and levels of actors over time [93] contribute to the literature on co-creation of healthcare services as well as of value in those settings. The digital transformation of healthcare services differs from other public sector organisations because of the complex governance and relationship to risk [94]. The study contributes to the literature on risks and safety issues, which have been poorly explored in relation to assisted living technology in the care for persons with dementia [95].

Conclusion

The successful implementation of novel digital monitoring technology in the care services is a complex and time-consuming process, and even more so when the technology allows the care providers to adopt radically transformed clinical practices at the point of care and offer new affordances in co-creation of value with the residents and their relatives. The timeframe in combination with the co-creation activities within the consortium was a prerequisite for most of the benefits realised in this first step of digital transformation. The existing healthcare ecosystem, relying on an external service division to provide IT competence, design and support, is not sustainable. Digital transformation of the municipal healthcare services requires more advanced IT competence to be integrated directly into the provision of care and value co-creation with service users, residents, patients and their relatives.

Abbreviations

AAL: Ambient Assistive Living Technology; ERN: Etty Ragnhild Nilsen; FG: Focus Group Interview; HCP: Healthcare Professionals; HCW: Healthcare Worker; HE: Hilde Eide; IAT: Intelligent Assistive Technologies; II: Individual Interview; IOT: Internet-of-Things; IT: Information Technology; ITM: Information Technology Manager; JD: Janne Dugstad; MIDI: Measurement Instrument for Determinants of Innovation; O: Orchestrator; PC: Personal Computer; PM: Project Manager; R: Researchers; RN: Registered Nurse; SMS: Short Message Service; T: Technologists; TE: Tom Eide

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Authors' contributions

All authors made significant contributions to the manuscript. The study was conceived and drafted in close co-operation between the four authors: JD, TE, ERN and HE. The data were collected by the Digital Night Surveillance

Research team, including the authors. JD, TE, ERN and HE contributed to the analysis. The manuscript was drafted by JD in close co-operation with TE, and reviewed by ERN and HE. All authors read and approved of the final manuscript.

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Availability of data and materials
The datasets supporting the conclusions for this article consist of transcribed interviews and observations in settings with a limited number of participants. These qualitative data will not be made available for privacy reasons.

Ethics approval and consent to participate
The Norwegian Data Service for Social Sciences approved the project according to the Personal Data Act (approval no. 34831 and 36230). Ethical approval in line with the Health Research Act was not applicable. The participants signed informed consent. The data are anonymised in the presentations.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Publisher's Note

Paper 3

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Evaluating Welfare Technology Implementation in Municipal Care Services

Contextual Adaptation of the Measurement Instrument for Determinants of Innovation

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Abstract

The Measurement Instrument for Determinants of Innovations (MIDI) was developed to identify facilitators and barriers during implementation processes in healthcare. Thereby the implementation strategies can be better targeted to obtain successful implementation. MIDI is theory- and evidence based, and provides a generic description of 29 determinants with suggested questions that need to be adapted to the specific innovation and implementation context. This paper aims to describe how MIDI can be contextually adapted; using welfare technology implementation in municipal care services as context. Based on this process we suggest operationalization of specific determinants on item-level in the MIDI adapted to the welfare technology context (MIDI-WT).

Keywords

Welfare technology, implementation strategies, determinants, contextual adaptation, questionnaire survey.

1 INTRODUCTION

Recent implementation research have called for improved methods for tailoring implementation strategies and for measuring implementation outcomes in healthcare [1, 2]. *Implementation strategies* represent the 'how to' in introducing and making use of an innovation in healthcare services [3]; the actions needed to make an innovation fit the organization and services, and to enable the organization, the healthcare providers and patients to use the innovation. *Determinants* are factors that act as *facilitators* for or *barriers* to achieve the desired outcomes of the implementation strategies [4]. *Implementation outcomes* are intermediate process results that influence the later production of *service outcomes*, such as increased efficiency, safety and patient centeredness, and *patient outcomes*, as increased patient satisfaction and function [5].

There is a multitude of theories, frameworks and models in implementation science [6], of which some are suitable for research, some for pragmatic implementation and some for both. The Measurement Instrument for Determinants of Innovations (MIDI) is a theory- and evidence based questionnaire in the latter category [7]. MIDI determinants and their underpinning theories overlap with other implementation frameworks [8-11], and are founded in Rogers' Diffusion of Innovations theory [12]. Healthcare organizations can use MIDI just prior to and/or during an implementation process. MIDI was designed to identify how healthcare providers evaluate the innovation and factors related to the implementation process. The care providers' feedback reveal the facilitating or impeding effects of the determinants, allowing for adjustments of implementation strategies in order to support successful implementation, achieve expected outcomes, and sustained use of the innovation. MIDI encompasses 29 determinants (D1-D29) related to the innovation, the adopting user, the organization and the socio-political context (table 1).

The innovation category consists of seven determinants associated with the welfare technology: procedural clarity (D1), correctness (D2), completeness (D3), complexity (D4), compatibility (D5), observability (D6) and relevance for the patient/resident (D7). In MIDI-WT, this category details how the welfare technology is delivered from the vendor and how it fits with the current practice, whereas integration of the welfare technology in the care workflow is detailed in the adopting user and care organization categories.

The adopting user category captures 11 determinants associated with the care provider who is using the welfare technology: personal benefits and drawbacks (D8), outcome expectations (D9), professional obligation (D10), resident satisfaction (D11), resident cooperation (D12), social support (D13), descriptive norm (D14), subjective norm (D15), self-efficacy (D16), knowledge (D17) and awareness of content of innovation (D18).

Ten determinants associated with the care organization or underlying unit implementing the welfare technology form the third category, the organization. This category includes formal ratification by management (D19), replacement when staff leave (D20), staff capacity (D21), financial resources (D22), time available (D23), material resources and facilities (D24), coordinator (D25), unsettled organization (D26), information accessible about use of innovation (D27) and performance feedback (D28).

The socio-political context determinant (D29) in the fourth category is related to legislation and regulations of the Norwegian municipal healthcare services.

The categories and determinants correspond well with factors associated with effective implementation of digital health reported in the literature [e.g. 13, 14-16].

A 5-point Likert response scale is applied to assess most of the MIDI items, with 1 representing the lowest level of agreement and 5 representing the highest level. D14 has a 7-point Likert scale ranging from 1 representing 'not a single colleague', to 7, 'all colleagues'. D18 has a 4-point Likert scale ranging from 1, 'I am not familiar with the (technology)', to 4, 'I am thoroughly familiar with the (technology)'. A dichotomous Yes/No scale applies to D19, D25 and D26.

According to the MIDI manual, the generic instrument needs to be adapted to the specific innovation and context, based on 'use as intended by the developers' [17]. Developers and vendors are challenged by the variety in users and needs when developing welfare technology instructions and guidelines. Firstly, a specific technology can be applied to solve a range of needs. Secondly, welfare technology implementation is characterized by various factors related to the care contexts, patients, organizational culture, infrastructure, work practices, and management practices [15]. Thirdly, implementations involve technical installation and service innovation processes related to training, clinical procedures, routines, and responsibilities [18]. Previous studies that used MIDI to assess health innovation implementations [19-21] have not described the contextual adaptation processes of the determinants and their items.

This paper aims describe the contextual adaptation of the MIDI questionnaire to the implementation of welfare technology in municipal care services. The research question was: Which welfare technology related items should be included to cover the determinants in MIDI-WT?

2 METHODS

2.1 Design and study setting

During 2014-2019, we performed an iterative evaluation of our adaptations of the MIDI questionnaire to the implementation of welfare technology in residential care services in eight municipalities.

2.2 Data collection

We collected and analyzed data in order to get deep knowledge about welfare technologies, service innovation processes, implementation strategies and outcomes by reading political documents, procurement protocols, technology manuals, instructions, and clinical routines. We interviewed healthcare managers, project managers, professional development advisors, care providers, vendors, IT service managers, and –staff, individually and in groups. We observed meetings between stakeholders, participated in and facilitated implementation workshops and co-creation activities. Moreover, we observed some care providers while they responded to the MIDI questionnaire. The data collection was integrated in larger implementation research projects that explored facilitators and barriers, implementation strategies and outcomes, types of resistance, co-creation as an overall implementation strategy, and the roles of different stakeholders, and their analyses and results are detailed in previous studies [18, 22-27].

2.3 Iterative evaluation of MIDI adaptation

The iterations included: 1) a cross-cultural adaptation of MIDI to the Norwegian healthcare setting [28] in parallel to piloting the MIDI during the first year of an implementation of digital night monitoring of persons with dementia in five residential care facilities [23]. 2) a cross-sectional study that used MIDI to assess the implementation of wireless nurse call systems in five residential care facilities [27]. In both iterations, the MIDI was contextually adapted and distributed to care providers, and their responses were analyzed. We documented and discussed our reflections related to the research question during each step of the iterative evaluation, resulting in an improved adaptation process over time, as detailed below, and recommendations for MIDI-WT determinants and items.

The adaptation of the questionnaire relied on contributions from stakeholders involved in the implementation, preceded by an agreement to undertake the MIDI-based measurement of the implementation of welfare technology. Through the iterative evaluation approach, we developed the following procedure for implementations that were new to the researchers, with novel technologies and contexts:

2.3.1 Interview with healthcare top management

The first step was an interview with a municipal healthcare top manager at the care institution level or higher. The interview addressed the long-term welfare technology implementation strategy and how the top management had prepared the implementation, including procurement of technology, delegation of responsibilities and allocation of resources. The interview was done by phone or in a meeting, and lasted for about 15 minutes. We made written notes of responses, reflections and concerns.

2.3.2 Interview with care unit management team

The next step was a meeting with the management team of the unit(s) in the care organization where the implementation took place. Following a brief introduction of the MIDI and the need for adaptation, the management team was asked about the same issues as the top management representative, in order to reveal familiarity with and any concerns regarding the procurement, planning, allocation of resources and responsibilities. The team was then encouraged to describe the welfare technology and how it would be used in the unit, as well as the implementation strategies in the order that they would be effected. We specifically asked about the responsibilities of and cooperation with the IT service and the vendors. The meetings lasted for 30 to 45 minutes and we made written notes of the team members' responses, reflections and concerns. Comments directly relevant for the adaptation of items, such as the expressions used to describe the welfare technology, were written directly on a printout of the MIDI questionnaire.

2.3.3 Interview with vendors and/or IT service

The vendors and the IT service employees were presented with the same questions as the care unit management teams. Both the vendors and the IT services provided detailing and contrasting information about all parts of the welfare technologies, technological infrastructure, and safety aspects, as well as the implementation strategies and the managers' and care providers' overall technological

competence level. We interviewed vendors and IT services in meetings or by phone for 20 to 30 minutes and documented as for the management teams.

2.3.4 Co-creating the adaptation of MIDI items with a super user

Succeeding the interviews, we discussed the questionnaire in an item-by-item manner with a super user of the welfare technology, based on a drafted version of MIDI-WT. Caution was taken to ensure that relevant items were included, detailing the welfare technology, the clinical use, the implementation strategies and the stakeholders involved, and that irrelevant items were omitted. Further, to ensure that the wording of the items was unequivocal and in line with the expressions used in the care unit. The meeting lasted for 30 to 45 minutes and notes were made directly on the MIDI-WT printout.

2.3.5 Additional sources of information

The implementations relied on the joint and coordinated efforts of a number of stakeholders; hence, we observed the interactions between them. This was particularly useful when the interviews indicated disagreements or resistance. The observations included status-meetings between the vendors, IT service and the healthcare service; training sessions for care providers; and information meetings for nursing staff or patients/residents/families. We arranged to do the interviews just prior to or after these observations, which eased the access for doing interviews.

Moreover, we asked all informants for available written material, such as implementation plans, technical data sheets, checklists, and clinical procedures. We received and analyzed the written material as the MIDI-WT adaptation progressed, and it added useful information.

2.3.6 Verification of MIDI-WT

We e-mailed the proposed MIDI-WT to the care unit management for verification and discussed their feedback in meetings or by phone, in which we also coordinated the practical details of distributing the questionnaire to the care providers. Finally, the MIDI-WT questionnaire adapted to the specific welfare technology was completed.

3 RESULTS

The results sum up determinants and items relevant to the MIDI-WT, based on the information collected and validated by the procedure described in section 2.3. Table 1 details MIDI-WT determinants and items.

3.1 Recommended determinants and items in the MIDI-WT, adapted to welfare technology

3.1.1 The innovation/ welfare technology category

The seven determinants in the innovation category was successfully presented as suggested in the MIDI manual, by replacing the word ‘innovation’ with the name of the technology, but with no further detailing. A short description of the welfare technology and related material/equipment, written procedures, and information was included in the introduction section of the questionnaire in order to prepare the respondents. In the cross-cultural adaptation of the correctness-determinant (D2), we used the expression ‘knowledge based’ in Norwegian instead of ‘based on factually correct knowledge’. Managers and super users questioned the relevance of D2, and we observed that some care providers who were non-native Norwegian speaking found the expression difficult. Hence, D2 can possibly be omitted.

3.1.2 The adopting user / care provider category

The care providers were grouped as nurses (registered nurse), healthcare workers (nurse assistant) other healthcare professions (e.g. physiotherapist and learning disability nurse) and unskilled (lack of formal education), in the background section of the questionnaire, which also asked for gender, age and number of years of professional experience.

Their anticipated or experienced personal benefits (D8) included how the welfare technology made their work better, more efficient and safer; and how the welfare technology implied more benefits than drawbacks, overall. One personal drawback (D8) was included, regarding how demanding it was to learn how to use the welfare technology. The outcome expectations (D9) were based on how the care services had defined the aims of the specific welfare technology with regards to the patients/residents, modified by the information collected in the interviews. D9 was detailed with a probability and an importance item for each expected outcome, as recommended in the MIDI manual. We found outcome expectations related to enhanced safety for patients/residents, faster detection of their need for assistance, and decreased response time to calls.

We did not adapt the professional obligation determinant (D10) to all tasks related to the welfare technology, but included an overall statement: ‘I feel it is my responsibility as a professional to use the (welfare technology)’.

During the implementations of welfare technology, the care providers cooperated closely with families of residents who had dementia. Hence, ‘families’ were added to all items related to the residents (i.e., D11, D12, D15 and D16).

We found the unit manager, the implementation project manager (if appointed), the care providers (we included nurses and healthcare workers), the super users, the IT service, the vendors, and the patients and families to influence the implementation strategies (i.e. D13 social support and D15 subjective norm, including normative beliefs and motivation to comply items). The influence by municipal politicians, municipal top management, janitor and union representatives was of less importance and could be omitted in the questionnaire.

The self-efficacy determinant (D16) was tailored with items detailing the operation and use of the welfare technology, e.g. being able to operate all the parts, charge the technology, troubleshoot if something does not work, prepare the technology for a patient/resident, and inform and instruct patients/residents/ families. We also included tasks related to the implementation process, such as participating in training and communicating with the different actors responsible for the implementation.

The knowledge determinant (D17) was detailed with items related to the current status of knowledge, background knowledge, and training. We included items regarding practical demonstrations of the welfare technology and acquisition of skills in relation to training.

Determinant	Item specification
Innovation: welfare technology	
D1 Procedural clarity	WT clearly describes all activities and their order
D2 Correctness	WT is based on factually correct knowledge
D3 Completeness	Information and materials provided by WT are complete
D4 Complexity	WT is too complex for me to use
D5 Compatibility	WT is a good match for how I am used to working
D6 Observability	The outcomes of using WT are clearly observable
D7 Relevance for resident	I think WT is relevant for the residents
Adopting user: care provider	
D8 Personal benefit	WT implies more benefits than drawbacks; makes my work performance better; more efficient; more interesting; safer
D8 Personal drawback	WT is too demanding to learn
D9A Outcome expectation	It is important that WT…. (e.g. increases safety for residents; gives faster assistance; increases safety for families)
D9B Outcome expectation	It is probable that WT …. (e.g. increases safety for residents; gives faster assistance; increases safety for families)
D10 Professional obligation	It is my responsibility as a professional to use WT
D11 Resident satisfaction	Residents/families will be satisfied when I use WT
D12 Resident cooperation	Residents/families will cooperate when I use WT
D13 Social support	To use WT, I can get support from the manager, a super user, a nurse, a healthcare worker, the IT service, the vendors
D14 Descriptive norm	The proportion of my colleagues that use WT as intended
D15A Normative beliefs	I'm expected to use WT by the manager, a super user, a nurse, a healthcare worker, the IT service, the vendors, the residents, the families
D15B Motivation to comply	I comply with opinions of the manager, a super user, a nurse, a healthcare worker, the IT service, the vendors, the residents, the families
D16 Self-efficacy	I can teach residents/families to troubleshoot if WT doesn't work; operate each part of WT; provide feed-back to the manager or super user
D17 Knowledge	I know enough to use WT; I had sufficient prior knowledge; I was offered training; I participated in training; I need more training; WT was demonstrated during training; I practice in idle time; I understand instructions by super users, managers, IT-service, vendors; I need to discuss my experiences and reflections
D18 Awareness of content	The extent to which I am familiar with WT
Organization: care unit	
D19 Formal ratification	Use of WT is integrated in plans
D20 Staff turnover	New colleagues are prepared to use WT
D21 Staff capacity	We are enough people to use WT as intended
D22 Financial resources	WT is supported by sufficient financial resources
D23 Time available	I have enough time available to use WT
D24 Material resources	I have enough equipment to use WT
D25 Coordinator	Responsible for WT implementation: Manager/super user, IT service
D26 Unsettled organization	Major changes are ongoing in parallel to WT implementation
D27 WT use information	I can easily find information about WT use
D28 Performances feedback	We get regular feedback about WT implementation
Socio-political context: Norwegian legislation	
D29 Legislation and regulations	WT activities fall within current regulations

Table 1 MIDI determinants and detailing items adapted to welfare technology implementation in municipal care services
Abbreviations: D; determinant, WT; welfare technology.

Further, items were included to specify whether the care providers understood instructions by all actors responsible for training. Finally, we included items about the need for repeated training and for discussions of experiences and ethical reflections.

The awareness of content determinant (D18) was presented with the following alternatives: 1) I'm not familiar with the (technology), 2) I'm familiar with the (technology), but have not explored it, 3) I'm familiar with the (technology) and have some experience with it, and 4) I'm well acquainted with and use the (technology).

3.1.3 The organization / care unit category

The coordinator (D25) determinant was detailed with items for the actors who had specific responsibilities in the implementation, i.e. the care unit manager, the implementation project manager (if appointed), and the IT service. We included 'I don't know' to the response scales of the formal ratification of management (D19), the replacement when staff leaves (D20), the staff capacity (D21), the financial resources (D22), the coordinator (D25) and the unsettled organization (D26) determinants. The recommendations during the interviews indicated that the care providers were not concerned with these issues and that some of the determinants could be omitted.

3.1.4 The socio-political context / Norwegian municipal healthcare service category

We included 'I don't know' to the response scale of the legislation and regulations determinant (D29), in line with recommendations during interviews.

4 DISCUSSION

By contextually adapting the MIDI to welfare technology implementation as proposed in the methods section of this paper, we have found the MIDI-WT useful for evaluating welfare technology implementation in research as well as in clinical practice. The item scores indicate whether the implementation strategies are functioning well or need adjustments [27]. Applying MIDI is an implementation strategy in itself. As suggested by Powell and colleagues, it 'Assesses various aspects of an organization to determine its degree of readiness to implement, barriers that may impede implementation, and strengths that can be used in the implementation effort' [29].

As implementation strategies are applied over time, various determinants come to play in the early, mid- and late stages of welfare technology implementation [18]. Hence, the adaptation of MIDI may very well include a smaller selection of determinants, customized to the strategies or outcomes that one seeks to evaluate [17]. Likewise, for well-known implementations, the process of adapting the MIDI could possibly be less extensive than the procedure for novel technologies and contexts previously described. We would like to urge the importance of including the perspectives of multiple stakeholders, as both the language and expressions used, as well as the detailing items of the determinants tend to be perceived as more relevant and easier to comprehend by the intended respondents by this approach.

MIDI-WT aims to support *successful implementation*. However, defining success in implementation is a complex notion to make. The digital monitoring technology implementation included in this paper was regarded successful because the new service was sustained in all municipalities 1.5 years after the implementation was completed. Even if a number of service- and patient outcomes were realized [24], numerous barriers were encountered and many participants did not perceive the implementation as successful [18]. Whereas the municipalities are motivated by and frequently define service- and patient outcomes prior to the implementation of welfare technology, it will be useful to look further into implementation outcomes in future research. Proctor and colleagues [5] classified the intermediate implementation outcomes as adoption, acceptability, appropriateness, feasibility, penetration, cost, fidelity and sustainability.

4.1 Recommendations for implementation practice

MIDI-WT can be applied to evaluate implementation-, service- and expected patient outcomes, as far as they have been realized, in relation to the following implementation strategies: 1) WT adopted as part of strategic development of care unit. 2) Management plans implementation, defines roles and responsibilities, and allocates resources. 3) Disturbances from other ongoing processes in municipality/unit are avoided. 4) Implementation coordination team established: unit/project manager, super users, IT service and vendors. 5) End users (patients) selected/recruited. 6) Information meetings for care providers and for patients/residents/families prior to implementation. 7) WT tested before integrated in workflow. 8) WT implemented as complete system or stepwise, introducing more parts and functionalities over time. 9) WT manuals available to care providers. 10) Written clinical procedures related to technology use available to care providers. 11) Training sessions, supervision and support offered to care providers by unit/project manager, super users, IT service and vendors. 12) Care providers can operate WT and instruct residents/patients/families. 13) Unit manager is actively involved in implementation and can operate WT. 14) Implementation issues, technological issues and clinical/ethical implications discussed during care providers' meetings on regular basis. 15) New clinical procedures, tasks and/or responsibilities developed/adjusted and integrated in workflow. 16) Service outcomes measured for care providers and care unit, and patient outcomes measured for patients/residents and families.

5 SUMMARY

This paper presents a recommended procedure for the contextual adaptation of the MIDI questionnaire to the implementation of welfare technology, MIDI-WT, including the order of collecting information from useful sources and settings, practical issues regarding planning and documentation of the process and the final adaptation of each MIDI-WT determinant with detailing items.

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Paper 4

Dugstad J, Sundling V, Nilsen ER, Eide H (2019). Facilitators and barriers during implementation of wireless nurse call systems in residential care. A cross-sectional study. (Re-submitted after revision).

TITLE:

Nursing staff's evaluation of facilitators and barriers during implementation of wireless nurse call systems in residential care facilities. A cross-sectional study.

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Abstract

Background: Traditional nurse call systems used in residential care facilities rely on patients to summon assistance for routine or emergency needs. Wireless nurse call systems (WNCS) offer new affordances for persons unable to actively or consciously engage with the system, allowing detection of hazardous situations, prevention and timely treatment, as well as enhanced nurse workflows. This study aimed to explore facilitators and barriers of implementation of WNCSs in residential care facilities.

Methods: The study had a cross-sectional descriptive design. We collected data from care providers (n=98) based on the Measurement Instrument for Determinants of Innovation (MIDI) framework in five Norwegian residential care facilities during the first year of WNCS implementation. The self-reporting MIDI questionnaire was adapted to the contexts. Descriptive statistics were used to explore participant characteristics and MIDI item and determinant scores (D1-29). MIDI items to which ≥20% of participants disagreed/totally disagreed were regarded as barriers and items to which ≥80% of participants agreed/totally agreed were regarded as facilitators for implementation.

Results: More facilitators (n=22) than barriers (n=6) were identified. The greatest facilitators, reported by 98% of the care providers, were the expected outcomes: the importance and probability of achieving prompt call responses and increased safety (D9 expected outcomes), and the normative belief of unit managers (D15 subjective norm). During the implementation process, 87% became familiar with the systems (D18 awareness of content), and 86% and 90%, respectively regarded themselves (D17 knowledge) and their colleagues (D14 descriptive norm) as competent users of the WNCS. The most salient barriers, reported by 37%, were their lack of prior knowledge (D17 knowledge) and that they found the WNCS

difficult to learn (D8 personal drawback). No features of the technology were identified as barriers.

Conclusions: Overall, the care providers gave a positive evaluation of the WNCS implementation. The barriers to implementation were addressed by training and practicing technological skills, facilitated by the influence and support by the manager and the colleagues within the residential care unit. WNCSs offer a range of advanced applications and services, and further research is needed as more WNCS functionalities are implemented into residential care services.

Key words: implementation, nurse call system, health care technology, nursing home, patient safety, care providers, workflow, learning, determinant framework

Background

Traditional nurse call systems (NCSs) used in residential care facilities rely on patients to summon assistance for routine or emergency needs. NCSs are light call-, care communication-, call-, paging- or patient call systems, and may constitute of a variety of features supporting the main nurse call function, which is to support patient safety and facilitate communication between the patient and the nursing staff. NCSs are well accepted health technologies (1), integrated in standards (e.g. the German DIN VDE 0834 standard) and recommendations (e.g. the British Health Technology Memorandum 08-03; the Norwegian State Housing Bank recommendation HB 8.C.8.) to ensure that the healthcare organizations apply statutory requirements. The importance of implementing a multifunctional NCS that addresses the users' needs and supports effective communication between patients, healthcare providers and management, is emphasized (2). Research on NCS

has predominately been hospital-based and has primarily reflected the major driving forces of the technical development, to enhance patient safety through reduced call response time and to eliminate alarm fatigue among healthcare providers (2-5). In the residential care sector, research on alarm fatigue and corresponding patient safety issues has been related to monitoring systems (6-9). As a part of the digital transformation of healthcare services and based on a recommendation from the Norwegian Directorate of Health in 2017, wireless nurse call systems (WNCSs) are currently implemented in Norwegian residential care facilities (RCFs). Monitoring technologies and smart technologies have primarily been implemented as stand-alone solutions, but are now increasingly integrated in WNCSs and this integration represents a novelty in residential care settings. Therefore, there is a need to investigate the implementation of WNCSs in RCFs.

New affordances for residents

Traditional NCSs consist of bedside call buttons or cords, light domes and audible alarms in corridors and at the nurses' stations, pagers or portable phones carried by nursing staff. These systems rely on the patients' capability to assess their own condition and summon assistance from healthcare providers for routine or emergency needs, thereby leaving the patients with some control in the care situation (10-12). However, capabilities as well as needs of older people living in RCFs are increasingly complicated by serious illnesses, dementia and comorbid conditions (13). To remediate this, pervasive and internet-of-things (IOT) technologies in WNCSs model the input from mobile transceivers (wristbands or pendants) and ambient or body-worn sensors by ontologies or statistics, spatiotemporal reasoning and decision-making techniques. The WNCSs allow detection of unattended events and hazardous situations, support prevention and timely treatment, and reduce injury and harm (14-17). Thus, WNCSs offer new affordances, properties and interactions, to patients who are not able to actively or consciously interact with the systems. Compared to fixed appliances within

limited spaces as provided by traditional, wired systems (18), WNCSs also offer increased mobility for all users.

Potential for improved alarm management

Nursing staff is responsible for handling calls (11) and rely on the NCS to coordinate their work (19). The NCSs generate data on the number of calls and response time, which enables the management to monitor the performance (20). Alarm adverse events have been found to involve human, organizational and technical factors (3). The most salient is alarm fatigue, i.e. healthcare providers' increased response time and decreased response rate to alarms (21-23). Thus, clinical alarm systems are rated as one of the most salient health technology hazards, imposing risk to patient safety (24). The increased number of appliances integrated in the WNCSs could potentially add to the number of alarms constantly interrupting the nursing staff's work, and compromise the caring relationship with patients (1, 10, 18, 19, 25). Converged mobile technology addresses these challenges and adds affordances to the nursing staff's utilization of the systems (26). WNCSs integrate middleware technology combined with smart-phones and have been found to successfully filter and bundle clinically significant alarms, resulting in real-time alerts and escalations for urgent alarms while at the same time reducing the number of redundant alarms (27). In addition, safer and more efficient workflows are allowed by algorithms for smart routing of patients' requests between care providers (28).

Implementation of transformative digital health technologies

Full-scale, transformative implementation processes are expected due to the wide-spread use of the WNCSs by nearly all patients and nursing staff within a healthcare facility (29, 30), and due to the range of new functionalities offered by the WNCSs compared to traditional call systems, as detailed above. In two longitudinal case studies, we have explored the

implementation processes of novel, digital monitoring technology in Norwegian RCFs. The implementation processes were complex, time-consuming and represented radical innovation (31), and resistance to technology and implementation strategies emerged as an immediate phenomenon (32). Since these studies were undertaken, the municipal sector had gained experience from pilot-implementations, and a national strategy of WNCS implementation with improved technological systems had been introduced. There was a need to explore how the care providers experienced the implementation of WNCS.

Residential care facilities, long-term care settings and nursing homes are characterized by a large portion of unskilled or semi-skilled staff, authoritative, hierarchical (top-down) communication and represent complex settings (33). This complexity should be accounted for and attended to in order to facilitate successful implementation, and develop new knowledge and practice. Within this complexity, factors that affect implementation processes include the physical environment and infrastructure, availability of time and resources, availability of staff training, availability of support, receptiveness of organizational culture, involvement of all stakeholders, demonstrable benefits of the change and empowering leadership (34-39).

Implementation strategies are “methods or techniques used to enhance the adoption, implementation, and sustainability of a clinical program or practice” (40). A recent study of the relationship between barriers and implementation strategies concluded that detailed evaluations are needed (41). Theoretical determinant frameworks can be applied to explore how human, organizational, technical and other contextual factors or implementation strategies affect the implementation processes (42). In this study, we use the Measurement Instrument for Determinants of Innovations (MIDI) framework (43-45) to evaluate facilitators and barriers of implementation of WNCSs in residential care settings.

To the best of our knowledge, facilitators and barriers related to human, organizational or technical factors, as well as strategies included in full-scale implementation of WNCSs, have not been described in the literature. This paper aims to explore healthcare providers' evaluation of facilitators and barriers during implementation of WNCSs in residential care settings.

Materials and methods

Design and study setting

The study had a cross-sectional design. The sample population of care providers included registered nurses, healthcare workers (a registered healthcare profession in Norway with a certificate of apprenticeship) and other health professions (physiotherapists, learning disability nurses, and nutritionists), in five RCFs in South-Eastern Norway. The RCFs were actively engaged in full-scale implementations of WNCSs when the study was undertaken. All units (n=16) involved in the implementation of WNCS at the time of the study were included. The RCFs offered round-the-clock services, and consisted of units or wards providing a variety of housing options, table 1. The residents were primarily older persons suffering from multi-morbidity and mild to severe cognitive deficiencies. At least one long-term somatic care unit was included for each RCF. Moreover, five secluded units with care services accustomed to the needs of persons with moderate to severe dementia were included.

(table 1 in here)

Data collection

The data collection was based on a questionnaire, and took place between September 2017 and February 2019. It was performed sequentially according to recruitment of RCFs, within their first year of WNCS implementation. We identified and approached the managers of RCFs that recently had procured WNCSs, of whom all consented for the RCF to take part in the study. The care providers were informed about the survey in nursing staff meetings by the researchers in RCF2-5. Care providers of RCF2-5 received written information about the study, the informed consent form, a paper questionnaire, and a return envelope, and were asked to complete the questionnaire. A digital survey was developed on demand by the RCF1 management. The digital survey was provided by and administered via the University of Oslo's research survey platform Nettskjema. We piloted the digital survey through several iterations within a group of approximately 10 laypersons, care providers, and researchers aged 18-70, in order to ensure usability in the smart phone format. After the initial information meeting for the care providers in RCF1, which was conducted by the manager, a text message containing information about the study, a request to fill out the questionnaire, and a link to the web-based survey was sent to the care providers' private mobile phones through the RCF administrative system. Care providers in all RCFs received a friendly reminder after one week.

The Measurement Instrument for Determinants of Innovations (MIDI)

MIDI is a theory- and evidence based questionnaire which is suitable for research, as well as for practical implementations (44). Departing from the diffusion of innovations theory (46), the development of MIDI was informed by a systematic literature review of empirical studies, and refined through Delphi studies as well as eight empirical studies of the implementation of evidence-based innovations (43, 47). MIDI was designed to improve the understanding of how critical determinants affect implementation of innovations within larger healthcare

organizations, allowing a more precise targeting of the innovation strategies applied (47). MIDI captures 29 determinants (D1-29) in four categories to be evaluated by care providers who are adopting the innovation (45). The first category is related to the innovation (D1-7), the second to the adopting user (D8-18), the third to the organization (D19-28), and the fourth category to the socio-political context (D29). With respect to instrument reliability, Kuunders, Jacobs, Goor, Bon-Martens, Oers, and Paulussen (48) have reported good internal consistency, Cronbach's coefficient α score ranged from 0.61 to 0.90 for the MIDI determinants. We found excellent internal consistency, Cronbach's coefficient $\alpha = .90$ (total scale), $\alpha = .76$ (the innovation scale), $\alpha = .84$ (the adopting user scale) and $\alpha = .84$ (organization scale; including items with Likert response scale only).

Adoption of MIDI to the wireless nurse call system implementations

The questionnaire consisted of an initial section for participants' background information, such as gender, age, profession and years of work experience, followed by MIDI adopted to the WNCS implementations (44). In order to adopt the questionnaire to the implementation processes in the RCF contexts, information about the systems, the new routines and responsibilities related to the systems, as well as the implementation strategies applied, was collected in accordance with a procedure recommended by Dugstad, Sundling, Nilsen and Eide (49). For each of the implementations, information was collected in meetings with a representative from the municipal healthcare top management, the RCF unit management team, the municipal IT support service, and the vendors. We co-created an adapted questionnaire with as WNCS super user. Finally, the questionnaire was quality-assured item-by-item in meetings with the respective RCF managements. An overview of the determinants, number of items and response scales are presented in table 2 and the items are further detailed in additional file 1. Each item of the MIDI questionnaire is scored on a scale from 1 to 3, 1 to 4, 1 to 5 or 1 to 7, table 2, according to the MIDI manual (45). The manual suggested

dichotomous scales (yes/no) for D18, D25 and D26. However, we also included a third response option “I don’t know” based on advice provided in the preparatory meetings with the RCFs.

(table 2 in here)

Statistical analysis

The Statistical Package for Social Sciences 21.0 was used for data analysis. In line with Verberne, Kars, Schepers, Schouten-van Meeteren, Grootenhuis, and van Delden (50), we defined MIDI items to which ≥20% of participants responded ‘totally disagree/disagree’ as barriers and items to which ≥80% of participants responded ‘agree/totally agree’ as facilitators for implementing the WNCS. Descriptive statistics (mean, standard deviation, median, range and percentage) were applied to the participant characteristics and MIDI scores. As the MIDI scale is not ordinal, the Kruskal Wallis test was used to explore differences between groups, with p-value ≤ .05 considered statistically significant. The internal consistency of the MIDI questionnaire, was assessed by Cronbach’s coefficient α (51).

Research ethics

The research was done in line with the Helsinki Declaration (52). The Norwegian Data Service for Social Sciences approved the project according to the Personal Data Act (record number 918960). The participants received information about the study both orally and in writing, and provided informed consent in writing or by responding to the digital questionnaire.

Results

The wireless nurse call system implementations

The WNCSs were based on digital platform solutions with a multitude of integrated technological applications and features, table 3. The implementation of the WNCSs had a stepwise approach in all RCFs, starting with basic alarm and monitoring functions compatible with existing workflows. New features would be included after the initial phase of implementation. The transition to the novel WNCSs relied on investments, approved and coordinated on higher organizational levels. The municipal administrations governed both the healthcare service organizations responsible for the RCFs and the information technology (IT) service organizations responsible for the support of the WNCSs. Further, they were in charge of the procurement of the WNCSs and the long-term service and support agreements with the vendors. Implementation coordination teams headed by the RCF managers were in charge of the implementations. All the municipalities included a digital transformation facilitator in their coordination team. The RCF management, including the unit managers, were responsible for the implementation strategies on a daily basis, table 4.

The management of RCF1 approached the WNCS implementation as a regular update of the previous NCS, and did not appoint WNCS super users or offer any training to the care providers. In contrast, the other RCF managements approached the WNCS implementations as digital transformative processes, and adopted implementation strategies to provide training, supervision and support to the care providers. The WNCS super users received extensive training and supported their colleagues in the use of the WNCS.

(table 3 in here)

(table 4 in here)

Participant characteristics

In total, responses from 98 care providers were analysed in the study, table 5. The total response rate was 28.3%, lowest (10.5%) for the digital survey and ranging from 44.2% to 52.2% for the paper-based survey.

(table 5 in here)

The care providers' average age was 43.1 years (range 21-69; n= 95). The mean duration of professional work experience was 16.6 years (range 0-50; n=94) and the mean duration at current job was 8.0 years (rage 0-32; n=95). There were no differences in the professional groups between the RCFs. However, there were statistically significant demographic differences between the professional groups, table 6.

(table 6 in here)

MIDI scores, facilitators and barriers

Overall, the care providers gave a positive evaluation of the NCS implementation; MIDI scores of all the 85 questionnaire items were either neutral or positive to the innovation. The care providers identified a number of facilitators and barriers that will be presented in the

following. We report the proportion (%) of the care providers who have responded 'agree/totally agree' regarding facilitators or 'totally disagree/disagree' regarding barriers, for each determinant or item. Determinants and items not identified as facilitators or barriers are detailed in additional file 1.

Facilitators

The item to which ≥80% of responding care providers responded 'agree/totally agree' or corresponding values in the most positive end of the response scale, are presented as facilitators in table 7. The facilitators with the highest scores, to which 98% of all the care providers (n=98) definitely or most definitely agreed, were the normative belief of the manager (D15A) and that the wireless NCS probably increased the safety for residents, and probably increased the feeling of safety for families (D9). Further, 95% expected that the call system probably would provide faster assistance to the residents (D9), and 98% of the care providers found it important that the wireless NCS increased the safety for residents, provided faster assistance to residents, and increased the feeling of safety for families.

In addition to the strong facilitating effect of the normative belief of the manager, the normative believes of care provider colleagues were also identified as facilitators (D15A). Furthermore, the care providers were most motivated to comply with the opinions of managers (92%), nurses (91%) and healthcare workers (92%) (D15B). In all, 90% of the care providers reported that almost all colleagues used the NCS as intended (D14). Moreover, the social support from the manager and nurse colleagues were described as facilitators by 80% of the care providers (D13).

The self-efficacy determinant (D16) encompassed several strong facilitating items. Three were related to the smart phone carried by all care providers during their watch. The majority of the care providers were confident that they could receive (96%) and manage (91%) alarms

using the smart phone, and use the emergency call application in order to alert a colleague (90%). Eighty-two percent felt confident that they could provide feedback regarding the call system to their manager or a super user. In all, 86% of the care providers knew enough to use the call system (D17) and 86% was aware of the content of the wireless NCS (D18). The majority of the care providers (84%) found the use of wireless NCS to be within their responsibility as a professional (D10).

The relative low score regarding the need for training and supervision on a regular basis indicated that the care providers had integrated the systems into their workflows, and was identified as a proximarker for facilitation of the implementation (D17h, table 8).

(Table 7 in here)

(Table 8 in here)

Barriers

Determinants and items to which ≥20% of responding care providers responded 'totally disagree/disagree' were identified as barriers and are presented in table 8. The two greatest barriers were the care providers' insufficient prior knowledge at the start of implementation (D17) and the difficulty to learn the wireless NCS (D8), reported by 37% of all the care providers. On the other hand 37% found their prior knowledge sufficient (D17), and 44% of the care providers did not find it demanding to learn the wireless NCS (D8). Twenty percent did not find their work to improve with the NCS (D8), which also constitute a barrier.

Regarding self-efficacy (D16), 22% could not operate the NCS software on a PC. The care providers were expected to instruct residents to use a mobile transceiver and 70% of the care

providers had been provided with demonstrations of the mobile transceiver during training, nevertheless 22% had not (D16). Moreover, 21% did not perceived that they had been supplied with sufficient material resources (D24).

Overall comments

To sum up the results, a thorough mapping of the WNCS components and features, as well as the implementation strategies, allowed us to adapt the MIDI questionnaire to the WNCS implementations. The care providers' responses identified 22 facilitators related to nine determinants, and six barriers related to five determinants. All the facilitators and most of the barriers were related to the adopting user, and one barrier was related to organization. No features of the wireless NCS were identified as barriers, nor was the complexity of use.

Discussion

This is the first study to explore facilitators and barriers during the full-scale implementation of WNCSs in residential care facilities using the MIDI questionnaire. The care providers' evaluation of the implementation identified far more facilitators than barriers. The most pronounced facilitators were identified by virtually all the care providers. The first were the expected outcomes of the WNCSs, the importance and probability of achieving shorter response time to calls and increased safety for residents and families. The second was the subjective norm, the perceived behavioural expectations, imposed on the care providers by the manager. The two greatest barriers were the care providers' status of knowledge at the start of implementation and the difficulty to learn the WNCS. Overall, the item scores indicated that the WNCSs were well received and that the implementation strategies and processes were satisfactory. This was supported by the facilitating effects of the care providers having gained some experience with the systems, that they considered the WNCSs to be in line with their

professional responsibilities, and that almost all of their colleagues used the systems as intended.

Safety first

The expected and perceived facilitating effects of the WNCS outcomes related to enhanced safety, were in line with previous implementations of less advanced call systems in residential care (53). Importantly, the WNCSs were perceived as safe, not just expected to be safe. This indicated that the ethical implications of the WNCS' design and functions corresponded well with moral values of the care providers, as found by Detweiler and Hindriks (14) and Ienca, Wangmo, Jotterand, Kressig, and Elger (54). Strong leadership combined with shared mental models among nursing staff have previously been found to be associated with prompt response to calls in hospital settings (4, 55), as well as in a geriatric evaluation facility (56). Cappelen, Harris, Storm and Aase (57) found engaged nursing managers to be role models for promoting improvements to patient safety in Norwegian nursing homes. The role taken by unit managers in combination with the safety propositions of the WNCSs found in our study, indicates that patient safety probably will be safeguarded through the use of the new system.

Motivating managers

The managers' level of engagement and active involvement in the implementation of WNCSs appears to be higher in this study than in previous studies of health information technology implementation in residential care facilities, which reported a lack of involvement as well as lack of systematic planning and decision-making from managers (29, 31, 32, 35). The care providers' evaluation of the managers' efforts supported the effect of an implementation strategy adopted by all care facilities; that the unit managers had learned to use the WNCS and taken an essential role for driving the implementation (58). The importance of the role as implementation champions is also supported by Shea and Belden (59) who found the

champions to impact the implementation process, the usage behaviour and the overall success of the specific technology. Moreover, a transformational leadership style, formulating a vision for the future and building nursing staff capacities, have been found to result in higher levels of success in implementing change initiatives in residential care facilities (60). However, the determinants and moderators of middle managers' role have not been explained (39). Our study did not aim to investigate managers' motivation, but the choice of implementation strategies as well as the results of the survey indicate that the managers were motivated. However, it is not conclusive as to whether the full-scale scope of the implementation involving all residents and nursing staff, a general increased interest in digital transformation, or perceived regulatory requirements as reported by Bezboruah, Paulson, and Smith (29), motivated the managers to be a driving force in the implementation process.

Rapid competence building

The two most prominent barriers occurred at the outset of the implementation and were related to competence. This was not surprising, as there are discrepancies between care providers' health technology proficiency as compared to the expectancies of the Norwegian government (61). Competence was evaluated with respect to knowledge, skills, learning strategies and implementation strategies. Even though the WNCSs were perceived as difficult to learn and the prior level of knowledge was somewhat low, the care providers rated themselves and their colleagues as competent users of the WNCS within the first year of implementation. The ability to acquire and maintain clinical competency is the result of both personal factors as well as contributing factors in the work environment (62). Within the window of time from the outset of the implementation until the survey was undertaken, the care providers had gained experience from using the WNCS devices. Most of them had acquired skills and increased their knowledge about the WNCSs through structured training-sessions, which is a recommended implementation strategy (35, 53, 63). They could easily

understand instructions given by their manager and communicate about the WNCS and the implementation. Once training had been provided, there seemed to be less need for further instructions than previously reported from similar settings (29, 31). Bearing in mind that a cross-sectional study can not establish causality (64), implementation strategies involving training and support most likely contributed to these outcomes and the rapid change in competence. Learning during implementations in residential care have been found to be a process of making connections between new knowledge and skills, and existing knowledge and practices (37). In our study, the care providers' smart phone application skills in fact facilitated the implementation. This was partly due to the learning strategies they applied, such as self-training and gaining experience from using the system over time. Personal knowledge and skills from using smart phones in their private lives probably further contributed to the rapid and successful uptake of smart phones and applications (65), since 95% of the Norwegian population (aged 9-79) have access to a smart phone (66).

Full-scale implementation with tiny innovative steps

Although the mobile transceivers worn by the residents and the smartphones operated by the care providers represented new technology in the residential care settings, the tasks and routines implied by the WNCSs were much in line with the workflows known from previous call systems. The strategic decision initially to implement well-known call system functionalities in full-scale and await the more complex functionalities was likely significant for the facilitating effects of the expected outcomes, ethical implications and competence building. Knowledge of and adherence to routines is fundamental to maintain patient safety (67), and the WNCSs were perceived not only to maintain, but to enhance patient safety. Such a connection between actions and outcomes has been found to further stimulate the learning process (37). Thus, the organizational readiness seemed aligned with the challenges imposed during the implementation along the four dimensions proposed by Holt, Helfrich (68):

appropriateness, managerial support, self-efficacy and personal valence. In our study, the WNCS was perceived as appropriate for the RCF by the care providers; they found the managers to be supportive; they became confident about their self-efficacy; and, they found the WNCS personally beneficial. In contrast, technology implementations that simultaneously challenge care providers' knowledge, values and workflows have been found to rely on resource intensive service innovations, compromising patient safety and predicting time consuming competence building and implementation processes (30, 31). According to Bezboruah, Paulson, and Smith (29) most nursing homes do not realize the full potential benefits that implemented health IT systems offer. It remains unknown if the RCFs will utilize all the WNCS features procured.

Implications for practice

This study has presented implementation strategies and WNCS functionalities, which seem to contribute to successful implementation, although not without complications. The importance of motivating managers was underscored, as was the impact of managers as role models with the ability to prepare the care unit for the implementation. The barriers identified in this study stress the urgency of providing equipment and material resources in due time, and offer training in the practical handling of the technology at the outset of the implementation. Nearly two out of five participants found it difficult to understand instructions provided by the vendors, which calls for specific attention to communication and information exchange between professions and groups involved in innovative implementations. This is in line with previous reports of differences in language and culture between technologists and care providers (32).

Further research

For alarms to be effective, they must be part of a much more comprehensive care plan for each resident (9). Some of the new digital functionalities offered by the WNCSs potentially expand and enrich the quality of care by allowing the care provider to remain focused on the residents, but may also have negative implications (1, 32, 69). The more complex technologies that presumably disrupt established workflows and challenge existing patterns of interdependence among individuals or groups, will be more demanding to implement (70) and potentially pose new threats to patient safety. The ECRI institute (71) recently introduced missed alarms resulting from inappropriately configured secondary notification devices and systems on their Top 10 Health Technology Hazards, and further research on patient safety issues is needed as more of the novel WNCS-functionalities are introduced into clinical practice.

The care providers' perceptions of the technology enhancing safety is likely to contribute to the residents' feeling of increased safety (72). This study did not include residents, and research on residents and families' perspectives related to WNCSs should be undertaken.

Strengths and limitations

This study contributes to the knowledge of full-scale implementation of wireless nurse call systems. The research is however limited to the first phase of the full-scale implementation, as the RCFs implemented WNCS-functionalities that primarily supported established workflows and planned to implement new and more advanced functionalities over time.

The questionnaire applied took the perspective of the care provider, meaning that the perspectives of the administration and management, the support agencies, the vendors, as well as residents and families are not reported.

A large proportion (19.4%) of the respondents were WNCS super users, who had received more extensive training, which represents a bias.

The response rate to the questionnaire was low, which may have given a bias of the measures of outcome. Hence, we have not made comparisons between professional groups or the RCFs regarding the MIDI scores, but have reported from the entire group of participants. We do not know whether the characteristics of non-responders would differ from responders.

The current study was conducted within the first year of WNCS implementation. We were not able to investigate whether the time from the outset of implementation to the administration of the survey (e.g. 0-3 months, 4-6 months, 7-9 months, or 10-12 months) affected the results. Further, we were not able to contrast how the two conceptualisations of WNCS implementation, as an upgrade or as digital transformative processes, affected the implementations.

Conclusions

The care providers gave an overall positive evaluation of the WNCS implementation. The expectations that the WNCS would lead to shorter response time and increased safety strongly facilitated the implementation, as did the firm influence and support by the manager and healthcare professionals within the residential care unit. Implementation barriers related to low levels of prior knowledge and perceived complexity inhibited adoption. The barriers seemed to be addressed by training and practicing technological skills. Further research is needed as more advanced WNCS functionalities are integrated into the residential care service. The MIDI questionnaire could be used for this purpose, with the inclusion of items adapted to the more advanced WNCS functionalities.

List of abbreviations

A/TA = agree/totally agree; D = determinant; IT = information technology; IoT = internet of things; MIDI = Measurement Instrument for Determinants of Innovations; NCS = nurse call system; RCF = residential care facility; TD/D = totally disagree/disagree; WNCS = wireless nurse call system

Declarations

Ethics approval and consent to participate

The project has been approved by the Norwegian Data Service for Social Sciences according to the Personal Data Act (approval no. 918960). Ethical approval in line with the Health Research Act was not applicable. The participants signed informed consent.

Consent for publication

Not applicable.

Availability of data and material

The dataset used during the current study is available from the corresponding author (JD) on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

All authors made significant contributions to the manuscript. The study was conceived by JD and HE. JD collected the data. JD, VS, ERN and HE contributed to the analysis. The manuscript was drafted by JD, and commented by VS, ERN and HE. All authors read and approved of the final manuscript.

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Tables

Table 1. Characteristics of the residential care facilities

	RCF1	RCF2	RCF3	RCF4	RCF5
RCF location	Rural	Suburban	Suburban	Suburban	Urban
Somatic unit profiles	Short-term rehabilitation unit; acute care unit; nursing home units; long-term sheltered housing units	Long-term sheltered housing units	Nursing home units	Nursing home units; long-term sheltered housing unit*	Nursing home unit
Units included	8	2	2	1	3
Somatic units	5	2	2	1	1
Secluded dementia units	3	0	0	0	2
Residents	136	46	50	26	39
Healthcare professionals^	190	49	50	23	34

Abbreviations: RCF; residential care facility. *Only the long-term somatic sheltered housing unit with round-the-clock services was included in the study. ^The number of employees eligible to participate in the survey (nurses, healthcare workers or other healthcare professions).

738 **Table 2. Overview of MIDI determinants, number of items, and response scales**

Determinant	No of items	Scale
Innovation: wireless nurse call system		
D1 Procedural clarity ^	1	1-5
D2 Correctness ^	1	1-5
D3 Completeness ^	1	1-5
D4 Complexity *	1	5-1
D5 Compatibility ^	1	1-5
D6 Observability ^	1	1-5
D7 Relevance for resident ^	1	1-5
Adopting user: care provider		
D8 Personal benefit ^	7	1-5
D8 Personal drawback *	1	5-1
D9 Outcome expectation, importance ^	3	1-5
D9 Outcome expectation, probability ~	3	1-5
D10 Professional obligation ^	1	1-5
D11 Resident/family satisfaction ^	2	1-5
D12 Resident/family cooperation ^	2	1-5
D13 Social support ^	8	1-5
D14 Descriptive norm **	1	1-7
D15a Normative beliefs ~	10	1-5
D15b Motivation to comply #	10	1-5
D16 Self-efficacy ~	10	1-5
D17 Knowledge ^	12	1-5
D18 Awareness of content ¤	1	1-4
Organization: residential care facility unit		
D19 Formal ratification ¨	1	1-3
D20 Staff turnover ^	1	1-5
D21 Staff capacity ^	1	1-5
D22 Financial resources ^	1	1-5
D23 Time available ^	1	1-5
D24 Material resources ^	1	1-5
D25 Coordinator ¨	2	1-3
D26 Unsettled organization ¨	1	1-3
D27 Information available ^	1	1-5
D28 Performances feedback ^	1	1-5
Socio-political context: Norwegian legislation		
D29 Legislation and regulations ^	1	1-5

739 Abbreviations: MIDI; Measurement Instrument for Determinants of Innovation. D; determinant. Response scales: ^ 1; totally disagree, 2;
740 disagree, 3; neither agree nor disagree, 4; agree, 5; totally agree. * 1; totally agree, 2; agree, 3; neither agree nor disagree, 4; disagree, 5;
741 totally disagree. ~ 1; most definitely not, 2; definitely not, 3; perhaps, perhaps not, 4; definitely, 5; most definitely. ** 1; not a single
742 colleague, 2; almost no colleagues, 3; a minority, 4; half, 5; a majority, 6; almost all colleagues, 7; all colleagues. # 1; very little, 2; little, 3;
743 not a little, not a lot, 4; a lot, 5; a great deal. ¤ 1; I'm not familiar with the wireless NCS, 2; I'm familiar with the wireless NCS, but have not
744 explored it, 3; I'm familiar with the wireless NCS and have some experience with it, 4; I'm well acquainted with and use the wireless NCS.
745 ¨ 1; no, 2; yes, 3; I don't know.

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751 **Table 3. Characteristics of the wireless nurse call systems**

		RCF				
NCS device/application	**Features**	**1**	**2**	**3**	**4**	**5**
Mobile transceiver for resident	Wrist band or pendant	x	x	x	x	x
	Call function	x	x	x	x	x
	Fall detection (wearable based)					
	Indoor localization			x	*	x
	Outdoor tracking (e.g. GPS)	*		x	*	x
	Speech interface			x	x	x
	Programmed to unlock/open/lock doors	x				
Alarm button (bedside/bathroom)	Optional for residents with dementia	x			x	
Ambient sensors for resident monitoring	Bed-exit sensors	x	x	x	x	x
	Door sensors (indoor)	x			x	
	Front-door sensors	x		x	x	x
	Fall detection (ambient or vision based)					
	PIR based motion detection	x	x	x	x	x
Smartphone for care providers	Receive and mange calls/alerts from residents	x	x	x	x	x
	Receive and mange alerts from ambient sensors	x	x	x	x	x
	Call on /talk to colleagues	x	x	x	x	x
	Emergency call function		x	x	x	x
	Task assignment and prioritizing	x	x	x	x	x
Wall mounted modules for care providers in corridors/common rooms	Alarm button	x	x	x		x
	Means to sign out alarms	x				
	Speech interface		x	x		x
	Emergency call function	x				
Wireless nurse call system solution	Adjustable, individual settings for residents	x	x	x	x	x
	Managerial reports of system access by whom and when, number of alarms, response times, missed alarms	x	x	x	x	x
	Smart network access points	x	x	x	x	x
	Alarm back-up system if wifi fails	x		x		x
	Battery back-up if power outage	x	x	x	x	x
	Integrated with fire alarm system	x		x	x	x

752 Abbreviations: NCS; Nurse call system, RCF; Residential care facility, GPS; global positioning system, PIR; Passive infra-red.
753 X= Implemented. *Functionality is offered by the system and will be integrated into the care service at a later stage.

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765 **Table 4. Implementation strategies related to wireless NCS**

	Implementation strategy	Responsible actor/agency
1	Wireless NCS adopted as part of strategic development of the RCF/unit	Municipal top management
2	Wireless NCS purchased according to procedures for public procurement, including negotiation of long-term service and support agreements with vendors	Municipal top management
3	Risk and safety assessments undertaken of wireless NCS in relation to existing building structure, infrastructure and care services, in order to prepare the implementation	Municipal top management IT support service RCF management
4	Implementation planned, roles and responsibilities defined, and resources allocated	
5	Implementation coordination team established: unit manager, NCS super users, IT service, digital transformation facilitator and vendors	
6	Information meetings for care providers and for residents/families	RCF management
7	Wireless NCS installed and tested before integrated in care workflows and routines	Coordination team
8	Unit manager actively involved in the implementation and can operate NCS devices and applications	Unit manager
9	Wireless NCS manuals and written clinical procedures made available to care providers	Coordination team
10*	Training sessions offered to care providers, focusing on practical handling of NCS devices and applications	Coordination team
11*	Supervision and support offered to care providers	Coordination team
12	Care providers integrated NCS devices and applications in care workflows and routines	Coordination team and care providers
13	Care providers instructed residents/families about NCS devices	Care providers
14	Implementation updates, technological-, clinical- and ethical issues discussed in coordination team meetings	Coordination team
15	Implementation updates, technological-, clinical- and ethical issues discussed in nursing staff meetings	Coordination team and care providers

766 Abbreviations: NCS; nurse call system, RCF; residential care facility. * Implementation strategies not adopted by RCF1

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Table 5. The response rates and participants' professional background by RCF, n(%)

Professional groups	Total	RCF1	RCF2	RCF3	RCF4	RCF5
Response rate (n,%)	98 (28.3)	20 (10.5)	25 (51.0)	26 (52.0)	12 (52.2)	15 (44.2)
Healthcare workers	61 (62.2)	16 (80.0)	16 (64.0)	15 (57.6)	4 (33.3)	10 (66.7)
Nurses	26 (26.5)	3 (5.0)	5 (20.0)	9 (34.6)	6 (50.0)	3 (20.0)
Other health professions	11 (11.2)	1 (0.5)	4 (16.0)	2 (7.6)	2 (16.7)	2 (13,3)
Super users*	19 (19.4)	0 (0.0)	4 (16.0)	8 (30.8)	2 (16.7)	5 (0.33)

Abbreviations: RCF; residential care facility. *The super users were nurses (n=7), healthcare workers (n=10) and other healthcare professions (n=2).

Table 6. Participants' gender, age and years of experience by profession, n(%)

Professional groups	Female (n=83)	Male (n=14)	Mean age (yr; range) *	Mean duration of professional experience (yr; range) **	Mean duration at current job (yr; range) ***
Healthcare workers	51 (61.4)	10 (71.4)	46.1 (21-69)^	18.7 (0-50)^	10 (0-32) ^
Nurses	22 (26.5)	3 (21.4)	38.4 (22-66)~	14.6 (0.5-40)~	5.5 (0.5-29)
Other health professions	10 (12.0)	1 (7.1)	37.6 (22-54)	10.3 (2.5-30)	3.5 (0.5-9)

Statistically significant difference between professional groups, Kruskal Wallis test *p=.011, **p=.042 and ***p=.028.
Missing data for ^ 3 participants for duration of professional experience and mean duration of current job and ~ 1 participant for duration of professional experience

Table 7. Facilitators for WNCS implementation

Determinant/*item*	Mean	SD	Median	Range	N	TD/D (%)	A/TA (%)
D9 Outcome expectation							
a) It is important that NCS increases safety for residents^	3.78	(0.47)	4	(2-4)	98	0	98
b) It is probable that NCS increases safety for residents~	4.63	(0.61)	5	(1-5)	98	1	98
c) It is important that NCS gives faster assistance to residents^	3.76	(0.45)	4	(2-4)	97	0	98
d) It is probable that NCS gives faster assistance to residents~	4.54	(0.74)	5	(1-5)	98	3	95
e) It is important that NCS increases safety for families^	3.67	(0.51)	4	(2-4)	98	0	98
f) It is probable that NCS increases safety for families~	4.56	(0.54)	5	(3-5)	98	0	98
D10 Professional obligation^	4.02	(0.91)	4	(1-5)	98	7	84
D13 Social support							
a) To use NCS, I can get support from the manager^	4.23	(0.97)	4.5	(1-5)	96	6	80
d) To use NCS, I can get support from a nurse^	4.18	(0.81)	4	(1-5)	95	2	80
D14 Descriptive norm**	5.99	(1.05)	6	(3-7)	96	5	90
D15A Normative beliefs							
a) The manager expects me to use NCS~	4.76	(0.48)	5	(3-5)	98	0	98
d) A nurse colleague expects me to use NCS~	4.55	(0.66)	5	(2-5)	97	1	92
e) A healthcare worker colleague expects me to use NCS~	4.48	(0.65)	5	(2-5)	97	1	93
D15B Motivation to comply							
a) I comply with opinions of the manager#	4.52	(0.68)	5	(2-5)	96	2	92
d) I comply with opinions of a nurse colleague#	4.42	(0.59)	4	(3-5)	95	0	91
e) I comply with opinions of a healthcare worker colleague#	4.40	(0.57)	4	(3-5)	94	0	92
D16 Self-efficacy							
d) I can receive an alarm on the smart phone~	4.56	(0.58)	5	(3-5)	98	0	96
e) I can manage an alarm on the smart phone~	4.49	(0.69)	5	(2-5)	97	1	90
f) I can use the emergency call application to alert a colleague~	4.46	(0.79)	5	(1-5)	98	3	91
h) I can provide feed-back to the manager or super user~	4.31	(0.87)	5	(1-5)	97	3	82
D17 Knowledge							
a) I know enough to use NCS^	4.18	(0.77)	4	(1-5)	97	3	86
D18 Awareness of content of the NCS¤	3.25	(0.75)	3	(1-4)	97	12	86

Abbreviations: NCS; nurse call system, TD/D; totally disagree/disagree, A/TA; agree/totally agree. A/TA value ≥80% indicates that the determinant or item is a facilitator for the implementation. The percentage values are rounded to the nearest whole number. Response scales: ^1; totally disagree, 2; disagree, 3; neither agree nor disagree, 4; agree, 5; totally agree. ~ 1; most definitely not, 2; definitely not, 3; perhaps, perhaps not, 4; definitely, 5; most definitely. ** 1; not a single colleague, 2; almost no colleagues, 3; a minority, 4; half, 5; a majority, 6; almost all colleagues, 7; all colleagues. # 1; very little, 2; little, 3; not a little, not a lot, 4; a lot, 5; a great deal. ¤ 1; I'm not familiar with the wireless NCS, 2; I'm familiar with the wireless NCS, but have not explored it, 3; I'm familiar with the wireless NCS and have some experience with it, 4; I'm well acquainted with and use the wireless NCS.

Table 8. Barriers to WNCS implementation

Determinant / *item*	Mean	SD	Median	Range	N	TD/D (%)	A/TA (%)
D8 Personal benefits							
*a) NCS makes my work performance better^*	3.45	(1.11)	4	(1-5)	98	20	55
D8 Personal drawbacks*							
NCS is too demanding to learn[1]	2.86	(1.13)	3	(5-1)	98	44	37
D16 Self-efficacy							
g) I can operate the NCS software on the PC~	3.19	(1.40)	3	(1-5)	75	22	38
D17 Knowledge							
*b) I had sufficient prior knowledge when NCS was introduced^*	3.04	(1.20)	3	(1-5)	98	37	37
*e) The mobile transceiver was demonstrated during training^*	3.81	(1.36)	4	(1-5)	98	23	70
*h) I need more training and supervision about NCS^*	3.24	(1.14)	3	(1-5)	98	26	48
D24 Material resources and facilities^	3.67	(1.00)	4	(1-5)	97	21	65

Abbreviations: NCS; nurse call system, TD/D; totally disagree/disagree, A/TA; agree/totally agree. TD/D value ≥20% indicates that the determinant or item is a barrier to the implementation. The percentage values are rounded to the nearest whole number. [1] In the personal drawback item, the barrier is expressed in the A/TA column. Response scales: ^ 1; totally disagree, 2; disagree, 3; neither agree nor disagree, 4; agree, 5; totally agree. * 1; totally agree, 2; agree, 3; neither agree nor disagree, 4; disagree, 5; totally disagree. ~ 1; most definitely not, 2; definitely not, 3; perhaps, perhaps not, 4; definitely, 5; most definitely.

Additional file 1. MIDI determinants, including adopted items and participants' response scores

Determinant	Item specification	Mean	SD	Median	Range	n	Totally disagree/ Disagree, or No (%)	Agree/ Totally agree, or Yes (%)
Innovation: wireless nurse call system								
D1 Procedural clarity [1]	NCS clearly describes all activities and their order	3.81	(0.89)	4	(1-5)	96	9	73
D2 Correctness [1]	NCS is based on factually correct knowledge	3.58	(0.98)	4	(1-5)	95	10	55
D3 Completeness [1]	information and materials provided by NCS are complete	3.56	(0.88)	4	(2-5)	97	13	57
D4 Complexity [2]	NCS is too complex for me to use	3.91	(0.96)	4	(5-1)	97	77	8
D5 Compatibility [1]	NCS is a good match for how I am used to working	3.78	(0.93)	4	(1-5)	98	7	69
D6 Observability [1]	The outcomes of using NCS are clearly observable	3.70	(0.83)	4	(2-5)	98	5	61
D7 Relevance for resident [1]	I think NCS is relevant for the residents	3.94	(0.81)	4	(2-5)	97	5	77
Adopting user: care provider								
D8 Personal benefit [1]	a) NCS makes my work performance better	3.45	(1.11)	4	(1-5)	98	20	55
D8 Personal benefit [1]	b) NCS makes my work more efficient	3.45	(0.98)	4	(1-5)	98	17	51
D8 Personal benefit [1]	c) NCS makes my work more interesting	3.15	(0.93)	3	(1-5)	98	17	29
D8 Personal benefit [1]	d) NCS makes my work safer	3.62	(1.01)	4	(1-5)	98	16	75
D8 Personal benefit [1]	e) NCS makes me better prepared for other technologies	3.62	(0.93)	4	(1-5)	97	8	62
D8 Personal benefit [1]	f) NCS implies more benefits than drawbacks to me	3.79	(0.89)	4	(1-5)	98	8	73
D8 Personal drawback [2]	NCS is too demanding to learn	2.86	(1.13)	3	(5-1)	98	44	37
D9 Outcome expectation [1]	a) It is important that NCS increases safety for residents	3.78	(0.47)	4	(2-4)	98	0	98
D9 Outcome expectation [3]	b) It is probable that NCS increases safety for residents	4.63	(0.61)	5	(1-5)	98	1	98
D9 Outcome expectation [1]	c) It is important that NCS gives faster assistance to residents	3.76	(0.45)	4	(2-4)	97	0	98
D9 Outcome expectation [3]	d) It is probable that NCS gives faster assistance to residents	4.54	(0.74)	5	(1-5)	98	3	95
D9 Outcome expectation [1]	e) It is important that NCS increases safety for families	3.67	(0.51)	4	(2-4)	98	0	98
D9 Outcome expectation [3]	f) It is probable that NCS increases safety for families	4.56	(0.54)	5	(3-5)	98	0	98
D10 Professional obligation [1]	It is my responsibility as a professional to use NCS	4.02	(0.91)	4	(1-5)	98	7	84
D11 Resident satisfaction [1]	a) Residents will be satisfied when I use NCS	3.99	(0.78)	4	(2-5)	95	3	74
D11 Family satisfaction [1]	b) Families will be satisfied when I use NCS	3.94	(0.72)	4	(3-5)	93	0	71
D12 Resident cooperation [1]	a) Residents will cooperate when I use NCS	3.73	(0.78)	4	(1-5)	98	3	59
D12 Family cooperation [1]	b) Families will cooperate when I use NCS	3.84	(0.72)	4	(3-5)	96	0	64
D13 Social support [1]	a) To use NCS, I can get support from the manager	4.23	(0.97)	4.5	(1-5)	96	6	80
D13 Social support [1,13]	b) To use NCS, I can get support from a super user	4.62	(0.69)	5	(2-5)	76	1	70
D13 Social support [1]	c) To use NCS, I can get support from a union representative	3.76	(1.17)	4	(1-5)	89	9	53
D13 Social support [1]	d) To use NCS, I can get support from a nurse	4.18	(0.81)	4	(1-5)	95	2	80

D13 Social support [1]	e) To use NCS, I can get support from a healthcare worker	4.14	(0.74)	4	(3-5)	92	0	75
D13 Social support [1]	f) To use NCS, I can get support from the IT service	3.52	(1.08)	3	(1-5)	89	11	28
D13 Social support [1]	g) To use NCS, I can get support from the janitor	3.04	(1.20)	3	(1-5)	90	26	29
D13 Social support [1]	h) To use NCS, I can get support from the vendors	3.83	(1.03)	4	(1-5)	90	6	56
D14 Descriptive norm [4]	The proportion of my colleagues that use NCS as intended	5.99	(1.05)	6	(3-7)	96	5	90
D15A Normative beliefs [3]	a) The manager expects me to use NCS	4.76	(0.48)	5	(3-5)	98	0	98
D15A Normative beliefs [3,13]	b) A super user expects me to use NCS	4.81	(0.43)	5	(3-5)	75	0	76
D15A Normative beliefs [3]	c) A union representative expects me to use NCS	4.40	(0.89)	5	(1-5)	92	3	78
D15A Normative beliefs [3]	d) A nurse colleague expects me to use NCS	4.55	(0.66)	5	(2-5)	97	1	92
D15A Normative beliefs [3]	e) A healthcare worker colleague expects me to use NCS	4.48	(0.65)	5	(2-5)	97	1	93
D15A Normative beliefs [3]	f) The IT service expects me to use NCS	4.13	(1.03)	4	(1-5)	87	6	68
D15A Normative beliefs [3]	g) The janitor expects me to use NCS	3.70	(1.25)	4	(1-5)	89	14	53
D15A Normative beliefs [3]	h) The vendors expect me to use NCS	4.40	(0.88)	5	(1-5)	88	3	76
D15A Normative beliefs [3]	i) The residents expect me to use NCS	4.29	(1.07)	5	(1-5)	93	6	76
D15A Normative beliefs [3]	j) The families expect me to use NCS	4.31	(1.13)	5	(1-5)	94	7	79
D15B Motivation to comply [5]	a) I comply with opinions of the manager	4.52	(0.68)	5	(2-5)	96	2	92
D15B Motivation to comply [5,13]	b) I comply with opinions of a super user	4.65	(0.51)	5	(3-5)	72	1	73
D15B Motivation to comply [5]	c) I comply with opinions of a union representative	4.08	(1.01)	4	(1-5)	90	7	76
D15B Motivation to comply [5]	d) I comply with opinions of a nurse colleague	4.42	(0.59)	4	(3-5)	95	0	91
D15B Motivation to comply [5]	e) I comply with opinions of a healthcare worker colleague	4.40	(0.57)	4	(3-5)	94	0	92
D15B Motivation to comply [5]	f) I comply with opinions of the IT service	4.05	(0.93)	4	(1-5)	87	3	65
D15B Motivation to comply [5]	g) I comply with opinions of the janitor	3.68	(1.10)	4	(1-5)	88	11	55
D15B Motivation to comply [5]	h) I comply with opinions of the vendors	4.17	(0.81)	4	(2-5)	87	2	70
D15B Motivation to comply [5]	i) I comply with opinions of the residents	4.21	(1.08)	5	(1-5)	92	7	78
D15B Motivation to comply [5]	j) I comply with opinions of the families	4.14	(1.08)	4	(1-5)	92	7	76
D16 Self-efficacy [3]	a) I can teach a resident the mobile transceiver	4.32	(0.86)	5	(1-5)	90	3	76
D16 Self-efficacy [3]	b) I can instruct and answer questions from families	4.17	(0.83)	4	(2-5)	94	3	77
D16 Self-efficacy [3]	c) I can find a solution if the mobile transceiver doesn't work	3.27	(1.08)	3	(1-5)	94	19	40
D16 Self-efficacy [3]	d) I can receive an alarm on the smart phone	4.56	(0.58)	5	(3-5)	98	0	96
D16 Self-efficacy [3]	e) I can manage an alarm on the smart phone	4.49	(0.69)	5	(2-5)	97	1	90
D16 Self-efficacy [3]	f) I can use the emergency call application to alert a colleague	4.46	(0.79)	5	(1-5)	98	3	91
D16 Self-efficacy [3,13]	g) I can operate the NCS software on the PC	3.19	(1.40)	3	(1-5)	75	22	38
D16 Self-efficacy [3]	h) I can provide feed-back to the manager or super user	4.31	(0.87)	5	(1-5)	97	3	82
D16 Self-efficacy [3,13]	i) I can find information about the NCS	3.86	(0.89)	4	(1-5)	72	4	40
D16 Self-efficacy [3,13]	j) I can participate in training sessions	4.28	(0.83)	4	(1-5)	75	2	65
D17 Knowledge [1]	a) I know enough to use NCS	4.18	(0.77)	4	(1-5)	97	3	86
D17 Knowledge [1]	b) I had sufficient prior knowledge when NCS was introduced	3.04	(1.20)	3	(1-5)	98	37	37

D17 Knowledge [1,13]	c) I was offered training before I started using NCS	4.18	(0.96)	4	(1-5)	77	5	68
D17 Knowledge [1,13]	d) I have participated in training-sessions	4.08	(1.13)	4	(1-5)	78	9	63
D17 Knowledge [1]	e) The mobile transceiver was demonstrated during training	3.81	(1.36)	4	(1-5)	98	23	70
D17 Knowledge [1]	f) The smart phone was demonstrated during training	4.02	(1.08)	4	(1-5)	98	10	79
D17 Knowledge [1]	g) I have practiced using NCS applications during idle time	4.01	(0.90)	4	(1-5)	97	6	76
D17 Knowledge [1]	h) I need more training and supervision about NCS	3.24	(1.14)	3	(1-5)	98	26	48
D17 Knowledge [1,13]	i) I understand instructions provided by super users	3.99	(0.79)	4	(2-5)	76	2	57
D17 Knowledge [1]	j) I understand instructions provided by the manager	3.92	(0.84)	4	(1-5)	97	5	74
D17 Knowledge [1]	k) I understand instructions provided by the vendors	3.47	(1.05)	3	(1-5)	95	10	44
D17 Knowledge [1]	l) I need to discuss NCS challenges and experiences	3.73	(1.00)	4	(1-5)	97	9	60
D18 Awareness of content [6]	The extent to which I am familiar with NCS	3.25	(0.75)	3	(1-4)	97	12	87
Organization: residential care facility unit								
D19 Formal ratification [7,8]	Use of NCS is integrated in plans					95	9	50
D20 Staff turnover [1]	New colleagues are prepared to use NCS	3.50	(1.02)	4	(1-5)	86	10	46
D21 Staff capacity [1]	We are enough people to use NCS as intended	3.73	(0.95)	4	(1-5)	93	5	62
D22 Financial resources [1]	NCS is supported by sufficient financial resources	3.40	(0.88)	3	(1-5)	88	8	48
D23 Time available [1]	I have enough time available to use NCS	3.56	(0.99)	4	(1-5)	95	13	55
D24 Material resources [1]	I have enough equipment to use NCS	3.67	(1.00)	4	(1-5)	97	21	65
D25 Coordinator [7, 9]	Manager/super user is responsible for NCS implementation					95	2	61
D25 Coordinator [7, 10]	The IT service bears responsibility in NCS implementation					95	11	36
D26 Unsettled organization [7,11]	Major changes are ongoing in parallel to NCS implementation					90	9	35
D27 NCS use information [1, 12]	I can easily find information about NCS use	3.72	(0.89)	4	(2-5)	25	7	16
D28 Performances feedback [1]	We get regular feedback about NCS implementation	3.29	(0.94)	3	(1-5)	98	17	39
Socio-political context: Norwegian legislation								
D29 Legislation and regulations[1]	NCS activities fall within current regulations	3.71	(0.82)	4	(1-5)	91	2	55

Abbreviations: D; determinant, NCS; nurse call system. Bold numbers indicate a barrier (≥20%) or a facilitator (≥80%).

Response scales: [1] 1; totally disagree, 2; disagree, 3; neither agree nor disagree, 4; agree, 5; totally agree. [2] 1; totally agree, 2; agree, 3; neither agree nor disagree, 4; disagree, 5; totally disagree. [3] 1; most definitely not, 2; definitely not, 3; perhaps, perhaps not, 4; definitely, 5; most definitely. [4] 1; not a single colleague, 2; almost no colleagues, 3; a minority, 4; half, 5; a majority, 6; almost all colleagues, 7; all colleagues. [5] 1; very little, 2; little, 3; not a little, not a lot, 4; a lot, 5; a great deal. [6] 1; I'm not familiar with the wireless NCS, 2; I'm familiar with the wireless NCS, but have not explored it, 3; I'm familiar with the wireless NCS and have some experience with it, 4; I'm well acquainted with and use the wireless NCS. [7] 1; no, 2; yes, 3; I don't know.

Other comments: [8] 38% replied I don't know. [9] 34% replied I don't know. [10] 50% replied I don't know. [11] 48% replied I don't know. [12] only presented to RCF2. [13] not presented to RCF1.

Appendices

Appendix 1a	Information letter and consent form, paper 1
Appendix 1 b	Information letter and consent form, paper 2
Appendix 2	Interview guide (in English), papers 1 & 2
Appendix 3	Information letter and consent form, paper 4
Appendix 4	Information letter to third parties, paper 4
Appendix 5	MIDI questionnaire, paper 4
Appendix 6	NSD approval no. 36230
Appendix 7	NSD approval no. 918960

Forespørsel om deltakelse i forskningsprosjektet

Prosjektets tittel: **Implementering av velferdsteknologi i helse- og omsorgstjenester. Opplæringsbehov og utforming av nye tjenester.**

Bakgrunn og formål
Arena Helseinnovasjon har sammen med Høgskolen i Buskerud og flere kommuner utviklet velferdsteknologi som nå implementeres. I en pilot i Risør, Holmestrand og Lier kommuner skal digitalt natt-tilsyn bidra til økt trygghet og sikkerhet for mennesker med demens. Vårt følgeforskningsprosjekt skal identifisere kompetansebehovet og organisasjonsendringer som oppstår i kommunene som følge av innføring av velferdsteknologi. Siden du deltar i utprøvingen og innføringen av digitalt natt-tilsyn ønsker vi om at du også deltar i vår studie.

Hva innebærer deltakelse i studien?
I studien vil vi samle inn informasjon gjennom intervju og observasjon. Vi vil ta direkte kontakt med deg i forbindelse med intervju. Et intervju vil ta ca en time. Observasjon vil foregå uten at arbeidet blir avbrutt. Intervjuene vil bli skrevet ned og oppbevart inntil studien er over.

Hva skjer med informasjonen om deg?
Alle personopplysninger vil bli behandlet konfidensielt. Navneliste og intervjuer vil bli oppbevart hver for seg og data vil bli slettet etter at studien er over. I publikasjoner fra studien vil persondata anonymiseres.

Prosjektet skal etter planen avsluttes 30.5.2014.

Frivillig deltakelse
Det er frivillig å delta i studien, og du kan når som helst trekke ditt samtykke uten å oppgi noen grunn. Dersom du trekker deg, vil alle opplysninger om deg bli anonymisert.

Dersom du ønsker å delta eller har spørsmål til studien, ta kontakt med
Etty Nilsen, prosjektleder, etty.nilsen@hibu.no, telefon: 97021325
Janne Dugstad, prosjektmedarbeider, janne.dugstad@hibu.no, telefon: 90993646

Studien er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS.

Samtykke til deltakelse i studien

Jeg har mottatt informasjon om studien, og er villig til å delta

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(Signert av prosjektdeltaker, dato)

Forespørsel om deltakelse i forskningsprosjektet

Prosjektets tittel: DIGITALT TILSYN, 2014-2017
Forskningsinstitusjoner: Høgskolen i Buskerud og Vestfold og Universitetet i Agder

Bakgrunn og formål
Målet med forskningsprosjektet er å identifisere faktorer som kan føre til vellykket innføring av velferdsteknologi i kommunalhelsetjenesten. Forskerne vil følge de institusjonene i kommunene som tar i bruk Digitalt tilsyn, og vil først og fremst være interessert i fire forhold:

1. Hvordan de ansatte opplever å jobbe med teknologien og hvordan opplæringen har vært
2. Hvordan velferdsteknologien (for eksempel mattene i sengene og dørsensorene) påvirker måten de jobber på og hvordan arbeidsdagen, evt. arbeidsnatten, er.
3. Hvordan de pårørende blir involvert og hvordan de reagerer
4. Vurdere etiske forhold ved innføring av teknologien

Siden du deltar i utprøvingen og innføringen av digitalt natt-tilsyn ønsker vi om at du også deltar i vår studie.

Hva innebærer deltakelse i studien?
I studien vil vi samle inn informasjon gjennom intervju og observasjon. Et intervju vil ta ca en time. Observasjon vil foregå uten at arbeidet blir avbrutt. Intervjuene vil bli skrevet ned og oppbevart inntil studien er over.

Hva skjer med informasjonen om deg?
Alle personopplysninger vil bli behandlet konfidensielt. Navneliste og intervjuer vil bli oppbevart hver for seg og data vil bli slettet etter at studien er over. I publikasjoner fra studien vil persondata anonymiseres.

Prosjektet skal etter planen avsluttes 30.4.2017. Data vil oppbevares i noe tid etter det.

Frivillig deltakelse
Det er frivillig å delta i studien, og du kan når som helst trekke ditt samtykke uten å oppgi noen grunn. Dersom du trekker deg, vil alle opplysninger om deg bli anonymisert.

Dersom du ønsker å delta eller har spørsmål til studien, ta kontakt med
Etty Nilsen, prosjektleder, etty.nilsen@hbv.no, telefon: 97021325
Janne Dugstad, prosjektmedarbeider, janne.dugstad@hbv.no, telefon: 90993646

Studien er meldt til Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste AS.

Samtykke til deltakelse i studien Digitalt tilsyn

Jeg har mottatt informasjon om studien, og er villig til å delta

_____

(Navn og arbeidssted med blokkbokstaver)

(Dato) (Signatur)

INTERVIEW GUIDE

Interview starts with "grand tour" question (around the table if focus group): How have you perceived your participation in the implementation?

THEME 1: COMPETENCE

Aim: To identify the emerging need for competence in the process of implementation of welfare technology.

1. How is the training organized? Description from A to Z: information and summons, who organized the training? What happened when you started to work with the technology? The role of the management? In your own words, what questions are asked and so on? Could you provide an example?
2. How can we characterize the communication between the technologists and the health care workers in the process of implementation? Can you describe a situation where you misunderstood each other? How do you experience this communication?
3. What barriers could be identified during training and implementation?
    a. what has been simple?
    b. what has been complicated?
    c. could you describe a situation that has been difficult?
4. How may the barriers be categorized?
5. What categories of knowledge are needed for implementation of welfare technology? Good information about the nature of the project? Practical training? What kind of knowledge has there been a lack of?

THEME 2: ORGANIZATIONAL CHANGES

Aim: Describe organizational changes that emerge as a result of implementation of welfare technology.

6. How would you describe the encounter with the organization and the employees (question for developers/technologists) OR with the technologists (question for health care workers)?
    a. Who have been interested in the project?
    b. Who have appeared best informed?
    c. Whom did you have the most contact with?
    d. How was the relation between the day and the night shift?
    e. The communication – what is your impression of the communication? Has it been of importance?
7. In what way does the division and organization of labor change as a result of the implementation of the new technology?
    a. Who have appeared best informed about the project?
    b. Who do you ask?
    c. What is the relation between the day and the night shift?
    d. The communication: has something changed as a result of the implementation project?
8. In what way have the tasks of the manager changed?
    a. how has the project been handled by the management?
    b. is the manager interested in the project?
    c. is the (top) management interested in the project?

Invitasjon til å delta i forskningsprosjektet

«Velferdsteknologi i helse- og omsorgstjenestene. Opplæringsbehov og utforming av nye tjenester»

Mange kommuner tar nå i bruk velferdsteknologi for økt trygghet og bedre kvalitet for beboere og ansatte i hjemmebaserte tjenester, bofellesskap og sykehjem. Ved Universitetet i Sørøst-Norge gjennomføres et doktorgradsprosjekt som følger personalet når velferdsteknologi tas i bruk i. Vi ønsker å kartlegge helsepersonells motivasjon og kompetansebehov, og endringer som oppstår i tjenestene og organiseringen i kommunene. Prosjektet samler data i minimum 4 kommuner. Vi inviterer deg til å delta …..(i en spørreundersøkelse / intervju)…om…(teknologitype)…… Siden ditt arbeidssted nylig har tatt i bruk …(teknologien)…., har vi avklart med ledelsen at ditt arbeidssted ønsker å delta i prosjektet. I dette skrivet gir vi deg informasjon om prosjektet og hva deltakelse vil innebære for deg.

Hva innebærer det for deg å delta?
De som deltar i prosjektet fyller ut et spørreskjema der vi spør om…(teknologien)…, opplæring og bruk. Vi spør både om dine egne erfaringer og hvordan du oppfatter at sykehjemmet har tatt teknologien i bruk. Det tar ca. 30 minutter å fylle ut skjemaet. På noen sykehjem gjør vi i tillegg observasjoner på møter. Noen ansatte kan også bli spurt om å delta på intervju. Observasjon og intervju avtales separat. Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykke tilbake uten å oppgi noen grunn. Alle opplysninger om deg vil da bli anonymisert. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger
Vi behandler opplysninger om deg basert på ditt samtykke. På oppdrag fra Universitetet i Sørøst-Norge har Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket. Vi behandler opplysningene konfidensielt. Signerte samtykkeskjema og utfylt spørreskjema på papir oppbevares hver for seg i låst arkiv. Digitale filer oppbevares i en forskningsserver på Universitetet i Sørøst-Norge. I publikasjoner og presentasjoner fra forskningen er også alle persondata anonymisert. Prosjektet skal etter planen avsluttes 31.12.2020. Alle data vil da anonymiseres og personopplysninger og eventuelle lydbåndopptak slettes.

Dine rettigheter
Så lenge du kan identifiseres i datamaterialet, har du rett til innsyn i hvilke personopplysninger som er registrert om deg, å få rettet personopplysninger om deg, å få slettet personopplysninger om deg, få utlevert en kopi av dine personopplysninger og å sende klage til personvernombudet eller Datatilsynet om behandlingen av dine personopplysninger. Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

- Universitetet i Sørøst-Norge ved Janne Dugstad. Janne.Dugstad@usn.no, mobil 90 99 36 46
- Universitetets personvernombud: Paal A. Solberg, Paal.A.Solberg@usn.no, mobil 91 86 00 41
- NSD – Norsk senter for forskningsdata AS, personvernombudet@nsd.no, telefon: 55 58 21 17

Hilsen

Janne Dugstad	Hilde Eide	Etty Nilsen
Doktorgradsstipendiat	Professor, hovedveileder	Professor, biveileder

Samtykke til deltakelse i prosjektet

Prosjektets tittel: **Velferdsteknologi i helse- og omsorgstjenestene. Opplæringsbehov og utforming av nye tjenester.**

Jeg har mottatt og forstått informasjon om prosjektet. Jeg har fått anledning til å stille spørsmål. Jeg samtykker til at mine opplysninger behandles frem til prosjektet avsluttes 31.12.2020.

Jeg samtykker til :

- ☐ å delta i spørreundersøkelse
- ☐ å delta i intervju
- ☐ å delta i møte som observeres av forskerne

Dato Signatur

Informasjon om pågående forskningsprosjektet

«Velferdsteknologi i helse- og omsorgstjenestene. Opplæringsbehov og utforming av nye tjenester»

Mange kommuner tar nå i bruk velferdsteknologi for økt trygghet og bedre kvalitet for beboere og ansatte i hjemmebaserte tjenester, bofellesskap og på sykehjem. Ved Universitetet i Sørøst-Norge gjennomføres et doktorgradsprosjekt som følger personalet i omsorgstjenesten når velferdsteknologi tas i bruk i. Vi ønsker å kartlegge helsepersonells motivasjon og kompetansebehov, og endringer som oppstår i tjenestene og organiseringen i kommunene. Prosjektet samler data i minimum 4 kommuner, ved hjelp av spørreskjema, observasjoner og intervjuer. Når kommunene installerer og tar i bruk velferdsteknologi, er helsepersonellet avhengig av støtte fra for eksempel leverandør, IT-tjeneste, vaktmester og sin nærmeste leder. Tillitsvalgte kan også ha en rolle. I forskningsprosjektet spør vi derfor helsepersonellet om de er kjent med hvilket ansvar ulike støttefunksjoner har i forhold til velferdsteknologien og hva slags form for støtte den enkelte helsearbeideren selv eventuelt mottar når hun skal jobbe med velferdsteknologien.

Du mottar denne informasjonen, fordi du kan ha en slik støttefunksjon i kraft av din stilling.

Hva innebærer det for deg? Ditt personvern
Vi behandler alle opplysningene konfidensielt. Eventuelle data om deg omtaler deg som «leverandør», «IT-tjeneste», «vaktmester» osv. I publikasjoner og presentasjoner fra forskningen er alle data om støttefunksjoner gruppert på tvers av alle kommunene, slik at det ikke er mulig å identifisere personer som har støttefunksjoner i den enkelte kommune eller det enkelte sykehjemmet.

På oppdrag fra Universitetet i Sørøst-Norge har Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket. Utfylt spørreskjema på papir oppbevares i låst arkiv. Digitale filer oppbevares i en forskningsserver på Universitetet i Sørøst-Norge. Prosjektet skal etter planen avsluttes 31.12.2020. Alle data vil da anonymiseres og personopplysninger og eventuelle lydbåndopptak slettes.

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- Universitetets personvernombud: Paal A. Solberg, Paal.A.Solberg@usn.no, mobil 91 86 00 41
- NSD – Norsk senter for forskningsdata AS, personvernombudet@nsd.no, telefon: 55 58 21 17

Hilsen

Janne Dugstad
Doktorgradsstipendiat

Hilde Eide
Professor, hovedveileder

Etty Nilsen
Professor, biveileder

Utdanning: _____ Stilling: _____

Antall år yrkeserfaring: _____ Antall år i nåværende stilling: _____

Superbruker? Ja ☐ Nei ☐ Kjønn: _____ Alder: _____

DEL 1. Her spør vi om din erfaring med det nye pasientvarslingssystemet. Vi spør om smykkealarmene for beboerne og telefonene for personalet, samt den delen av systemet som ligger på PC. Systemet består også av materiell som brukerveiledning og sjekklister. Systemet er avhengig av internett for å fungere.

Sett kryss ved det svaret som passer best
Du trenger ikke svare på spørsmål som ikke gjelder deg eller du ikke forstår

1. I pasientvarslingsanlegget er aktivitetene jeg skal utføre tydelig beskrevet

☐ 1 helt uenig
☐ 2 uenig
☐ 3 verken enig eller uenig
☐ 4 enig
☐ 5 helt enig

2. Pasientvarslingsanlegget er kunnskapsbasert

☐ 1 helt uenig
☐ 2 uenig
☐ 3 verken enig eller uenig
☐ 4 enig
☐ 5 helt enig

3. Pasientvarslingsanlegget inneholder all informasjon som er nødvendig for å arbeide godt med systemet

☐ 1 helt uenig
☐ 2 uenig
☐ 3 verken enig eller uenig
☐ 4 enig
☐ 5 helt enig

4. Pasientvarslingsanlegget er altfor komplekst å bruke for meg

☐ 1 helt uenig
☐ 2 uenig
☐ 3 verken enig eller uenig
☐ 4 enig
☐ 5 helt enig

5. Pasientvarslingsanlegget passer godt med hvordan jeg er vant til å arbeide

☐ 1 helt uenig
☐ 2 uenig
☐ 3 verken enig eller uenig
☐ 4 enig
☐ 5 helt enig

6. Pasientvarslingsanlegget gir synlige resultater

☐ 1 helt uenig
☐ 2 uenig
☐ 3 verken enig eller uenig
☐ 4 enig
☐ 5 helt enig

7. Jeg synes pasientvarslingsanlegget er relevant for beboerne jeg har ansvar for

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

8. Jobben jeg utfører er bedre med det nye anlegget, enn med det gamle

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

9. Pasientvarslingsanlegget gjør at jeg kan jobbe mer effektivt

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

10. Pasientvarslingsanlegget gjør jobben min mer interessant

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

11. Pasientvarslingsanlegget gjør at jeg får økt trygghet på jobb

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

12. Jeg tror jeg står bedre rustet til å jobbe med flere typer velferdsteknologier, nå som jeg har erfaring med pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

13. Det er i tråd med mitt ansvar som helsepersonell å bruke pasientvarslings-anlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

14. Min totalvurdering er at pasientvarslings-anlegget innebærer flere fordeler enn ulemper for meg

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

15. Det er krevende å lære seg å jobbe med pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

16. Det er viktig for meg å bidra til at beboerne får økt trygghet.

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

17. Jeg forventer at pasientvarslingsanlegget gir økt trygghet for beboerne

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

18. Det er viktig for meg å bidra til at beboerne får raskere hjelp.

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

19. Jeg forventer pasientvarslingsanlegget bidrar til at beboerne får hjelp raskere

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

20. Det er viktig for meg å bidra til at pårørende føler økt trygghet.

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

21. Jeg forventer at pasientvarslingsanlegget gir økt trygghet for pårørende

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

22. Beboerne vil generelt være fornøyde hvis jeg bruker pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

23. Beboerne vil stort sett samarbeide hvis jeg bruker pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

24. Pårørende vil generelt være fornøyde hvis jeg bruker pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

25. Pårørende vil stort sett samarbeide hvis jeg bruker pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

26. Hvor stor andel av dine kolleger bruker pasientvarslingsanlegget slik det er ment?

- ☐ 1 Ingen kolleger
- ☐ 2 Nesten ingen kolleger
- ☐ 3 En liten del av kollegene
- ☐ 4 Halvparten av kollegene
- ☐ 5 En stor del av kollegene
- ☐ 6 Nesten alle kollegene
- ☐ 7 Alle kollegene

27. Jeg kan regne med tilstrekkelig hjelp fra følgende personer hvis jeg trenger det for å bruke pasientvarslingsanlegget (sett kryss for hver person/funksjon som er listet opp)

		Helt sikkert ikke	Sikkert ikke	Kanskje, kanskje ikke	Sikkert	Helt sikkert
a	Avdelingsleder					
b	Superbruker					
c	Tillitsvalgt					
d	Sykepleier kollega					
e	Helsefagarbeider / hjelpepleier kollega					
f	IT-tjenesten					
g	Vaktmester					
h	Leverandør					

28. I hvilken grad for forventer følgende personer at du bruker pasientvarslingsanlegget? (sett kryss for hver person/funksjon som er listet opp)

		Helt sikkert ikke	Sikkert ikke	Kanskje, kanskje ikke	Sikkert	Helt sikkert
a	Avdelingsleder					
b	Superbruker					
c	Tillitsvalgt					
d	Sykepleier kollega					

		Helt sikkert ikke	Sikkert ikke	Kanskje, kanskje ikke	Sikkert	Helt sikkert
e	Helsefagarbeider / hjelpepleier kollega					
f	IT-tjenesten					
g	Vaktmester					
h	Leverandør					
i	Beboer					
j	Pårørende					

29. Når det gjelder å arbeide med det pasientvarslingsanlegget, i hvilken grad vil du legge vekt på synspunkter fra følgende personer? (sett kryss for hver person/funksjon som er listet opp)

		Helt sikkert ikke	Sikkert ikke	Kanskje, kanskje ikke	Sikkert	Helt sikkert
a	Avdelingsleder					
b	Superbruker					
c	Tillitsvalgt					
d	Sykepleier kollega					
e	Helsefagarbeider / hjelpepleier kollega					
f	IT-tjenesten					
g	Vaktmester					
h	Leverandør					
i	Beboer					
j	Pårørende					

30. I hvilken grad er du kjent med innholdet i pasientvarslingsanlegget?

- ☐ jeg kjenner ikke til pasientvarslingsanlegget i det hele tatt
- ☐ jeg kjenner til pasientvarslingsanlegget, men jeg har ikke satt meg helt inn i det (ennå)
- ☐ jeg kjenner pasientvarslingsanlegget og har litt erfaring med det
- ☐ jeg kjenner pasientvarslingsanlegget og har satt meg grundig inn i det

31. Jeg vet nok til å bruke pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

32. Jeg hadde nok bakgrunnskunnskap da vi begynte å bruke pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

33. Jeg fikk tilbud om opplæring da vi begynte å bruke pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

34. Jeg deltok på opplæring da vi begynte å bruke pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

35. Bruk av smykkealarmer ble demonstrert da jeg fikk opplæring

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

36. Funksjonene på telefonen ble demonstrert da jeg fikk opplæring

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

37. Jeg har selv sørget for å teste litt og trene på funksjonene i pasientvarslingsanlegget, i ledige stunder

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

38. Jeg har behov for hjelp og mer veiledning om pasientvarslingsanlegget med jevne mellomrom

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

39. Superbruker(e) driver opplæring på en måte jeg forstår

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

40. Avdelingsleder kan svare på spørsmål og drive veiledning på en måte jeg forstår

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

41. Leverandøren driver opplæring på en måte jeg forstår

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

42. Jeg har behov for å diskutere utfordringer og erfaringer med andre som jobber med pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

43. Hvor sikker er du på at du kan utføre disse aktivitetene om du går inn for det? (sett kryss)

		Helt sikkert ikke	Sikkert ikke	Kanskje, kanskje ikke	Sikkert	Helt sikkert
a	Veilede brukerne i hvordan de skal anvende smykkealarmen					
b	Veilede og svare på spørsmål fra pårørende om smykkealarmen					
c	Finne ut hva som er feil, dersom smykkealarmen ikke virker					
d	Motta alarm på telefon					
e	Behandle alarm på telefon					
f	Tilkalle hjelp fra kollega via telefon					
g	Jobbe med den delen av systemet som ligger på PC					

h	Gi tilbakemelding om pasientvarslingsanlegget til superbruker og leder					
i	Finne og bruke informasjonen som er laget om bruk, prosedyrer og rutiner					
j	Delta på intern opplæring					

44. Har ledelsen formalisert bruk av pasientvarslingsanlegget på arbeidsplassen (i strategiplaner, arbeidsplaner og liknende)?
- ☐ 1 ja
- ☐ 2 nei
- ☐ 3 vet ikke

45. På min arbeidsplass har superbrukere ansvar for å bidra i driften av pasientvarslingsanlegget
- ☐ 1 ja
- ☐ 2 nei
- ☐ 3 vet ikke

46. På min arbeidsplass har IT-tjenesten ansvar for å bidra i driften av pasientvarslingsanlegget
- ☐ 1 ja
- ☐ 2 nei
- ☐ 3 vet ikke

47. Er det i tillegg til pasientvarslingsanlegget andre endringer på arbeidsplassen, som omorganisering, kommunesammenslåing, innsparinger eller innføring av andre teknologier, enten nå eller i nær framtid?
- ☐ 1 ja
- ☐ 2 nei
- ☐ 3 vet ikke

48. På min arbeidsplass er det rutiner slik at dersom medarbeidere som bruker pasientvarslingsanlegget slutter, så blir de tidsnok erstattet av medarbeidere som kjenner eller blir opplært i bruk av det digitale alarmsystemet
- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

49. Det er tilstrekkelig med personale på arbeidsplassen til å anvende pasientvarslingsanlegget slik det er ment
- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

50. Det er nok økonomiske ressurser til disposisjon til å bruke pasientvarslingsanlegget slik det er ment

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

51. Jeg har fått nok tid avsatt i det daglige eller nattlige arbeidet til å bruke pasientvarslingsanlegget slik det er ment

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

52. På min arbeidsplass har jeg nok utstyr og andre ressurser til rådighet for å bruke pasientvarslingsanlegget slik det er ment

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

På min arbeidsplass får vi jevnlig tilbakemelding på fremdrift med implementering og drift av pasientvarslingsanlegget

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

53. Aktivitetene som inngår i pasientvarslingsanlegget er innenfor gjeldende lover og forskrifter

- ☐ 1 helt uenig
- ☐ 2 uenig
- ☐ 3 verken enig eller uenig
- ☐ 4 enig
- ☐ 5 helt enig

Nå er du ferdig med skjemaet. Fint om du legger det i en konvolutt og leverer det inn.

Takk for innsatsen ☺

Norsk samfunnsvitenskapelig datatjeneste AS
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Janne Dugstad
Institutt for optometri og synsvitenskap Høgskolen i Buskerud
Postboks 251
3603 KONGSBERG

Vår dato: 15.11.2013 Vår ref: 36230 / 2 / MSI Deres dato: Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 07.11.2013. Meldingen gjelder prosjektet:

36230	*Velferdsteknologi i helse- og omsorgstjenester. Opplæringsbehov og utforming av nye tjenester*
Behandlingsansvarlig	*Høgskolen i Buskerud, ved institusjonens øverste leder*
Daglig ansvarlig	*Janne Dugstad*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, ombudets kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/meldeplikt/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://pvo.nsd.no/prosjekt.

Personvernombudet vil ved prosjektets avslutning, 30.06.2017, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Vigdis Namtvedt Kvalheim

Marte Byrkjeland

Kontaktperson: Marte Byrkjeland tlf: 55 58 33 48
Vedlegg: Prosjektvurdering

Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.

Personvernombudet for forskning

Prosjektvurdering - Kommentar

Prosjektnr: 36230

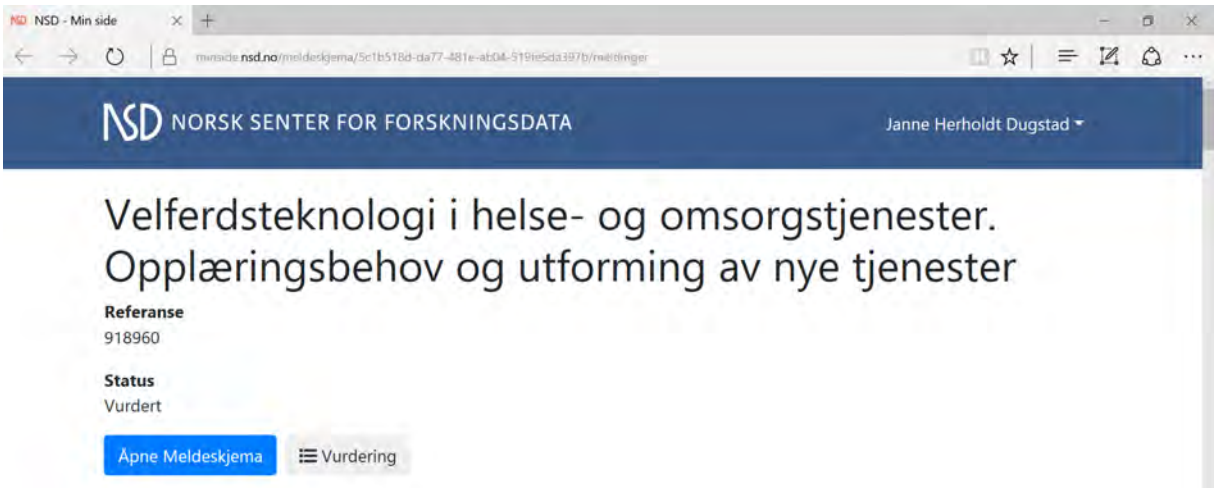
Formålet er å undersøke hvordan velferdsteknologi implementeres i flere kommuner. Utvalget består av ansatte i kommunal helse- og omsorgstjeneste.

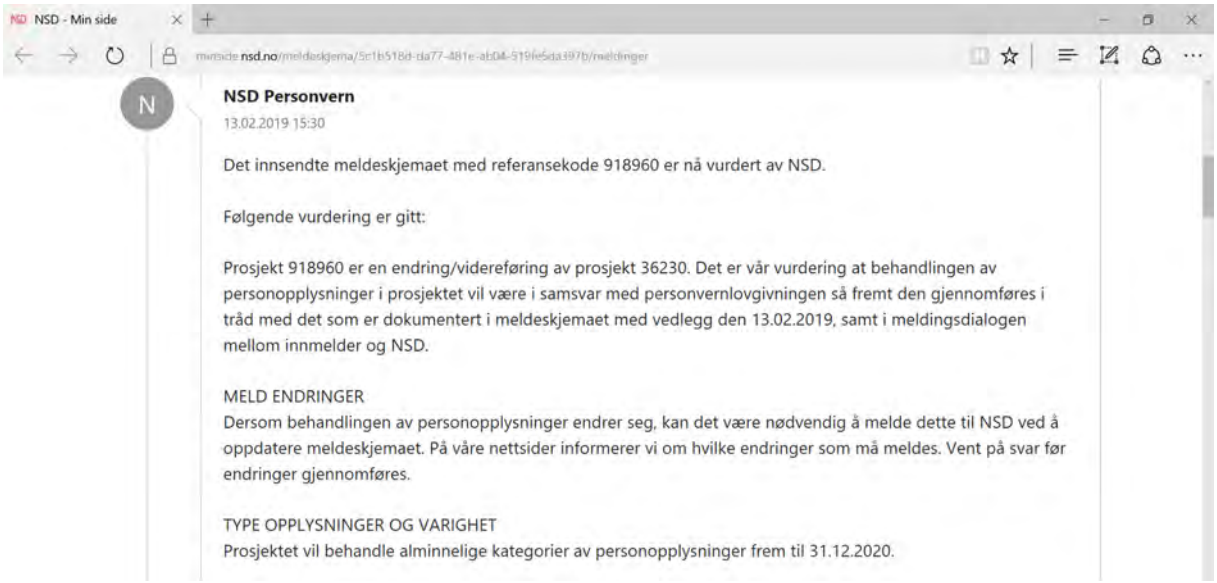
Data samles inn gjennom spørreskjema, observasjon og intervju, individuelt og i gruppe. Personvernombudet legger til grunn at det ikke registreres personopplysninger om pasienter og at taushetsplikten ikke er til hinder for datainnsamling. Vi anbefaler at forsker avklarer med REK hvorvidt det er nødvendig med dispensasjon fra taushetsplikten i forbindelse med observasjonsdelen, eller om en taushetserklæring er tilstrekkelig.

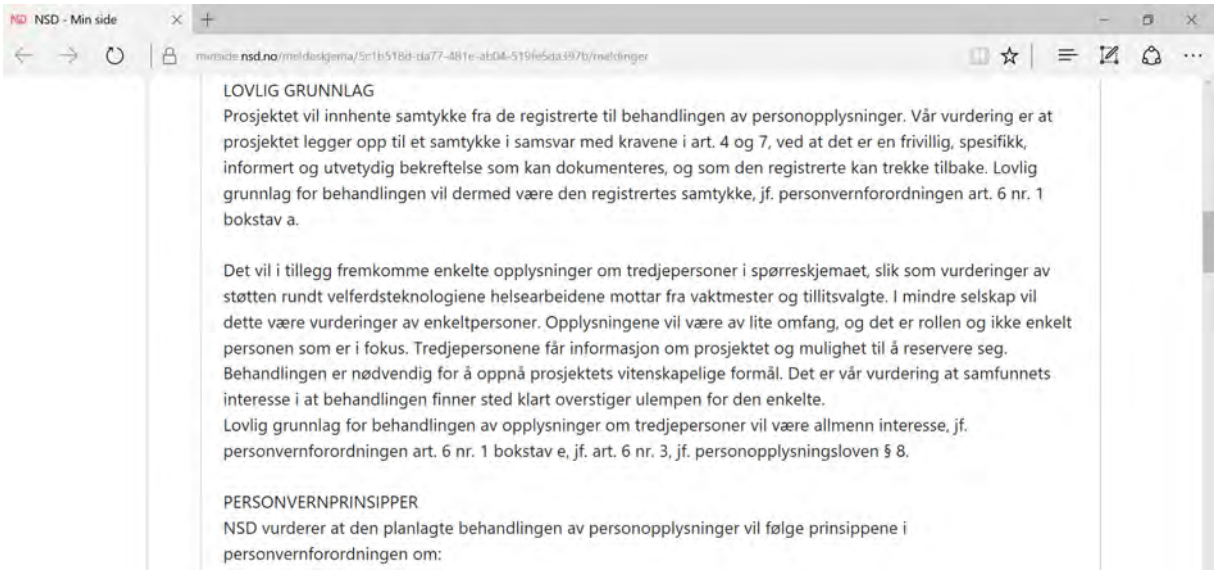
Ifølge prosjektmeldingen skal det innhentes skriftlig samtykke basert på muntlig og skriftlig informasjon om prosjektet og behandling av personopplysninger. Personvernombudet finner informasjonsskrivet tilfredsstillende utformet i henhold til personopplysningslovens vilkår.

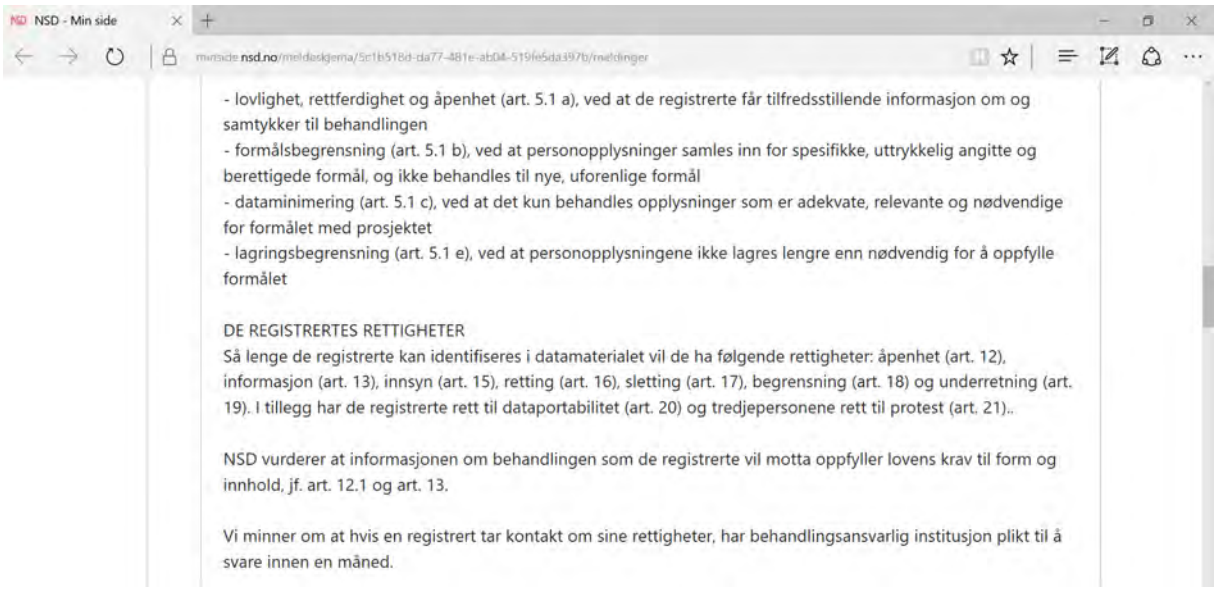
Det er oppgitt at navneliste oppbevares i kryptert forskingsdatabase ved høyskolen, separert fra andre data. Personvernombudet legger til grunn at behandlingen av personopplysninger er i samsvar med Høgskolen i Buskerud sine rutiner for informasjonssikkerhet.

Prosjektet skal avsluttes 30.06.2017 og innsamlede opplysninger skal da anonymiseres og lydopptak slettes. Anonymisering innebærer at direkte personidentifiserende opplysninger som navn/koblingsnøkkel slettes, og at indirekte personidentifiserende opplysninger (sammenstilling av bakgrunnsopplysninger som f.eks. yrke, stilling, arbeidssted, alder, kjønn) fjernes eller grovkategoriseres slik at ingen enkeltpersoner kan gjenkjennes i materialet.


NSD - Min side
NSD NORSK SENTER FOR FORSKNINGSDATA
Janne Herholdt Dugstad
Velferdsteknologi i helse- og omsorgstjenester. Opplæringsbehov og utforming av nye tjenester
Referanse
918960
Status
Vurdert
Åpne Meldeskjema
Vurdering


NSD - Min side
N
NSD Personvern
13.02.2019 15:30
Det innsendte meldeskjemaet med referansekode 918960 er nå vurdert av NSD.
Følgende vurdering er gitt:
Prosjekt 918960 er en endring/videreføring av prosjekt 36230. Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet med vedlegg den 13.02.2019, samt i meldingsdialogen mellom innmelder og NSD.
MELD ENDRINGER
Dersom behandlingen av personopplysninger endrer seg, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. På våre nettsider informerer vi om hvilke endringer som må meldes. Vent på svar før endringer gjennomføres.
TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 31.12.2020.


NSD - Min side
LOVLIG GRUNNLAG
Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake. Lovlig grunnlag for behandlingen vil dermed være den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.
Det vil i tillegg fremkomme enkelte opplysninger om tredjepersoner i spørreskjemaet, slik som vurderinger av støtten rundt velferdsteknologiene helsearbeidene mottar fra vaktmester og tillitsvalgte. I mindre selskap vil dette være vurderinger av enkeltpersoner. Opplysningene vil være av lite omfang, og det er rollen og ikke enkelt personen som er i fokus. Tredjepersonene får informasjon om prosjektet og mulighet til å reservere seg. Behandlingen er nødvendig for å oppnå prosjektets vitenskapelige formål. Det er vår vurdering at samfunnets interesse i at behandlingen finner sted klart overstiger ulempen for den enkelte.
Lovlig grunnlag for behandlingen av opplysninger om tredjepersoner vil være allmenn interesse, jf. personvernforordningen art. 6 nr. 1 bokstav e, jf. art. 6 nr. 3, jf. personopplysningsloven § 8.
PERSONVERNPRINSIPPER
NSD vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:

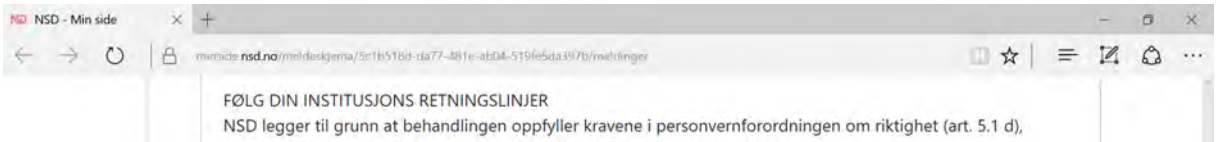


- lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke behandles til nye, uforenlige formål
- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER
Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: åpenhet (art. 12), informasjon (art. 13), innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18) og underretning (art. 19). I tillegg har de registrerte rett til dataportabilitet (art. 20) og tredjepersonene rett til protest (art. 21)..

NSD vurderer at informasjonen om behandlingen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.



FØLG DIN INSTITUSJONS RETNINGSLINJER
NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

Nettskjema er databehandler i prosjektet. NSD legger til grunn at behandlingen oppfyller kravene til bruk av databehandler, jf. art 28 og 29.

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og/eller rådføre dere med behandlingsansvarlig institusjon.

OPPFØLGING AV PROSJEKTET
NSD vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Lykke til med prosjektet!

Kontaktperson hos NSD: Kajsa Amundsen
Tlf. Personverntjenester: 55 58 21 17 (tast 1)

Doctoral dissertation no. 73
2020

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Co-creating digital transformation in care of older persons
A longitudinal mixed-methods study

Dissertation for the degree of PhD

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Janne Herholdt Dugstad

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