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Remote patient monitoring in Norway: Drivers, barriers and transition dynamics

A case study of remote patient monitoring (RPM) in four Norwegian municipalities

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Master's thesis

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Keywords: *RPM, MLP, Drivers, Barriers, Transition, innovation, case study, health care*

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FORORD

Denne oppgaven har vært en tidkrevende og strabasiøs affære. Den kunne ikke vært muliggjort uten støtte fra venner, familie og veiledere.

Jeg vil takke mine veiledere Markus M. Bugge og Arne Fevolden for konstruktive tilbakemeldinger og et godt samarbeid. Videre vil jeg takke min samboer Anette Simonsen, min bror Karl Kristian Kirchhoff og min venn Stian Larsen for språklig veiledning, og annen intellektuell stimulus.

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ABSTRACT

Norway is experiencing a demographic shift, caused by an ageing population. The shift will result in an increased proportion of inhabitants with chronic Non-communicable diseases (NCDs). One of the innovations tested to keep the Norwegian municipal healthcare model financially sustainable is the pro-active service of remote patient monitoring (RPM). RPM is a branch of welfare technology, where digital technology is used to collect clinical and other forms of health data from users in one location, transmitting that information electronically and securely to a response-centre for assessment and recommendation by a healthcare professional. The RPM program started in 2016 and consisted of four regions (Oslo, Sarpsborg, Stavanger and Trondheim).

This thesis investigates the innovative dynamics of RPM and aims to answer (1) What are the drivers and barriers for implementing RPM in Norwegian municipalities, and (2) How can RPM be perceived as a part of a wider socio-technical transition.

The analytical framework employed builds on a functional pattern analysis, derived from the theories of technological innovation system (TIS). The Multi-level perspective (MLP) is adapted to analyse RPM as a socio-technical transition, through the three layers (landscape, regime and niche) of socio-technical analysis. The methodology relies on a qualitative case study approach. Data collection is based on a triangulation approach, applying the methods of document analysis, literature review, interviews, observations and field-work to answer the thesis questions.

The main drivers found were increased patient related effects on improved feeling of safety, improved health literacy and a healthier diet, especially for users with Diabetes mellitus. This creates legitimacy among users, interest groups and home-care workers. Remote patient monitoring is also viewed as a favourable work-environment by nurses, making the position of “operator” at the response-centre a attractive position.

The main observed barriers are manifold, but primarily revolve around uncertainties of the cost-effectiveness, and difficulty of proving the effectiveness of a pro-active service. Uncertainty around the use and quality of medical technical equipment (MTE), and lack of solid scientific evidence leads to scepticism and resistance from general practitioners (GPs).

The wider socio-technical transition of welfare technology and RPM is here understood as the external pressure of the demographic shift, changes in the patient role towards patient activation and, particular for a Norwegian context, fluctuating oil prices. These external factors create pressure on the existing socio-technical configuration, creating a window of opportunity for welfare technology, which encourages RPM implementation and testing through co-creation and co-evolution. RPM is thus part of a wider welfare technology implementation process, and gains legitimation and human capital from safety technology implementations.

Resistance mechanics is observed in the regime of usual care, changing the intention of RPM as a pro-active service, towards being a re-active service, through the recruitment of users that are severely ill. Public policies and political power do however favour RPM as it increases coordination and knowledge sharing between healthcare actors in both the primary and secondary healthcare provisions.

Table of Contents

List of figures

Abbreviations and acronyms

AAL	Ambient assisted living
CHF	Chronic heart failure
COPD	Chronic obstructive pulmonary disease
DEH	The Norwegian Directorate of eHealth
DM	Diabetes mellitus
EHR	Electronic health record
EMR	Electronic medical record
EPR	Electronic patient record
EV	Evolutionary Economics
GPs	General practitioners
HF	Heart failure
MLP	Multi-level perspective
MTE	Medical technical equipment
NCDs	Non-communicable diseases
NDEH	The Norwegian Directorate of eHealth
NDH	The Norwegian Directorate of Health
PCC	Personnel connected health and care (in Scandinavian typology often interpreted as welfare technology)
RPM	Remote patient monitoring
T1DM	Type 1 diabetes mellitus
T2DM	Type 2 diabetes melltius
TIS	Technological innovation system

1 INTRODUCTION

Extrapolations measured by Statistics Norway publications (SSB) estimate a doubling of inhabitants aged 65 years or older by 2100 (SSB, 2017b). This demographic shift will cause a strain in the provision of Norwegian health and social care for an increasingly elderly population. Longer life expectancy leads to an older population which in turn results in a larger proportion of inhabitants diagnosed with Noncommunicable-chronic diseases (NCDs).

The Norwegian white paper on economic predictions of 2013 (Perspektivmeldingen) and the recent version of 2017 concluded with the same message: The combination of fewer occupationally employed, increases in the elderly population and falling oil revenue is predicted to create financial uncertainties in future state budgets (Finansdepartementet, 2016-2017b).

The revised national budget (RNB) of 2013 granted money for the establishment of a national program for development and implementation of welfare technology solutions (Helsedirektoratet, 2017a). The national welfare technology program runs from 2013-2020 and seeks to establish welfare technology in Norwegian municipalities, give recommendations about safety alarms and standardisations, and frameworks for welfare technology (Helsedirektoratet, 2017b).

As part of the national welfare technology program, the Norwegian government granted 30 million NOK for a national remote patient monitoring (RPM) program[1] aimed at users with NCDs. The purpose is to secure valuable knowledge for further diffusion of welfare technology on a national scale. The tender for participation in the program was won and distributed among four regions: Sarpsborg, Stavanger, Oslo and Trondheim. Two technology suppliers provide the software and hardware for RPM; Imatis AS, and Dignio AS.

RPM is a branch of welfare technology, where digital technology is used to collect clinical and other forms of health data from users in one location, transmitting that information electronically and securely to a response-centre for assessment and recommendation by a

[1] The project is named “Avstandsoppfølgingsprosjektet”, which translates to remote patient monitoring program

healthcare professional. The data sent from the users are stored in a relational database so that the healthcare worker can analyse the data to view trends or alerts in the user's clinical values.

1.1 Aims and objectives

There are currently many political initiatives that seek to reduce costs and increase productivity, to retain the financial sustainability of the health sector. Welfare technologies, including remote patient monitoring (RPM), are therefore being tested as viable solutions. The prospects of RPM technology are alluring. It may reduce costs, improve patient health, improve patient quality of life, and postpone institutionalisation. However, measures to create changes in established systems such as the healthcare sector, are often met with resistance from various actors, institutions, cultures and other socially established structures.

This thesis is a case study that aims to shed light on this health sector transformation, by making use of theories and insights from technological innovation systems (TIS), and the Multi-level perspective (MLP). The research questions guiding this thesis are:

RQ: 1) What are the drivers and barriers for implementing remote patient monitoring in Norwegian municipalities?

RQ: 2) How can remote patient monitoring be perceived as a wider part of a socio-technical transition?

Building on theoretical insights from the innovation studies literature, this thesis hopes to create a better understanding of a transition with potentially vast implications. Noncommunicable diseases (NCDs) strains the healthcare sector, and costs society substantial amounts, partly because of care, but also from loss of productivity. People with chronic diseases also suffer, and experience reduction in quality of life and premature death. NCDs disproportionally affect low- and middle-income people, and thus governmental subsidies and grants increasingly cover a substantial amount of the costs.

Lastly, I will remark that by being on the leading technological edge in welfare technology, the experience learned, might also be an asset for Norwegian export. While the desire to innovate is based mainly on concerns of keeping the public health sector financially viable, a secondary effect might be gained by building prominent solutions that can be valuable to countries in similar situations. NCDs kill approximately 40 million people globally each year, equivalent to 70% of all premature deaths (WHO, 2017). Innovating service delivery towards NDCs is a widespread issue worldwide. The program in this study was implemented in Norway, but many of its elements can be recognised in other countries and societies facing the same demographic shift and the same wave of chronic disorders.

1.2 Terminology and background

Before directing the reader through this thesis, I will address terminology of welfare technology, and where RPM is situated in this context

Combining ICT with healthcare is nothing novel and have existed in various forms throughout the last decades. Each new technological advancement, whether telephone lines, broadband or text-messaging, have all been incorporated into healthcare in one form or another.

“Telehealth” has become a term which encompasses all distribution of health-related services and information within a geographical distance. Telehealth was created to provide a better quality of care and reduce health expenses for people living in remote areas that suffered from a lack of care-giving infrastructure.

As more technological innovations have entered society, different terms have been applied and adapted. The terms “Telemedicine” “Telemonitoring” and “e-health” is now more frequently adopted, even though they are often used interchangeably (Fatehi & Wootton, 2012). These all-encompassing terminologies are often too abstract when aiming to describe a specific form of technological architecture. Newer, more specific terms are therefore often adopted. “Telehealth” and “Telemedicine” is however still the main Medical Subject Headings (MeSh) applied when searching for publications in medical databases such as PubMed, and Ovid Medline.

In Norwegian semantics, the term welfare technology (velferdsteknologi) is applied when covering: “*Technological assistance that contributes to greater security, safety, social participation, mobility and physical and cultural activity, and strengthens the ability of individuals to fend for themselves in everyday life despite illness and social, mental or physical disability”* (Helsedirektoratet, 2012).

The term *welfare technology* is predominantly used in Scandinavia, considering how the combination of “welfare” and “technology” suits the political climate in the social democratic countries of Scandinavia (Mørk, 2010, p. 7). The term originated from Denmark and became the fixed term in Norway following the governmental white-paper “innovasjon i omsorg” of NOU 2011:11 (innovation in care). In international literature, the terms *ambient assisted living* (AAL) and *personal connected health and care* (PCC), are more frequently used, and mostly fit the same concepts.

Welfare technology is used to cover a broad range of various caregiving technologies. Welfare technology is divided into four categories by the Norwegian Directorate of Health (NDH) (Helsedirektoratet, 2012, 2017b):

(1) *Safety technologies* enable users to feel safer and contribute towards elderly being able to live at home longer. Applications include possibilities for social participation and to hinder solitude and isolation

(2) *Empowerment technologies* enable users to better master personal health and diagnosis. Applications include technological solutions towards people with chronic diseases, psychological challenges and users with a need for rehabilitation. *RPM* falls under this category.

(3) *Diagnostic and treatment technologies* enable advanced medical investigation and home-based treatment.

(4) *Wellness technologies* contribute towards users being more aware of their health, and to help with regular day to day activities.

RPM is thus a branch of welfare technology. RPM is specifically a method of securely transmitting medical data to and from a remote location to a response-service managed by healthcare personnel, allowing remote medical supervision of patients.

1.3 Thesis outline

In section 2, I will present the conceptual framework adopted for this thesis. I will begin by describing the ideas and concepts behind technological transitions and relate it to the concept of the multi-level perspective (MLP). Next, literature from technological innovation systems will be discussed. Lastly, the analytical framework adopted for empirical operationalisation and analysis will finish the section.

In Section 3, I will present the methodological approach used for answering the research questions of this thesis. This involves a qualitative case study, found suiting for the conceptual framework adopted. Empirical collection approaches include document analysis, literature review, interviews, observations and field-work.

In Section 4, I will map and present each case of RPM being tested in the municipalities/regions of Oslo (VIS), Sarpsborg (Mestry), Stavanger (GodHelseHjemme) and Trondheim (HelsaMi+).

In Section 5, the theory of Technological innovations systems and the Multi-level perspective will be applied to discover RPM as part of a wider sociological-transition and to explore possible drivers and barriers for implementation.

In Section 6, I will summarise the findings from the analysis in section 5 and conclude on this thesis research questions: **"**What are the drivers and barriers for implementing remote patient monitoring in Norwegian municipalities?" And, "How can remote patient monitoring be perceived as a wider part of a socio-technical transition?"

2 CONCEPTUAL FRAMEWORK

In this section I will position the chosen conceptual framework within the context of RPM, discussing why the selected theory is appropriate for the phenomenon of this thesis, and how it paves the way for empirical investigation.

The selected theory will be presented in separate but connected parts. With the purpose of conceptualising the first research question (RQ: 1: What are the drivers and barriers for implementing remote patient monitoring in Norwegian municipalities*?)*, the technological innovation systems (TIS) approach, and the framework of analysis for functions patterns will be presented.

When answering RQ: 2 How can remote patient monitoring be perceived as a socio-technical transition? - The Multi-level perspective theory will be discussed within the framework of context of remote patient monitoring. This provides a complex analysis of transition, and will conceptualise the layers of technological transitions, selection environments and niche co-evolution and co-construction.

Lastly, I will summarise the analytical framework that is applied throughout this thesis and explain how this affects further operationalisation. The section will be concluded with a discussion of the strengths and weaknesses of the selected theoretical concepts.

2.1 Innovation systems

Systems of innovation are frameworks for analysing and understanding innovation processes, as well as the distribution and production of knowledge in the economy. Innovation systems are composed of actors and institutions that develop, diffuse and use innovations (Markard & Truffer, 2008). The interaction between institutional and organisational elements creates the theoretical backbone of systems of innovation (Edquist, 2013).

Hekkert et al. (2007) argue that to make technological change sustainable, technical change alone is not adequate. Changes in the social dimension, such as industrial networks, regulation and user practices – cannot be avoided. As a theoretical model, innovation systems endorse phenomena such as path dependency, lock-in, interdependence, cumulative effects and other non-linearities, as also found in the multi-level perspective (MLP) theory.

Further, innovation systems are categorised for different purposes of analysis. The distinct levels are *National systems of innovation*, *regional systems of innovation*, *sectorial systems of innovation* and *technological systems of innovation*.

The different systems are defined and compared, with a basis in the functions they execute. *Functions* are conceptualised as the generation, diffusion and use of innovation, and the emergent properties of the interplay between actors and institutions. The various levels of system innovation are delineated regarding the functions of the system, and the purpose and scope of the analysis (the aggregate level). With the case of RPM implementation, the framework provided by *technological innovation systems* (TIS) fits these functions, as an emerging service, framed around a new technological architecture.

The concept of “innovation system” has won the approval and swayed an increasing number of innovation scholars interested in the processes underlying innovation, industrial transformation and economic growth. Innovations system approach has gained traction among international organisations such as the OECD, The European Commission, and UNIDO (Bergek et al., 2008).

2.2 Technological innovation system (TIS)

Innovation systems that focus on a particular technology is conceptualised as *technological innovation systems*. The TIS model has been developed to study the emergence and production of new technologies over time, and to identify general patterns guiding the course of such processes (Meelen & Farla, 2013). Markard and Truffer (2008) describes TIS as "*A set of networks of actors and institutions that jointly interact in a specific technological field and contribute to the generation, diffusion and utilisation of variants of innovative technology and/or a new product".*

Before utilising the theories of TIS on the study subject at hand, the analysis first involves choosing a starting point. The starting point is either identifying the field of analysis as a *knowledge field*, or a *product/artefact (Bergek et al., 2008)*. For operationalisation, the two starting points represent separate ways of empirical delineation. In the context of RPM, *knowledge field* represents the broader sphere of welfare technology and the different connections. The product/artefact is narrower in its analysis and seeks to conceptualise a specific product, for example, RPM technology. When adopting TIS concepts, the starting point will be the *product* of RPM, since externalities and disconnected actors are covered in the MLP framework in the concepts of landscape and regime.

2.2.1 Structural components of TIS

A technological innovation system is conceptualised through its structure. The structure represents the relationship between actors, networks and institutions that develop, diffuse and use innovation (Markard & Truffer, 2008).

Actors

Actors represent the "players" involved in the system. Actors are individuals, but also organisations such as private firms, non-governmental agencies, research institutes, universities etc. The relationship between the actors is manifold. Actors may compete or collaborate, and most often have different visions for the innovation. In the case of RPM, relevant actors are users, technology suppliers, primary care physicians, interest groups, home-care workers etc. Another distinction is made between the *inner core actors,* and supportive actors. Since RPM is in an early stage of diffusion, the focus in this thesis will be on the *inner core actors*.

Networks

Networks constitute important nodes for the transfer, or sharing, of knowledge among the various actors and institutions within the structure. Networks can have distinct functions, such as political networks, or learning networks.

Networks can be formal or informal. Some networks are geared towards a specific task within the structure and are, therefore, more orchestrated. Such networks can be seminars for involved actors or technology standardisation goals. Other forms of networks are less orchestrated and represent buyer-seller relationships, or interest groups giving recommendations towards the relevant actors. Networks are therefore often oriented towards either technological tasks, market formation, or political initiatives. While formal networks often are easy to identify, informal networks might often be more hidden and often require interviews with the *inner core actors* to be observed and mapped.

Institutions

Institutions set incentives for actors to complete particular activities, and to avoid others (Markard & Truffer, 2008). Institutions are rules that influence the activities and decisions of the actors. Institutions include norms, laws, regulations, guidelines, contracts, values, culture, cognitive frames etc. Institutions can be interpreted as the rules of the game, while actors, or organizations, are the players (e.g. Edquist, 2005; North, 1990). The concept of institutions shares many distinct similarities with the socio-technical regime conceptualised from the MLP framework. In the analysis, institution will be covered by the Multi-level perspective, in the form of regime selection environments (RSEs), covered in 2.4.2.

Identifying the structural components of the system (actors, networks, institutions) provides a basis for the following step, which constitutes the core of the analysis: analysing the TIS in functional terms (Bergek et al., 2008)

2.2.2 Functional patterns

Actors, networks and institutions thus constitute the players, norms, culture and rules of the system, i.e. the structural components. Functions represents the interplay between these actors, and the process of how specific policy goals are meet. However, actors do not necessarily share the same goal, and they do not have to be working together. Indeed, conflicts and disagreement between the various structural components are part of the dynamics of innovation systems (Bergek et al., 2008).

The concepts of “functions” (in some articles referred to as activities) is not commonly defined, and therefore the understanding of the dynamics vary among scholars. When applying the analysis of functions towards the TIS of RPM, the framework provided by Bergek.Et al. 2008: *Analysing the functional dynamics of technological innovation systems: A scheme of analysis*, is adopted. The analytical framework provides seven key functions that are identified through a qualitative methodology and given a “generic” explanation towards the functions they fulfil within the TIS. When discussing these functions below, examples from RPM will be used to exemplify.

i. **Knowledge development** represents the knowledge base of the TIS. Important distinguishes in types of “knowledge” can be technological, scientific or market knowledge. This function describes how well the TIS is understood, and how this knowledge is diffused to other actors. For measurement, indicators could be the size of R&D projects, academic activity on the subject/service, or patent applications.
In the case of the RPM program, knowledge development can be categorised as two main knowledge fields. The first represents the scientific knowledge around the costs, improved efficiency, improved quality of life and other success criteria of the service. The second crucial knowledge field is how well the diffusion of knowledge is shared with other municipalities going through the same endeavour of RPM implementation, such as how to organise, how to adopt the technology and which user’s groups have the most benefit of the service.

ii. **Influence on the direction of search** describes the incentives and/or pressure to enter the TIS. Here the level of vision, expectations and belief in growth potential in the specific system (i.e. RPM) is measured. To indicate how well established this function is within

the structural components, the extent of regulatory pressure or market growth can be examined.
For RPM, this function is closely interlinked with landscape externality of the demographic shift, indicating a substantial growth in future consumers/users.

iii. **Entrepreneurial experimentation** illustrates the technological and industrial development of the TIS. Experimentation with innovative technologies/artefacts and applications within the TIS is necessary to avoid stagnation. For measurement, mapping the diversity of firms and the diverse types of applications within the TIS, provides insight into the entrepreneurial experimentation of the TIS. In the case of RPM, the two main technological suppliers, Dignio AS and Imatis AS, are testing and experimenting different technologies and applications, and some levels of experimentation is already observed.

iv. **Market formation** for an emerging TIS, markets may be underdeveloped - Performance may be poor, customers/users is fragmented in their demand. This generates uncertainty in demand, and how the market works. Market formation usually develops trough three distinct phases: First, the nursing market, which represents the early phase where the TIS is still in radical formation. Second, the bridging market where volumes and actors increase. Finally, the mature market, where the TIS is established within the mass market. This final phase often develops several decades after the formation of the initial market. To measure in which phase a TIS is located, the researcher needs to analyse the demand, purchasing power of potential customers and the institutional stimuli for market expansion. For RPM, the level of market formation is heavily interlinked with how wide the scope of empirical delimitation is set. While the branch of RPM is rather underdeveloped in Norwegian municipalities, similar systems is being tested and implemented around the world.

v. **Legitimation** the function of legitimacy is a matter of compliance with relevant institutions and social acceptance. The TIS needs to be considered desirable and relevant for resources to be mobilized. Legitimacy also sways expectations for the TIS and is acknowledged as a prerequisite for the formation of new industries. For understanding the functional dynamics of legitimacy, an analysis of various actors and stakeholders and their considerations towards the TIS must be mapped. With RPM as the research topic, it is crucial to understand which level of legitimacy this new healthcare service has for general practitioners, healthcare workers and governmental stakeholders.

vi. **Resource mobilization** refers to the function of how well the TIS can activate human capital through education, entrepreneurship, management, financial capital and complementary assets such as interlinked services, products, infrastructure etc. For measurement and analysis, rising volume of capital, volume of human resources towards the field and changes in complementary assets must be mapped and examined. The TIS surrounding RPM in Norwegian municipalities is heavily reliant on capital and human knowledge around this novel form of healthcare delivery.

vii. **Development of positive externalities** capsulate the generation of positive externalities derived from the six previously mentioned functions, and how these positive externalities entwine and incorporate together. The function of development of positive externalities is thus not independent but embody the strengthening of the other six functions. It may therefore be viewed as an indicator of the overall dynamics of the TIS. For analysis, its thus important to capture the strengths derived from knowledge development, Influence on the direction of search, entrepreneurial experimentation, market formation, legitimation and resource mobilization and how they together create positive externalities between each other. An example for RPM, can be how knowledge development increases the legitimation of healthcare workers, thus boosting the market development.

2.2.3 Assessing functionality

After covering the interplay of functions within the structural components of the TIS, the researcher can do a tentative evaluation of system functionality. Here evaluating not *how* the system functions, but *how well* the system functions. Before evaluating on *how well* the system functions, the researcher needs to assess in which phase of development the TIS is located and whether there is similar TISs that the system can be compared to. In defining the phase, TIS have two different articulations - The *formative phase* and the *growth phase*.

The *formative phase* of development is characterised by high uncertainty in terms of markets and technologies. Price and performance is not well developed, demand from consumers/users is unarticulated and a volume of diffusion and economic activities which is but a fraction of estimated potential (Bergek et al., 2008). For functional understanding, the term "nursing market" is here a terminology of the *market formation*. In the *growth phase*, the system shifts to expansion and large-scale diffusion through the establishment of *bridging markets*, and subsequently *mass markets*. Categorising a TIS into one of these phases is not always as relevant, since this will differentiate between the level of empirical delineation, and which function that is observed. However, in the case of RPM, the system is decidedly located in the *formative phase* having only been functioning for a brief period, as well as only covering a miniscule amount of the available market.

The next step in analysing the TIS, is mapping the inducement and blocking mechanisms. To understand these mechanisms, the development of functions is analysed. Is the function developing in a positive direction, or is it slowed-down? In a *formative phase*, such mechanisms for functionality is important to map and analyse when aiming to explore which functions that needs to be nurtured for expanding and growing the TIS.

Figure 1 illustrates how such an analysis of blocking mechanisms and functional patterns is analysed by Bergek et al. (2008).

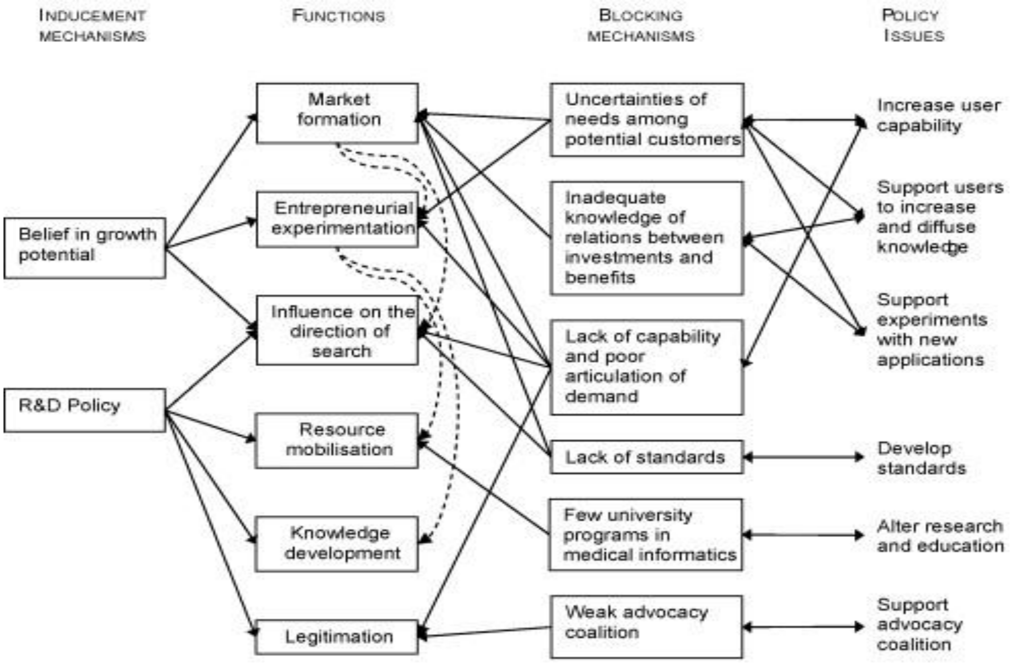


Figure 1 (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008)

2.2.4 System delineation

How to delineate an innovation system is both important, but also challenging. Delineation affects system boundaries of analysis and will thus influence the findings of a study. It is therefore important to describe which parts of the system that is investigated, and which parts that is left out. Choices between analytical depth and whether to include some or all related products/services within the technological field must be made.

When dealing with such choices, a general answer is to consider the research questions and the purpose of analysis (Markard & Truffer, 2008). However, system delineation is often an iterative process, where system boundaries is adjusted as the understanding of the system deepen.

The delineation of this thesis, when exploring the technological innovation system encompassing the RPM program will be on a meso-aggregate level. Since the system is in an early phase, with rapid development, focusing on the *inner core actors*, and the functional patterns that this system outlines will strengthen the rigour and the relevance of the study. By expanding the system further, essential components and functional patterns would most likely be drastically different after a brief time span. I therefore chose to investigate those structures that is found empirically essential for fulfilling for the system. The drivers and barriers, interpreted through functional patterns and blocking mechanisms, will be extracted from the core of RPM functionality.

The next sections will discuss technological transition literature, and the Multi-level perspective of socio-technical analysis, with the purpose of answering the second research question of this thesis.

2.3 Technological Transitions and Socio-technical change

The analysis of radical innovation processes and technological transformations of entire societal sectors is a common study object in the innovation literature. Scholars have approached such fundamental changes from at least two major perspectives. Either:

I. *Focusing on the dynamics of an innovation, that has the potential for disruptive changes. Especially, focusing on drivers and barriers of a particular product or technology and the identification of general patterns shared by divergent innovation processes (Markard & Truffer, 2008, pp. 596-597).*

II. *Analysing broader transitions processes at a more aggregate level, including a variety of innovations. In such a transition, questions regularly consist of which factors that drive these transformations processes (ibid).*

The concept of socio-technical transitions combines these two approaches.

Frank W. Geels (2002), describes technological transitions as major long-term *technological changes* in the way societal functions are accomplished. Thus, not only changes in the technology itself, but also elements such as user practices, industrial networks, infrastructure, policies and symbolic meaning, which all ingrained describes a *sociotechnical configuration*. A technological transition is therefore a change from one sociotechnical configuration, to another, not only changing the technology, but also markets, user practises, policy and cultural meaning (Frank W. Geels, 2010, p. 495).

The process of such a change does not occur easily, because the elements of a *socio-technical configuration* are strongly interlinked and aligned together (Frank W. Geels, 2002). Innovative technologies often have a challenging time diffusing on a larger scale, even if they are superior (supposedly). Because existing regulations, infrastructure, user practices and maintenance networks tend to be configured in support of the existing technology.

Furthermore, the short-term costs are likely to be high as new technologies don't have the advantage of dynamic scale and learning effects, which results in cost reductions per unit of output and evolutionary improvements in the technology (Kemp, 1994). The inertia of well-established technology can therefore be a large barrier for implementation and diffusion of radical innovative technologies.

Connections between “sustainable transitions” and RPM can be found in governmental policy plans. “Samhandlingsreformen” (Helse- og Omsorgsdepartementet, 2009), which states that its goal is to improve public health and enhance healthcare services in a *sustainable* manner. The “sustainable” part refers to managing the demographic shift. At the same time, public health services are large and complex, making their sociotechnical configuration hard to penetrate for innovative technologies. Sustainable development emphasises precise interest in the normative direction of innovation. Thus, the challenge of innovation no longer rests solely in economic potential, but also in the societal changes induced and the consequences of this for social sustainability (Smith, Voß, & Grin, 2010, p. 437)[2].

In understanding the transition process, technological change has many different models that have been tested and utilised[3]. In this thesis, the multi-level perspective (MLP) and Technological innovation system (TIS) will be adopted. MLP understands transitions as outcomes of alignments between developments at *multiple levels* (Frank W. Geels & Schot, 2007, p. 399).

2.4 The Multi-level perspective

Schot and Geels (2008), explains that a root notion of MLP is that transitions occur through interactions between processes at three distinct analytical levels. These levels are categorized as the *niche-level*, *regime-level* and *landscape-level*, together constituting a nested hierarchy of structuring processes (Smith et al., 2010). The different levels are not meant as existential characterisations of reality, but as an analytical concept which purpose is to understand the complex dynamics of socio-technical change (Frank W. Geels, 2002).

2.4.1 Macro level (Landscape)

The *socio-technical landscape* includes the external pressure on the regime and niche-level. The *landscape* is explained as an external structure or exogenous force that describes the interaction of actors within the regime and niches, while also pushing and pulling its technological trajectories. Factors affecting the socio-technical landscape is for example war, oil prices, change in values, cultural norms or other forms of societal challenges (Frank W.

[2] A problem often brought up in «welfare technology», as there are multiple factors which effect is hard to evaluate against another. Like costs>patient welfare

[3] Regime Transformation, technological revolutions, system innovation etc.

Geels, 2002). Changes at the landscape level are slow, and often take decades, but may also be unexpected external shocks, such as wars or budgetary crises.

Van Driel and Schot (2005) has further conceptualised the above-mentioned attributes of landscape developments into tree types: (1) factors that do not change, or that change very slowly, (2) rapid external shocks, and (3) long term changes in a certain direction. These forms of pressure do not “determine” change, but provides deep structural forces that make some actions easier than others (Frank W. Geels & Schot, 2007, p. 403).

The case of RPM implementation can thus be viewed as a transition that is responding to externalities found at the landscape-level. These externalities create instability on the regime level, which RPM as a niche tries to align itself with.

2.4.2 Meso level (Regime)

The *sociotechnical regime* within MLP theory, is an extended version of Winter and Nelsons (1982) *technological regime* (Frank W. Geels & Schot, 2007). A technological regime refers to the shared cognitive routines within an engineering community and explains how they work and design along *technological trajectories*. Sociologists have since broadened this definition, arguing that scientists, policymakers, users and special-interest groups also bestow “power” and change of technological development (Frank W. Geels & Schot, 2007, p. 400). A socio-technical regime thus constitutes the mainstream and highly institutionalized way of currently realising societal functions. A sociotechnical regime forms the “deep structure”, that produces the stability of an existing sociotechnical-system (Frank W. Geels, 2011, p. 27).

Change that occurs on the regime level tend to be incremental and path dependent. The stability of well-established socio-technological configurations rely on linkages between different elements. These linkages, that connects the varied elements, are the result of activities of social groups and actors which produce and reproduce them (Frank W. Geels, 2002). When radical, innovative technologies try to establish themselves within the existing socio-institutional framework, resistance often occur.

Implementing innovative solutions is often complicated, since existing user-practises, norms and rules are well established. While the technology accepted in sociotechnical systems tends to be sufficient in solving its task in “todays” environment, its established routines and technology might not be able to solve future challenges (Smith & Raven, 2012); a pattern that seems to fits with the challenges the health sector currently faces with regard to the demographic shift and an influx of patients with chronic diseases.

The Norwegian healthcare sector is, both at the municipal, regional and state level, a heavily interlinked regime which has “deep” practises that is produced and re-produced. RPM can thus be viewed as an *innovation* that on certain dimensions challenge these regime-structures. Understanding how the regime is configured, creates opportunities for the researcher in understanding how it is linked with the other levels, and where resistance is extensive.

2.4.2.1 Regime selection environment

In more detail, the regime is a set of self-reinforcing practises, and regime selection environments (RSEs) which feedback upon another (Frank W. Geels, 2011; Smith & Raven, 2012). These RSEs make up the configuration of elements within the socio-technical configuration. Technological transition literature does not apply the concept of RSEs within the socio-technical configuration coherently (Markard & Truffer, 2008). Some key analytical dimensions are however more frequently adopted than others. Below follows a description of six RSEs extracted from Smith and Raven (2012), and their connection within the transition of RPM in municipal healthcare:

a. ***Technologies and infrastructure*** represent the dominant and established architecture of the regime, and involves articulated technical standards and infrastructural agreements (Smith & Raven, 2012). Innovative technologies are often not compatible with existing structures, making niche innovations working sub-optimally with the existing infrastructure. In the case of RPM, the service must adopt and co-align to the existing IT-structure (EPJs) being used by the municipalities involved in the program.

b. ***Industry structures*** embody the arrangement and network of relationships, industry platforms and resource allocation procedures within the current regime. These connections and structures have co-evolved over time and rooted itself on the dominant design (ibid). For RPM to break through these structures, it must align itself with these arrangements. These can be the refunding structures for medical help, and healthcare workforce allocation on time usage per patient.

c. ***Knowledge*** relate to the shared socio-cognitive practises and guiding principles that are geared towards incremental knowledge development. Niche novelties thus often have insufficient resources attributed towards R&D development, academic research and other knowledge building activities which enhance the innovation.

d. ***Markets and user practises*** symbolise stabilised market institutions, supply and demand, price mechanisms and user preferences. RPM might require inconvenient user practises compared to usual care. For accustomed habits to be changed, RPM must be perceived as a superior service.

e. ***Culture*** is the cultural significance attached to a specific regime. This constitutes for example the regime's widespread symbolic representation and appreciation. Niches have a disadvantage, because they often represent unfamiliar cultural values. In contemplation of RPM, this cultural shift represents the fundamental values of patient relationship.

f. ***Public policies and political power*** represent prevailing regulations, policy networks and relations with incumbent industries. Political power is framed upon sustaining the status quo, in terms of budgets, taxes, jobs and votes (Smith & Raven, 2012). RPM, being a new service, requires large initial infrastructure, rearranging of work environments and other changes that will stir up budgets, and might create friction with certain voting blocks.

Together these RSEs constitute the selection environment that rejects, accepts and configures external niches trying to establish themselves within the dominant design of realising a societal function.

2.4.3 Micro level (Niches)

Technological niches form the micro-level where radical novelties emerge (Frank W. Geels & Schot, 2007, p. 400). Radical innovations often develop at the micro-level in niches, either in response to top-down pressure in the landscape-level or in a bottom-up fashion from niches (Genus & Coles, 2008). Niches act as a protected space where radical innovation can experiment and enable social networks to be built up, without pressure from the RSEs. For a niche innovation to "break" through the socio-technical regime, a "window of opportunity" must be fixed. These “windows” can occur when the current socio-technical configuration is unable to serve its purpose or design, or when there is external pressure coming from the landscape level, which in turn creates incentives for novelties. Niches that provided the “tipping point” in historical transitions, had to overcome the constraining influences of regimes, branch out, connect with wider occurring changes, and drive transformations in those regime structures over the longer term (Smith et al., 2010, p. 441).

Synthesised, Frank W. Geels (2011) has identified three core processes in niche development. These are listed below, together with their connection to RPM:

The articulation (and adjustment) of expectations or visions*,* which provide guidance to the innovation activities, and aim to attract attention and funding from external actors. For RPM, this represent the effects of the implementation. These expectations are however interpreted differently among actors and agencies. For example, a substantial increase in quality of life is most pressing for the users and their relatives. The increased productivity and decreased costs associated with the implementation is perhaps envisioned and expected to a larger degree among government agencies and institutions in decision making.

The building of social networks and the enrolment of more actors, which expand the resource base of niche innovations. The social network for RPM is important. Getting healthcare personnel to understand and recruit users are essential for a successful implementation. Especially in healthcare, some actors influence decision making amore then others, such as general practitioners.

Learning and articulation processes on various dimensions, e.g. technical design, market demand and user preferences, infrastructure requirements, organisational issues and business models, policy instruments, symbolic meanings (Frank W. Geels, 2011, p. 28). The trial of RPM is a dynamic process where changes to the technological equipment, organisation of response-centres, policy initiatives and user preferences are changing throughout the program.

RPM is part of a larger process (welfare technology) of *niche novelties*, which has gained access through a window of opportunity. This “window of opportunity” is found in the national welfare technology scheme but might also be interpreted through the overall digitalisation of the healthcare sector and the demographic shift. With the commencement of the remote patient monitoring program, RPM solutions are being tested against the dominant design of usual care in municipal healthcare.

2.4.3.1 Niche co-evolution and co-construction

MLP theory explains that novelties at the niche-level often have a miss-match with the existing regime, thus making it hard to *breakthrough*. An important pattern in the breakthrough of innovations is therefore located between the linkages of multiple technologies (F. W. Geels, 2005). These linkages can be analysed as the *co-evolution* and *co-construction* of emerging novelties.

Technical add-on and hybridization, emphasise that niche innovations and the dominant design not always compete from the start, but might create some sort of symbiosis (F. W. Geels, 2005, p. 629). When analysing RPM technology, many of its compound elements do not necessarily compete with existing solutions. For one thing, the services that RPM delivers might not be within the municipal services at all, making the RPM service an add-on to the regime.

Sequential accumulation is an interaction where the "first" technology acts as a "catalyst," hence initiating a breakthrough into the regime. This provides opportunities for similar technologies to link up and exploit the window of opportunity created. Welfare technology solutions in the form of safety alarms, GPS localisation devices and medical pill dispensers, work as a "stepping stone" for further technological diffusion of RPM. In both Oslo (VIS) and Trondheim (HelsaMi+), initial attempts at implementation began with safety technology and medical pill dispensers. Staff knowledge on the assessment systems, their technical know-how, as well as contact with the technological supplier has therefore already been established when the RPM program initiated.

These elements of co-evolution and co-construction correspond with the various pathways in which novelties emerge and develop.

Further laying the "fundamentals" of transition processes, Frank W. Geels and Schot (2007) explains that niche innovations have a *competitive*[4] relationship with the established regime, when they aim to replace it. Niche innovations have a *symbiotic* relationship if they can be

[4] Similar to «disruptive innovation».

embraced as competence enhancing add-ons in the existing regime, to solve problems and improve performance (thus being like the established typology of incremental vs. radical technology but focusing solely on niches).

The process of digitalising the healthcare sector with welfare technology is often followed by further implementations and adaptations of more radical technology (changes in organisation, processes and services). Welfare technology, such as medical pill dispensers and safety features (e-locks, fall-alarms, etc.), have slowly but steadily been piloted and adopted by numerous municipalities (Skretting & Bærum kommune, 2015) (Stavanger, 2016) (Ausen, 2016). This is not the case for distance monitoring of chronically ill patients, i.e. remote patient monitoring. This does not mean that RPM necessarily is competitive, but rather aligns itself somewhere between being symbiotic and competitive, depending on which actor or agency it affects.

In understanding the dynamics of transition from one system to another, the three analytical levels of landscape, regime and niche must be understood as a co-evolutionary process between heterogenous elements. Figure 1 (on the next page) exemplifies a generic model on how these three levels interact in a transition process.

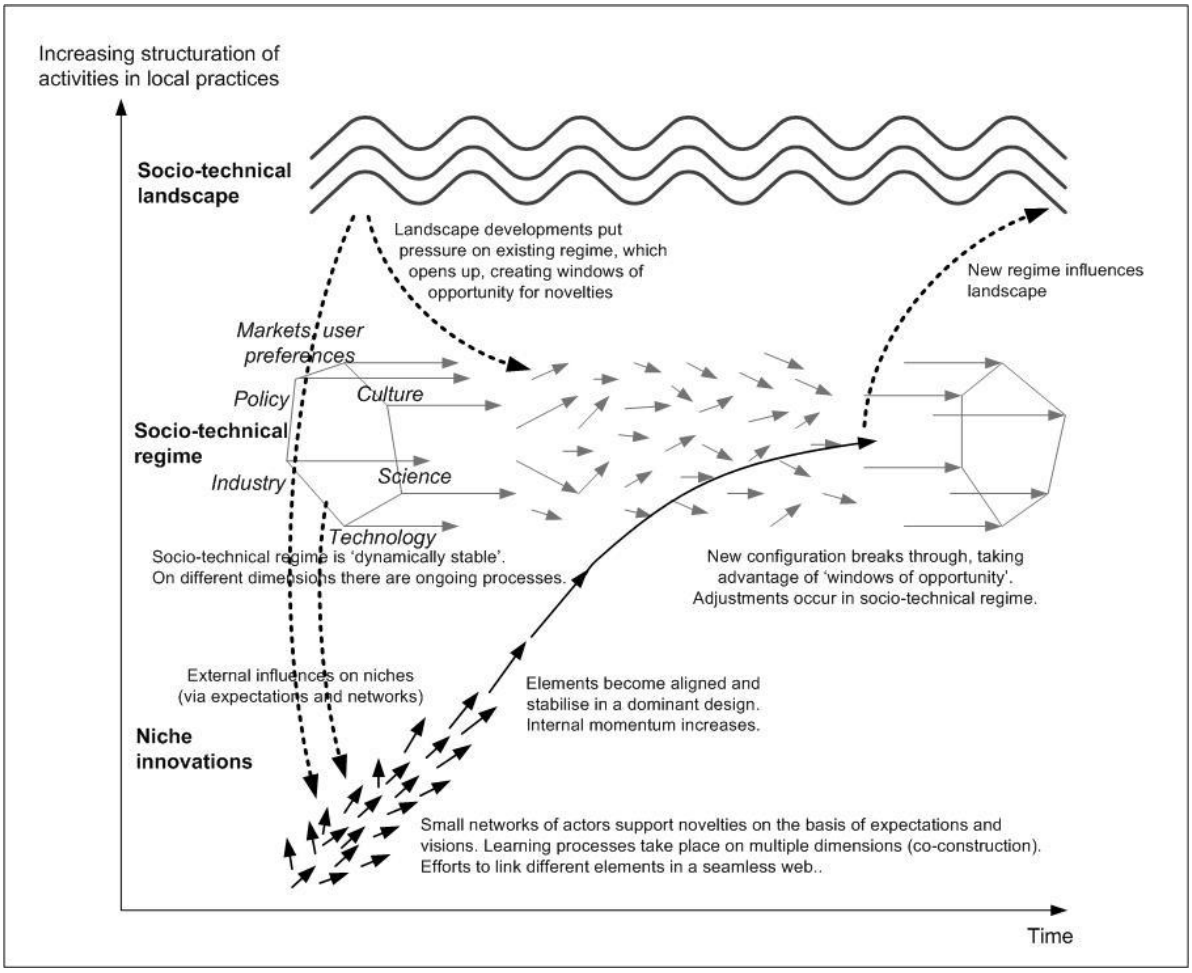


Figure 2 Multi-level perspective (Geels & Schot 2007)

2.5 Analytical framework

Technological innovation system theory is selected to examine the first research question RQ:1) "What are the drivers and barriers for implementing remote patient monitoring in Norwegian municipalities?"

The framework applied follows the schematic analysis put forward by Bergek et al. (2008), which presents a method for mapping structural components (actors, networks and institutions) and the *phase (formative or growth*) of the system. Further, the *inducement mechanisms* and the dynamics of *functional patterns* is examined. Drivers is then interpreted from "how well" each function behaves, and barriers is derived from the blocking mechanisms. This provides an in-depth analysis, at the meso-level, on the most vital elements for implementation and growth of RPM as a municipal service.

Figure 3 exemplifies the model that will serve as a tool for the analysis of functional patterns, to uncover drivers and barriers in RPM implementation.

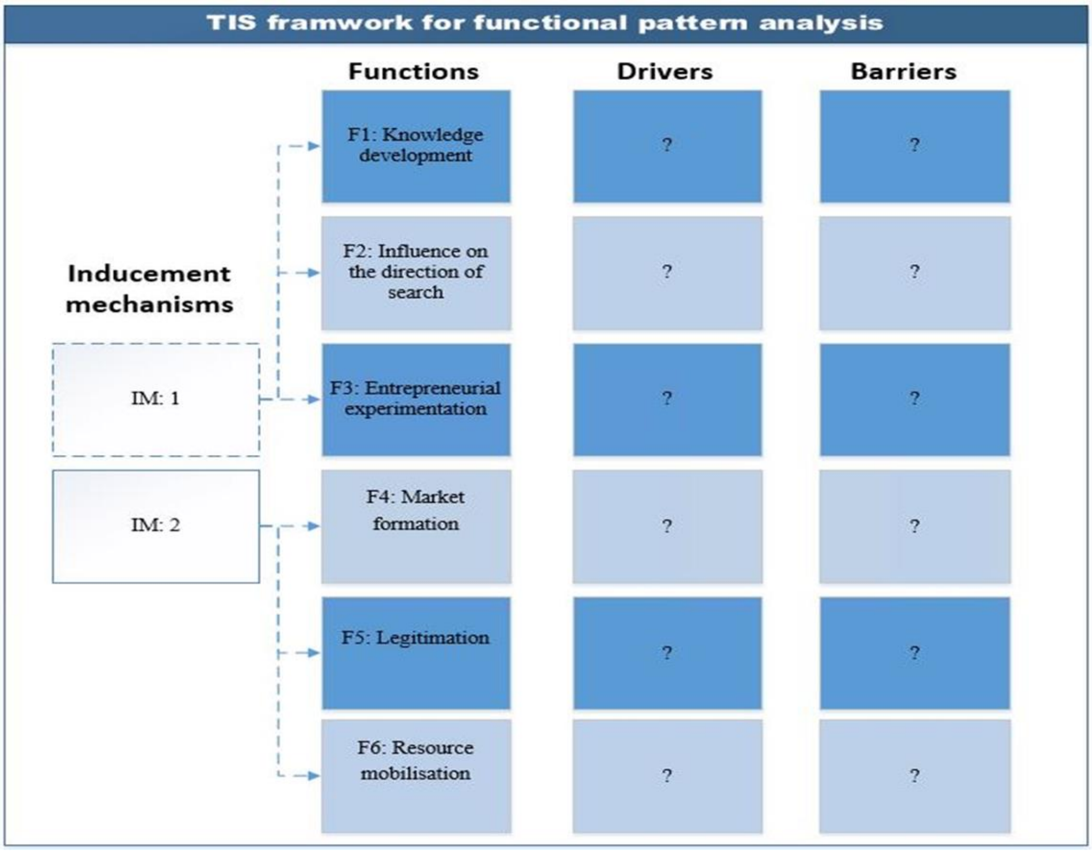


Figure 3: Analytical framework of functional pattern analysis. The figure is based on (Bergek et al., 2008)

When answering RQ (2) *How can remote patient monitoring be perceived as part of a wider socio-technical transition?"* the analytical framework of the Multi-level-perspective, first presented by Frank W. Geels, will be adapted.

Firstly, the landscape level provides insight into which external factors that pushes and pulls for change within the *regime* and *niche-level*. Further, the regime level will be analysed, and more specifically the various regime selection environments (RSEs) that either restrict or accept diffusion. Lastly, the niche will be covered, analysing RPM as part of a co-construction and co-evolution niche, its window of opportunity, and how it aligns within the larger sphere of welfare technology implementation and growth.

Figure 4 illustrate how the MLP analysis will be used to illuminate RPM as a socio-technical transition, by utilising the concepts from landscape, regime and niche. Figure 4 is based on the articles of (F. W. Geels, 2005; Markard & Truffer, 2008; Smith & Raven, 2012), and constructed for this thesis.

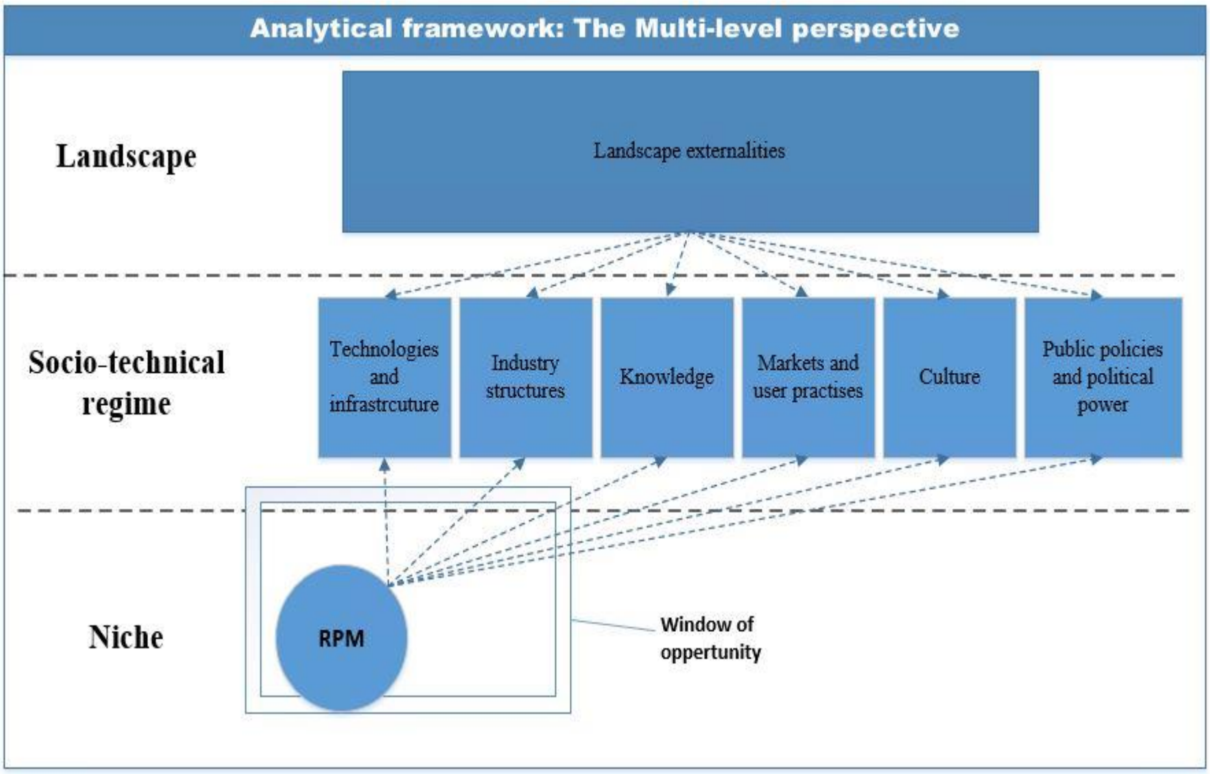


Figure 4: Analytical framework of MLP, to explore RPM as part of a wider socio-technical transition. The connected arrows represent possible acceptance, rejection and pressure dynamics between the three analytical levels. The model is a modified version, built on the generic figure 2, created by Frank. W. Geels

2.6 Strengths and weaknesses

Grin Rotmans, and Schot (2010), argue that the MLP is as an *"abstract analytical framework, that identifies relations between general theoretical principles and mechanisms. But it does not specify precise, substantive mechanisms of interactions between technology, culture, politics, economics, science, etc. To give precise explanations of such substantive relationships, the MLP needs to be complemented with more specific theories".*

This thesis is therefore adopting and combining concepts from Technological innovation systems, to strengthen the analysis. By employing these concepts, empirical delineation of the topic, and which actors to analyse becomes clearer.

This form of an "open framework" is welcomed by (Frank W. Geels, 2010, pp. 507-508), who view mobilizing insight from other theories as enriching and more suited than constructed MLP models (Frank W. Geels, 2011, p. 30). An integration between the two frameworks has also been presented by (Markard & Truffer, 2008)

Using the MLP to explain transitions related to ageing and health has been done previously by innovation scholar Pekkarinen (2011), who analysed population ageing and its socio-technical transition. Further, the analytical framework of functional patterns first introduced by Bergek et al. (2008) has been adopted in similar fashion, when analysing IT in home-care.

The health sector as a public organisation, is a complex system. A common criticism of the MLP is about the problem of drawing boundaries and defining the topic of analysis (Frank W. Geels, 2011, p. 31). The regime in this thesis will be limited to the development and transition of innovative ways of delivering healthcare towards users with chronic illnesses, more specifically NCDs. While MLP is often used for analysing transitions on the highly aggregate- level (electricity system, renewable energy, ageing in society), it also allows the researcher to scope the empirical topic, creating their own empirical delineation.

To gain empirical insight into the research questions, and the adopted analytical framework, a qualitative case approach was found most suitable. The next chapter will clarify choice of methodological advent, and the process of empirical accumulation.

3 METHODOLOGY

Methods concern how data is collected, analysed and processed. A methodology is therefore an approach in how to solve a problem and how to retrieve new knowledge. This chapter includes detailed descriptions of the research process and provides arguments for why the selected methods were chosen. The chapter also includes discussions regarding the strengths and weaknesses of the applied methods, and the rigour of the research.

Choosing the “appropriate” framework is the choice of what Harré (1979) termed as either “extensive” (questionnaires and statistics) or “intensive” (ethnography and qualitative analysis) research. Extensive research focuses on patterns and regularities among large groups of people, typically involving statistical analysis. Intensive research pursues processes with a small number of people, using interviews, ethnography and qualitative analysis for data interpretation(Cloke et al., 2004, p. 127). Given the specific context of the remote patient monitoring program, and the analytical framework chosen, a qualitative research approach has been adopted.

3.1 Qualitative case study

Schmid (1981) describes qualitative research as the study of the empirical world from the viewpoint of the person under study (Krefting, 1991, p. 214). Schmid also recognises two underlaying principles. The first principle states that behaviour is influenced by the sociocultural, physical and physiological environment – this being the nature of *naturalistic* inquiry. The second principle is a postulation that behaviour goes beyond what is observed by the researcher. Subjective meanings and impressions of the informant are critical in qualitative research, and it is the researchers “obligation” to access these (ibid).

A qualitative methodological approach allows you to get in-depth knowledge about regime dynamics, culture, behaviour and other “deep structures.” Within transition theory, formal quantitative methods may be limited to stable socio-technical situations (Smith et al., 2010, p. 444). However, the case of RPM implementation addresses an emergent, dynamic and reflexive phenomenon, where qualitative methodologies is more suited.

According to Robert K. Yin (2009), case studies are applied when the phenomena is contemporary-topical and complex. The case study is an intensive description and analysis of a phenomenon or social unit such as an individual, group, institution, or community (Merriam, 2002, p. 8). By concentrating upon a single phenomenon or entity, the case study seeks to describe the phenomena in depth.

Another advantage of the case study lies in its ability to function well together with both the concepts of technological innovation systems, and the Multi-level perspective framework. The case study allows the researcher to describe the behaviour of groups and/or actors within the regime, while also setting a much-needed boundary for the data collection. In an emerging field such as remote patient monitoring, different branches and facets of knowledge might occur, and a case study approach may therefore help the researcher to better frame its search light, and consequently avoid unnecessary complications.

3.1.1 Access and gatekeepers

Access and gatekeepers are an essential part of qualitative research. Arranging meetings with people who open doors, facilitate interviews and otherwise work as gatekeepers for academic research is often what makes a researcher eligible to collect data. However, for the researcher, how you gain access and how much influence the gatekeepers have on your academic endeavour, might constitute problems. In a "perfect" academic world, no influence or power-relationships would "contaminate" your data. In the real world, however, organisations are hierarchic, and people have their own interests. In the real world, however, organisations are hierarchic, and people have their own interests. No matter how you contact your informants, you will have no guarantees that your approach did not influence the data you managed to gather.

For this project, the initial gatekeeper was a contact from Dignio, a technological supplier for the remote patient monitoring program. I originally contacted the gatekeeper with hopes of writing a master's thesis in collaboration with the firm.

However, Dignio instead provided me with the contact information of Intro-International, a consultancy agency responsible for conducting quantitative cost-analysis and effect research on the RPM program. After contacting Intro-International, we agreed that I would conduct a literature review, which could be used in my master thesis, while also giving them valuable knowledge on the topic at hand. This collaboration also meant that I could join and observe seminars, meetings and establish contact with the different project leaders. Working with the researchers at Intro-International has been crucial for this study, giving me the opportunity to participate and observe meetings with The Norwegian Directorate of eHealth (NDE) and The Norwegian Directorate of Health.

3.2 Data collection and analysis

In this section, I will present the different processes of data of answering the research questions of this thesis. The data has been collected from document analysis, literature review, interviews, observations and fieldwork.

3.2.1 Document analysis

Document analysis is a systematic method for reviewing or evaluating documents – both printed and electronic material (Bowen, 2009, p. 27). Like other qualitative research methods, document analysis requires that data is investigated and interpreted to draw out meaning, understanding and develop empirical knowledge on the subject. Atkinson and Coffey (1977) refer to documents as “social facts”, which are produced, shared, and used in socially organised ways.

Document analysis is often used in a combination with other qualitative research methods, with the purpose of “triangulation” (the consolidation of methodologies in a study of the same phenomenon) (Bowen, 2009, p. 28). As a research method, document analysis is decidedly pertinent to qualitative case studies, in its focus on researching a single phenomenon.

While document analysis is time efficient, produces a broad coverage and gives the researcher valuable information, it also has some shortcomings.

Biased selectivity refers to how the gathered and available documents might shape the view of the researcher, leading to biased and less rigorous analyses. It might also be problematic in the sense that the available literature is “one-sided” meaning that some elements are extensively covered, thus neglecting others. This might again “dilute” how the researcher views the phenomenon, thinking some aspects of a phenomenon are already established, e.g. the drivers or barriers of RPM. It is here “triangulation” shows its necessity value, hopefully countering eventual bias, and providing trustworthiness to the study.

Analysing and interpreting government documents, research reports and other forms of documents has been crucial in many phases of this study. Firstly, to understand the complexity of the phenomenon, find out what kind of technologies are being used in the marked, how they are being used, and for whom they are developed. Secondly, for understanding what the government policy aims to achieve (effects), and how “they” plan to achieve it. And thirdly, to examine what kind of drivers and barriers previous research already has examined and documented. Having a firm grasp of the issues being studied, before making analytical judgements is an essential part of the case-study approach (Yin, 2013).

While literature on RPM is rather fain in Norwegian studies, international literature is comprehensive. In cooperation with consultancy firm Intro-International, a literature review on the subject was conducted and delivered to The Norwegian Directorate of Health.

3.2.2 Literature review

In the process of identifying users, actors, drivers, barriers and what RPM hopes to achieve, it quickly became obvious that information on the topic had to be gathered systematically. While the analytical framework provides clues and hypothetical discourse about where to empirically acquire such knowledge, it still needed a foundation as to what contemporary research on the topic already had identified. A concept-centric literature review on effects, drivers[5] (drivers) and barriers was hence conducted. The aim of this study was co-evolved together with Intro-International and The Norwegian Directorate of Health.

The literature review produced knowledge and information regarding which drivers and barriers to look for, why effects are so difficult to measure and the clinical state of people suffering from chronic diseases. This gave me a decisive understanding about the subject before conducting interviews with the involved actors. As Kirk and Miller (1986) specify: “qualitative research fundamentally depends interacting with informants on their own language, on their own terms” (Krefting, 1991, p. 214).

[5] Drivers has since been changed to drivers.

The literature review was delivered to The Norwegian Directorate of Health and Intro-international 10.02.2017. Below, you will find a presentation of the search strategy, the study selection process, and a summary of the information that was acquired. The full literature review can be viewed in attachment 1.

Search strategy

Searches were conducted in Medline Cochrane, PubMed and Swemed+, using Boolean searches. A full composition for database search approach can be viewed in attachment 1. Search strategy was supported with the assistance of a medical librarian, using the following keywords: Telemedicine, Telemonitoring, Telenursing, Telerehabilitation, Technology, Telemetry, Pulmonary Disease, Chronic Obstructive, Diabetes mellitus, Cardiovascular diseases, heart diseases, hypertension, blood pressure, welfare technology.

Articles or records published before 2013 was excluded. Other exclusion criteria included; Patients that were institutionalized, patients with cognitive disorders, healthcare technology not being measured at a "distance", countries not in the OECD. Languages was restricted to English, Norwegian, Danish and Swedish. A list of exclusion criteria's and their reasoning can be viewed in Tabell 2.

Exclusion criteria	Explanation
Articles published before 2013	Research and literature within the field has grown sustainably in recent years. To make a state-of-the-art review, present-day research is preferable.
Users that is institutionalized	A large part of RPM implementation is to reduce institutionalisation and keep patients home longer.
Users with cognitive disorders	While some distance monitoring technology have shown positive results in treatment of patients with cognitive disorders, patients are not able to consent with the intervention.
Technology not using distance-monitoring	Telemedicine, RMP, Telehealth, and Telemonitoring are the preferred intervention methods analysed in this study. However, regarding the conceptual confusion in the terminology other interventions are also considered, if it includes distance monitoring within the research question.

Tabell 3-1: list of exclusion criterias for literature review, and a brief explanation

Study selection

Searches was conducted in Medline Cochrane 22.12.2016, SweMed+ 23.12.2016 and PubMed 25.12.2016. Identification of eligible literature followed a 4-step selection process and is presented in figure 5.

1. **Identification:**
    a. Phase 1: 901 records identified through database searching and admittance of exclusion criteria (language, year).
    b. Phase 2: 10 additional record identified through Norwegian (n=8) and Danish (n=2), totalling n=916 records.
2. **Screening:**
    a. Phase 1: 690 records removed for duplication, availability, title and exclusion criteria Phase 2: 136 records screened for abstract, methodology and exclusion criteria, 72 records removed, totalling n=64 record remaining.
3. **Eligibility:** 64 full text articles assessed for quality and fitting research objectives. 31 articles excluded
4. **Included:** 33 records included in the literature review comprised of: 5 systematic reviews on effects, 4 systematic reviews on barriers and drivers/drivers, 10 reports/cases, 8 randomised controlled trials, 1 predictive algorithm study, 2 meta synthesis/analysis, 1 scoping review, 1 data analysis and 1 integrative review.

Literature review: Summary

Webster and Watson (2002) advise that a literature review is an essential feature of any academic project. A well conducted literature review creates a firm foundation for knowledge, facilitates theory development and uncovers areas where research is needed. Empirical knowledge gathered for the literature review was indispensable when comprehending critical elements of this thesis. While the review focused on medical journals, and not innovation studies, the lessons learned helped me in a multitude of ways.

First, it made me aware of the various terminological issues related to “telehealth” solutions (as discussed in section 1.4). Before conducting the review, I was unaware of the numerous terminologies, lack of standardisation of nomenclature and the various definitions used when addressing various distance monitoring solutions. This made it clear to me that the thesis needed more clearly defined boundaries, both empirically and theoretically. Accordingly, the literature review helped me frame the research questions more precisely, and helped with creating connections to analytical frameworks, thus *facilitating theory development*.

Second, the review helped shed light on specific areas where there was a need for further research and pointed to a general lack of considerable evidence on the effects (on clinical values, cost reduction, quality of life, etc.) of telehealth technologies. While there were certainly positive trends on a range of topics, the results were often ambiguous and scholars often criticised articles for being of poor rigour and methodological quality.

Lastly, the study provided a better comprehension of how chronic diseases touches patients' lives. This was important both ethically, as in understanding the gravity of their situation, but also educationally, as it made me able to manoeuvre conversations with healthcare personnel without halting the conversation with "novice" questions. In this way, the literature review created a *firm foundation of knowledge*. Bergek et al. (2008) states: "*Moreover, an analysis always needs to have a strong international component simply because a spatially limited part of a global TIS can neither be understood, nor assessed, without a thorough understanding of the global context".* Having a firm understanding of the international scientific literature was essential when analysing, using the TIS framework.

After conducting the review, interviews with actors involved in the ROM program was conducted.

3.2.3 Interviews

"*Interviewing is rather like a marriage: everybody knows what it is, an awful lot of people do it, and yet behind each closed door there is a world of secrets" -A. Oakley (1981)*

An interview is a great method to access information about events, opinions and experiences. The purpose of the interview is to gather the diversity of opinions and experiences to give an understanding as to why the opinions differentiate between the actors. As Patton (2002) explains: "The fundamental principle of qualitative interviewing is to provide a framework within which respondents can express their own understandings in their own terms."

The process of getting access to the informants represented a couple of issues. Considering how Intro-International helped me get access, some of the project leaders questioned my motives. Therefore, it was important to explain that participation was voluntarily, and in no way, was forced upon them. Having participated in a conference with the project leaders in Sarpsborg, directed by the Norwegian Directorate of Health, I had the ability to make acquaintances. Those that I did not have the opportunity to meet, had the ability to verify my presence. My contact with Dignio, meant that they were forthcoming when scheduling observations and interviews.

A total of 17 interviews was conducted. The length varied from 30 to 70 minutes. Before the tape recorder was activated, I clarified my purpose, asked for permission to record their voice, and noted their age, academic background, years in the healthcare service, their job-description within the project and how long they had worked with the project. All informants agreed to record their voice. I also made sure to mention that all informants would be anonymised, and that no part of the information they gave me could be used to harm their professional or personal life. When conducting interviews in Grünerløkka (Part of the VIS project), Karin Almqvist from The Architect and Design Academy in Oslo, helped with field notes.

Interview guide

A research interview usually follows an interview guide. The interview guide lists the questions or issues that are to be explored over the course of the interview (Patton, 2002, p. 247). An interview guide can be structured, semi-structured or unstructured, or a combination of these. The structured interview follows a concrete set of questions and allows little room for deviances. The semi-structured guide has a set of questions in which the interviewer guides the interview, however there is also open-ended questions, breaking the structured process. The unstructured interview guide is informal, spontaneous and the direction of the conversation is often set by the respondent.

When conducting the interviews for this thesis, I have primarily adapted the *semi-structured* interview guide (n=13) but have also followed the *unstructured guide* (n=4 respondents), 13 interviews were done face to face with the respondent, while four conversations were conducted over skype.

The interview questions were a mixture of experience/behaviour questions, opinion questions, feeling questions, knowledge questions and "devil's advocate", often informants exemplified their views and opinions through storytelling. This could be professional stories or life stories which exemplified something they wanted to tell or share. The interview guide can be viewed in attachment 2.

Respondents consisted of project leaders (n=3), nurses (n=10), technology suppliers (n=3), and a representative of a diabetes patient organisation (n=1). All respondents were directly or in-directly connected to the RPM program.

The average respondent age was 44 years old. Their combined average work-related healthcare experience was 20 years. 16 out of 17 respondents were female, and 12 out of 17 had formal nursing education.

Approach	Interview form	Agency	Education*	Gender (F/M)	Age	Interview length
face-to-face	semi	Mestry	Nurse	F	46	45
face-to-face	semi	Mestry	Nurse	F	46	63
face-to-face	semi	Mestry	Nurse	F	59	54
face-to-face	semi	Mestry	Nurse	F	60	56
face-to-face	semi	Mestry	Nurse	F	45	50
face-to-face	semi	VIS	Nurse	F	49	43
face-to-face	semi	VIS	Nurse	F	29	47
face-to-face	semi	VIS	Nurse	F	29	73
face-to-face	semi	VIS	Nurse	F	55	55
Video	semi	HelsaMi+	Logistics	M	45	56
Video	semi	HelsaMi+	Nurse	F	36	59
Video	semi	HelsaMi+	Nurse	F	29	24
Video	semi	HelsaMi+	Nurse	F	51	52
face-to-face	Unstructured	Dignio	Nurse	F	51	43
face-to-face	Unstructured	Dignio	Industrial Desig	F	28	75
face-to-face	Unstructured	Dignio	Civil Engineer	F	58	45
face-to-face	Unstructured	Interest grou	Nurse	F	-	23

Tabell 3-2 tabel of repondents charechteristics and interview approach

A challenge when conducting the interviews was not to ask questions that were “guiding”. Many of the respondents energetically shared problems and barriers experienced by the users but seemed more reluctant to share self-observed problems by themselves or their colleagues. Controlling the conversation was also difficult, many of the respondents was spirited about the project, thus conversations often would go in many unexpected directions. I therefore adopted a strategy of memorising the questions, and then instead of following the guide, tried to let the respondents finish their “lines of thought”.

The interviews worked as a dominant source of empirical knowledge covering the structural components, functions and actor behaviour. However, to ensure methodological quality, and to improve the knowledge base, I participated in conferences, seminars and conducted fieldwork at the response centres.

3.2.4 Observations and field research: Introduction

Interviews are a primary source of data in qualitative research – so too are the use of *observations* (Merriam & Tisdell, 2015, p. 137). Further Merriam and Tisdell (2015) distinguishes observations in two ways: First, observations take place under circumstances where the phenomenon naturally occur, rather than a chosen location where the purpose is to interview. Second, observational data depict eyewitness encounters with the phenomena of importance, rather than second-hand narratives of the phenomena obtained in an interview. Making use of observations and field research in combination with document analysis and interviews is a common feature in case studies.

Observations have been utilised throughout this thesis to gather empirical data, verify claims and opinions from interviews, informal conversations, and compare system configurations between response centres. The observational work in this thesis consists of conferences (n=7), and field-observations within response-centres (n=2). Watching people in their own “territory” is a fundamental aspect of qualitative methodology (Kirk & Miller, 1986, pp. 9-12).

3.2.4.1 Observations: Conferences and seminars

The first conference was partaking at the innovation-conference 2016: Patient health-services[6], in Trondheim. The conference was hosted by InnoMed (a national competence network for innovation activity within health and homecare services). Participants at the conference were mainly actors from the public sector. The conference was attended early in the research process, when the research questions were still under construction, and lacked a “solid direction.” The conference gave valuable data on the dynamics of landscape pressure, technological difficulties and regime resistance. After the conference, I had the opportunity to make informal conversations with relevant actors within the healthcare system.

The next observations were made while participating at an RPM-seminar in Sarpsborg, arranged by the Norwegian Directorate of Health, for actors involved and interested in the program. I attended the seminar as a research assistant for Intro-International. The seminar provided informal conversations with project leaders, discussion from an expert group of professionals regarding effects of RPM, and temporary status presentations from the projects. This gave crucial observational data on the functional dynamics of the program, while also granting access to project leaders for further engagement in interview scheduling.

These two conferences were vital when understanding the scale of welfare technology implementations, and secondly, to understand the inner dynamics of the RPM program. I participated in five more conferences, both project and program related through this thesis study. The next section of observational data gathering, describes the process of field visits.

3.2.4.2 Observations: Fieldwork

Field observations were conducted after the initial interview rounds. The method was applied with the purpose of understanding the configuration and practical implications of managing an RPM response centre. The visits were then followed up by interviewing the technological supplier (Dignio). This approach provides specific incidents, behaviours, and other reference points for subsequent interviews (Merriam & Tisdell, 2015, p. 139).

Two field visits were conducted, one field visit at Grünerløkka response centre (part of the VIS project) and one visit too Sarpsborg (Mestry) response centre. The field visits at

[6] «innovasjonskonferansen 2016: Pasientens helsetjeneste»

Grünerløkka were arranged through the project leader, while the visit to Sarpsborg was organised with Dignio, which is the technological supplier that operates the centre.

When visiting the response centres as a researcher, I tried to minimally disturb the work that was conducted. Most of the personnel managing the response centre had been interviewed the week before, and they were therefore already familiar with my research.

When observing, I had the chance to ask informal follow-up questions on the tasks conducted by the personnel, and questions related to their daily response centre routines. Conducting field visits at two response centres also produced comparative knowledge between a city district-run response centre and one managed privately.

Table 4 lists the various observations applied in this thesis. The next section will discuss data analysis, and the scientific rigour of these empirical approaches.

Type	Activity	Location	Duration	Date
Observation	Innovation-Conference: “Patient healthcare” 2016	Trondheim	8 t	24/11/2016
Observation	Gathering: Remote patient monitoring	Sarpsborg	7 t	18/01/2017 – 19/01/2017
Field-research	Response-centre: Grünerløkka	Oslo	5 t	22/03/2017
Field-research	Response-centre: Fredrikstad	Fredrikstad	6 t	27/03/2017
Observation	Health technology: Future health-challenges and technological opportunities	Oslo	7 t	25/04/2017
Observation	Welfare technology In Oslo: Presentation	Oslo	4 t	03/10/2017
Observation	User-Conference	Sarpsborg	3 t	11/10/2017
Observation	Gathering: Remote patient monitoring	Oslo	10 t	18/10/2017 – 19/10/2017
Observation	Evaluation conference: Digitalisation	Oslo	8 t	23/10/2017-24/10/2017

Tabell 3-3: List of conducted field-work and observations for data gathering

3.2.5 Data analysis

Data analysis is often perceived as the most crucial and difficult aspect of qualitative research. The process is a dynamic, intuitive and creative process of inductive reasoning, thinking and theorizing (Basit, 2003, pp. 143-144). Throughout the process of data analysis, researchers attempt to achieve a broader understanding of what they have researched and to constantly refine their interpretations. Qualitative data analysis is not a procedure performed in the final stages of research. It is an all-embracing activity that carry on all through the life of the thesis (Basit, 2003, p. 145).

Coding and categorising the retrieved data is a process between data collection and a more thorough data analysis. Interviews was transcribed as fast as possible after they had been conducted. The transcription, together with field-notes was then placed under the actor/project which the respondent was from. If statements could be coded towards negative/positive, the frequency was counted.

A difficult element with this type of data analysis, was the sheer amount of data collected. Creating an order out of field notes from field research, observations and the transcription of 17 interviews was a sturdy but knowledge creating experience.

3.3 Methodological considerations and limitations

There are very few cases in which a methodological approach can catch all the relevant data to give an objective conclusion. However, by being aware of possible biases, ethics, positionality and rigour, the researcher hopefully becomes aware of their own bias, while also giving the reader full disclosure on the process of knowledge acquirement.

3.3.1 Scientific Rigour, validity and reliability

Qualitative research is sometimes criticised for lacking scientific rigour, at least within the health-related field (Mays & Pope, 1995, p. 109). The question, "is qualitative methods valuable?", has however moved on to: how rigour can be ensured and enhanced (Barbour, 2001, p. 1115). While "technical fixes" such as *triangulation, respondent validation* and *purposive sampling* has been applied in this methodology, this does not alone confer scientific rigour. However, as (Frank W. Geels, 2011) argues: "*The research of complex phenomena* *such as transitions cannot be reduced to the application of methodological procedures and will always contain elements of creative interpretation”.*

Triangulation of multiple methodologies are often used as a tool for confirmation or refutation of *internal validity*. However, in most cases the method might just “refine” the findings(Barbour, 2001, pp. 1114-1117). While triangulation does provide a broad view by applying multiple methods of data collection, it must be acknowledged that triangulation is difficult to perform “properly,” and that the collected data might be hard to compare. The adaptation of document analysis, interviews and observations applied in this thesis provide data that might not always be comparable, and much is left to the researcher’s subjective responsibility as to validate its rigour.

Bias from the researcher in how the data is being interpreted, might often dilute both the internal and external validity. With the use of purposive sampling, the respondents might be “hand-picked” thus suiting the “narrative” of the researcher or from a gatekeeper. In this study, respondents were chosen by the “gatekeeper” in each project, i.e. the project leaders. Before gathering respondents, the project leaders were asked to deliver one respondent from each supply chain within the project (recruiters, nurses, home nurses, etc.). This practise somewhat excluded possible bias in the sampling of actors. Another bias to address, is the one in form of the respondents. By participation and being employed within the RPM project, the respondents are naturally more positive towards the intervention then perhaps other actors employed in municipal healthcare.

3.3.2 Ethical concerns and critical reflexivity

Emphasising ethical considerations in the conduct of research, has increasingly been valued as an important aspect of qualitative research (Cloke et al., 2004, p. 164). As a researcher, it is crucial to be aware of the impact our actions have on the informants. It is therefore important that the researcher stretches, so not to interrupt respondents' everyday life and work environment.

The way in which questions are asked may affect the responses of the informants. Questions may also touch upon subjects that can reveal respondents' personal issues or confidential information. Therefore, all respondents were informed that their information would be anonymised. This was a natural approach when wanting the respondents to address problematic elements in their workplace.

Reflexivity is a common concern among researchers adopting a qualitative research design. Reflexivity deals with how the researchers' *positionality* and thoughts affect interviews and data collection in general. Positionality emphasises how the researcher's actions, language, clothing, and other forms of behaviour modify the collected data. When approaching informants, I therefore tried to be modest, dress casually and be sufficiently prepared and generally interested in how their work within the project unfolded. Having conducted the literature review helped a lot when asking about more specific and detailed issues surrounding each disease.

By being modest and proclaiming my lack of medical education, the respondents seemed relaxed and forthcoming. When moving towards questions that related to clinical terminology, the respondents were happy to lecture me on different topics. After establishing a good relationship with the respondents, I always tried to push the more tricky and hard (i.e. "devil's advocate") questions after setting a good tone with the respondent. When interviewing various healthcare workers this approach was unproblematic. On the other hand, when interviewing the project leaders this was challenging. It seemed like disclosing obstacles within the project was something they were not accustomed to. Therefore, I did not push these questions on them any further.

Lastly, the thesis was submitted to The Data Protection for Research (NSD) for a project assessment, since some of the empirical material encompassed personal information.

Summary: Methodology

This thesis has adopted a qualitative case study approach for gathering empirical data on the topic of remote patient monitoring (RPM) and other welfare technology services.

The methods of document analysis, literature review, interviews (n=17), observations (n=6) and field-research (n=2) has been selected with the purpose of triangulating and understanding the main structural components and functional patterns of the technological innovation system encompassing RPM. The methods have also given insight into how RPM can be understood as a wider socio-technical transition.

Access to data was granted through the consultancy agency Intro-International and the Norwegian Directorate of Health. Working together with the researchers at Intro-International has granted rich empirical knowledge, but also shaped the path of this thesis. Discussions around the technology, the organisation and the future of RPM together with my colleagues have been a valuable experience when interpreting the findings. Participation in user conferences and program seminars have further given valuable empirical insight into the diversified aspects of welfare technology transition.

The literature review provided essential knowledge into the nomenclature of medical interventions. This proved valuable when interviewing healthcare personnel from the projects, strengthening my understanding of the users that the service is meant to help. The interviews gave fruitful knowledge on drivers, and barriers in each project. It also helped in mapping each project, giving me a detailed insight into how each project is organised.

Field-visits provided interesting data for this thesis. Especially the ability to make informal conversations with the operators at the response-centre. Here, I could observe how the service was delivered, and respondents were happy to talk about the different experiences they had with working in an RPM environment,

The next chapter will map each project participating the RPM program individually, giving the reader an in-depth understanding on how RPM as a service is delivered.

4 MAPPING THE REMOTE PATIENT MONITORING PROGRAM

The remote patient monitoring (RPM) consist of four projects. In this chapter, each project will be mapped. I will start by giving the reader and understanding of the three primary diseases that has been used as inclusion criteria for the program. I will also give a brief list, based on the conducted literature review, on factors that RPM might contribute towards the user.

Each project is then mapped in detail. Here, I will describe the target group, and the technology and response-centre organisation. After each project have been discussed, an illustration showing an overview of each project is presented. The illustrations was made when conducting the effect assessment, provided to The Norwegian Directorate of Health on the 15.02.2018 (International, 2018).

Lastly, the effects put forward in the ongoing research for the program is presented (International, 2018) for each project. The effects concern variables about patient safety, health literacy and day-to day habits such as eating and sleeping development following the service. I will also introduce the effects measured on participant health care usage following the intervention. The effects are measured as the average distance between 180 days before and after the user acquire RPM. 30 days before and after the service started was excluded for sensitivity control. The numbers presented is the average frequency per patient per year and the percentile of difference between before and after (the data is extrapolated to represent 360 days).

A summary at the end of the chapter will present a table with key variables for understanding the similarities and differences between the projects.

4.1 Target group of the RPM program

Users recruited in the RPM program, are diagnosed with noncommunicable diseases (NCDs), which includes: Diabetes mellitus (DM), Chronic obstructive pulmonary disease (COPD) and

Chronic heart failure (CHF, or Heart Failure) and Cancer. In the RPM program, the three diseases DM, COPD and CHF/Heart failure functions as the three main recruitment diseases.

Many of the recruited patients are affected by more than one disease, comorbidity, making treatment complicated. These diseases are also often interlinked, as a worsened health status of one disease might lead to another. Below follows a brief description of each disease, their scope within Norway, and what RPM might achieve for the user group.

Diabetes Mellitus (DM)

Diabetes is a metabolic disease in which there are elevated levels of blood sugar over a lengthened period. If left untreated, DM can cause complications, such as diabetic ketoacidosis, nonketoic hyperosmolar coma or death. DM often leads to heart diseases (Helse- og Omsorgsdepartementet, 2013). Prevention of the illness involve maintaining a normal BMI (Body mass index), physical exercise and a healthy diet. Common treatments are proper foot care and blood pressure control. When addressing patients that might benefit from RPM technology there are two types of diabetes that is evaluated: Type 1 Diabetes Mellitus (T1DM) and Type 2 Diabetes Mellitus (T2DM). About 28 000 people suffer from T1DM, and approximately 340 000 suffer from T2DM in Norway(Helse- og Omsorgsdepartementet, 2013).

The disease needs close monitoring and long-term management. RPM is therefore viewed as a viable cost-reducing tool to **1)** prevent complications, **2)** reduce fatalities and expensive medical interventions, and **3)** improve patient QoL (quality of life) (Jalil, Myers, & Atkinson, 2015).

Chronic heart failure (CHF)

Heart failure or chronic heart failure (HF/CHF) occurs when the heart can’t pump sufficient amounts of blood to maintain a healthy blood flow to the body. This causes problems such as shortness of breath and tiredness and may be fatal for the patient. Chronic heart failure is one of the most common diseases in the developed world, causing disability and death (Hofmann et al., 2015). With an increasingly aging population, costs related to manage HF patients is expected to rise substantially (Hale, Jethwani, Kandola, Saldana, & Kvedar, 2016). It is estimated that 450 000 people suffer from heart diseases in Norway.

RPM might help **1)** increase patient medication adherence, **2)** reduce morbidity and mortalities, and **3)** reduce hospitalisations among the patient group, which is a big contributor to costs associated with the disease.

Chronic obstructive pulmonary Disease (COPD)

Chronic obstructive pulmonary disease(COPD) is a lung disease which includes shortness of breath, cough and septum[7] production. COPD is one of the most frequent diseases worldwide. The illness is characterized by progressive deterioration in health, often resulting in Acute Exacerbations (AE) (Pedone & Lelli, 2015). The stages of COPD are often used together with the criteria from The Global Initiative for Chronic Obstructive Lung Disease (GOLD), ranging from one to four. There is estimated that 400 000 people suffer from COPD in Norway. About 40 000 of these must be continuously monitored by health-services (Helse- og Omsorgsdepartementet, 2013).

The illness is non-treatable. However, RPM is viewed as a viable technology to **1)** monitor vital signs, thus potentially avoiding exacerbations, **2)** improve patient self-care and Quality of Life (QoL), and **3)** pulmonary rehabilitation, with information and consultation (Gregersen et al., 2016).

The next sections will describe each project participating in the RPM program.

4.2 Oslo (VIS)

In the capital city of Norway, Oslo, the project is named “Velferdsteknologi I Sentrum” (VIS). The project involves four city-districts: *Grünerløkka, St. Hanshaugen, Sagene and Gamle Oslo*. Each city-district manages their response-centre independently.

VIS is a continuation of an earlier project, carrying the same project name, which ended in the first quarter of 2016. The former project also included digital and analogy medicine dispensers and alarms, thus working like a hybrid between safety technology and RPM.

VIS continued the former project in the last quarter of 2016, through funding from the RPM program. The service still operates medical pill dispenser. The service functions as a *technical add-on* to the city-district health services, and thus operate in a *symbiotic* relationship with the

[7] name used for the coughed-up material from the lower airways.

dominant design of primary healthcare. The project is scheduled to end the summer of 2018. Each district director has agreed to continue the service after the project has been finalised.

4.2.1 Target group and recruitment channels

Included users are primarily diagnosed with COPD, DM, CHF, suffering from nutritional diagnosis's and/or cancer. Some of the participants also suffer from cognitive disorders, but many of these were excluded at the end of 2017. Compared to the other projects (Stavanger, Trondheim and Sarpsborg), VIS have included users more broadly, and followed less strict inclusion criterias. A total of 500 participants have tested the service from 2015 – 2017. As of 31.12.2017, the project had 226 active users. The average age for participants is 70,7 years.

Recruitment from Lovisenberg Diakonale Hospital (LDS), is covered by a specialist-nurse. The four city districts share a 20 % position for recruitment of patients to the projects. The position at LDS has been one of the largest channels for recruitment to the project. Another primary recruitment channel has been the various home care services operated by each city district. Interviews with healthcare workers in VIS explain that the former project greatly helped in *the building of social networks and the enrolment of more actors*. Having established good relationships with other city-district health services and proven that the technology might benefit the users, has been a significant contributor towards the ability to recruit so many participants (Only VIS and Mestry has reached the recruitment user goal set by The Norwegian Directorate of Health).

Only a few users have been recruited from their general practitioner (GPs). *GPs* consult the projects but is not part of the core project workforce. User GPs is informed with a message through DIPS[8] when they are enrolled in the project. Involvement from general practitioners occur, but problems around reimbursement models from The Norwegian Health Economics Administration (HELFO) have made GP involvement troublesome.

4.2.2 Technology and response-centre organisation

The user interface and technology solutions for the project are delivered by the technology supplier Dignio AS. Dignio is reimbursed for medical technical equipment (MTEs) (including iPad), data usage (sim-card), and a license per user for the application MyDignio, and the

[8] A communication system between primary and secondary healthcare services (general practitioners, hospitals, primary healthcare, etc)

assessment system Prevent. The Norwegian Health Directorate allocates the project funds. However, some costs are covered by the city-districts..

All participants are given a tablet (iPad), and MTEs suited for their needs and based on their diagnosis. The iPad is pre-programmed with the application “MyDignio”, which locks the system, making the tablet solely available for RPM related functions. These functions are measurements of biometrical values, answering clinical questions and communication with the response-centres. Table 4.1 lists the MTEs in the project, as well as their function.

Medical technical equipment	Function/Biometric data
Tablet (IPad)	Clinical questions
Blood glucose meter	glucose in the blood
Blood pressure meter	Systolic/diastolic blood pressure and pulse rate
Pulse Oximeter	Pulse rate and oxygen saturation (SO_2)
Spirometer	Capacity of the lungs (FEV1 and PEF)
Weight	Kilograms
Thermometer	Body temperature

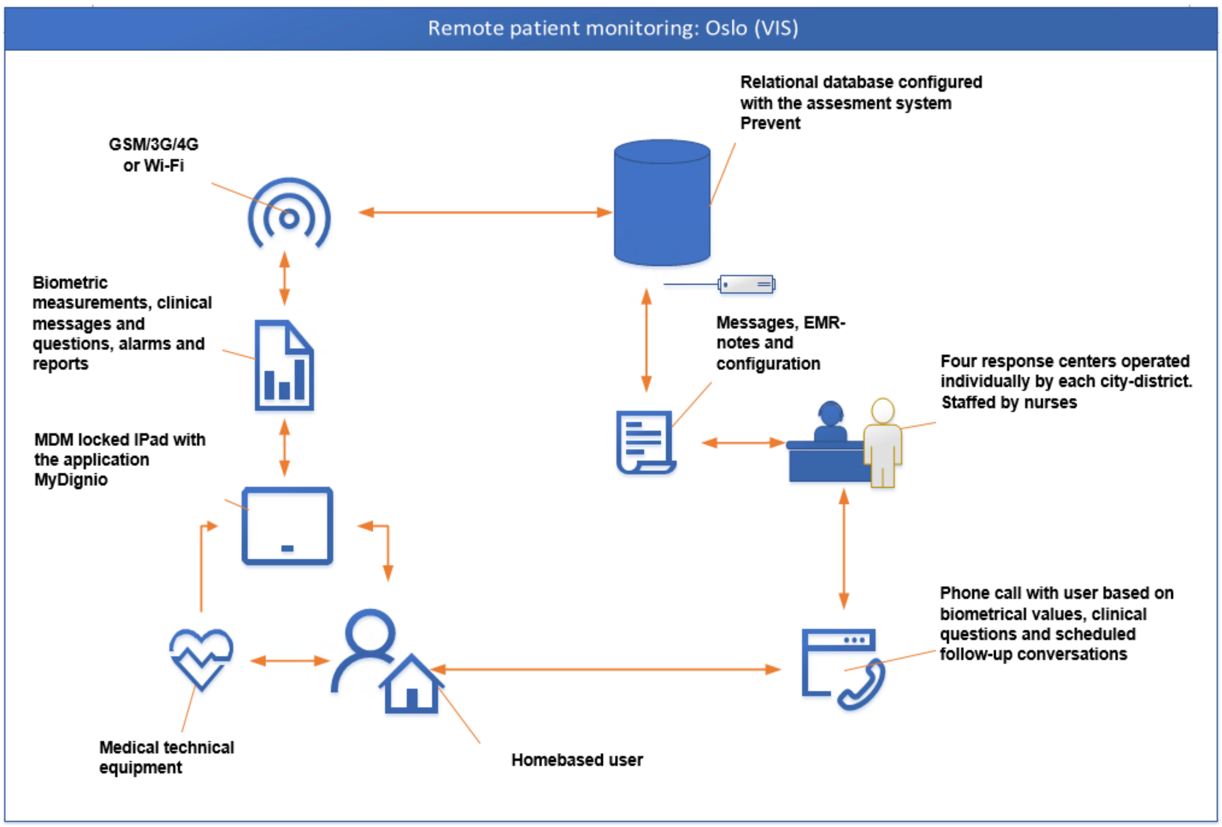
Tabell 4-1 Overview of medical technical equipment applied in the VIS project

Nurses operate the Response centre. The city districts of Grünerløkka and Sagene rotates on operating and staffing the response-centre every other week. Gamle Oslo and St. Hanshaugen operate their response centre independently. The response centre in VIS can be categorised as a “community-response centre[9]”, since both the location and the employees of the response centre is in close-proximity of district inhabitants.

Healthcare personnel at the response-centres view incoming results with the assessment system “Prevent”. The system highlights if the incoming measurements or clinical responses are alarming. These notifications are illustrated with the colour scale of green (positive), yellow (troublesome) or red (alarming). Whether a measurement is alarming, is based upon threshold values, previous biometric measurements of the user and the user’s own opinion of his or her health situation. If a user forgets or doesn’t send a planned measurement, this might also trigger an alarm[10]. The average reported measurement per patient per week with the response-centre is estimated at 3.1 contact points.

[9] «nærresponssenter»
[10] The user and response-centre personnel agree before starting the service whether this should trigger a call

The response-centres operates a call-list for different users that need communication and advice verbally. Call-ups are often about nutrition, clinical advisory, drug management, preparation for an impending operation or other clinical procedures. The response-service in VIS is available for the users between 08:00 and 15:00 and is closed in weekends and holidays.



Figur 6 Remote patient monitoring in Oslo

4.2.3 Effects

The effect study covering the implementation of VIS, share exiting results (International, 2018). The study indicate that users experience a greater feeling of safety, control over their health situation and the experience that someone is monitoring their health. Approximately 20 % of the questioned participants (n=82) answer that they eat healthier after receiving RPM. When dividing the groups into diagnosis, 50 % of participants with Diabetes mellitus anwer they eat healthier after RPM.

The effects on health service usage reveal a reduction for participants (n=221) in acute hospital exacerbations (-3.1 = -35 %), general practitioner consultations (-2,7= -16 %) and acute municipal day-care (-0,4 = -58 %). Planned hospital visits and home care usage imply a slight increase in usage. The standard deviation for each data source in healthcare usage nullifies the reduction. Conclusions based solely on available data are therefore speculative.

Calculated costs per patient per year for implementing the service is estimated at 33 000 NOK. The price is predicted on each city-district having 75 users, that the quality of service stays the same and that full-time equivalents (FTEs) are reduced, mostly from administrative positions.

4.3 Sarpsborg (Mestry)

In the city of Sarpsborg, the RPM project is named Mestry. The project separates itself from the others by having a private response-centre operationalised by the technology supplier Dignio AS. The response centre is located at the company's headquarters in Fredrikstad, a neighbouring city of Sarpsborg. The project collaborates with the local diabetic clinic, the regional hospital Kalnes and municipal general practitioners.

The service is a mixture of *symbiotic* and *a competitive*. It is symbiotic in that it does not replace any home care or hospital services. However, competitive for the municipal diabetic clinic where users are given RPM, instead of regular monthly consultations.

Mestry is scheduled to end in the summer of 2018. Sarpsborg municipality did not direct enough funds to continue the project when finances from The Norwegian Directorate of Health ends. However, the municipality is applying for new tenders, in the hope of continuing the service.

4.3.1 Target group and recruitment channels

The target group for the project is users diagnosed with COPD, DM or CHF/HF. These inclusion criteria have been adapted rigorously. The project started with a target of 150 users, and this number was meet the summer of 2017. However, as funding for the project was dis-adequate, the project reduced its users to 75 on the 31.12.2017. The average age for participants is 65 years.

Users in the project have been recruited from the municipal diabetic clinic, through a hired (20 % FTE) specialist-nurse at Kalnes regional hospital, general practitioners and media advertisement in newspapers and radio. Since a sizeable proportion of the recruited participants have contacted the project on their own accord, and not through hospital admissions or other channels of deteriorating health, some of the users are younger and healthier than in the other projects. This also holds true for users recruited from the diabetic clinic, where users generally are younger than those suffering from heart failure or COPD.

4.3.2 Technology and response-centre organisation

Dignio AS operates the response-centre but also functions as the technology supplier for the project - delivering the assessment system and the medical technical equipment (MTE). The technological equipment and its functions are therefore the same as in Table 4.1, described in the VIS section.

During observations at the response centres, some differences in the delivery of these services were noticed. While Sarpsborg primarily uses digital messages via the system to inform its users of results, Oslo uses the telephone more frequently. It was also observed that the nurses working in Sarpsborg response centre also read the biometrical values of peak expiratory flow (PEF)[11] and FEV1[12] for users with COPD, as an indication of deteriorating health. The response-centre also don’t operate with call-lists. So even though the two projects use the same assessment system (prevent), and the same MTEs, differences in methods is noticeable. A dominant way of delivering the service is hence not yet established.

Mestry has managed to integrate the EHR system “Prevent”, with the municipal EPR – Gerica. This means that homecare workers can view and analyse the biometric results measured by the users. They can also view the historical values for the user, thus having more clinical information when making clinical patient related decisions.

The private response centre in Sarpsborg is available for the users from 08:00 to 16:00 and is closed in weekends and holidays. Figure 4.2 illustrates the service of RPM tested in Mestry.

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[11] PEF = The maximal flow achieved during a maximally forced expiration, measured in liters per minute or second

[12] FEV1 = Is the volume of air that can be expatriated, after full inspiration

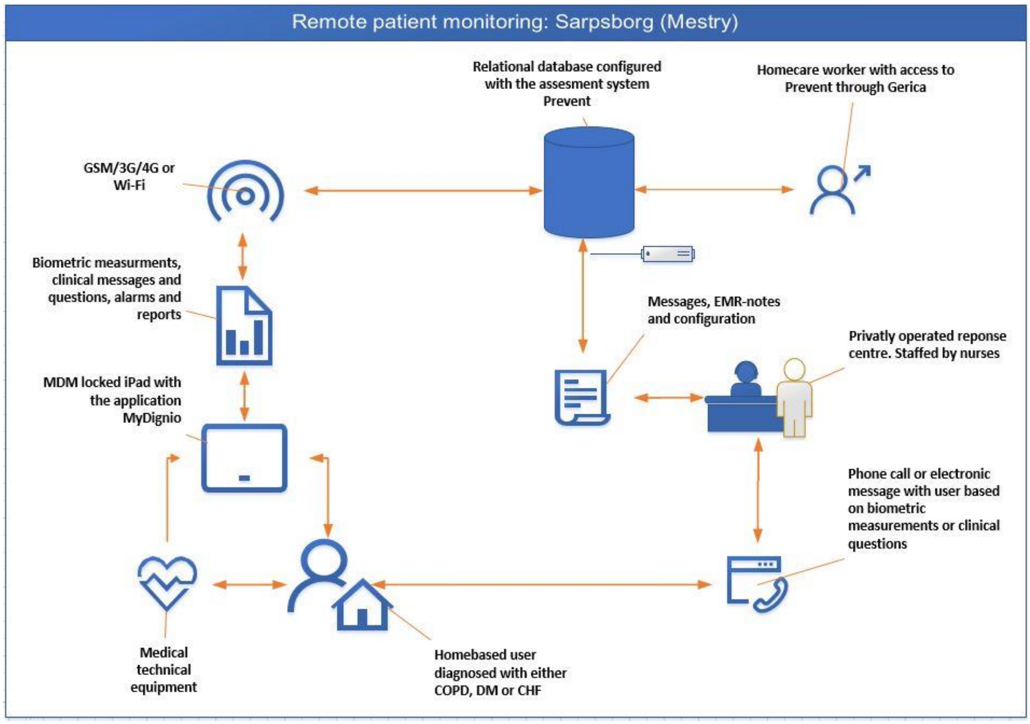

Figure 5: Remote patient monitoring in Sarpsborg

4.3.3 Effects

From the research side, Mestry inhabits the most satisfied users (n=161) on all parameters. Users report exceedingly positively on monitoring of health, health control, safety and understanding health symptoms. Further, 52 % (n=96) of the questioned users report that they eat healthier after receiving RPM. When divided intro diagnosis groups, 75 % of users with Diabetes mellitus answer that they eat healthier after the service.

Health care usage after implementation of RPM demonstrate a slight increase in acute hospital exacerbations (0,7 = 18%), a reduction in general practitioner consultations (-1,4 = -10 %), a slight decrease in planned somatic hospital consultations (-0,3 = -12 %) and a minor increase in home care visits (0,2 = 7%). Standard deviation nullifies the effects, and the numbers profess high uncertainty.

Calculated costs per patient per year are estimated at 49 000 NOK if the service where to be implemented. The estimation is built on the premise that 75 users are enrolled, that the quality and frequency of contact stays the same and that municipal FTEs is reduced, mostly from administrative positions. The price per patient is sensitive towards the total amount of users since more users equal fewer costs per patient.

4.4 Stavanger (GodHelseHjemme)

In the city of Stavanger, the project is named GodHelseHjemme (Good health home). The project collaborates with the municipal nurse-clinic, where the response-centre also operates from. GodHelseHjemme employs a web portal where users can view informative videos regarding their disease (nutritional, educational, breath-techniques), and answer clinical questions related to their day to day health status. Users can also conduct up to five video consultations with the response-centre. The project started in the last quarter of 2015 and is scheduled to end the summer of 2018.

The service functions in a *symbiotic* relationship with the current municipal healthcare system. It seeks not replace any other healthcare service, but instead work pro-actively by educating and creating “health-literacy”, so that healthcare usage over time might decrease.

Technical difficulties on the web portal and security (two-factor authorisation) has frequented the project. The service has therefore not been able to function adequately from the start, making communication with the response-centre and users difficult. The municipality has decided not to continue funding the service after the summer of 2018.

4.4.1 Target group and recruitment channels

Users in the project are diagnosed with COPD. The average age is 70 years. A total of 44 users have tested the service throughout the period. 36 users remained active in 31.12.2017.

The project recruits and collaborates with the local healthy life centre (frisklivssentralen) for recruitment and user guidance. Users have also been recruited from media advertisement in patient organisation newspapers and some from general practitioners. The recruitment channels employed results in users that mostly don’t receive home care services and are generally not frequent consumers of healthcare services.

4.4.2 Technology and response-centre organisation

The project is testing a web portal which provides information about nutrition and educational videos about COPD. The project team creates the informative videos, and the web portal is provided by the technology supplier Imatis AS.

Using the portal, users can answer four prefixed questions about their disease, with three options. The options are ranged from green, yellow, or red, indicating the severity. Participants are also offered five video consultations with the nurse-clinic throughout the project. Video consultations revolve around medical, nutritional and other recommendations about living with COPD.

Users provide their own devices to participate in the project. There is no measurement of biometrical values. GodHelseHjemme has a much lower contact frequency between users and the response-centre, compared to the other projects (0,8 per patient per week).

The response-centre in Stavanger is open from 08:00 to 15:00 and is closed in weekends and holidays. Figure 4.3 illustrates a simplified model of how the service of RPM is delivered in GodHelseHjemme.

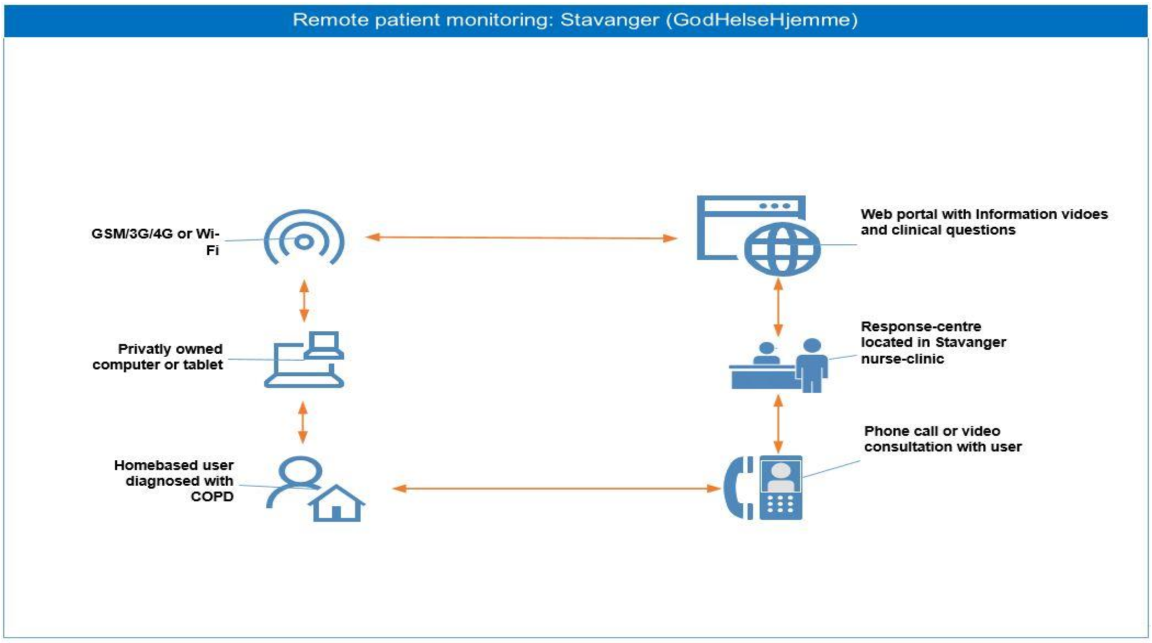

Figure 6: Overview of RPM service delivered in Stavanger (GodHelseHjemme).

4.4.3 Effects

The knowledge of GodHelseHjemme is considerably less robust than the three other projects. This has to do with two main factors: **(1)** The projects have experienced technical issues around the web portal, users adopting private equipment and video consultations not working on the Safari web browser. **(2)** The project has a low data pool considering a relatively small number of users, and failure of getting access to hospital data for analysis.

The technical issues are also reported by the users (n=20) where 20 % of respondents agree on the statement “I think the measurements are difficult to conduct” and 37 % agreeing to the statement “I experience that the service doesn’t fit my situation”.

In health care usage, only general practitioner consultations have been measured (n=46). The results indicate a slight reduction (-0,3 = -2%) in consultations. Like the other projects, the standard deviation is high and nullifies the effect.

Costs per patient per year are estimated at 32 000 NOK if the service is to be implemented. The costs are deduced from a total of 50 users, and that the service is organised approximately the same way. The estimated amount per patient do however not consider the costs necessary to improve the essential technical difficulties experienced in the web portal, and costs for making updating educational videos.

4.5 Trondheim (HelsaMi+)

In Trondheim region, the project is named HelsaMi+. The project includes the municipalities of Trondheim, Klæbu, Malvik, Melhus and Midtre Gauldal. The response-centre is located in Trondheim.

Trondheim region has established a goal of having various welfare technology solutions integrated into their services within 2020. The project HelsaMi+ has, therefore, had numerous previous welfare technology solutions being tested and implemented, such as safety alarms and e-locks. The response-centre, named “Helsevakta (Health Guard) is therefore operated together with other kinds of safety technology. The service is also interlinked with the “safety patrol” (trygghetspatruljen) which is a home care service operating 24/7 and is instructed and delegated by the response-centre.

The RPM service in HelsaMi+ can lean itself on the *social networks and the enrolment of actors* established by the preceding implementations. The service functions as a mixture of *symbiotic* and *competitive* depending on healthcare actor and depending on where the delineation of HelsaMi+ is drawn. If HelsaMi+ includes all the services provided by the health-guard, the service is *competitive* for home care services.

The project collaborates with the regional Hospital St. Olavs for recruitment, and guidance. A general practitioner has also been assigned to the project in a 20% position. Other collaborating partners are Norwegian Healthnet (Norsk Helsenett), and Central Norway Regional Health Authority (Helse Midt-Norge). HelsaMi+ has been given regional funds for continuing the service after project funds from NHD end in the summer of 2018.

4.5.1 Target group and recruitment channels

Users included in the project suffer from either COPD or/and CHF. Average participant age is 72 years. A total of 99 users has tested the service throughout the intervention period, whereas 87 still were active in 31.12.2017.

Participants are recruited from specialist nurses at St. Olavs Hospital, their general practitioner or through their home-care services. When the project started one of the inclusion criteria was that users did not receive home care services. These criteria have been abandoned, and the project is now planned to include users regardless of other home care services provided. This provides an example of *learning and articulation processes on various dimensions*, where market demand and user preferences adopt as the niche diffuses.

4.5.2 Response-centre organisation and technology

The response-centre is in Trondheim and is named “Health guard” (Helsavakta). The health guard also operates other welfare technology solutions, thus working as a hybrid between many novel solutions. The technology supplier for the project is Imatis AS.

The users in the project receive a tablet (Android) where they answer four prefixed clinical questions depending on the diagnosis. The user can also send an informal message to the response-centre, after answering the prefixed questions. The questions are answered as green, yellow or red, indicating the severity. Compared to Mestry, and VIS, the tablet distributed in HelsaMi+ is open, and users can exploit the tablet for private entertainment.

Every user included in the project receives a treatment plan. The plan is developed by the user’s general practitioner, together with staff from the response-centre and the user. The plan functions as a checklist, giving each user-specific advice on how to react, and which medicine to consume if their illness is progressing. Some users also report biometrical values with medical technical equipment. Both measurements and clinical questions are sent to the “health guard", and are illustrated as either green, yellow or red according to previous measurements and, answer history and values given in their treatment plan.

Table 4-2 show the medical technical equipment and their function in the project.

Medical technical equipment	Function/Measures
Tablet (Android)	Clinical questions
Blood pressure meter	Systolic/diastolic blood pressure
Pulse Oximeter	Pulse rate and oxygen saturation (SO_2)
Weight	Kilograms

Tabell 4-2 Overview of medical technical equipment available for HelsaMI+ users

The response centre is located at the municipality emergency room and is open 24/7. The response-centre can be categorised as a centralized response centre, as opposed to Oslo where each participating city districts operate each response-centre individually. The service in HelsaMi+ is staffed by both nurses and regular home-care workers. Figure 8 illustrates how the service of RPM is delivered in the Trondheim region.

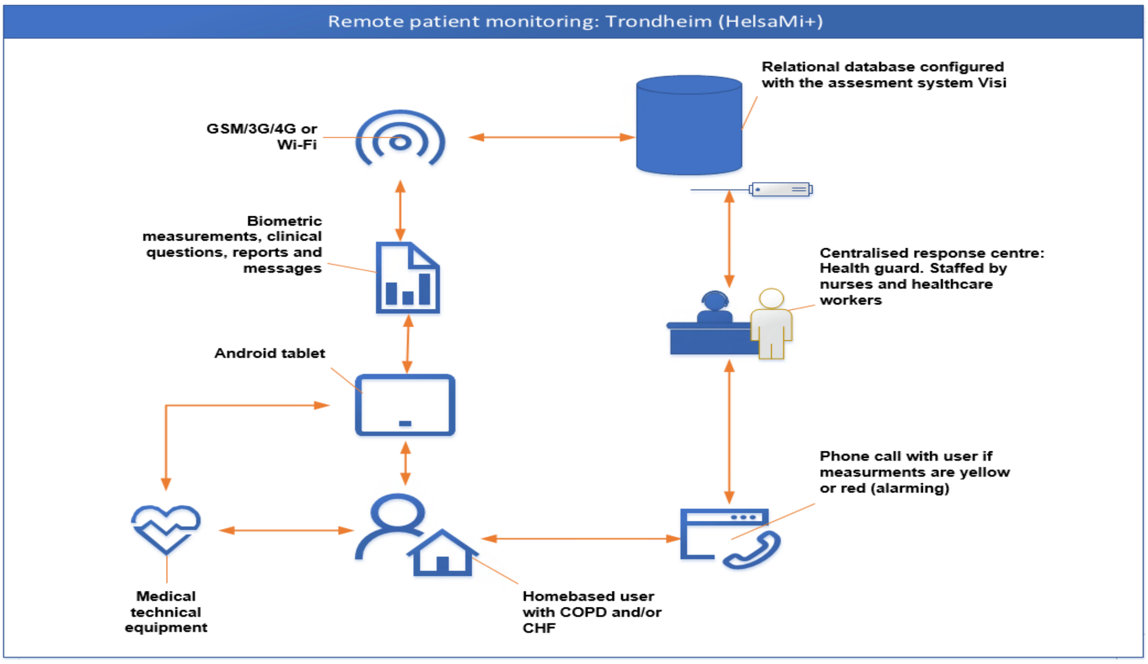

Figure 7: The service of RPM delivered in Trondheim region (HelsaMi+)

4.5.3 Effects

Questionnaires from 36 participants indicate that users generally view the service as a contributor towards safety, control of their own health situation and the experience that someone is monitoring their health status. Approximately 28 % of the participants answered that they eat healthier after receiving RPM (International, 2018).

Health care usage was analysed with data extracted from 86 participants. Reductions was found in acute hospital exacerbations (-1,3 = - 39%), general practitioner consultations (-2,5 = -12 %) and somatic hospital consultations (-2,4 = -56 %). Home care usage showed a slight increase (+ 9%). Standard deviation for all health parameters was considerable high.

Costs per patient per year if the service is to be implemented is calculated at 19 000 NOK. The estimate is based on 250 users per year and that the service is open from 8:00 AM to 16:00 PM (instead of 24 hours). The costs do not cover the other safety technologies and the safety patrol also operated from the response-centre.

4.6 Summary: Mapping the RPM program

The four projects involved in the program have approached the delivery of RPM differently. In VIS each city district manages the response service individually. In Mestry, the response centre is operated privately by the technology supplier Dignio. In HelsaMi+, the response service is centralised and operated together with other safety technology solutions. In Stavanger the response centre is in the municipal nurse-clinic but is primarily built around a web portal.

Table 4.5 shows a summary of each analysed projects and their distinct characteristics.

Variable	VIS	Mestry	GodHelseHjemme	HelsaMi+
Location	Oslo	Sarpsborg	Stavanger	Trondheim region
Technology supplier	Dignio	Dignio	Imatis	Imatis
Target Users	COPD, DM, CHF	COPD, DM, CHF, and other	COPD	COPD and CHF
Active users*	246	146	36	86
Response-centre	Public (decentralised)	Private (centralised)	Public (centralised)	Public (centralised)
Symbiotic/competitive	Symbiotic	Mixture	Symbiotic	Mixture
Biometric measurements	Yes	Yes	No	Yes
Average contact frequency per week, per user	3,1	6,7	0,8	2,3
Cooperating hospital	Lovisenberg	Kalnes	-	St. Olavs
Assessment system	Prevent	Prevent	Visi	Visi
Estimated cost per patient per year (in thousand NOK)	33 NOK (300 users)	49 NOK (75 users)	32 NOK (50 users)	19 NOK (250 users)
Continuation of the service approved	Yes	No	Yes	No

Table 3: Summary of key elements between studied projects. *Active users pr.31.12.2017, avrage contact frequency and estiamted cost per patient is gathered from (International, 2018).

5 ANALYSIS

Combining the analytical framework from chapter 2, methods from chapter 3, and in-depth knowledge of each RPM project in chapter 4, this chapter seeks to analyse the research questions of this thesis.

The first research question "*What are the drivers and barriers for implementing remote patient monitoring in Norwegian municipalities?* – Is analysed in section **5.1**, using the conceptual framework of technological innovations systems, and functional pattern analysis. Drivers is extracted from how well each function is working, and barriers is derived from the system blocking mechanisms. The framework follows the schematic analysis, put forward by Bergek et al. (2008): *Analysing the functional dynamics of technological innovation systems: A scheme of analysis,* albeit with some modifications.

The second research question "*How can remote patient monitoring be perceived as part of a wider socio-technical transition?* – is analysed in section **5.2**, applying the concepts from the Multi-level perspective, first presented by Frank. W. Geels. Here the conceptual analysis is influenced by Markard and Truffer (2008): *Technological innovation systems and the multi-level perspective: Towards an integrated framework* and Smith and Raven (2012): *What is protective space? Reconsidering niches in transitions to sustainability*. The analysis will illuminate RPM through the heuristic levels of Landscape, regime (specifically regime selection environments) and niche-level.

After each research question has been analysed, and outlined, the next chapter (chapter 6) will conclude this thesis research questions.

5.1 Technological innovation systems: Analysis

Having created an understanding on how each project is delivering RPM in *chapter 4*, the next step of analysis is creating a model of the involved *structural components*. Here a generalised model is formatted, built on the common denominator of an emerging municipal RPM system for chronic disease management.

The model is swayed by the influence of each project and the agreement of continuation, thus GodHelseHjemme and Mestry will have less influence then VIS and HelsaMi+. The details of structural components are further weighted by a focus on the *inner core actors*. The focus is mainly on those actors and networks that directly contribute, evolve and design the system of RPM.

The analysis will start by establishing the structural components, then analyse the functional patterns for the system. Lastly, figure 3 from the analytical framework will be modified to illustrate the main drivers and barriers observed.

The section will conclude with a summary, before analysing RPM as a socio-technical transition.

5.1.1 Structural Components

The primary structural actors drawn from mapping the remote patient monitoring program are *Governmental bodies*, *service suppliers*, *technology suppliers*, *supportive actors*, *users* and *interest groups*. The following text will detail each actor, and the formal networks displayed within the structure of RPM.

The actor of ***Governmental bodies*** is represented by The Norwegian Directorate of health (NDH), The Directorate of eHealth (DEH) and Norwegian Healthnet (only for HelsaMi+). NDH functions as the primary actor, providing funding and guidance for the project. DEH is working on creating a technological framework for RPM technology. The framework seeks to standardise and make technological recommendations as to what software and hardware that should be used when implementing RPM technology, while also creating a “hub” for connecting welfare technology together (e-helse, 2018).

The governmental bodies of NDH and DEH facilitate two primary networks in the structure and growth of RPM. NDH provides funding, and the direction of search to each project

(*Service supplier*). DEH functions more individually but share information and knowledge with technology suppliers when making technology recommendations and research.

The next actors in the system is the four projects, as an actor categorised as the ***Service supplier***. The service supplier consists of a mixture of nurses, administrators, recruiters and in some projects, assistance from general practitioners. The service supplier can also be interpreted as a city-district or municipality when adopted for new implementations/projects.

The service supplier is in the centre of the innovation system and has networks with all the involved actors. The first network is between the ***service supplier*** and the ***technology supplier***. This network is a buyer-seller relationship where the projects dictate how and which kind of technology that is needed to deliver the service. The network is also geared towards improving the technological solutions being provided, as well as testing and improving new medical technical equipment (MTEs) for measurements of biometric values. The network is therefore also a feedback-loop for the technology supplier which uses each project to develop and test the technology.

Another important network for ***service supplier***, is between the ***supportive actors*** in healthcare services being provided both the primary, and the secondary health care sector. These networks can be formal towards recruitment and guidance, such as in VIS where they share the responsibility of a specialist nurse for recruitment. Or as in Mestry where there is a formal network of recruitment from the local diabetic clinic and Kalnes Regional Hospital, or as in HelsaMi+ where St. Olavs hospital and general practitioners provides recruitment, but also collaboration on the creation of each user’s treatment plan. All projects also conduct training and technical assistance towards municipal healthcare personnel in the management of MTEs. There are also examples of informal networks such as consultations with general practitioners, hospital collaboration for users that has planned clinical procedures or communication with home care workers about user health-status.

The last imperative network for the ***Service suppliers,*** is with the **Users.** The network functions through the response-centre and represent the core network of the system. This network deals with how the service is delivered, and the day-to-day communication with each user.

The ***Technology supplier*** provides the technological system and equipment for providing the service of RPM. The role of the technology suppliers differs greatly among the projects. In Mestry (Sarpsborg) the technological supplier (Dignio AS) also operates the response service, thus also functioning as the *service supplier*. In the other projects, the service supplier primarily functions as a retailer of RPM software and hardware.

The ***Users*** represent those receiving the service within the system. The service of RPM is targeted primarily towards the elderly population, which suffers from an NCDs. Exemptions is however common in VIS (also includes nutritional disorders and cancer), and Mestry where some users are under 30 years. While those receiving the service is essential, relatives also play a vital role as users. Relatives, spouses and domestic partners is affected by the system on many dimensions, and interviews with respondents confirms that “relatives” helps users to conduct measurements and encourage rehabilitation practises.

Interest groups portray the worker unions and the patient organisations. Interest groups have been involved in the different projects in shaping the system and giving user feedback on how the service should function. **Interest groups** have established both formal and informal networks with **service suppliers**, **users** and **technology suppliers**. Interest groups have helped with patient recruitment through meetings and advertisements in news-letters and magazines. Interest groups have further participated in developing guidelines for operators at the response-centre. In GodHelseHjemme, the video conference guidelines that the nurses follow in video-conferences, has been developed together with the National Association for Hearth and Lung Disease (LHL). Technology suppliers have also relied on interest groups for user feedback on medical technical equipment, and clinical question experimentation.

The last major actor in the technological innovation system are the healthcare services provided in the primary, and secondary health care sector. These actors are categorised as ***Supportive actors***. This covers general practitioners, nurse specialists and various municipal caregiving services. The activity and involvement of other healthcare actors towards the service is generally for recruitment of users, specialist knowledge and guidance, or interaction between the response-centre and other healthcare options for the users.

5.1.1.1 Structural components: Model

A comprised model of the structural components of municipal RPM towards chronic care management is illustrated in figure 9.

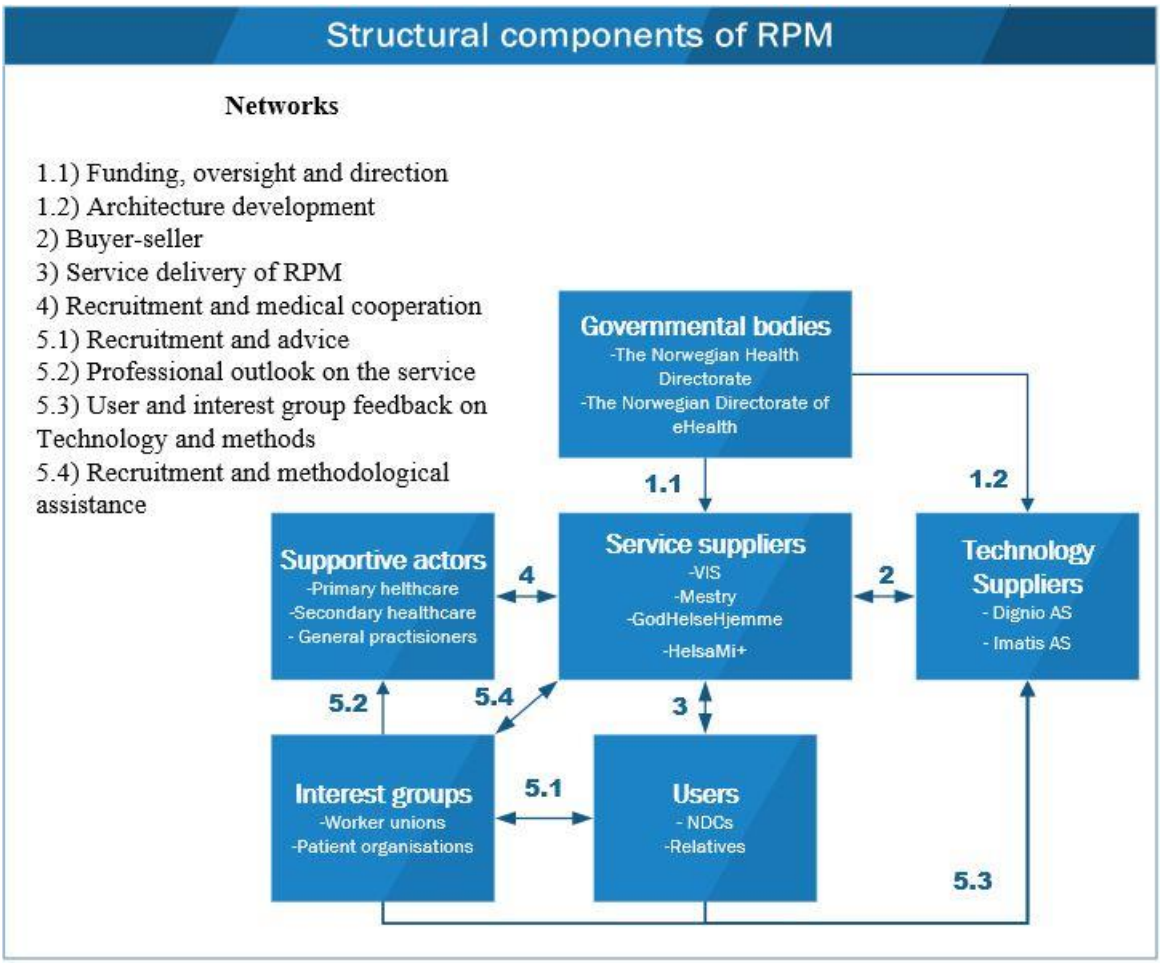

Figure 8: Illustration of the networks and actors in the inner core process of RPM municipal delivery.

As the figure illustrate, the response-centre provided by the service suppliers functions as the main input and output actor in the system. Thus, becoming a hub for technological testing, user interaction, cooperation and medical advice with supportive actors. The service also fulfils other roles then just RPM. By having a broader understanding on the patient health status, and day to day activities, the response-centre also functions as a facilitator and gatekeeper towards other healthcare services such as doctors, physiotherapist, occupational therapists, diabetic clinics, hearth and lung specialists and others. A respondent from VIS explained:

Respondent: **“**The follow-up is so much more than just welfare technology, it also gives us the opportunity to facilitate other health services”

The strength of comprising the structural components, is further seen in the easiness of understanding the essential building blocks of how such a system affects the various actors, and where responsibility for the patient is localised.

The weakness of simplifying the structural components of RPM lies in the sphere of influence of each system. While some actors exhibit more dominance that others, depending on which project that has been analysed. Simplifying the actors into large groups also has its shortcomings. While the actor-group is tasked with a set of variables for making the system function, these actor-groups is comprised of various professions, age groups and regional differences that interpret and use RPM quite differently, with institutional alignments. Institutional acceptance and rejection will be covered in section 5.2.2. (When answering the second research question).

The model does however function as a “snapshot” on how RPM is delivered in the contemporary solution, and how the technological innovation system is emerging. It also provides a necessary way of empirical delineation when analysing the system. The components of *Governmental bodies, service supplier, technology supplier, users, interest groups* and *supportive actors* will stay prominent while the system evolves, and thus creates the groundwork for functional pattern analysis for understanding the drivers and barriers of the system.

5.1.2 Functional patterns

Having mapped the main structural components derived from the *inner core actors* of municipal RPM system, the next step of analysis is to analyse each function and describe how and “how good” they are performing, and what the possible blocking mechanisms might be (drivers and barriers). Since there are differences among each project, certain projects will be detailed more than others. Some functions asserted to a specific project might also be an overall function attributed towards the TIS.

Another element to establish before inquiring a functional analysis, is anchoring the *inducement mechanisms* for the system (Bergek et al., 2008). The inducement mechanisms embody what the system seek to achieve, or more precisely, what the system seeks to improve which the current regime fails to accomplish. The inducement mechanisms thus encompass what would be accounted as the success of the system.

The RPM program being a governmental initiative funded by the national budget, makes the inducement mechanisms “controlled” by what the actor of governmental bodies hopes that the system can accomplish. Simplified, these mechanisms can be categorised as (1) *reduced patient costs*, and *increased healthcare productivity* and (2) *improved user health and health literacy*.

While the specific project of remote patient monitoring also has other inducement mechanisms such as, the possibility of giving technology recommendations and creating technological standards, these mechanisms end goal is the achievement of creating a more financially stable primary health care sector and improving patient health.

The covered functional dynamics for uncovering drivers and barriers are ***F1***: *knowledge development*, ***F2****: influence on the direction of search*, ***F3****: entrepreneurial experimentation*, ***F4:*** *market formation*, ***F5****: legitimation*, ***F6****:resource mobilisation and* ***F7:*** *development of positive externalities*. After each function has been covered, a concise summary of potential drivers and barriers derived from the functionality is portrayed in a text-box.

5.1.2.1 Knowledge development

The function of knowledge development is typically placed in the centre of a TIS and is concerned with the knowledge base of the TIS, and how that knowledge is diffused and combined in the system (Bergek et al., 2008). To gain legitimation, the effects of the RPM program need to be conclusive.

With RPM working as a health service and thus viewed as a medical intervention, the knowledge base of scientific knowledge is crucial. Scientific evidence needs to concur strongly with actors such as general practitioners to gain legitimation and acceptance.

The scientific knowledge embodying RPM is a complex and uncertain field. The many different variances in organisational methods, architecture and target groups makes it hard to compare scientific results achieved in other RPM interventions, or between the four different projects themselves. Variances in medical technical equipment, response-centre organisation and the target group significantly impact both the clinical and statistical accuracy of studies conducted. Comparing results between interventions is therefore troublesome.

RPM is also challenging to do research on. The service is supposed to function pro-actively. Hence, large cohort studies with control groups need to be established to analyse the impact of the service over time. However, the technology and methods adopted are in continues renewal, and improvements and modifications are made at a steady pace. When measuring the impact of a specific service, such changes to the core service collides with the rigour of analysis. Within the medical research field, randomises controlled studies are the gold standard, and no such studies has yet to be conducted in Norway.

An example in the difficulty in studying RPM is observed in the largest telehealth trial conducted, The Whole Demonstrator program in the UK. The programme was launched in 2008 and included 6191 patients (control and intervention group), 238 general practitioners practises across three regions. The included users suffered from Diabetes mellitus, Chronic compulsive pulmonary disease and heart failure. In the trial, improvements in technology and methods could not be adopted, since this would collude with the scientific research conducted. This caused frustration among employees who naturally wanted to improve aspects of the service that functioned poorly.

The Whole demonstrator program also experienced similar recruitment complications as seen in the Norwegian RPM program - How and which users that are recruited greatly affects the measured effects of the study (The same problem was observed in the RPM program and is discussed in section 5.2.2.2). Thus, the trial recruitment process is difficult to control, and creates uncertainty on research rigour and the scientific findings (Steventon et al., 2012).

The scientific knowledge gathered on the three projects VIS, Mestry, GodHelseHjemme and HelsaMi+ indicate major differences between the projects, and some uncertainty on the implication of the findings. The effects can be divided into three main categorises, **(1)** Patient related effects, **(2)** healthcare usage and **(3)** cost-benefit on the service.

Patient related effects of remote patient monitoring reveal that users experience an increased feeling of safety, health control, the feeling that someone is following their health and increased health literacy on their disease. Respondent nurses from all the interviewed response-centre also confirmed that RPM increased health literacy among patients (regardless of diagnosis.

The patient related effects were most prominent in Mestry, followed by VIS and HelsaMi+, and GodHelseHjemme quite far behind. Users also answered that they slept better and that their diet were healthier after RPM. Especially users with diabetes mellitus seemed to eat heathier, and a nurse specialist working at the local diabetic clinic in Sarpsborg (Mestry location) informed that the glycated haemoglobin (HbA1c, long term measurement of blood sugar values) was improved after users started with RPM. Informal conversations with users that I meet at conferences supports these results, and many expressed concerns about the project ending in the summer of 2018. The literature review conducted on telehealth effects also support that diabetes mellitus patients might improve their blood sugar levels when receiving RPM related technologies (Jalil et al., 2015; Nicolucci, Cercone, Chiriatti, Muscas, & Gensini, 2015; Rasmussen, Lauszus, & Loekke, 2016; Su et al., 2016).

In HelsaMi+ where the tablet (Android) is open for private use, respondents informed that users achieved increased quality of life from learning how to use the device (technological literacy), and by connecting with friends and family.

The effects on reduced health care usage following the RPM implementation are less conclusive. While the projects in VIS and HelsaMi+ experience a sharp reduction in acute hospital exacerbations and municipal acute day-care, the results are unclear with a high standard deviation (International, 2018). The conducted literature review demonstrated the same results – statistical significance is hard to prove when analysing pro-active services (Chatwin et al., 2016; Cruz, Brooks, & Marques, 2014; Gregersen et al., 2016; Harré, 1979; Kenealy et al., 2015). Since no randomised control study has been conducted on RPM services in Norway, medical actors view the service with scepticism.

The cost-benefit of the RPM is scheduled to be delivered in September 2018. The potential cost-benefit of the program has therefore not yet been established. Estimations on future operational costs of the service has however been conducted. The cost per patient per year ranges from 49 000 NOK (Mestry), to 19 000 NOK (HelsaMi+). The significant difference between these two projects revolve around hidden costs, the use of medical technical equipment and contact frequency per patient per week with the response-centre. In HelsaMi+ the “extra” services provided in the form of an ambulant home-care team (trygghetspartuljen) and other safety-technologies are not included in the costs. Mestry is also more labour intensive, since each user has one or more medical technical equipment.

There are many uncertainties in how RPM affects municipal healthcare. Much of these can be ascribed to the difficulty of measuring pro-active services, where the potential reductions are stretched over many years. At the same time, the user group has a deteriorating health (age and illness) making firm and proven statements as to how the service affects users problematic. The effect studies conducted on the program has proven that users receiving the service say that they feel more safe, have more control over their disease and that many eat healthier (International, 2018).

Knowledge development summary

Research and development encircling telehealth solutions has been growing and developing both internationally and in Norway. However, the variances in technological architecture, target groups and organisational structure makes comparisons of the effects of such implementations/interventions challenging. The effects are further difficult to measure since the service is pro-actively oriented, and because patient's health is expected to deteriorate over time.

This creates barriers towards legitimisation and the incentives for municipalities to fund such a service. The functional pattern of knowledge development is nonetheless eminently positive for the users, where effects show increased safety, a better understanding of their disease, and the feeling that someone is monitoring their health. Users also report that they eat healthier, and the diabetic clinic in Sarpsborg report that DM patients have reduced/controlled their hba1c after the service.

5.1.2.2 Influence on the direction of search

The incentives or pressure to enter the market is interpreted through the expectations and growth potential of the TIS. Here, growth in the system, and system technical bottlenecks and reverse salient is analysed.

In the Norwegian healthcare sector RPM is growing, albeit in different configurations then municipal operated response-centres. Roughly 17 individual projects (including the RPM program) is testing and implementing telehealth/RPM technologies (U. Knarvik, Rotvold, Bjørvig, & Bakkevoll, 2017). Other forms of organising RPM are either through the general practitioner (GPs) offices (primary care team model), or through the hospital.

The Norwegian Directorate of Health initiated the 1-april 2018 a pilot project in eight Norwegian municipalities. The project is built on the primary care model, which includes operating a response-centre from the general practitioner office. A specialist nurse is given the role (like a response-centre) to contact GP patients by welfare technology solutions. The aim is to release the workload of GPs, and to facilitate better follow up for patients on questions regarding medication, diagnosis and pro-active measures to prevent complication or deteriorating health (Helsedirektoratet, 2018b).

Another, similar project is starting in the fall of 2018, and is named medical remote distance monitoring (medisinsk avstandsoppfølging). Here, the organisation will also be directed through municipal GPs (primary care model). Approximately 4 – 8 municipalities will participate (dependent on municipality size), and approximately 600 chronic disease patients will be recruited (Helsedirektoratet, 2018a).

Growth and expectations is also considerable in organising response-centres in an hospital environment. The technology supplier Dignio is cooperating with Kalnes regional Hospital towards delivering RPM services to patients diagnosed with cancer and receiving chemotherapy. (Torgersen, 2017). The configuration is comparable to the system being tested in the RPM program - The patients obtain an IPad, weight, thermometer and a blood value measurement device. Nurses at the hospital answer questions from the patient, and evaluate the biological values collected by the user.

Growth and *co-construction* is also occurring from the service suppliers. The city-district St. Hanshaugen is testing palliative care for district inhabitants. The palliative care model is incorporated with the response-centre and offers patient with terminal illnesses the option for fast contact and consultation with healthcare personnel. Palliative care of municipal inhabitants constitutes a great workload for home care services. In 2011, 41 300 people died in Norway, more than three out of four of these received municipal long-term care (Ramm, 2013). Municipal palliative RPM is thus an interesting design of RPM, that can benefit many potential inhabitants.

The technological innovation system of RPM delivery is promising, with growth and diversity in projects and complementary resources. Some technical bottlenecks regarding the MTEs and software however need to be dealt with if legitimation is to become anchored for the service. These will be detailed next.

5.1.2.2.1 Technical bottlenecks

While the incentives for entering the technological innovation system of RPM seems strong, with substantial growth potential for involved actors, there are many observed challenges when configuring the system. Such bottlenecks are often viewed as small, and manageable, but together they contribute to substantial difficulties for users, service suppliers and other system actors. Below follows a brief description of the most salient technical difficulties observed within the TIS of municipal RPM.

Log-in problems seem to be handled either by technicians remotely configuring the tablet, or a healthcare worker traveling to the user's home. In some cases, relatives help the users with minor difficulties. Relatives helping the user seemed to be a common occurrence when interviewing healthcare personnel.

The problem of log-in difficulties also seemed more frequent in HelsaMi+, compared to Mestry and VIS. A possible explanation for this lies in the fact that users in Trondheim can use their tablet for other activities, such as social-media or using their browser. Whereas, in VIS and Mestry the tablets are locked towards only using the device for RPM related activities. However, all projects experienced log-in problems when either Apple or Samsung launched operating system updates. When discussing the issue with healthcare personnel from VIS, some respondents addressed that the technological supplier often configured system updates whiteout informing the personnel, which created extra guidance in helping users connect back on their tablet. This seemed to frustrate the users, which again frustrated the healthcare personnel.

Sim-cards not functioning abroad was observed in some instances. This barrier seemed most frequent in Sarpsborg, where users regularly travel to Sweden for vacation. The same problem occurred in Trondheim, when a user travelled to Spain for vacation. This barrier can be interpreted as quite minor, since this affected few users, and only caused disturbance in measurements for a brief period.

Connection issues, happens when data cannot be transmitted between the user and the response centre. When approaching users in informal conversations, these problems seemed to occur less frequent, the when the project was initiated. In the beginning of the program, the devices could only communicate with the GSM network, and thus experienced connection issues when the coverage was insufficient. However, this has been solved by also making the tablets able to transmit data over Wi-fi.

Lack of adequate technical training, some users lacked adequate education in how to handle the technological equipment. This often-caused frustration, and users abandoning the service if not fixed quickly. Some respondents meant that these issues were most frequent with older women. However, other personnel had an opposite experience on this issue. Regarding the medical technical equipment one respondent said:

Respondent: "*It seems they have tested these devices on the healthiest people" …*

Respondents addressed the issue that some of the equipment easily broke[13] and was difficult to use. The user perceptive when designing the equipment was an issue many respondents felt was insufficient. Especially for users with COPD, when using the MTE for measuring oxygen saturation and pulse. Since many of the users are older, diseases such as Parkinson is frequent among the populace. This causes shaking which makes it difficult to complete the measurements.

Measurement quality, the last technical problems observed is that of measurement quality retrieved from the medical technical equipment. Especially, the weight and thermometer were sensitive, and sometimes produced wrongful data. This issue often caused anxiety for users, resulting in complaints towards the response-centre. Response-centre operators was also troubled by this, since such occurrences sometimes activated wrongful "alarms". In HelsaMi+ the project stopped experimenting with medical technical equipment[14] when general practitioners raised issues on the reliability of the measurements.

The technical bottlenecks of *log-in problems, sim-cards not functioning abroad, connection issues, lack of adequate technical training* and *measurement quality* together construct

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[13] The device that seemed most frequently to conduct errors was the weight and thermometer (In Mestry and VIS)

[14] Some users, albeit a few, still use the equipment

frustration and misinformation, users dropping the service and loss of legitimation among relevant healthcare actors such as general practitioners.

Influence on the direction of search summary

Albeit a "snapshot" of this functional patter, the development and growth of the technological innovation system is growing. Complementary assets and new governmental projects is being tested in both general practitioner offices and at hospitals. Further, the city-district in VIS is experimenting the service for patients with palliative needs, increasing the potential target group for RPM.

On the technical side, some problems, both minor and moderate is observed. Technical difficulties are expected in a novel and developing technological innovation system. Since the service is medically orientated, such challenges is less accepted. Trouble with the quality and certainty of medical technical equipment causes frustration among response-centre personnel (operators), and the loss of legitimation for general practitioners.

5.1.2.3 Entrepreneurial experimentation

The function of entrepreneurial experimentation is important to keep the system functional and to avoid stagnation. Entrepreneurial experimentation can be divided into three main elements for the service of RPM, software experimentation, hardware experimentation and organisational experimentation.

Software embody the assessment systems and the applications installed on the tablet. Hardware embody the medical technical equipment (MTEs). The technology suppliers provide the software for each project. This mainly revolves around the assessment system, applications for the device, communication between the MTEs and the response-centre. Hardware is most frequently imported from Italy, China and Great Britain, and is yet to be produced by the technology suppliers. Organisational experimentation can be interpreted by the diversified way of delivering RPM in each project.

Throughout the project, both hardware and software experimentation has taken place. In VIS and Mestry the tablet was changed from Android (Samsung) to IOS (IPad). The technology supplier Dignio, made the decision on the basis that IOS supported a more sophisticated

MDM (mobile device management system) enabling the technology supplier to control and configure user's devices remotely. Different thermometers, weights, oxygen saturation equipment, blood glucose equipment has also been changed throughout the project and ordered from different manufacturers. Both projects (VIS and Mestry) have also experimented with different combinations of MTEs for the users, and the tailoring of clinical questions seems to give the users a more personal service, as opponent to HelsaMi+ and GodHelseHjemme where the clinical questions are fixed and nonadjustable.

Interviews with informants from the technology supplier expressed how *hardware experimentation* was a complicated process. While the company received numerous messages from Users and Service suppliers about technical problems (discussed in 5.1.2.2.1) and incremental improvements, these improvements was hard to communicate towards the manufacturers.

When the technology supplier ordered batches, it was in miniscule numbers (ca. 100-500 units). The manufacturers did not seem to take into consideration the technology supplier's modification proposals. Ergo, even though the service supplier hosted discussions groups among interest groups and healthcare personnel, this knowledge was rarely considered by the manufacturers, because the service technology lacked adequate leverage. Lack of leverage from the technological suppliers meant that incremental improvements was not done and created frustration for users and response-centre personnel.

In *GodHelseHjemme* experimentation has mainly consisted of the development of educational videos and video consultation guides. Experimentation within the project has been severely hampered by the web portal experiencing technical difficulties, and that the web browser safari is non-compatible with the video consultation software. Experimentation and development within the project has thus stagnated.

HelsaMi+ has primarily focused on software and organisation experimentation throughout the project. Experimentation has consisted of integrating the assessment system VISI, with the established system of safety technology assessment systems. Further experimentation has consisted of improving and developing the patient treatment plan, which is given to each user entering the project. Experimentation on medical technical equipment was stopped, following issues with general practitioner scepticism.

The functional pattern of entrepreneurial experimentation is evaluated as a positive function, with various trials and advancements in both software, hardware and organisational methods. However, technology suppliers seem to have insufficient leverage when contacting manufacturers about improving the design of MTEs. The leverage will presumably adjust as RPM grow.

Entrepreneurial experimentation summary

The functional pattern of entrepreneurial experimentation has a well-functioning development in both VIS, Mestry and HelsaMi+. In these projects, experimentation in software (assessment system improvements, and integration with municipal EPJ in Mestry), hardware experimentation (utilising different combinations of MTEs, and switching manufacturers) and organisational experimentation have been progressing throughout the program period. However, HelsaMi+ was stopped their testing of MTEs,

Technology suppliers seem to have insufficient leverage when contacting manufacturers about improving the design of MTEs. The leverage will presumably adjust as RPM grow, and market formation is matured.

5.1.2.4 Market formation

The functional pattern of market formation attends to the market development, and what drives the market. Market formation is conceptualised as *nursing* (radical formation, service development and protective learning spaces), a *bridging market* (volumes increase and enlargement of engaged actors) and *mass markets (Bergek et al., 2008)*. To analyse *market formation*, the researcher need to understand what *drives the market* and the *market development*.

RPM is located between a *nursing environment*, where radical formation and service development is taking place and a *bridging market* which allows for volumes to increase and where actors and organisational methods are advancing. *Nursing* because the service is still under construction with service development, and protective spaces in the form of being a part of a governmental funded program. The market is also *bridging,* since volumes are increasing, and the two largest projects (VIS and HelsaMi+) has agreed to continue the service, and that new municipalities are scheduled to implement RPM services. The market development of RPM is thus in a growing and positive development.

The market for RPM is *driven* by the landscape development of the demographic shift. This shift causes a rise in potential RPM users. This will leave a heavy toll on primary health care, which is profoundly labour reliant (Holmøy, 2016), making the incentives for any service that can control or reduce costs favourable. Further, market development receives positive feedback by in the future acquiring a more technology savvy and technology confident generation of both healthcare workers, and users (Radhakrishnan, Xie, Berkley, & Kim, 2016; Teknologirådet, 2009). This is predicted to decrease overall frustration form technical problems (especially log-in problems) and thus create more goodwill towards the system, while also decreasing the time used for education and training towards the equipment.

Price and performance related to RPM as a service is however unresolved. Prices vary profoundly (from 49 000 NOK to 19 000NOK), and the estimated costs contain large uncertainties. The performance of the system is also ambiguous (International, 2018), making the cost-benefit of RPM not yet proven.

F4: Market formation

The functional pattern of market formation is an emerging market, and is conceptualised as a nursing market, with indicators of a premising *bridging market*.

Price/performance and the articulation of user demands is still underdeveloped. However, market development and market drivers imply positive inclination with the agreement to continue the service in HelsaMi+ and VIS, the widening of target groups with complementary projects and assets, a more technology savvy generation in the future.

5.1.2.5 Legitimation

Legitimation is a function that for RPM is closely dependent on the function of knowledge development. If RPM is to be perceived as a viable medical solution, the clinical effectiveness, and more significant cost-benefits models need to be documented.

Legitimation in home care, hospital nurse specialists, users and relatives, and interest groups seem relatively strong from interviews and observations. Empirical data from media channels, interviews and document analysis indicate that supportive actors (primary and secondary healthcare), users and service suppliers view RPM as a viable and practical solution towards chronic care management. However, general practitioners are often sceptical, which severely hampers legitimation as this actor sways authority in user health planning.

Inadequate positive support from general practitioners is an important obstacle for legitimation. General practisers (GPs) functions as the gatekeeper for many healthcare services, and lack of support therefore decreases the legitimacy of RPM by other actors, for recruitment and the development of RPM. The resistance exhibited by general practitioners stems from **(1)** *Lack of RCT studies and solid scientific knowledge*, **(2)** *measurement quality of biometrical values and how to establish biometrical values*, and **(3)** *unclear GP tariff compensation*.

Discussed in the function of knowledge development, RPM has unclear clinical documentation as to the effects of the service. GPs thus remain hesitant towards acknowledging the service a feasible medical service. This resistance is further strengthened by problems with measurement quality of the MTEs adopted, firming sceptics towards the service being “unsafe”. In HelsaMI+, the use of MTEs was almost abandoned since GPs did not feel comfortable in setting clinical biometric/physiological values for which values that would be alarming when users did measurements.

Lastly, a settled tariff compensation from the Norwegian Economics Administration (Helfo) has largely been missing throughout the project period. This has further deteriorated GP activity, since financial incentives for consulting patients towards RPM, and making time towards creating a patient treatment plan has been missing. The issue of compensation was solved in January of 2018, when Helfo agreed that tariff (14)[15] can be used for RPM related consultations. This obstacle has thus been solved, increasing the incentives for GPs to assist in treatment planning, and user guidance.

Interviews with *service suppliers* provided some dispute on the available resources regarding operating the response-centre. Often, the available time and resources allocated by the municipality towards managing the response-service felt inadequate. The respondents in one location argued that each response-centre should have at least two operators working simultaneously, to share the workload, but also to confer about medical advice. When access

[15] (Legeforeningen, 2017, p. 22)

for resources where raised, it was often interpreted as problematic to get municipal administration to understand the need of resources. In Mestry the service was not continued in the municipal budget for 2018/2019, even though the effects on patient safety, diagnosis understanding, and the appearance of a healthier diet was strongest in this project.

One *Service suppliers* also experienced that getting support from other healthcare actors, especially in the secondary healthcare sector could often be stagnant. An example can be seen in GodHelseHjemme where the project failed to get access to a recruiter on the regional hospital (Stavanger university Hospital). While the other three projects experienced an influx of users by cooperating with closely linked hospitals, GodHelseHjemme was dismissed in their approach. The reasoning for this failure of cooperation of recruitment was interpreted as in that the hospital was conducting their own research on COPD patients and was reluctant to "collude" the research group. This obstacle was not because of lack of legitimation, but competition over resources. However, the absence on cooperation with Stavanger Hospital did impact the legitimacy of the project.

The functional pattern of legitimation for RPM is strongly linked with function 1: Knowledge development. GPs is sceptical of the service, if solid scientific medical results are "inadequate". GodHelseHjemme have has lost legitimation by not being able to cooperate with the regional hospital but has gained legitimation by involving interest groups in both recruitment and service delivery. For RPM to be considered as a viable and solid health service, partnership with both primary and secondary healthcare services need to be established.

Legitimation summary

For users, legitimation indicate a strong functional behaviour. Users enjoy the service and view it as valuable application, that provides safety and a better understanding of their disease. Interest groups also seem positive.

General practitioners do however seem sceptical towards RPM. This severely hampers legitimation as this actor often functions as a gatekeeper for recruitment, medical expertise and overall legitimation of the service. While the issue of GP tariff code has been resolved, absence of rigours scientific knowledge and uncertainty towards biometric measurements makes this actor unconvinced, and sometimes uncooperative.

5.1.2.6 Resource mobilisation

Resource mobilisation covers the functional pattern of how well the TIS can mobilise competence/human capital, entrepreneurship and finance *complementary assets* (Bergek et al., 2008).

Globally, RPM as a healthcare service has grown substantially in recent years. The global remote patient monitoring market was estimated at $703 million in 2015, and is expected to grow at a compound annual growth rate (CAGR) of 17 % to reach $2,130 million by the end of 2020 (Sumant & Jaiswal, 2016). These figures are collected from a diversified pool of RPM technology covering municipal, hospital, GPs and privately accommodated RPM services. And thus, constitute a wider aspect then of the targeted technological innovation system of municipal healthcare.

International growth in RPM helps **F1:** Knowledge development - by creating a stronger scientific understanding of the service further helping **F5:** legitimation, by diversifying the complementary assets and technology, organisational methods and possible target groups. Growth in international RPM expenditure further pushes **F4:** Entrepreneurial experimentation by including more technology suppliers and creating greater competition in the development and design of RPM services and products.

The production of complementary assets and R&D funding in Norway, both in the organisational level, but also with regards to other welfare technology solutions that can be integrated and operated together with RPM. As discussed in function F2: influence on the direction of search, new projects and funding from government initiatives is being tested and implemented throughout Norwegian municipalities and GP offices. Hence, increasing the availability for funds, possible service suppliers and creates incentives for technology suppliers to enter the market.

Growth in R&D and capital both internationally and in Norway is a positive functional pattern for the technological innovation system. On the human capital element, development is more adverse. While diversity in nursing education is slowly taking place within the educational sector, including more informatics and telerehabilitation courses, the number of available nurses is witnessing a decline (Ugreninov, Vedeler, & Heggebø, 2017). Nurses represent the profession within Norway which has with highest scarcity and shortage (sykepleierforbund, 2016; Thommasen, 2018). 1 out of 5 nurses leave their profession before 10-year period, and The Norwegian Association of Local and Regional Authorities adverse that nurses are among the professions that is hardest to recruit. Estimates indicate that Norway may be without 75 000 nurses within 2030.

While the decline in available nurses most likely will weaken the available pool of human capital, this development might not directly be of negative impact for the technological innovation system of RPM. Nurses at the response-centres informed through interviews that they had *actively* applied for the position, and that the positions were popular among colleagues. They further informed that the position offered professional specialisation (seminars and education about specific diseases), less workload on the body, less stress and higher medical authority. The positions were popular among healthcare personnel, and when one operator had to leave for maternity leave, the competition for the available position was strong. Ergo, the popularity of the operator position might compensate for the future decline in human capital of nurses.

Resource mobilisation summary

Resources in the scheme of both financial and human capital indicate an overall positive performance in the technological innovation system. Financial capital and government funding is rising both internationally and nationally, albeit with a variety in structural components, target groups and technological architecture.

Available human capital of nurses I expected to have major shortcoming in the years to come. RPM might however overcome, and even gain from this development by being viewed both as the solution to this problem (increased productivity per FTE), and because the position of response-centre operator is attractive.

5.1.2.7 Development of positive externalities

The development of positive externalities explains how the divergent functions support each other and generate positive developments between functions.

Early examples of this can be found in how "*influence on the direction of search*" is a well-functioning pattern which over time strengthens the growth of "*Entrepreneurial experimentation*" by increasing actors, establishing complementary assets and increasing "*market formation*". In this way, increasing the number of users, which could cause greater leverage for *technology suppliers* when contacting MTEs manufacturers.

Further dwelling on the development of positive externalities is reversed, since the system is still mostly located in a nursing market, where radical formation is still taking place. Since I have yet to be able to determine how, and how well this function magnifies the development of the TIS, it is further excluded from analysis. Such a step was also taken by Bergek et al. (2008) when analysing IT in home-care.

5.1.3 Assessing functionality: Uncovering divers and barriers

The structural components encompassing the TIS of municipal RPM consist of *inner core actors* represented by *Governmental bodies* (NDH and NDEH), *Service suppliers*, *technology suppliers* and *users.* These actors have established formal networks, that have different configurations, but generally seek to fulfil the same tasks. These networks are beginning to show signs of being rooted and ingrained.

On the fringes of the TIS, *Supportive actors (*General practitioners, primary health care, secondary health care) and *interest groups (Workers unions, patient organisations)* are located. Within the RPM project these actors have different responsibilities, and authority over the service. Over time, the development indicate that GPs might be replaced as the service suppliers, or at least be more incorporated and part of the *inner core actors*. This also holds true for secondary actors, i.e. hospitals, which also is expected to implement and test RPM services, albeit towards a more diffused target group.

The *inducement mechanisms* for implementing the TIS are manifold: increased quality of life, patient empowerment, increased safety, reduced healthcare usage, decreased costs, decreased institutionalisation and increased productivity and decreased primary healthcare costs. The service thus offers an alluring bucket of incentives for users, service suppliers and governmental bodies. Streamlined, the two main *inducement mechanisms* push the system development. These are (1) *reduced patient costs*, and *increased healthcare productivity* and (2) *improved user health and health literacy*. Since RPM still is funded by governmental budgets, the incentives are top-down oriented, and mainly focused on resource necessities.

The *phase of development* for municipal RPM, is in the *formative phase.* In this phase, the TIS is still undergoing entry of new firms and organisations, institutional alignment and formation of networks (Bergek et al., 2008). Hence, the TIS is a rudimentary structure where radical formation is still taking place. Other factors aligning with the TIS being in a *formative phase* are: large uncertainties around markets and applications, price and performance being not well adopted (or understood), a volume of diffusion which is but a fraction of the estimated potential, demand for the product being unarticulated and the absence of powerful self-reinforcing features.

Aligning the functional patterns of municipal RPM under these conceptual structures, provides insight into *how well* each functional pattern is performing. Thus, creating a framework for understanding the positive functional patterns (drivers) and the blocking mechanism (barriers). Tabell 5.1 summaries each functional pattern, and the drivers and barriers observed in each function.

Functional pattern	Drivers	Barriers
F1: Knowledge development	Strong patient related effects on increased safety, health literacy and a healthier diet	Uncertainty around costs and reduction of health care usage
F2: Influence on the direction of search	Growth in complementary assets	Technical difficulties hampering the quality of medical technical equipment
F3: Entrepreneurial experimentation	Innovate experimentation in software, hardware and organisational methods	Small-scale orders in medical technical equipment making it difficult to communicate improvements to manufacturers
F4: Market formation	Estimated growth in complementary assets and increased technology literacy for users and healthcare workers	Without robust evidence of increased productivity and reduced costs, market incentives are inadequate
F5: Legitimation	Support from interest groups, users and nurses	General practitioner scepticism and resistance
F6: Resource mobilisation	Growth in both international and national funding towards RPM related services. Nurses view response-centre positions as favourable	N/A

Tabell 5-1: Functional pattern analysis, observed drivers and barriers for RPM implementation and future growth

Figure 9 illustrate the inducement mechanisms for the technological innovation system, and how the functional patterns reinforces and strengthens other patterns observed in the technological innovation system.

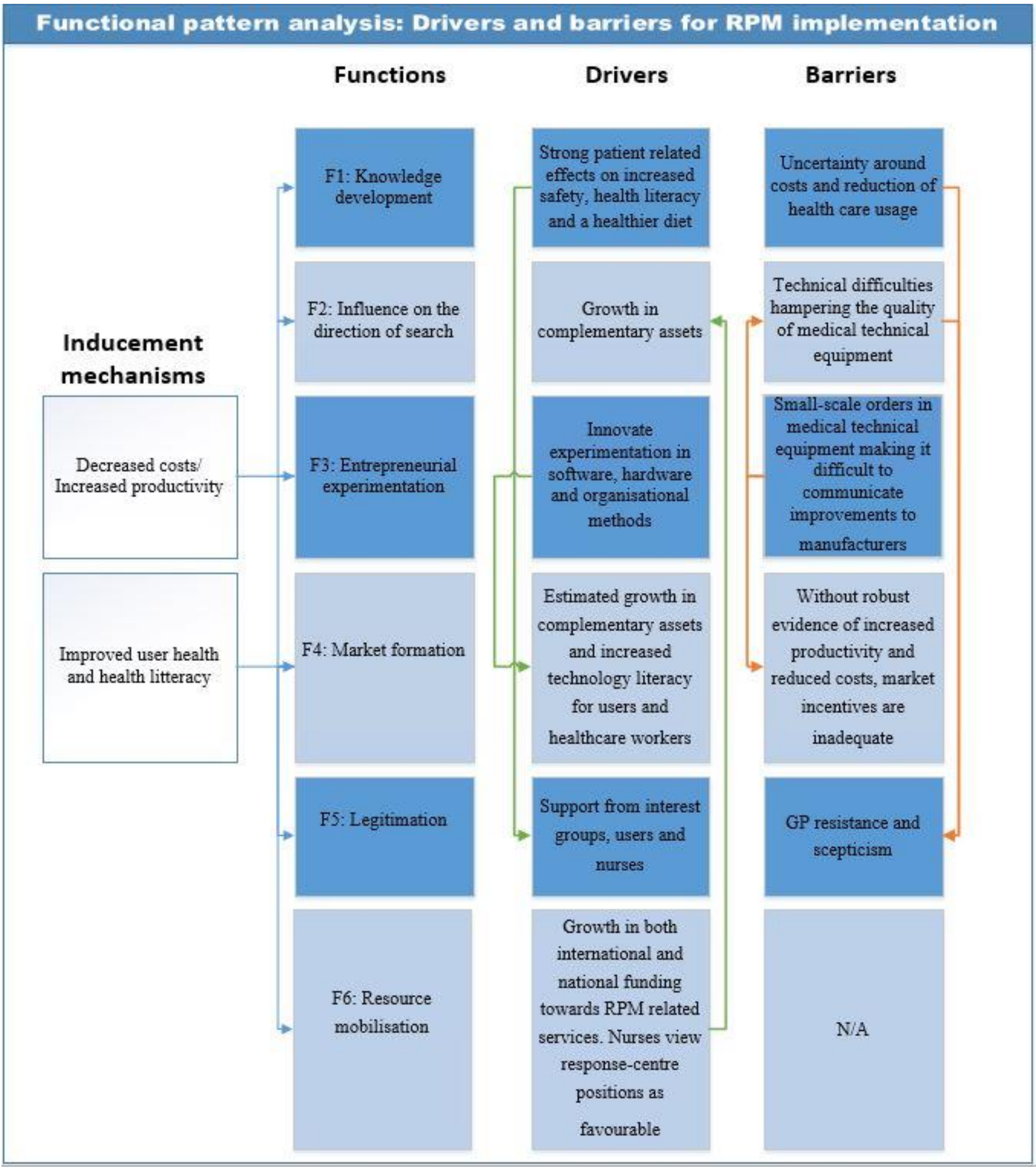


Figure 9 Barriers and drivers derived from each functional pattern of RPM, explanation of arrows:

Driver-patterns: (1) Positive patient related effects, creating legitimation among users, nurses and interest groups (2) experimentation in software, hardware and organisational models helping growth in complementary assets (3) growth in funding and projects, creating a diversity of new RPM services.

Barrie-patterns (1) uncertainties in scientific knowledge and reduced costs, and malfunctioning medical technical equipment leading to general practitioner resistance. (2) Small quantities in medical technical equipment orders, leads to difficulty in incremental improvements

5.1.4 Summary: Functional pattern analysis

The main *structural components* observed consist of governmental bodies, service suppliers, technology suppliers, supportive actors, interest groups and users. These components are observed in each project participating in the program, but their networks are different. In Mestry the technology supplier is also a service supplier, and in GodHelseHjemme, the interest group participate in response-centre methods. The system is in a *formative* phase, signifying that the system is underdeveloped, and that radical formation is likely to occur as the system grows. System actors, technology and markets examined might therefore change drastically as the system grows. However, by focusing on the *inner core actors* the conducted analysis will most likely stay relevant, as these actors most likely will follow the system through changes.

The inducement mechanisms represent the incentives of the system. These are interpreted from governmental documents and interviews with project managers as (1) decreased costs and increased productivity and (2) improved user health and health literacy. By adapting a functional pattern analysis, drivers and barriers are interpreted from "how good" each function performs, and barriers from the conceptualised blocking mechanisms. The discovered drivers and barriers is a mixture of actors related functions, and market related functions.

The primary drivers discovered are: robust evidence towards improved patient related effects, such as increased safety, heightened health literacy and a healthier diet, particularly for users diagnosed with diabetes mellitus. This creates legitimacy among users and healthcare workers that witness the effects, and from interest groups. There are also positive tendencies in growth of complementary assets and technologies, with more projects testing RPM solutions in hospitals and general practitioner offices. Interviews also confirm that nurses view RPM positions as attractive work places.

Detected barriers for implementation of RPM is mainly around general practitioner scepticism. Uncertainties around the scientific evidence of RPM as a healthcare service, and challenges with the quality of medical technical equipment makes general practitioners unconvinced, which severely hampers RPM legitimacy.

5.2 The multi-level perspective: analysis

This section covers the second research question of this thesis *"How can remote patient monitoring be perceived as part of a wider socio-technical transition?"* The analysis will follow the three heuristic levels conceptualised in the MLP framework – The landscape level, the regime-level and the niche level.

The landscape-level represents external forces and pressure that exist at the macro layer. Conceptualised, the landscape creates pressure on the existing socio-technical configuration of delivering chronic management in the primary health care sector, while also creating windows of opportunity for novel technologies to integrate into the existing system.

The regime-level exhibit the micro layer of analysis and constitutes the existing dominant design of municipal chronic healthcare. In this level, regime selection environments (RSEs) will be mapped, to better understand what rejection and acceptance mechanics that the system endows towards RPM.

The niche-level exists at the meso layer of analysis. By building on the knowledge created in chapter 4 and section 5.1, the analysis will focus on the co-construction and co-evolution discovered around the novel technology of RPM, and what kind of alignments RPM might display towards the existing socio-technical regime.

In the end of this section, I will make use of the analytical framework of the Multi-level perspective in illustrating how RPM can be perceived as part of a wider transition process.

5.2.1 Landscape dynamics

The *socio-technological landscape* interpreted through the lens of the multi-level perspective, constitutes an exogenous environment pushing for transition within the macro-level of analysis. These forces exemplifying deep *cultural patterns*, *macro-political* developments or *macro-economics*. These external circumstances together shape pressure on the regime, causing instability. Van Driel and Schot (2005) has further conceptualised the above-mentioned attributes of landscape developments into tree types: (1) Factors that do not change, or that change very slowly, (2) rapid external shocks, (3) long term changes in a certain direction. These forms of "pressure" do not determine change, but provides deep structural forces that make some actions easier than others (Frank W. Geels & Schot, 2007, p. 403).

While some landscape forces are more country-specific then others (natural-disasters, war, etc.) Landscape pressures are divergent and can be categorised as positive pressure or negative pressure, i.e. the socially embedded mental analysis in pushing for change.

5.2.1.1 Demographic shift

The initiative for the national policy program for welfare technology is the result of a top-down external landscape pressure by political initiatives (National welfare technology program). The major driver for technological transition is the demographic shift, i.e. an aging population. (Frank W. Geels, 2011, p. 28); Frank W. Geels and Schot (2007, p. 400) , conceptualises demographic shifts as a broad political, social and economic "landscape" development. The demographic shift further aligns with the conceptualisation of a long-term change in a certain direction (Van Driel & Schot, 2005). This significant *landscape pressure* is caused by two major factors:

The first factor relates to the "baby boom – generation", coming of age. In 1946, a year after the second world war, 70 727 births were registered in Norway, the highest rate of births ever recorded in Norwegian history. The rate of births continued to exceed 60 000 a year before declining in 1971[16] (Østby, 1999). This phenomenon is shared by most other industrialised nations.

[16] Østby (1999) Explanation: The education-revolution in the 70's, amongst women

A second factor for the demographic shift is life expectancy (LE). In 1980, the average LE was 75,5. As of 2017, the average life expectancy is set 82.4 years (84,17 for women and 80,61 for men), with expectations to rise even more (SSB, 2017a). The raise of LE is also shared by other industrialised nations, but Norway rank among the top in the world (Legeforening, 2001)[17].

The raise of an elderly population includes a larger portion of people with chronic disorders. (Finansdepartementet, 2016-2017b, p. 218; Legeforening, 2001; Helse - og omsorgsdepartementet, 2014-2015, p. 159). This creates pessimistic future predictions, where the societal debate revolves around the demographic shift, being a "burden" and a "crisis" (Pekkarinen, 2011, p. 25). The influx of more people with chronic diseases causes financial strain on municipality budgets and is expected to "drain" resources in healthcare-labour and institutional housing for elderly. In recent years' municipality budges has been pressured by increased expenditures on nursing and care (SSB, 2017b), leading to a willingness of innovation, in the hopes of improving productivity of homecare management (Finansdepartementet, 2016-2017a, p. 8). The notion of innovating to keep society sustainable is hence created by the landscape pressure of the demographic shift, as Jesper W. Simonsen, Director of society and health for the Norwegian research council proclaimed at the evaluation conference: *"Innovating Norwegian healthcare, is about the sustainability of the welfare state".*

5.2.1.2 Patient activation

"My goal as healthcare-minister, is to create the patients' health service" -Bent Høie

While the *landscape pressure* of the demographic shift is a quite pessimistic force of exogenous macro-economic nature, pushing for transition, there are also cultural-patterns at play. *Active aging, patient self-management, health-literacy* and *patient empowerment*, is closely interlinked with the notion of pro-active initiatives and is an interesting factor of the *socio-technological landscape* externalising *long term change in a certain direction (Van*

[17] Nr.1 is Japan

Driel & Schot, 2005). While these terms have various definitions, together they synthesise a sociological and cultural change on how society and healthcare approaches illnesses. Changes in societal values is often mentioned as a common feature among landscape developments (Frank W. Geels, 2011, p. 28).

This societal change in approach encircle the sentiment that users should be able to live home longer, that their rights should be valued more deeply, giving the user more control of their disease and that healthcare services should work more pro-active (Helse- og Omsorgsdepartementet, 2012-2013; Helse - og omsorgsdepartementet, 2014-2015, p. 60). Statistics from SBB support the notion that patients is increasingly handling their health care, and are less reliant on home based caregiving services. Even though the elderly populations has risen since 2008, the number if users that receive home care from municipalities in 2013 was the same (Ramm, 2013).

When observing the conferences in Trondheim and Oslo this "patient-empowering" way of reflecting about healthcare was evident among numerous speakers. At the conferences, speakers often brought up engaging the patient and the topic of user-involvement. Most notably from the leader of Norwegian Nurses Organisation, Eli Gunhild by – *"Who wished for more innovation defined by the patients"*. Followed by honorary president of European patients' forum (EPF), Anders Olauson, that – *"wondered why the patients' perspective wasn't the primary starting point"*. He also wished for a more holistic[18] view in patient welfare, and made a point about public health being nr.3 (out of 17) sustainable development goals defined from United Nations (UN) (UN, 2015).

Andreas Moan, Ass. Director Research and Development at Oslo University Hospital proclaimed that the healthcare sector: *"needed to let patients do the work himself, just look at banks, they make users do everything"*. However, today Norwegian healthcare is: "*just like the old Norwegian liquor stores[19], we are still sitting behind a desk helping one patient at a time"*.

[18] "The treatment of any subject as a whole integrated system, esp, in medicine, the consideration of the complete person, physically and psychologically, in the treatment of a disease" (Dictionary, 2014).
[19] Referring to the old system at the national Norwegian liquor stores (vinmonopolet) where you had to the cashier and ask for which liquor you wanted, which naturally caused an insufficient system where lines often were long

The notion of giving users with chronic diseases feedback, clinical values and advice thru RPM is closely interlinked with empowering the patient to attend their own disease. The occurrences of chronical illnesses are closely connected to increased urbanisation, sedentary lifestyles, and rising obesity values among the populace (Economics, 2017). "Activating" the patient is thus a wanted incentive. In fact, the main-goal of the RPM program is "*To give persons with chronic diseases better opportunities to master their own health" (e-helse, 2016b).* Thus, working as a destabilising mechanism on the *socio-technical regime* of usual care where financial investment in such approaches has been limited, and the regime is built around the notion of being re-active (SSB, 2017b).

The idea of ICT related healthcare being empowering towards the patients is evident in the medical research gathered from the literature review, Stated by: (Wildevuur & Simonse, 2015): *"We postulated that ICT could help persons with chronic conditions to interact directly with their health care providers about their personal health concerns and thereby empower them in the self-management of their personal health (information) and care plan"..*

When conducting interviews with healthcare personnel, this notion was brought up by the respondents repeatedly. When the question: "How do you think, your profession will change" (In the light of RPM), respondents often addressed the adjustments on how homecare-service is organised and how patient focus became increasingly important in their line of work.

Changes in the perception on how healthcare is delivered, and patient-participation constitutes a landscape externality that is changing *socio-institutional* structures, creating room for *innovations* that empower or educate the patients. However, this "change in perception" also reflect an *internality* where users within the regime expects that the services-delivered are better tailored for their needs. Among healthcare workers, this line of thought sometimes causes friction, destabilising the "usual practise" on how they have always worked. The "change in perception" that is re-configuring the sociotechnical regime and system in Norwegian healthcare represents a *landscape pressure* as a societal change that on some regime-levels shake certain *normative values* (Frank W. Geels, 2007, p. 1414).

5.2.1.3 Fluctuating oil prices

The last *landscape externality* addressed, is the sudden decline of oil prices in 2012, that rattled Norwegian society, policy discussion and governmental decision making. The North Sea crude-oil price fell 42 % from 2012 -2016 (Finansdepartementet, 2016-2017b), creating pressure on a multitude of sectors.

Firmly placed within the macro-level, oil prices are deeply embedded in Norwegian budgets, thus also interlinked with public sector *innovation willingness* (Finansdepartementet, 2016-2017b, p. 222). The sudden decline of prices on north sea oil is a *landscape pressure* conceptualised as a sudden external shock (Van Driel & Schot, 2005). While oil-related revenue is a key factor in many countries around the world, Norwegian society is deeply encapsulated, both economically and socially in petroleum related activities. In Norwegian society, petroleum related activities constitutes the largest governmental revenue-stream and employed 240 000 people, directly and in-directly in 2014 (Regjeringen, 2015). In 2016, the petroleum-sector covered 12 % of Norwegian GDP, 13 % of all governmental revenue and 36 % of export value (Finansdepartementet, 2016-2017a).

By cause of declining revenue and future revenue potential, governmental documents and policy-instruments is increasingly investigating how public-sector services can increase productivity and be more cost-efficient. Especially in the municipal and regional healthcare sector, where digitalisation and technology is seen as a propitious solution (Finansdepartementet, 2016-2017b, pp. 187-188). Welfare technology is here singled out as a key priority issue, in increasing efficiency, reducing costs and improving quality for elderly and users with chronic illnesses.

When attending conferences, “welfare technology” was often mentioned as the “new-oil[20]”, referring to its potential cost-reduction and export capacity. While this reference is regularly hurled around various sectors, the promises of welfare technology solutions, and especially those related to chronic illnesses is regarded as a valuable focus area, considering recent decreased oil-revenue. The uncertainty of future oil revenue is hence an external *landscape*

[20] A term that has increasingly been adopted in Norwegian societal debates around several sectors, for example fishing and bio-technology

development which is pressuring the socio-technical regime to improve its services. Thus, creating a “window of opportunity” for welfare technology niches.

5.2.1.4 Landscape-level: Summary

In the conceptualisation of MLP, externalities create pressure on the regime of treatment and caregiving for users with chronic disorders. The empirically captured landscape externalities, pushing the regime for transition is thus:

1. *The demographic shift*, causing a bigger workload while also creating an influx of elderly, which again increases the frequency of chronic non-communicable diseases (NCDs)
2. *Patient activation*, causing governmental policies and program to focus on how to activate the patient and to deliver a pro-active service
3. *Fluctuating oil prices*, causing a larger focus on increasing productivity, and reducing healthcare budgets

The covered externalities create a “window of opportunity” for innovating the primary healthcare sector. The next section of analysis is uncovering the socio-technical regime and the regime selection environments (RSEs) that control niche acceptance, or rejection.

5.2.2 Regime selection environments

Frank W. Geels (2011) conceptualises the regime-level as: “*the locus of established practices and associated rules that stabilize existing system”*. The regime is hence a deeply rooted system, which solves the tasks that RPM seeks to replace, or assist.

The regime experiences pressure from the landscape level, either in form of shocks (i.e. oil prices), or long-term developments (i.e. demographic shift and patient activation). However, the regime has various assortment mechanics, in MLP theory conceptualised as RSEs (regime selection environments) (Smith & Raven, 2012) that is hard to penetrate for innovative niches.

Using the analytical framework of RSEs, the following section will analyse the empirically observed selection environment rejecting or accepting the system of RPM. The analysed environments are *technologies and infrastructure*, *industry structures*, *knowledge*, *markets and user practises*, *culture* and *public policies and political power*.

5.2.2.1 Technologies and infrastructure: Electronic Patient Records

Technologies and established infrastructure are a vital part of the regime selection environment. Innovative technologies are often not compatible with the existing structure, making niche innovations working sub-optimally with the existing infrastructure.

In Norway, Electronic Patient Records (EPRs) are legally regulated by “Regulations on patient’s records” (Forskrift om pasientjournal), that states *§ 4:” Business that serves healthcare are acquired to create an Electronic Patient Record[..]* When delivering the service of RPM, each project must document various health related information about their user contact in the municipal EPR system. The dominant infrastructure in Trondheim, Oslo and Sarpsborg is the EPR *Gerica* and *CosDoc* in Stavanger.

The projects in Sarpsborg, Oslo, Stavanger and Trondheim operate with their own Electronic Health Records (EHRs) for measuring biometric data, and for communication with the user. There are two EHRs systems in the RPM program: *Prevent (*Used in Sarpsborg and Oslo), created by Dignio, and *Visi* (Used in Stavanger and Trondheim) created by Imatis. Both systems cannot function isolated in a municipal caregiving environment but must function together with the dominant EPR of usual care.

Lack of integration between the project EHR and the municipal EPR leads to (**1)** Patient health related information being manually punched into the municipal EPR, since the project system and the municipal system is not integrated. **(2)** Other healthcare personnel/services loose access to measurements and other clinical information stored in the project EPR.

When response-centres in each location receive and communicate vital user related information, this must be registered in municipal EPR. Healthcare personnel operating the response-centres are thus obligated to punch all relevant data manually into the EPR, creating substantial workload. Healthcare personnel expressed frustration about this additional workload in interviews. One informant expressed *“it’s like putting electricity on a sheet of paper”*. Figure 11 illustrated the connection between the assessment system and the municipal EPR in each project.

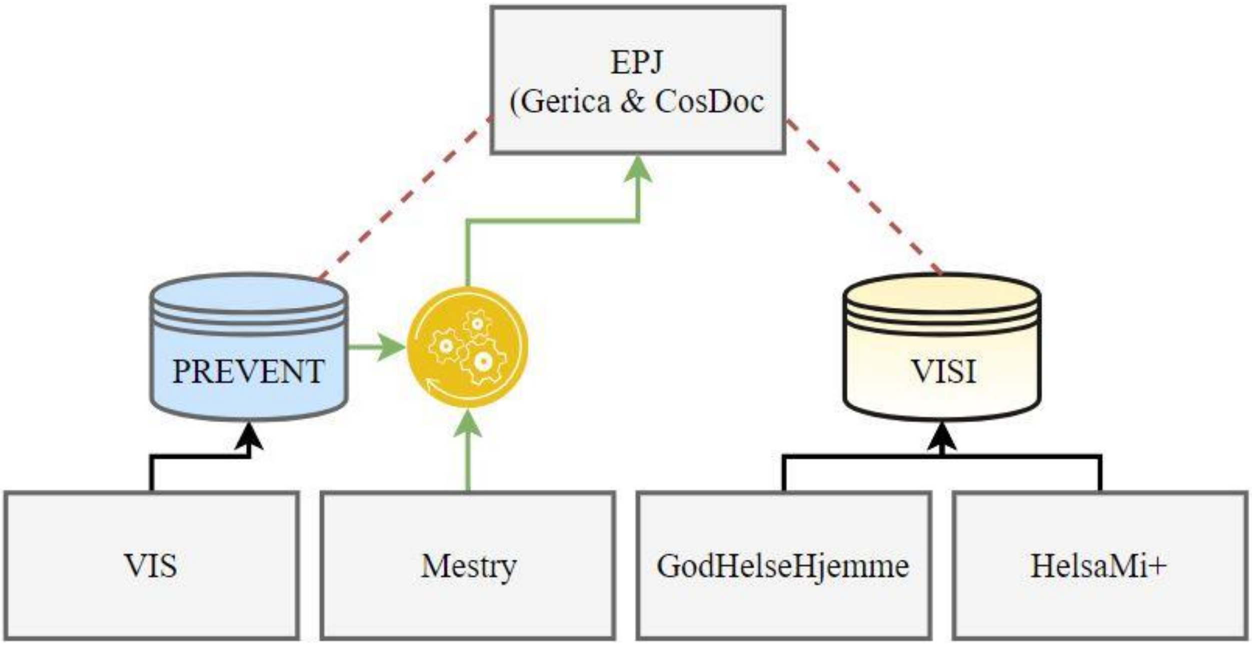


Figure 10: System relation EHR and EPR. Dotted lines represent an unconfigured connection, healthcare personnel must punch these data manually. Mestry has a managed to put forward an integration with an API.

In Sarpsborg, this barrier of additional workload is being worked on. Tieto, the manufacturer of *Gerica*, is working together with the project group to create an application programming interface (API), with a module "E-essens". Thus, making Prevent able to communicate with Gerica in real-time, removing manual punching from the equation. And making it possible for those that don't have access to Prevent, able to read and evaluate the measurements registered by the user. This configuration has been tested since January of 2018, and selected homecare workers can now view biometric data and trends.

A fixed API with *Gerica* is one way of working around the RSE, of infrastructure. However, what type of information that is to be stored is still not resolved. If RPM is to be implemented throughout Norwegian municipalities other infrastructure problems arise. Municipalities use different EPJs, and sometimes different versions of the same EPJ, meaning that more APIs need to be developed and tested. The process is further complicated by lack of standardisation, and unclear guidelines on how and what kind of data that needs to be shared between the systems (Fensli, Smaradottir, & Boysen, 2017).

There are however signs that integration between assessment systems might be an easier task in the coming years. Following the Norwegian governmental white paper "one inhabitant – one record" (Omsorgsdeparement, 2013), Norwegian health records are slowly becoming more standardised and uniformed. The goal is to establish a common electronic patient record for all regions in Norway. Projects like Common implementation of Clinical systems (FIKS – in Norwegian) is trying to configure one patient record for all the regions in Northern Norway, then in the rest of the country. The projects were started in 2012 and was due to be finished in 2016. However, the project is still running, and the system is still under construction.

The selection environment of technologies and infrastructure make diffusion of the RPM system challenging, and time consuming. However, integration can be done, something Mestry has proven. Home-care workers in Mestry can view biometric measurements made by the users, strengthening their knowledge when making patient related decisions.

5.2.2.2 Industry structures: Recruitment bias

The established socio-technical system of caregiving for users with chronic disorders are mostly configured around *re-active* services. They are *re-active* in the way of providing treatment and care if a user is diagnosed with a disease or experience a health-related situation, then following up with medication and clinical administration. Shortened, the municipal populace visits the healthcare sector when they are ill, and usually not before. RPM is however "advertised" and interpreted as a pro-active service. RPM seeks to engage the patient before their diseases are acute or worsened (e-helse, 2016a).

When discussing aspects of recruitment of users to the project with one project leader, an important topic was raised: While the RPM program seeks to be a pro-active service, its recruitment channels configures it to recruit users who have had a severe worsening of their disease. Either, by acute hospitalisation, larger demand for homecare services or other factors that are aligned with increased healthcare usage. Thus, pushing RPM in a re-active direction. The respondent further drew figure 8 on a paper, and stated:

"We were supposed to include users in this category (see mark X), *but since these users are harder to recruit, and are harder to show effects from* (referring to effects of decreased healthcare usage) *we recruit almost all our users from this category* (see mark Y).

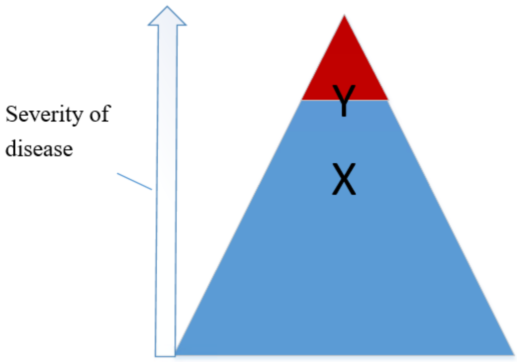


Figure 11: Respondent drawing recreated

When viewing the drawn figure, it occurred that I had seen the same figure when conducting document analysis. Figure 13 was found in a governmental presentation related to the implementation of the program.

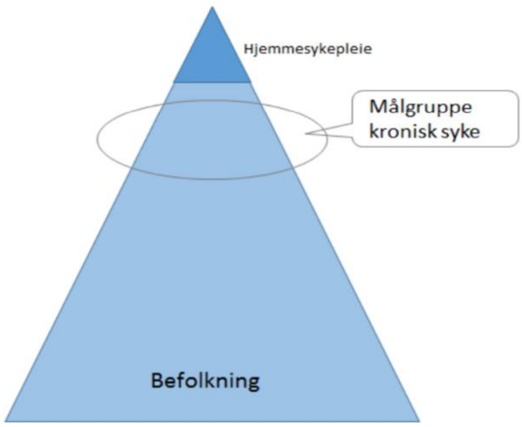


Figure 12: Early assessed target group of the RPM program. The rounded circle represents the target group area, the top of the pyramid represents those users that recive homecare nursing

A comparable situation also occurred in the project HelsaMi+, where one of the starting exclusion criteria was that recruited patients did not receive home-care services. These criteria were however abandoned, since the project struggled to meet their target user goal of 150.

Such changes in recruitment exemplifies how novelties trying to breakthrough a socio-technical configuration shapes niche innovation seeking to change the existing regime. Even tough RPM is a niche novelty, being tested and piloted, it can't escape the existing socio-technical configuration and the established RSEs that dictates of how healthcare meets potential users.

5.2.2.3 *Knowledge*: Lack of specialised knowledge

The established socio-technical configuration of municipal healthcare for users with chronic diseases is an interlinked system with knowledge being shared and practised by homecare workers, nurses and general practitioners, in both municipal (primary), regional level and national (secondary). Each actor and institution in the dominant design are tasked with clear and restricted actions regarding how the user is meet, and what type of service that is provided. Specialist knowledge is hence anchored within each actor and have co-evolved over time through education and workload parameters.

Nurses at the response centre don't have the same mechanics of knowledge sharing, and educational tailoring which other positions enjoy. Being tasked with guiding and giving advice through phone-calls and messages to three distinct users groups (DM, COPD and CHF) demands additional knowledge than what the educational system for nurses provide. The dominant design of education and other positions has not prepared healthcare personnel at the response-centres to work in this manner. Making other actors in the regime hesitant towards RPM. As one general practitioner explained following an informal conversation after a conference:

Respondent-physician: "*Many of my co-workers are resistant to mention RPM as a viable option to their patients, they are sceptical of the competence of those working there in dealing with such delicate diseases"*

The resistance and communication problems with municipal practitioners has been a reoccurring problem throughout the RPM program. Another respondent addressed the same issue of knowledge on the response centre:

Respondent-nurse: "*When talking to patients that I have recruited, many of them say that advice given has been plain wrong, and sometimes potentially harmful. I think that some of those operating the response-centre lack adequate knowledge on the disease* (Mentioning COPD particularly)*"*

Resistance from specialists towards generalists is a recurring theme within healthcare, and other sectors. If specialists view the service of RPM as potentially "dangerous ", being hesitant towards the service will naturally occur in any healthcare service or any other service for that matter.

The knowledge on how to aid and assist chronically ill persons over telephone or through text messages is lacking in some of the projects. This is also the case for separate RPM systems that are being tested (e-helse, 2016a). This creates suspicion among other healthcare services and personnel, that perhaps might categorise RPM as “unprofessional”. To overcome such a resistance environment, the knowledge and methods applied by the response-centre operators need to be defined and legitimised to other healthcare actors in the socio-technical regime.

5.2.2.4 Markets and user practises: Ambiguity of demand and benefits

Markets and user practises abbreviate the selection environment of supply and demand and user preferences. The socio-technical regime of municipal healthcare has deeply established market institutions and price mechanisms for service delivery which is hard to penetrate.

The ambiguity of demand epitomizes the vagueness of which target group that RPM should be given too. While the target group in the program has been users suffering from non-communicable diseases, this target group exhibit a wide range of age-groups, co-morbidity and hence, functional status.

The question of which users that should receive RPM, how long RPM should be delivered, and what the criterias for receiving the service are important questions that needs to be solved before implementing the system. In the project timeline, users have been given the service without any other time limit[21] then when the projects stop. Such uncertainties about target groups and service scope/timeline is a resistance which is also addressed in other types of welfare technology solutions (U. T. Knarvik, Marianne, 2016). Summarised these questions revolve around costs. Giving RPM to relatively healthy users, with no time limit, is a price that no municipality is willing to cover. At the same time, RPM is to be given to users before a worsening of their disease, making the market a complex matter, with several uncertainties.

The service is further complicated by the unclarity as to which services it replaces, if it can replace any service at all (symbiotic or competitive). Other forms of welfare technology such as medical pill dispensers replace a task of a homecare worker giving the user medicine. RPM however has no immediate clear replacement function, making it an ad-hoc service. These

[21] Except for Sarpsborg

unresolved questions lead to an immature market, where both the possible market, and user preferences is left unanswered.

Another uncertainty regarding RPM implementation is related to costs and benefits. In the program, costs are covered by the NDH. For implementation, costs need to be covered and financed by the municipalities or regional agencies. However, the economic benefits of RPM for the NCD population seems to be mostly targeted towards the hospitals(International, 2018). An issue on who gets the benefit of RPM is however difficult to measure. While the users presumably get a better health and quality of life, the decreased costs are divided between the primary health sector, and the secondary health sector. While the municipality invest in all the costs of operating and maintaining RPM, the effects indicate that the hospital is the main beneficiary of reduced costs associated with decreased healthcare costs.

However, municipal budgets are heavily reliant on governmental funding for implementing and testing innovative caregiving technologies. Thus, even though a project may show evidence of possibly improving home care productivity, and reducing patient healthcare usage over time, the initial costs for implementation creates resistance. When discussing the issue with an informant from the technological supplier, the informant expressed frustration about municipalities rarely continuing the service after the initial implementation. Even though the research and knowledge around the testing was positive, municipalities rarely wanted to invest in expensive new equipment which supposedly can reduce costs over time.

Resistance forces over initial costs are common in innovation theory. Short-term costs are likely to be high as new technologies don't have the advantage of dynamic scale and learning effects, which results in cost reductions per unit of output and evolutionary improvements in the technology (Kemp, 1994). Combining this with relatively low political pressure from voter bases, and interest groups, leaves few incentives for municipal political forces to implement welfare technologies.

5.2.2.5 Culture: warms hands and private sector scepticism

Within the regime of municipal healthcare there are many cultural variables at play. The most prominent among these when inquiring about distance monitoring was, **(1)** the issue of "warm hands" (varme hender) and **(2)** a sceptical attitude towards private sector firms entering the municipal healthcare system.

Warm hands refer to the issue of healthcare personnel losing face to face time with patients and substituting it by some sort of technology, in theory disconnecting the closeness and personal care given to the patient. The impact technology has on patient relationship was a frequent issue in the literature review. The systematic review by (Brewster, Mountain, Wessels, Kelly, & Hawley, 2014) found that healthcare personnel where troubled by telehealth solutions, and how it might impact their patient relationship in seven out of 14 analysed studies.

A generalisation within MLP proclaims that: Actors embedded in the established socio-technical configuration might slow down the transition of innovative technologies, following a pattern known as "cartel of fear" (F. W. Geels, 2005, p. 693). This "cartel of fear", is within welfare technology, and thus RPM, an essential issue on the regime level on how healthcare should be delivered. One of the pursued effects of RPM is to increase productivity. Decreasing human contact is therefore a cost measurement often proclaimed as an desired effect in evaluation studies (Henderson et al., 2014). The reduction of human contact is an element of RPM being a sustainable innovation for demographic changes, which creates the premise of its effect, i.e. cost reduction and increased productivity.

The Health & Social Services Ombudsman[22] in the region of Finmark, alerted Norwegian media channel Norwegian public broadcaster in April – 2017: *"Is it robots that are visiting people in the end? Who is going to nurture theme? Who will give theme pain relief medications? Who is going to be there to comfort theme and dry their sweat?",* referring to the regions interest in welfare technology solutions. The notion of warm hands was immediately different among those actors in the niche-regime, as one respondent in Oslo proclaimed:

Respondent-nurse*: "I get so tired of the discussion about warm hands. I have very cold hands, but hopefully a warmer heart. There is great scepticism among people because they don't know what it is, they are not used to thinking like this. We have some colleagues that use welfare technology, and they are positive when they see that it works. However, I think we have a long way to go. People need to know what it is" …*

[22] An organisation assisting with formulating and communicating issues or complaints to the appropriate authority in the municipal health, social and specialist healthcare service

Changing the culture on is a notable element for a socio-technical transition, and often a long a complex process. For a culture to be changed, both knowledge about the service, and the professional education system need to align itself with the technology. Such processes are already gradually taking place with the grander digitalisation of the healthcare sector.

The other resistance environment within regime culture, is that of a privatised healthcare sector. When interviewing both service suppliers and technology suppliers, they expressed that sharing knowledge of RPM was sometimes challenging, since non-affiliated actors often behaved sceptical towards a private firm taking control of their caregiving capability. The resistance was dubbed from questions about costs, the integrity of a private firm and their motivations, and the loss of human expertise within the municipality.

5.2.2.6 Public policies and political power: Favourable policy goals

System changes are rarely expected to unfold on its own, but often requires active governance from political stakeholders (Bugge, Coenen, & Branstad, 2018). The selection environment of public policies and political power is envisioned through the welfare technology program which RPM is a part of.

The program has a municipal perspective for integrating innovative healthcare services and aims to integrate welfare technology solutions together with the dominant design of primary healthcare within 2020. It's main goals is to test welfare technology services in municipal environments to create knowledge and standards for future implementations (Helsedirektoratet, 2017b).

In the official report "innovation in care" (Helse- og Omsorgsdepartementet, 2011) and the white paper "Tomorrow's healthcare" (Helse- og Omsorgsdepartementet, 2012-2013) the demographic shift is referred to as the problem, while patient activation and pro-active services is envisioned a ways of managing this challenge. The welfare technology program can be interpreted as a response to the external dynamics of the demographic shift, and patient activation dynamics pushing the regime to change.

The "coordination" reform (Helse- og Omsorgsdepartementet, 2009)[23] made a precedent for better coordination and integration between the primary and secondary healthcare entities.

[23] Samhandlingsreformen

The reform transferred power and responsibility in healthcare provision from the state to the municipality. The reform also sought to increase the information flow between both primary and secondary healthcare entities, increasing coordination and making it easier for users to acquire necessary healthcare services.

RPM har a strong political advantage by functioning as a communication hub for users, facilitating coordination between the different healthcare services easier and more reliable. RPM fulfils these visions, by connecting different healthcare actors, and making it easier for users to get in contact with healthcare personnel.

An example is seen in GodHelseHjemme, where the project manager expressed how even though the project had experienced major technological difficulties, one of the most functioning aspects was guiding users towards relevant healthcare actors. Positive sings of increased cooperation are also found in Mestry, where both homecare workers, general practitioners and a nurse at the diabetic clinic observe data measured by the users.

In HelsaMi+ the creation of a treatment plan together with the user, the general practitioner and often a disease specialist from St. Olavs hospital get together to inform and consult the user on measures to prevent further complication. Coordination between healthcare actors are also evident in VIS, where the local city-district response-centres are located together with the other district services. Here respondents often expressed how they would help the user apply for services, such as practical help, or occupational therapy.

The regime selection environment of public policies and political power favours RPM solutions, making political alignment for growth possible.

5.2.3 Summary: Regime selection environments

The following section will summarise the findings discovered when analysing the regime selection environments (RSEs) accepting or rejecting remote patient monitoring (RPM).

RSEs encompassing (RPM) embody a diverse constellation of selection processes. The challenge of integration between RPM and municipal electronic patient records (EPRs) is a common feature in health technology implementation. Mestry has however been able to link up with the municipal EPR (Gerica) through an application programming interface (API), making the data generated by the system visible for home-care workers in Gerica. In HelsaMi+ a similar integration is being worked on.

Industry structures creates a recruitment bias that in some respects hinders RPM to function as a full worthy pro-active service. Patients that are recruited have often experienced an acute exacerbation, or a worsening of health symptoms. Changing the service to a re-active function and aligning RPM with how the primary healthcare sectors usually operate.

The diagnostic knowledge of operators at the response-centres are sometimes criticised by specialist's actors. Some regard the competence of workers as unfit, and that advices given have been harmful.

The market of RPM display uncertainties around the cost-benefits, but also a miss-match between the municipality as the funder, and the hospitals "capturing" the saved costs. Ambiguity of the market also concern how long and to which inhabitants that RPM should be provided too.

The culture of the dominant design is used to face-to face contact with the patients. A "cartel of fear" surrounding the loss of patient contact is exhibited by some healthcare actors, and government stakeholders. For the Mestry project, where the response-centre is operated by a private company, there is also resistance towards private sector entities entering the primary healthcare regime.

Public policies and political power strongly favours the attributes of increased coordination, a pro-active service and potentially increased productivity that RPM pursue as a healthcare service.

Table 5-2 summaries the observed selection processes discovered in RPM transitioning.

Regime selection environment	Selection process
RSE 1: Technologies and infrastructure	Challenges with Integration between municipal EPRs and RPM EHRs. Integration is proven possible in Mestry
RSE 2: Industry structures	Recruitment bias, making the service re-active instead of pro-active
RSE 3: Knowledge	Lack of specialised knowledge among response-centre operators in diagnostic knowledge and communication, making some healthcare actors hesitant towards RPM
RSE 4: Markets and user practises	Uncertainty about which users the service should be provided too, and time duration of the service.
RSE 5: Culture	In some health professions a "cartel of fear" that technology will substitute face to face contact, generating less "warm hands" and scepticism towards private firms entering primary health care
RSE 6: Public policies and political power	Positive alignment with political goals and expectations

Table 5-2: Summary of the observed resistance and acceptance mechanics identified when analysing regime selection environments (RSEs) for remote patient monitoring (RPM) transitioning into the dominnt design of primary healthcare.

5.2.4 Niche level: Co-evolution and Co-construction

MLP theory explains that for a niche to successfully enter the socio-technical regime, a *window of opportunity* must be fixed. This window can be opened by landscape dynamics pushing for transition, and that the socio-technical regime fails to respond to the transition.

However, niche development and integration rarely occur in an isolated setting. Welfare technology as a solution to external pressure, and socio-technical inertia, is launching the way for branches and facets of modern healthcare delivery and is thus making it possible for RPM to be tested and implemented as part of a wider transition. From the first of June 2017, approximately 200 Norwegian municipalities were testing or had implemented welfare technology solutions funded from the Norwegian Directorate of Health or the County Governor (Fylkesmannen) (e-helse, 2017).

In this way, RPM is a part of a wider socio-technical transition of welfare technology implementations and diffusion. A *window of opportunity* is opened for RPM, building on the structure, policies and human capital generated by previous implementations of welfare technology started by the national welfare technology program (Helsedirektoratet, 2017a).

Innovation scholar Frank W. Geels (2011) interprets three cores process as essential for niche development and diffusion, these are (1) *building of social networks and the enrolment of more actors, (2) the articulation (and adjustment) of expectations or visions* and *(3) learning and articulation processes on various dimensions.* When studying RPM as part of a wider socio-technical transition, these processes was observed in the following dimensions:

The previous implementations of safety technology made the *building of social networks and the enrolment of more actors* possible. The Establishment of recruitment channels and legitimation among the users and primary healthcare personnel have helped RPM in creating a foundation for functioning. Response-centre operators in both HelsaMi+ and VIS had knowledge and experience with the technology supplier before the RPM program started. Operators had knowledge on how the assessment system worked, and technology suppliers had created information channels for the exchange of information and improvements. Hence, being able to draw on the process of *learning and articulation processes on various dimensions* created from earlier experiences, and other implementations (Group, 2016).

Learning and articulation processes on various dimensions, was evident in the VIS project when Endre Sandvik, the municipal director and councillor ward for elderly and social services[24], describied Oslo's implementation journey of welfare technology in three stages:

1 **Medical support**: A common technological device within welfare technology, either analogue or digital. A medical pill dispenser[25] that alarms and distributes medicine to the user at a set time. This functioned as the initial technology in Oslo, making users and health care worker see the benefit if welfare technology implementations.
2 **Safety technology**: Focuses on people with cognitive disorders, elderly and people with moving impairments. Consisting of notice alarms, GPS localisation, e-locks and other forms of equipment mean to reduce the response time and give information to healthcare workers, as well as relatives. Here, the implementation was a more challenging process. However, the knowledge generated on this implementation was crucial for the next step…
3 **Remote patient monitoring:** By the assistance of tablets and technological devices – users can make vital measures at home, which are ported wirelessly to a Response-centre

[24] "Confrence: HELSETEKNOLOGI: Fremtidens helseutfordringer og teknologiens muligheter"
[25] «Pilly» made by Dignio is most common on the market

by healthcare workers. At the RPM stage, Oslo can manage and operate various welfare technology solutions and facilitate coordination between city-districts and the different healthcare services provided.

The same process of implementation steps has also been followed in HelsaMi+ . RPM is thus often a service which is to be applied in later stages of a series of welfare technology implementations, building on knowledge form earlier welfare technology implementations. RPM can also be integrated with the organisational and technical architecture that has been implemented by other safety technologies. Especially the response centre, can function as a hub for many different welfare technology solutions

Additionally, *the articulation (and adjustment) of expectations or visions* has been framed upon these earlier installations. The previous implementations of welfare technology have created expectations and visions of reduced costs, and decreased health care usage among participants (Intro, 2015). This has created optimism and enthusiasm among actors, and in some projects, disapproved of scepticism from *inner core actors* towards such technologies. As one respondent expressed when discussing the previous implementation of VIS:

Respondent-Nurse: "*Many people was sceptical at start, both users that had "Pilly"* (a medical pill dispenser) *and home care workers that we gave technical assistance. However, as they saw that it worked, it became so much easier to convince people*"

MLP theory further elaborates that niche-level novelties often have a miss-match with the existing socio-technical regime, making it hard to "breakthrough" the layer of dominant design. A *window of opportunity* thus not constitute immediate acceptance.

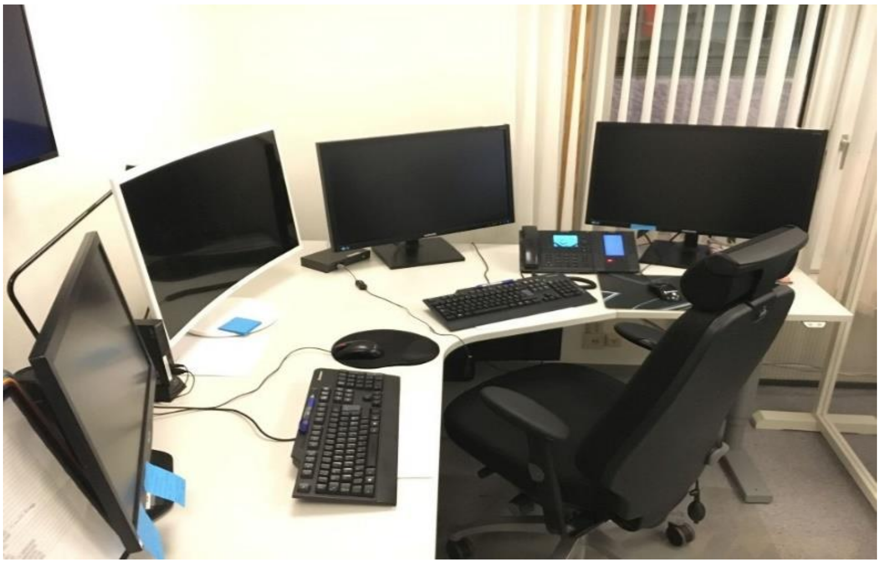
Sequential accumulation highlight that the first "interaction" between the niche technology and the regime often functions as a "catalysts", opening the door for further innovation and diffusion. The service of RPM is itself is a mixture of *symbiotic* and *competitive* behaviour towards the dominant design. If RPM is to reduce and, in some instances, replace home based nursing, the service is *competitive*. However, replacing the dominant design usually takes decades (F. W. Geels, 2005).

The former VIS project had an effect conducted. The report *The Introduction of Personal Connected Health and Care in the Central Districts of Oslo* (Intro International & Oslo, 2016) displayed positive results, indicating a sharp reduction of hospital visits and use of home care services. The results were monetised and stated cost-savings for both the primary (city-districts) and secondary (hospitals) sector. The report was politized and received attention from both political stakeholders and media channels (Tangen, 2016) (Tandstad, 2016). The knowledge gathered in the report was a significant contributor towards the continuation of VIS, and in some respects, RPM being interpreted as a viable solution for a sustainable healthcare service (Helse- og Omsorgsdepartementet, 2016). The former VIS project hence worked as a "catalyst", *where sequential accumulation* of earlier implementations worked as a "breakthrough" for further testing and implementation.

However, the socio-technical regime of municipal caregiving is designed in such a way that the service for the foreseeable future will function in a *symbiotic* matter. Further, elaborating on (5.2.2.4 ambiguity of demand), it is still unclear what RPM is to replace, and if it can replace usual care practises at all.

Technical add-on and hybridization emphasise that niche innovations and the dominant design not always have to compete. As elaborated in 5.2.2.1 (technologies and infrastructure) welfare technology assessments systems functions as a technical add-on to the existing infrastructure of electronic patient records (EPRs). RPM being a part of this system cannot replace the existing dominant design but must finds was to integrate. This is observed in Mestry, where the project has created an API between Prevent and Gerica, thus constituting a hybridisation and the creation of a *symbiosis* and showing that institutional alignment is possible.

A similar symbiosis is also found in HelsaMi+ where operators at the response-centre (Helsavakta) is administrating both safety technologies and the RPM service simultaneously, together with the EPJ Gerica. Picture 1 illustrate how operators manage different systems and screens, different phones and different tasks simultaneously. The two keyboards (on the desk) for each employee illustrates that the niche still has substantial improvements to be made, but also show how welfare technologies can function in a symbiosis.



Picutre 1: Helsevakta response-centre in Trondheim. The picture show one of the working spaces for the operator, and illustrate how different welfaretechnology soluitions might function together in a symbisos, with the response-centre working as a “ traffic-hub”

5.2.5 Summary: Niche-level

The niche of Remote patient monitoring (RPM) have co-evolved together with harmonising welfare technology solutions. Earlier implementations such as medical pill dispensers and safety technology have involved a range of actors and made the implementation of RPM more manageable for the projects in VIS and HelsaMi+. The two projects have been approved continued funding after the program ends in the summer of 2018.

Earlier welfare technology has worked as a “catalysts”, providing prosperous indicators of the effects that welfare technology can achieve on primary healthcare. This has legitimatised welfare technology and made it easier to venture into more complicated ways if innovating established primary health care models. The response-centre delineate a conceivable hub for connecting the different technologies that welfare technology will diffuse into the market.

A window of opportunity was opened in the national welfare technology program, and RPM have been able to enter this window through co-evolution and co-construction of technology, actor involvement and institutional alignment.

5.2.6 Summary: Multi-level perspective analysis

In this section, I have analysed how RPM can be analysed as part of a wider socio-technical transition. Below follows a summary of this analysis. Afterwards, chapter 6 will conclude on the research questions of this thesis.

The external dynamics making the transition of remote patient monitoring (RPM) possible is understood as the demographic shift which is putting pressure on the socio-technical regime of primary health care delivery. This dynamic is an example of a long-term and influential change, that creates pessimistic future predictions on the financial capability of municipal budgets.

Part of the response to these external factors is welfare technology solutions. This creates a window of opportunity for innovation and radical change in the healthcare system. The niche technology of RPM uses the window of opportunity opened by the rapid diffusion of other welfare technology implementations and architecture, most notably the response-centre that functions as a hub for different purposes of healthcare delivery.

The regime selection environments are however embedded and constrained forces, that reject or accept certain changes. Niche technologies that seek to gain access to the system must configure itself to align with the deeply rooted structures of the socio-technical regime to gain traction. While there are several observed resistance dynamics, the industry structure of recruitment bias and the market environment experiencing ambiguity of demand are the most pressing.

Industry structures creates a recruitment bias that in some respects hinders RPM to function as a full worthy pro-active service. Patients that are recruited have often experienced an acute exacerbation, or a worsening of health symptoms. Changing the service to a re-active function and aligning RPM with how the primary healthcare sectors usually operate. The market of RPM further project uncertainties around the cost-benefits, but also a miss-match between the municipality as the funder, and the hospitals “capturing” the saved costs.

Figure 14 illustrate how RPM can be perceived as part of a wider socio-technical transition of welfare technology solutions.

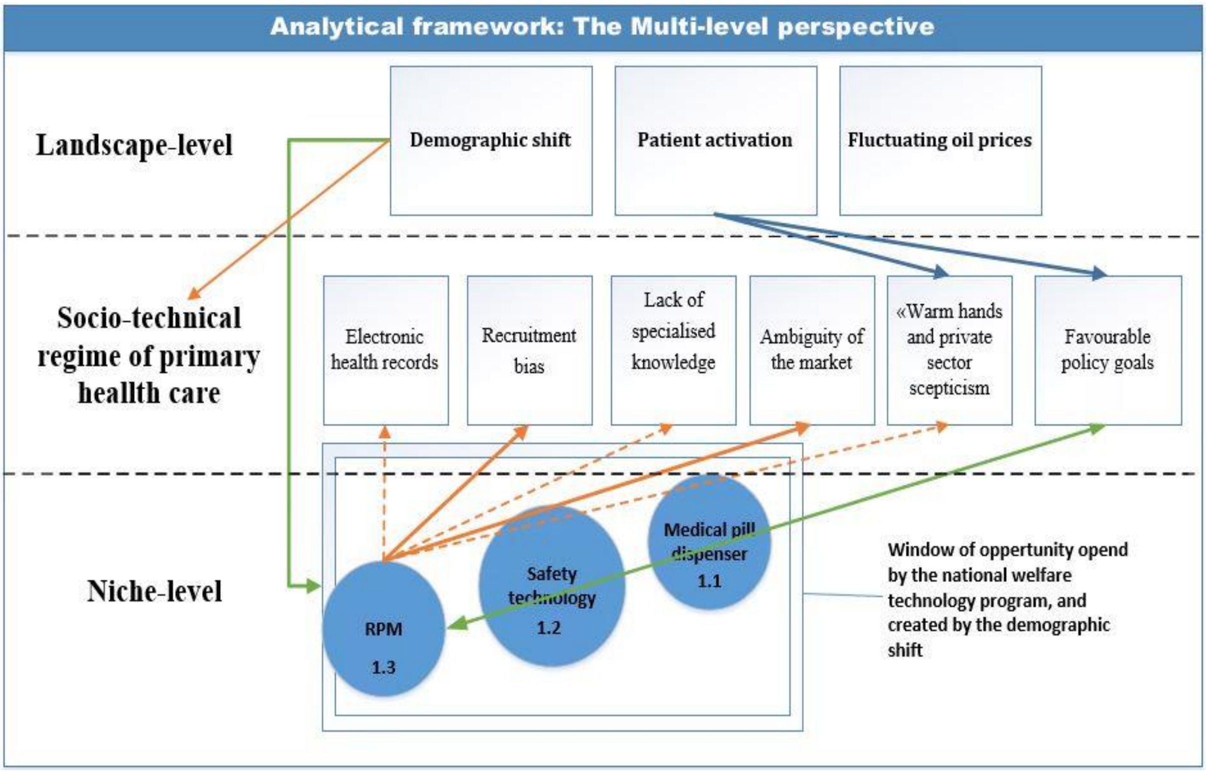


Figure 13: Illustration of remot patient monitoring as part of a wider a socio-technical of welfare technology implementaions. Explenation of figure:

1. The demographic shift put pressure on the existing socio-technical regime of primary healthcare. Patient activation further enables welfare technology diffusion by putting pressure on the culture of the socio-technical regime, and fluctuating oil prices accelerate public policies and political power.
2. This creates a window of opportunity for welfare technology solutions (the welfare technology program) to compete with the dominant design.
3. Remote patient monitoring (RPM) co-evolves and co-construct by leaning on the successful implementations of medical pill dispensers and safety technology. Together these niches in two projects (VIS and HelsaMi+) form a symbiosis through the response-centre. The response-centre becomes a hub for welfare technology solutions, and RPM is established as a part of a wider socio-technical transition
4. Dotted orange arrows signify common or minor resistance from the regime selection environment
5. Orange striped lines signify crucial selection environments that must be overcome if the nice of RPM is to be established in the socio-technical regime.

6 CONCLUSIONS

The mapping of each project in chapter 4, and the following analysis of structural components and functional patterns in section 5.1 have identified drivers and barriers for RPM implementation in a municipal environment, thereby providing answers to RQ 1).

The technological innovation system (TIS) of remote patient monitoring (RPM) is in a *formative phase*. In this phase, the TIS sees a constant entry of new firms and organisations, institutional alignment and formation of networks. Hence, the TIS constituted by RPM is in a rudimentary structure, where radical change is still taking place.

The *inducement mechanisms* (incentives) for implementing the TIS are manifold. Two *inducement mechanisms* provide the push for system development. These are (1) *reduced patient costs*, and *increased healthcare productivity* and (2) *improved user health and health literacy*. Since governmental budgets still fund RPM the incentives are top-down oriented, and mainly focused on resource necessities, i.e. cost reduction and productivity gains.

The main structural components of the TIS have been identified as the governmental bodies (chiefly The Norwegian Directorate of Health), the service suppliers (municipalities operating the response-centre), technology suppliers, users (persons with NCDs and their relatives), supportive actors (General practitioners, hospitals, primary health care services) and the interest groups (National Association of Hearth and Lung Disease, The Diabetic Association) These structural components represent the *inner core actors* that take part in fulfilling the functions of the service, through established networks of communication and coordination.

The primary drivers observed were positive patient related effects in an increased feeling of safety, increased health literacy and improvement of diet, especially for users with diabetes mellitus. This strengthens the legitimacy of the TIS, making *interest groups* and *home-care worker*s favourable towards the service. As the voice of users is increasingly being heard in healthcare-policy planning, this driver might prove to be decisive for future RPM support and growth.

Another important driver is the favourable view displayed by response-centre operators towards the position of working with RPM. Interviewed nurses spoke highly of the prospects of professional specialisation, less workload on the body, less stress and higher medical authority when communicating with specialist nurses and general practitioners. Operators also expressed joy in finally being able to give proper guidance and advice to patients and following their progression on the disease. RPM might, therefore, attract nurses, which is a profession that is expected to be in scarcity in the coming decade.

The central blocking mechanism, interpreted as a barrier, is the lack of legitimation from general practitioners, caused by uncertain scientific evidence and uncertainty on the quality of measurements. The general practitioner functions as a gatekeeper in the primary health care environment, and thus hampers the legitimacy of other actors as well. For further growth of the RPM service, this actor needs to be assured of the qualities of the service, if successful diffusion is to be achieved. A possible solution to this challenge is to make general practitioners more involved in the effects studies conducted on RPM implementations.

Technology suppliers further highlight the barrier of small-scale tenders, and modest orders of medical technical equipment for the measurement of biometrical values, leading to a lack of leverage when contacting manufacturers for improvements on the equipment. Technology suppliers actively listen to users, operators and interest groups for experimentation and improvement of the service, but negotiating improvements is challenging when they are perceived as a trivial buyer. One some occasions, the technology supplier has had to change manufacturer, thus creating additional workload of synchronising the new equipment. If larger orders of equipment were to be ordered, technology suppliers could better communicate and negotiate improvements on equipment towards the manufacturers. Market growth could therefore eradicate some of the most prominent technical challenges, leading to better quality on the biometrical measurements.

RPM can be perceived as a wider socio-technical transition (RQ2), since it shares the same landscape dynamics of the demographic shift, patient activation and fluctuating oil prices as welfare technology and IT in home-care innovations.

These landscape externalities create pressure on the socio-technical configuration of municipal health care delivery, creating a window of opportunity for niche innovations. This window of opportunity was further opened by the national welfare technology program, and the alluring effects studies conducted on these early implementations, indicating reduced costs, improved patient literacy and decreased health care usage.

Earlier welfare technology has worked as a “catalysts” for RPM. This has legitimatised welfare technology and made it easier to venture into more complicated ways if innovating established primary health care models, something Remote patient monitoring (RPM) has gained traction from. In this way, RPM has co-evolved together with complementary welfare technology solutions. Earlier implementations such as medical pill dispensers and safety technology have activated and enrolled actors and made the implementation of RPM manageable for the projects in VIS and HelsaMi+. These two projects have been approved funding for continuing the service, after the program ends in the summer of 2018.

The other two projects, Mestry and GodHelseHjemme, have yet to receive continued funding. In GodHelseHjemme a difficult path was taken by making users provide their own equipment. While this proved challenging, the costs if this where to function correctly would greatly reduce the price tag of RPM. In Mestry both project administrators and users seem disappointed that the service is to be closed. The positive effects achieved on patient related effects is however an important indicator on how RPM can increase the quality of life for users with chronic non-communicable diseases.

The analysed regime selection environments of Industry structures create a recruitment bias that in some respects hinders RPM to function as a full worthy pro-active service. Patients that are recruited have often experienced an acute exacerbation, or a worsening of health symptoms. Changing the service to a re-active function and aligning RPM with how the primary healthcare sectors usually operate. Future inclusion criterias should be more thoroughly orchestrated if RPM is to function as a pro-active service.

The market of RPM display uncertainties around the cost-benefits, but also a miss-match between the municipality as the funder, and the hospitals “capturing” the saved costs. Reductions in acute exacerbations primarily saves hospitals costs, the schemes for funding RPM solutions should, therefore, investigate how operational costs can be divided among the primary and secondary healthcare regime to increase the incentives for municipal funding.

The landscape dynamics and the observed drivers for RPM indicate that RPM as a primary healthcare solution will continue to grow in the coming years. Complementary assets in the form of general practitioner RPM organisation, and RPM hospital organisation indicate possibilities for future development and growth. However, the selection bias of recruiting severely ill patients, and the lack of adequate support from general practitioners might slow down this positive transition.

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ATTACHMENT 1: LITERATURE REVIEW

Effects, Barriers and drivers of Telehealth implementation for chronic disease patients

TABLE OF CONTENTS

ABSTRACT

Aims and objectives

The objective of this review is firstly, to scope the clinical and cost-related effects documented in contemporary research regarding Telehealth interventions for patients with chronic diseases. Secondly, to identify common barriers and drivers for the implementation of Telehealth solutions.

Methods and data sources

Systematic review method has been used when acquiring literature. Three electronic medical databases were accessed: PubMed/MEDLINE, SweMed+ and Cochrane Review.
The search included English, Norwegian, Swedish and Danish articles on telehealth in the databases published from January 2013 - December 2016.The articles was selected and identified in four stages of scanning and reviewing, following the PRISMA standard.

Results

33 studies met the inclusion criteria. Studies that reported on effects was divided into two main themes, clinical effects and costs. The clinical effects reported are often inconclusive, except for biometric effects on patients with Diabetes Mellitus. Hospital rates was reportedly positive, while healthcare costs lack quality in their evaluations. Barriers and drivers was identified within 6 actors. Patients and Service providers are the actors most frequently documented, while research on relatives seems neglected.

Conclusions

Patients with Diabetes Melltius seems to benefit from Telehealth implementation. QoL (Quality of life) studies, are often inconclusive. Effects on Hospital reduction showed a positive tendency in a considerable amount of systematic reviews. Included literature on costs are overall positive. Barriers and drivers among patients and service providers both relate to usability of technology. Contemporary research shows a tendency towards patients becoming more comfortable with Telehealth as society is becoming more digitalised.

BACKGROUND

With the expansion of the elderly populace, chronic diseases are expected to rise drastically in coming years. Handling these demographic shifts is essential to keep in check healthcare costs and to keep expenditure on healthcare sustainable. Calculations estimate, that the healthcare sector in Norway, will have twice as many FTEs[26] (Full-time equivalents) within 2060 if organised in the same way (Teknologirådet, 2015). Distance monitoring in the form of telemonitoring[27], is increasingly seen as a major part of the solution.

While the interest in telemonitoring-innovation is large, research on the subject are often not conclusive. This review seeks to gather present-day evidence on Telemedicine by examining scientific literature concerning the effects of the available technologies. The wanted effects are measured as clinical (biometric and patient-related), and in costs (Hospital rates and cost-effectiveness). This review also seeks to shed light on the documented barriers and drivers experienced in telemonitoring implementations. Learning from projects like those carried out in Norway, might help policy makers better facilitate telemonitoring programs.

For the review, the term "Telemonitoring" was the main search term. It should be noted that semantics regarding "telehealth" are full of facets. Conceptual confusion regarding the terminological aspects of telehealth have been thoroughly documented (Fatehi & Wootton, 2012; Hale et al., 2016; Martin, Kelly, Kernohan, McCreight, & Nugent, 2008; Widmer et al., 2015).

Terms such as tele-monitoring, Telemedicine, home monitoring-health, ambient assisted living telemedicine, distance-monitoring-health, tele rehabilitation and telenursing telecommerce, have been included in the review, based on delivering healthcare technology through distance monitoring. When reviewing articles and publications the terminology used by the authors will not be altered. However, in cases of missing descriptions, the liberty of endowing a suited terminology has been taken.

[26] FTEs = «Årsverk» in Norwegian
[27] Telehealth= Telemedicine, Telenursing, Telerehabilitation, Technology, telemonitoring etc.

Defining which specific effects are wanted for such a large group as "people with chronic disease" or "healthcare workers" are problematic. However, scaling actors down to more specific subgroups makes for an impractical policy instrument. When addressing the actors touched by Telemonitoring, the framework provided by Bull-berg (2015) for The Norwegian research institute SINTEF will be applied, *Table 1*.

Table 1

Actor	Definition
Patients	Users that the service is applied upon. In this literature review referring to people with chronic diseases receiving telemedicine or telehealth.
Service Suppliers	Healthcare workers, municipal providers.
Government	The Norwegian Directorate of eHealth (NDE), The Norwegian Directorate of Health, The Norwegian Association of Local and Regional Authorities or other types of government affiliated with the technology.
Relatives	Family and friends that resides with the receiver or who otherwise have a close affiliation with the receiver.
Business	Provider of technology or other private service suppliers
Others/Society	Society in general, such as neighbours, police or the fire department.

(Bull-berg, 2015)

METHODS

2.1 Search strategy

Searches were conducted in Medline Cochrane, PubMed and Swemed+, using Boolean searches. A full composition for database search approach can be viewed in attachment (1). Search strategy was supported with the assistance of a medical librarian, using the following keyword: Telemedicine, Telenursing, Telerehabilitation, Technology, Telemetry, Pulmonary Disease, Chronic Obstructive, Diabetes mellitus, Cardiovascular diseases, heart diseases, hypertension, blood pressure.

Any articles or records published before 2013 was excluded. Other exclusion criteria included; Patients that were institutionalized, patients with cognitive disorders, healthcare technology not being measured at a "distance", countries not in the OECD. Languages was restricted to English, Norwegian, Danish and Swedish. A list of exclusion criteria's and their reasoning can be viewed in *Table 2*.

Table 2

Exclusion criteria	Why
Articles published before 2013	Research and literature within the field has grown sustainably in recent years. To make a state-of-the-art review, present-day research is preferable.
Receivers/users that is institutionalized	A large part of telehealth implementation is to reduce institutionalisation and keep patients home longer.
Users with cognitive disorders	While some telehealth technology has shown positive results in treatment of patients with cognitive disorders, patients are not able to consent with the intervention.
Technology not using distance-monitoring	Telemedicine, Telehealth and Tele monitoring are the preferred intervention methods analysed in this study. However, regarding the conceptual confusion in the terminology other interventions are also considered, as long as it includes distance monitoring within the research question.

While international literature on telehealth is flourishing, the pool of Norwegian studies on telehealth and chronic disorders are limited. Additional literature added are primarily Norwegian reports (n=8) regarding welfare technology towards the elderly[28] and are therefore exempted from the rigid exclusion criteria's. The Norwegian literature added, functions as (1) comparative cases regarding technological use, (2) identification of common barriers and drivers in healthcare technology implementation.

2.3 Study selection

Searches was conducted in Medline Cochrane 22.12.2016, searches in SweMed+ 23.12.2016 and PubMed 25.12.2016. Identification of eligible literature followed a 4-step selection process.

5. **Identification:**
    a. Phase 1: 901 records identified through database searching and admittance of exclusion criteria (language, year).
    b. Phase 2: 10 additional record identified through Norwegian (n=8) and Danish (n=2), totalling n=916 records.

[28] Ambient assisted living and/or welfare technology, primarily directed towards the elderly

6. **Screening:**
    a. Phase 1: 690 records removed for duplication, availability, title and exclusion criteria
    Phase 2: 136 records screened for abstract, methodology and exclusion criteria, 72 records removed, totalling n=64 record remaining.
7. **Eligibility:** 64 full text articles assessed for quality and fitting research objectives
8. **Included:** N=33 Records, illustration of selection process, **Feil! Fant ikke referansekilden.**.

N=33 articles is composed of: 5 systematic reviews on effects, 4 systematic reviews on barriers and drivers, 10 reports/cases, 8 randomised controlled trials, 1 predictive algorithm study, 2 meta synthesis/analysis, 1 scoping review. 1 data analysis and 1 integrative review.

3.0 RESULTS: EFFECTS

The literature search identified N =19 (19/33=57%) recordings documenting effects on monitoring interventions for patients with chronic diseases. After evaluating the effects found in the records, two main effect themes and three chronic disorders were identified. The two main effect themes consist of clinical effects and costs. Clinical effects were then charted into two sub-categories, biometric effects and patient related effects. The same process was applied to costs, which was divided into Hospital rates and cost-effectiveness.

The documented effects were then charted accordingly into which diseases the intervention wanted to improve. However, it is to be noted that co-morbidity is common among patients with chronic disorders. The disease heterogeneity of extracted populations is therefore varying.

The three chronic illnesses that will be thoroughly reviewed in relation to Telemedicine are COPD, DM and CHF/HF.

For a full composition of retrieved effect articles and their disease distribution *Table 3*.

Table 3

Disease	n =	Biometric effects	Patient related effects	Hospital readmission	Cost-effectiveness
Chronic obstructive pulmonary disease	10	0	6	5	6
Heart failure	7	5	3	7	4
Diabetes Mellitus	6	5	4	2	3

3.1 CLINICAL EFFECTS

Clinical effectiveness can include a range of different aspects (Ashcroft, 2002). This literature review has categorised clinical effects into two themes, biometric and patient related. Biometric effects include clinical data transmitted with the technological devices or clinical data the patients measure themselves. Patient related effects is defined as quality of life, satisfaction, anxiety, mortality and acute exacerbations. This structure is created to give a clear overview and is a mix of the article-structures gathered from clinical and cost effects literature.

3.1.1 Biometric effects

Telemedicine often provide biometric data such as vital signs, weight and self-reported symptoms. This is then monitored by a clinician, usually at a response centre. Data transmitted is often disease specific[29]. Within distance monitoring, clinical parameters are often set to give an alert if a patient's biometric data is worsening. Distance monitoring holds exciting potential to improve healthcare delivery through improved integration of care, while also reducing ambulant execrations.

[29] hbA1c= Diabetes, Oxygen saturation for =COPD

3.1.2 Diabetes Mellitus

Four studies evaluated patients hbA1c (glycosylated haemoglobin) before/after the intervention, (Jalil et al., 2015; Nicolucci et al., 2015; Rasmussen et al., 2016; Su et al., 2016).

Su et al. (2016) completed an extensive Meta-analysis on Telemedicine for diabetes, including results from fifty-five RCT trials. The analysis included 9258 (Intervention= 4607, controlled=4651) patients. Significant difference was found favouring telemedicine hbA1c values over usual care (P= < 0,001). The effects were more favourable among patients with T2DM (type 2 diabetes mellitus) (P=< 0,001), then those with T1DM (P=0,027). An explanation given by the authors for the difference, is that patients with T1DM have more experience in management of their disease and are therefore less sensitive to lifestyle changes compared to patients with T2DM.

Nicolucci et al. (2015) conducted a large randomized, parallel-group, open-label, multicentre study in Italy among 302 (intervention =103, controlled= 104) patients with T2DM. The study researched whether telemonitoring could improve metabolic control and decrease overall cardiovascular risk in individuals by remote educational support and feedback from a general practitioner compared to usual care. After twelve months, patients in the intervention group measured a reduction in average HbA1c (<7.0%) compared to the controlled group. But, there was found no solid difference as for body weight, blood pressure or lipid profile.

Another RCT trial, researching Telemedicine among patients with T2DM over six months in Demark, was conducted by Rasmussen et al. (2016), and share similar positive results. 40 patients (intervention= 18, controlled= 22), was enrolled. The patients received telemedicine in the form of a videophone (TandBerg E20) and a blood pressure monitor, both connected through a broadband connection. HbA1c(P=0,016), blood glucose (P=0,015) and cholesterol (P=0,044) were significantly lower in the intervention group when compared after six months.

All four studies established statistical significance when comparing distance monitoring over usual care, leaving a positive perception in the possibilities Telemedicine might have for people with Diabetes mellitus. Su et al. (2016), intriguingly points out that remote patient monitoring, while being generally more expensive than teleconsultations, was not associated with better clinical outcomes. Which leaves the question of whether it is the technology that improves patient biometric values or just the case of being followed up by a clinician.

3.1.3 Chronic heart failure

Only one study, presented biometric data regarding distance monitoring of patients with Chronic heart failure. Widmer et al. (2015) conducted a systematic review (51 articles) and meta-analysis (9 RCTs) regarding digital health interventions[30] (DH) on people with cardio vascular diseases (CVD). The results were organised into primary prevention and secondary prevention outcomes.

Primary prevention analysis found a significant reduction (P=0.006) in BMI[31] (body mass index) and reduction also observed significant a significant reduction (P=0.02) in total cholesterol[32].

In secondary prevention studies, only BMI[33] data gathered from 6 studies reached statistical significance(P=0.03). Pooling from primary and secondary prevention studies showed no positive impact on triglyceride levels. However, the trials analysed in this research was mostly composed of teleconsultation studies using SMS text, Telephone and e-mail as interventions methods, and is therefore similar to telemonitoring, but also more liberal regarding the technological aspects of inclusion. However, the positive results found in the systematic review show it is not necessarily the most expensive equipment that has the most desired effects.

3.1.4 Chronic obstructive pulmonary disease

None of the 19 studies reported on COPD patient HR and/or SpO_2 before/after intervention. There was neither found any biometric data on any other forms of measurement such as BMI or cholesterol.

Variations in Heart rate (HR) and pulse oximeter oxygen saturation (SpO_2) are biometric data often used as markers with patient deteriorating health (Vianello et al., 2016). None of the recordings used these measurements as “end points”. Which is natural, considering remote monitoring does not improve these values for the patients. Instead, the biometric data is used to detect exacerbations, which will be presented in the Acute Exacerbations chapter.

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[30] telemedicine, Web-based modalities, e-mail reminders, SMS texting, mobile application, and data monitoring
[31] (n=12) (mean difference, -0.29 kg/m^sup 2^; 95% CI, -0.5 to -0.09 kg/m^sup 2^; P=.006; I^sup 2^=98%)
[32] (n=13) (mean difference, -5.39 mg/dL; 95% CI, -9.80 to -0.99 mg/dL; P=.02; I^sup 2^=98%;)
[33] (n=6) (mean difference, -0.31 kg/m^sup 2^; 95% CI, -0.60 to -0.03 kg/m^sup 2^; P=.03; I^sup 2^=67%;)

3.1.5 Biometric Summary

Retrieved literature on biometric values is mainly composed of two meta-analysis studies, which covers a wide variety of interventions and study populations. The results show a favourable tendency in regard to distance monitoring interventions, which is supported by the added RCT studies. An interesting discovery is that both meta-analysis studies emphasize that clinical outcomes have a positive effect, regardless of the technological advancement used in the intervention.

3.2 PATIENT RELATED EFFECTS

Patient related effects or "patient experiences" are an essential aspect for the push in distance monitoring for patients with chronic disorders. Retrieved data on patient related effects has been categorised in three sub-themes: Quality of life (QoL) and behavioural improvements, Mortality, and Acute Exacerbations (AE).

3.2.1 Quality of life and Behavioural improvements

QoL is a catch all term covering the different measures used to evaluate the "overall quality" a person view on his/her life at a given point. Health related quality of life (HRQoL) is an evaluation of QoL and its affiliation with the patients perceived health. This is often measured over time, to study possible effects from the applied technological intervention.

Behavioural improvements include satisfaction, self-care, health literacy[34], anxiety and depression. While some of these measurements can be found under QoL studies, many of them are measured separately.

3.2.2. Diabetes Mellitus

Four studies conducted research regarding patient related effects in DM, (Jalil et al., 2015; Kenealy et al., 2015; Nicolucci et al., 2015; Wildevuur & Simonse, 2015).

[34] the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions

Jalil et al. (2015), conducted a meta-analysis on 19 studies documenting telemedicine interventions. The included records range from 1990 – 2014, hence covering simple technological interventions, as well as more modern instruments. Every clinical trial showed a noteworthy positive behavioural outcome. However, behavioural improvements were not the main scope in any of the studies, therefore making the results diverse and difficult to quantify. Positive results were also reported by Wildevuur and Simonse (2015), who conducted a scoping review including 350 (n=103 regarding DM) studies on "the big 5"[35] chronic disorders. Among the selected disorders, DM had the most positive impact indicator[36].

Nicolucci et al. (2015) measured QoL using the Short Form 36 (SF-36) in a RCT-telemedicine trial in Italy. After 6 months, a statistically significant[37] improvement was measured in 5/10 dimensions[38]. After 12 months, a significant improvement (P=0.006) in the Mental health dimension still consisted in the intervention group.

Positive outcomes were reported in all included publications that analysed patient related effects among DM patients. This positive tendency is strong, but lack sufficient quality and rigour in the retrieved meta-analysis studies. Any conclusiveness on the subject is therefore difficult to establish, by the reason of study dispersity in measurements.

3.2.3 Chronic Heart failure

Three studies conducted research on patient related effects regarding CHF, (Hale et al., 2016; Kenealy et al., 2015; Wildevuur & Simonse, 2015).

Wildevuur and Simonse (2015), pooled positive/negative impacts from 89 studies on cardiovascular studies using ICT (information and communication technology) for PCC (person centred care). 57/89 studies reported on patient related outcomes, where 78,9%[39] of the studies had a positive impact indicator.

Hale et al. (2016), conducted a small RCT study in the United States, including 29 (intervention=13, controlled=16) patients. The intervention group received telehealth for 3

[35] COPD, CHF, DM, Stroke, Cancer
[36] Positive outcome indicator was reported 469 times (134%), = diabetes (36.3%, 127/350).
[37] The article list 6 significant findings in their table, but only mentions 5 dimensions in the text.
[38] physical functioning, role limitations due to physical problems or to emotional problems, mental health, Physical Component Summary score, and Mental Component Summary score.
[39] 57 studies reporting on patient related outcomes, (positive= 45, negative= 12)

months provided by MedSentry, a remote medication monitoring system. HRQoL was measured using the MLHFQ (Minnesota living with Heart Failure Questionnaire) and PHQ-8 (Personal health Questionnaire Depression Scale). There was no significant difference in self-related health or depression assessed from the PHQ-8. However, the intervention group measured a significantly lower(P=0.002) MLHFQ score[40]. The authors hypothesize that an unequal baseline, is the root for a negative HRQoL in the intervention group.

The RCT study conducted in New Zealand by Kenealy et al. (2015) also measured different QoL questionnaires among its CHF groups (intervention=98, controlled=49). SF-36, HAD (Hospital anxiety and depression scale), SEMCD (Self Efficacy for Managing Chronic Disease), SCHFI 6.2 (Self Care for Heart Failure Index) questionnaires was gathered at baseline, and after 6 months. No significant improvement or reduction was measured between the study groups. The study also conducted qualitative interviews with the patients, reporting that patients felt safer, increased their health-literacy and made theme more engaged in self-care.

While the included meta-analysis shows a clear positive tendency, this is not reflected statistically, in the included RCTs. Conclusiveness on the effects related to distance monitoring and CHF is hence unclear. Positive remarks in qualitative interviews, thus however indicate that measuring patient related effects with statistics might not give the right image on how the patient themselves perceive the effects.

3.2.4 Chronic obstructive pulmonary disease

9 studies presented patient related effects on COPD, (Chatwin et al., 2016; Cruz et al., 2014; Gregersen et al., 2016; Kenealy et al., 2015; Pedone & Lelli, 2015; Stausholm et al., 2016; Udsen, 2015; Vianello et al., 2016; Wildevuur & Simonse, 2015).

Three systematic reviews investigated and interpreted QoL studies in their reviews: (Cruz et al., 2014; Gregersen et al., 2016; Pedone & Lelli, 2015). Gregersen et al. (2016) was the most thorough review, by the cause of only focusing on QoL measurements. The review analysed eighteen studies, largely composed of Randomized controlled trials. Numerous modes of outcome measurements were included, the most frequent being the SGRQ (St. George's

[40] Intervention = (62.2) vs controlled = (28.2)

respiratory questionnaire). The result of this analysis was not conclusive, showing a wide variety of outcomes among the study group.

Pedone and Lelli (2015) also included satisfaction among patients. All six studies reviewing satisfaction, displayed improved results. Patient satisfaction was also reported conclusively positive in a supplemental RCT study done by Paré et al. (2013). 60 patients in Canada with COPD were asked to give a score between 1 and 5 (where 1=not at all and 5=enormously) on their satisfaction of the technological device. The overall average was 4.0, which indicate a very high satisfaction among participants.

Vianello et al. (2016) conducted an RCT study among 140 (intervention= 136, controlled=104) patients with acute exacerbation of COPD in Italy, lasting twelve months. The intervention method was telemonitoring, which transmitted Heart Rate and Oxygen Saturation (SpO_2) to a central data management unit. Measuring HRQOL was done using the SF-36 questionnaire. The results were quite disappointing, after twelve months there was no statistical difference between the intervention and controlled group in their HRQoL. Nonetheless, the authors propose an interesting hypothesis; that telemonitoring does not increase HRQoL in areas where care standards are high and medical services are well established.

(Gregersen et al., 2016) comes to a similar hypothesis in their literature review, where they observe that patients with a low HRQL baseline reportedly have greater potential for improvements when accessing telehealth. Hence, speculating that users with severe COPD will benefit more than other groups of COPD in the adoption of telehealth technology. It is also remarked: if it is reasonable to expect, or even demand, an improvement in HRQoL from the implementation of telehealth? Another observation in the literature review, is that patients in the invention group will stay stable or decline less in HRQoL compared to the controlled group. Thus, making an argument that a stable HRQL should also be viewed as a success criterion when implementing telehealth.

This understanding is shared in a report by Udsen (2015), which performed a large RCT study using telehealth to help people diagnosed with COPD in Denmark. The study lasted four years, 2011-2015. The intervention group received a “TeleKit” consisting of a tablet, weight monitor, blood pressure monitor and oxygen saturation monitor. While the EQ-5D (EuroQol five dimensions) form was used to check the baseline of quality of life, SF-36v2 was used to measure life quality over the research period. The study found similar results observed by Gregersen et al., both population groups experienced a decline in quality of life. However, the drop was lower in the intervention group. The study also interestingly reports, that when only looking at patients with severe COPD, a more beneficial indicator is observed in the controlled group.

In a small study conduct in Norway, Barken, Thygesen, and Soderhamn (2016) used a phenomenological research approach to interview 10 patients suffering with COPD that was part of a telemedicine project (United4heallth). The descriptive data collected from the patients was analysed and showed a clear tendency towards a better knowledge of their disease which resulted in better mastery and control. The authors link this knowledge towards an indirectly increase in HRQoL that was also experienced. The study fails however to describe how it came to this result and the sample size is considerably small.

In conclusion, the literature describing users with chronic diseases receiving telehealth solutions are often not decisive on quality of life measurements. This is also the case for the largest RCT trial conducted to this date, The Whole Demonstrator programme. The study measured HRQOL, anxiety and depressive symptoms among (n=1573) patients in England, and found no evidence of improvement in the intervention arm (Cartwright et al., 2013).

As discussed, this occur since the criterion of success is wrongful regarding a deteriorating health in the patient group with or whiteout telehealth. It should also be noted that questionaries' specifically aimed at anxiety and mental health, like the HAD (hospital anxiety and depression scale) questionnaire, seems to have a greater tendency for positive results (Kenealy et al., 2015), (Chatwin et al., 2016).

Relatives are often not included in the research conducted in telehealth trials. However, Kenealy et al. (2015), Chatwin et al. (2016), both of which failed to produce any conclusive results on their respective objectives, report on secondary qualitative data regarding relatives. Both studies experienced increased family knowledge about the disease, while also making theme feel safer about the well-being of the patients.

3.2.5 Acute exacerbations

Acute exacerbation (AE) is a sudden decline of COPD symptoms that can last for several days. As COPD develops with the patient, exacerbations increase. Despite the fact that only

10% - 15% of all patients with COPD will experience severe exacerbations that require hospital admission, costs associated with hospitalization represents more than 70% of all COPD related medical expenditures[41] (Wang, Stavem, Dahl, Humerfelt, & Haugen, 2014) . AE is hence, a very interesting indicator, having strong correlation with clinical effectiveness and costs. Therefore, strategies aimed to identify and manage exacerbations at early stages are desired in order to prevent hospitalizations, improve quality of life and to reduce healthcare expenditures (Pedone & Lelli, 2015).

Three of the systematic reviews covering effects and costs specifically mentioned AE related research, (Cruz et al., 2014; Gregersen et al., 2016; Pedone & Lelli, 2015). Cruz et al. (2014), displays the most homogenous and conclusive results on the subject. However, the review only included four studies. Two of these studies, totalling 204 patients, addresses the number of respiratory exacerbations during the intervention. Results indicate that usual care have a higher incidence of respiratory events (P= 0.152). A worsening of oxygen saturation was the most frequent clinical finding by the tele monitoring system, which resulted in an early detection of a respiratory exacerbation. This conclusion is supported in COPD research by Pedone and Lelli (2015), that also, intriguingly found a stronger tendency towards reduction in exacerbations, hospitalizations and mortality among studies with Telerehabilitation compared to Telemedicine.

A study performed by Chatwin et al. (2016), in England, came to less positive conclusions. The study design was a RCT and consisted of 68 patients suffering from chronic lung diseases and lasted for six months. Telemonitoring was adopted as the intervention method, using Philips Motiva system as the monitoring technology. The system is installed in the patient's home and monitors heart rate, finger pulse oximeter, weight and blood pressure. The patients also responded to a questionnaire on breathlessness and sleep quality. The results showed that telemonitoring did not improve the time for the patients next exacerbation, requiring acute hospitalization. In fact, the admission rate increased for the intervention group. In explaining these results, the authors point to the possibility of reduction in self-efficacy, causing the patients to rely more heavily on the healthcare workers. While this conclusion is somewhat an

[41] In the United States

anomaly for the literature acquired in this review, the effects show nonetheless the exact opposite of what is desired when using this kind of technology.

The results exhibited by Chatwin et al. is similar in the large RCT study conducted in Denmark by Prosjektsekretariatet et al., which neither could document any reduction in acute exacerbations among its COPD intervention group, but rather an increase. The cause of this, is explained by the introduction of a new way of conducting a blood sample in the artery. The study also lack data on the subject, because hospitals did not have information on whether a patient was part of a telemedicine project or not.

3.2.6 Mortality

The measurement of mortality rate is often used in combination with QALY studies (quality adjusted life years), which combines mortality rates with the quality of life. Mortality rates affiliated with telehealth interventions is thus essential for making cost-effectiveness analyses that can relate incremental costs to a combined measure of mortality and morbidity (Udsen, Hejlesen, & Ehlers, 2014).

Three of the systematic reviews (Cruz et al., 2014; Pedone & Lelli, 2015; Widmer et al., 2015), included mortality rates in their assessments. None of the reviews could find any conclusive results. However, Widmer et al. (2015) points out that there seems to be a positive reduction in mortality rates if taking a broad definition of digital health interventions applied to the studies. Morbidity and all-cause mortality seemed to patients with CVD to have a positive effect when the intervention was secondary [42].

A two-arm randomized pilot study completed by Hale et al. (2016), reviewed different meta-analysis studies and their assessments on medication monitoring systems regarding chronic heart failure (CHF) patients. The findings were overall of a positive nature. One of the studies evaluated was a telemonitoring analysis by Clark et al. reporting an all-cause mortality improvement of 20% among CHF patients. Similar, encouraging results were found in two other meta-analyses.

[42] Telerehabilitation

The usage of medical dispensers in the distribution of medicine has also been implemented and adopted in Norway. Ausen (2016) made a report based on a welfare technology pilot study in Larvik municipality. Mortality rates was not reported in this study and the patients was not necessarily suffering from chronic diseases. However, the overall patient and health worker impressions was very positive in the adoption of the technology. The same medical dispenser, Pilly, was also implemented in Oslo municipality in another welfare technology project (Intro, 2015). Some of the patients receiving the technology had chronic diseases such as T2DM and COPD, but not necessarily everyone. The overall impression was that patients experienced increased health literacy and safety in usage of the technology. Neither this study reported mortality rates.

The combined Impression on research from international and Norwegian literature shows considerable potential in the usage of electronical medical dispensers for patient welfare. There is however little evidence that telehealth reduces mortality rates in the existing literature.

3.2.7 Summary: Patient related effects

Records documenting patient related effects are collectively inconclusive for patients with COPD and CHF. While statistical significance is uncommon, there is a tendency towards positive outcomes in the intervention groups. Patients with DM seems to be the group that benefits the most, showing a very clear tendency towards improved behavioural outcomes. Reduction in AE for patients with COPD are similarly inconclusive. While the systematic reviews show positive results, the RCTs included show no clear improvement. Interestingly, Pedone et al. remarks that Telerehabilitation provided greater reductions in exacerbations compared to Telemedicine. There was no evidently reduction in Mortality rates documented among patients with DM or COPD. Patient with CHF did however seem to benefit from telehealth when applied preventively.

3.3 COSTS

A major driver in Telehealth implementation is the potential of reducing healthcare costs. Costs have been divided into two themes, Hospitalisations and healthcare costs. While

Hospitalisations affect healthcare costs directly, many studies only use the hospitalisation rate as an endpoint when conducting research.

3.3.1 Hospitalisation

Hospitalization (HR) is an indicator that includes a variety of factors. These factors can be hospital readmission, hospital length of stay and emergency department visit rates. While emergency department visit-rates have been discussed in the Acute exacerbation chapter, this only included COPD related incidents. According to a study performed by Miller et al. (2005), COPD related costs to hospitalizations represent more than one-half of the total costs attributable to COPD.

The importance of HR is also reflected in the systematic reviews, where all five studies included, addresses the subject. Interestingly, all five reviews report unanimously positively on the subject, albeit with a varying degree of scientific certainty and conclusiveness. Cruz et al. (2014) found that patients with COPD receiving telemonitoring had a significantly (p=0.034) lower risk of hospitalization than those getting usual care, when pooling eight studies, totalling 406 patients.

Correlative results have also been documented by supplemental literature. Paré et al. (2013), which in a review found that nine of ten studies had reported a statistically significant decrease in the number of hospitalizations in patients with COPD.

Hale et al. (2016), which performed a RCT trial on the medication monitoring system for patients with CHF, exhibit an 80% reduction in the risk of all-cause hospitalization. A significant (p=0.03) decrease was also identified in the number of all-cause hospitalization length of stay, in the intervention group compared to usual care.

The retrieved literature on hospitalization rates are overwhelmingly positive. It should however be noted, that differences among diseases, intervention methods and healthcare setup change the results drastically among studies. This might be affected by patients often suffering from multiple-illnesses (co-morbidity) and what the different countries evaluates as a clinical parameter for hospitalisation.

3.3.2 Healthcare costs

The final effectiveness indicator to be examined is healthcare costs (HC). As is the case with hospitalization rates, this indicator is affected by numerous variables. There are many ways of building cost-analyses, however there is frequently used in healthcare. (1) Cost-effectiveness analysis compares monetary expenses of at least two or more interventions, together with a nonmonetary outcome, like clinical parameters or hospital days prevented (Grustam, Severens, van Nijnatten, Koymans, & Vrijhoef, 2014). (2) Cost-benefit analysis matches economic costs with monetized economic benefits. Its purpose is to analyse whether the intervention is economically superior to the competing alternative.

Which actors that are most affected by HC varies considerably between countries. In Norway, healthcare services are primarily handled by the government and the municipalities. Reducing societal costs related to chronic diseases is hence a strong political incentive for telehealth diffusion. As Gregersen et al. (2016) remarks; *the political popularity of telehealth rests on the hope invested in the potentials rather than the proven merits of the new technology*. Thus, underlining that telehealth might not live up to its expectations.

"Costs" in general are mentioned in some form in all five systematic reviews. Though, only two reviews documented the effects comprehensibly. Cruz et al. (2014) performed a charting of thirty-two studies researching costs associated with telehealth interventions on patients with Chronic heart failure. Seventeen studies (60%) recorded telehealth being cost-effective, compared to usual care. Only one study saved costs with increased effectiveness. Four studies reported equal effectiveness and equal costs, and two studies noted increased costs and equal effectiveness. The authors conclude that the gathered reports are of general poor scientific quality, lacking methodical rigor and unbiased conclusions. Secondly, the authors address the issue of capturing all the consequences and effects of telehealth when making economic evaluations.

This conclusion is supported by Udsen et al. (2014), who also reports on potential cost savings from telehealth on patients with COPD, but also describing the scientific quality of reviewed economic evidence as poor. The authors also argue that studies with broad analytical perspectives are needed. Pointing out the lack of clarity on the societal perspective, specifically regarding the passing of additional costs on to the relatives.

A comprehensive literature review by Gregersen et al. (2016), identified a seemingly positive trend regarding the advantages of telehealth in almost all studies, regardless of its size. Although, often not statistically significant. The author argues that it is important to gather information from trials of "adequate" size.

The largest RCT of telehealth and telecare project to this date and which should be of adequate size, is The Whole System Demonstrator (WSD) programme. The study was conducted in England, and included patients with Heart failure, COPD and Diabetes. An incremental cost per quality-adjusted life year (QALY) for the project was examined by Henderson et al. (2014). The results were rather disappointing, while the QALY gained in the intervention group was similar to those receiving usual care, the costs in social and health services were higher. The authors thus stated that policy makers should not characterize the technology as a "magic bullet".

Similar results are also reported in the populous TeleCare Nord RCT in Demark. When comparing with the patients suffering from COPD in both intervention and controlled group, no evidence was found for improved cost-effectiveness or QUALY. The authors thus propose, that if targeting those patients with more severe COPD, 7.000 dk. per patient can be saved annually. Costs are "saved" due to reduction in healthcare utilization and hospital admissions. This beneficial indicator regarding people with severe COPD, was also reported in Vianello et al., when assessing quality of life. Hence, it seems like there is a clear tendency towards improved benefits for people suffering with severe COPD.

There has been little research aimed at economical evaluations on chronic diseases and telehealth implementation in Norway. However, healthcare costs related to welfare technology[43] has reportedly been reduced in Larvik municipality (Ausen, 2016), Stavanger municipality (Stavanger, 2016), Oslo Municipality (Intro, 2015) and the Lister region (Mette, 2016) in projects involving distance monitoring. When scaling, costs reductions experienced in the VIS project from Oslo, to a national level, the cost-savings is remarkable (NyAnalyse, 2016). But, the validity and rigor reported in the Norwegian projects is often lacking small sample sizes and quality assessments, such as a controlled group to compare with the intervention group.

[43] And/or ambient assisted living

3.3.3 Costs Summary

A common theme among the acquired systematic reviews is the authors complaints regarding lack of quality, in the economical records gathered. While smaller studies often show, beneficial economic indicators related to reduced costs and hospitalisation, these results are less common in larger RCTs studies. It seems that scaling up smaller studies, is a weak indicator for the actual costs associated with telehealth implementation. The literature also indicates that tailoring Telehealth solutions to those most severely affected by their illness would be the most cost-effective form of telehealth implementation.

Intriguingly, hospitalisation rates are the most concludingly positive effect measured among the acquired literature. It is interesting that Telehealth solutions decreases hospital rates among patients to such a large degree, but that these effects are not captured by economic assessments.

Conclusion: Effects

Retrieved literature on patient related outcomes are often found non-conclusive. The studies focusing on Quality of life in patients with COPD, might lack this certitude because the illness is always progressing, thus making it difficult to determine if the intervention have the desired effect. The severity of COPD also seems to affect QoL. The literature suggests that patients suffering harshly from the illness might have a greater advantage if adopting the technology.

Reduction in Acute exacerbations among COPD patients when implementing distance monitoring also lack sufficient evidence. The systematic review retrieved on the subject show a positive tendency, but no statistical significance. Supporting RCTs show no clear reduction in response time or in the number of exacerbations. Instead, the RCTs document an increase in healthcare utilization in the intervention groups. This is in contrast to the documentation that Telehealth reduces hospitalisation rates among patients with COPD.

Meta-analysis studies on CHF show a positive tendency on patient related effects and clinical effects, but this is not supported in the RCTs included on the matter. Qualitative interviews do however demonstrate positive responses from the patients. Which begs the question if the QoL studies used to measure patient related effects are sufficient.

Patients with DM is the group that seems to benefit the most from telehealth interventions, notably patients with T2DM. This Indicates that self-learning is an important aspect of Telehealth implementation, and one effect that is often difficult to measure.

4.0 RESULTS: BARRIERS AND DRIVERS

4 systematic reviews, (Foster & Sethares, 2014; Gorst, Armitage, Brownsell, & Hawley, 2014; Kapadia, Ariani, Li, & Ray, 2015; Radhakrishnan et al., 2016) and 1 integrative review ,(Foster & Sethares, 2014), gathered literature regarding drivers and barriers for Telehealth implementation. Collectively this amounts to 139 articles analysing barriers and drivers for distance monitoring implementation among patients suffering from chronic diseases,

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Using the actor framework provided by (Bull-berg, 2015) in **Feil! Fant ikke referansekilden.** , the actors are identified as patients, service suppliers, government, relatives, business and others/society. To better understand which barriers and drivers that is experienced among the actors, results from the systematic reviews where then charted, counted and their citations distributed among the different barriers and drivers to better understand how frequently the occurrences was mentioned. While patients and service suppliers was well captured in retrieved literature, there was a lack of information regarding relatives, business, government and other/society.

Acquired literature regarding barriers and drivers all describe technological interventions using telemonitoring among patients with chronic disorders. A predominant common theme is elderly with chronic diseases. While distance monitoring is considered an alternative for all ages suffering from chronic diseases, a tendency in contemporary research is to focus on the largest population group; the elderly. Chronic illnesses are more common in the ageing, so this “uneven” distribution in population research is quite logical.

Barriers and drivers n= 5
y= mentioned, n=not mentioned
P= Patients
SS= Service Suppliers
G= Government
R= Relatives

Title	Study type	Included records	Barriers						Drivers					
			P	*SS*	*G*	*R*	*B*	*O*	*P*	*SS*	*G*	*R*	*B*	*O*
(Brewster et al., 2014)Factors affecting front line staff acceptance of telehealth technologies: a mixed-method systematic review. [Review]	*Systematic review*	*14*	*N*	*Y*	*N*	*N*	*N*	*N*	*N*	*Y*	*N*	*N*	*N*	*N*
(Kapadia et al., 2015) Emerging ICT implementation issues in aged care	*Systematic review*	*58*	*Y*	*Y*	*Y*	*N*	*Y*	*N*	*N*	*N*	*N*	*N*	*N*	*N*
Barriers and Drivers for Sustainability of Tele-Homecare Programs	*Systematic review*	*16*	*Y*	*Y*	*Y*	*N*	*N*	*N*	*Y*	*Y*	*Y*	*N*	*N*	*N*
Home telehealth uptake and continued use among heart failure and chronic obstructive pulmonary disease patients:	*Systematic review*	*37*	*Y*	*Y*	*N*	*N*	*N*	*N*	*Y*	*Y*	*N*	*N*	*N*	*N*
Drivers and Barriers to the Adoption of Telehealth in Older Adults: An Integrative Review	*Integrative review*	*14*	*Y*						*Y*					

4.1 RESULTS: BARRIERS FOR TELEHEALTH

A barrier is identified as an obstacle that prevents access or movement. When discussing barriers among the different actors involved in the diffusion and implementation of Telehealth, it is important to address each actor individually, since their means to overcome theme are often distinctively different. Humans interpret obstacles and hindrance individually, generalising these problems will therefore almost never create a "solid truth". It is nonetheless important to address common barriers among the actors, to create feedback for technology designers and policy makers to better facilitate Telehealth solutions.

While patients and service suppliers are adequately covered in the acquired literature. This is not the case for Government, Relatives, Business and Society. The chapters discussing patients and service suppliers are hence superior in the coverage among the actors.

4.1.1 Patients

Patients suffering from chronic diseases are primarily elderly. Many suffer with more than one illness (co-morbidity) and often have mobility problems. While the different diseases produce individual barriers for the patients, some common obstacles can be observed among the whole populace.

4.1.2 Technological Usability, Design and Functionality

A common theme identified in the literature are technological difficulties experienced by patients in the adoption of telehealth. 46% (n=17),of the articles analysed by Gorst et al. (2014), are related to patient-technological problems. This includes difficulty connecting to the system and usability challenges.

These issues are supported by Kapadia et al. (2015), remarking that patients with higher levels of education tend to use Internet communication technology (ICT) more in their daily life than those with lower levels of education . The importance of considering the patients experience with technology should therefore be an important aspect when implementing successful telehealth projects. Another important aspect is that specifically older patients prefer devices that are similar to household devices such as; radio controls or televisions.

4.1.3 Perceived need

A separate barrier is the patients' perceived need for technology. Studies researching telehealth use population samples where the participants often are eager to receive and use new technological devices. However, many elderly don't see any benefit of adopting telehealth technology, considering it to be redundant or invasive (Gorst et al., 2014). In the study by Heart and Kalderon (2013), 62% of older patients did not find any use of ICT, or were not interested in adopting ICT.

Participant refusal rate in implementation of telehealth, has similarly been analysed in detail by Gorst et al. (2014). In eight acquired studies, 32% of patients offered telehealth refused to participate. The most common reason being not interested or believing telehealth to be unnecessary.

4.1.4 Costs

Kapadia et al. (2015), mentions affordability as one of the main hindrances in the adoption and use of Telehealth solutions among the elderly population. One factor is the problem that tablets, smartphones and other technological artefacts is expensive equipment. Another hindrance is the lack of apparent cost-savings for the patients, making it unfavourable to invest in the equipment.

3.1.5. Summary

The difficulties observed in the literature regarding patient adoption of telehealth technology show a wide variety of obstacles. An interesting finding is that many patients do not think the technology has any solutions to making their life easier. Many of these barriers will probably change in time. As new generations of elderly face chronic diseases, a bigger proportion will have more experience with technological equipment. Hopefully, the perception of benefits will then also change. The costs of Telehealth equipment will presumably also dwindle as economics of scale incur.

4.2.1 Service Suppliers

Primarily the service suppliers discussed in the acquired literature are home-care workers, nurses and doctors. The composition of service suppliers is different among countries. On the other hand, there is some common ground among the developed countries and their service suppliers. Firstly, nurses are predominantly female. Secondly, many service suppliers, especially in the homecare services, are increasingly foreigners. How this affects their handling and perception of telehealth is difficult to determine but is an important aspect of telehealth implementation.

4.2.2 Technological difficulties

Healthcare worker’s resistance towards remote monitoring is a recurring theme in the literature (Brewster et al., 2014; Kapadia et al., 2015). Many nurses expressed concerns regarding lack of computer skills, lack of technical skills and being a non-native language speaker. If healthcare workers encountered negative experiences with the initial implementation of telehealth, they were less likely approve its continued use. Especially non-native language speakers and immigrants are increasingly finding work within the healthcare sector.

Rasmussen et al. (2016) which conducted a RCT trial in Demark, identified barriers to implementing video consultations that came from doctors and healthcare staff. Feeling they can’t perform professionally by video, or/and fearing the treatment might become weakened and prolonged.

4.2.3 Legal issues

Issues related to possible legal disputes is a concern documented among clinicians who deliver care through different distance monitoring (Brewster et al., 2014; Radhakrishnan et al., 2016). Clinicians are afraid they might become accountable for missing symptoms and alerts that indicated a patient crisis. The literature suggest that healthcare workers perception of legal risk contribute to their acceptance or rejection of distance monitoring (Brewster et al., 2014). Making good and established legal frameworks when implementing Telemedicine seems important in reducing the uncertainty among staff.

4.2.4 Patient relationship

In the systematic review by Brewster et al. (2014), 50% (n=7) of the articles included, reported healthcare workers experiencing concern that telehealth may change the patient relationship, thus reducing the human contact. Seeing as reduction on homecare visits by healthcare workers is often measured as a positive end point value in cost-analysis's regarding distance monitoring, this barrier might be hard to subdue.

4.3 Government

A barrier for the diffusion and implementation on large scale remote patient monitoring, might be related to problems in documenting positive results. When conducting economic evaluations, there are many limitations like: limited generalisability, few completed cost-benefit analyses, lack of long-term cohort studies, absence of quality data and appropriate measures (Udsen et al., 2014). These problems are also experienced when documenting clinical effects.

4.4 Relatives

66% of the population using telehealth sampled by Gorst et al. (2014), were residing with their spouse, partner or relative. However, when investigating acquired literature, there has been no mentions of barriers regarding relatives. This noted gap in the literature is also detected by Foster and Sethares (2014).

4.1 Summary: Barriers

The perception and handling of Telehealth technology seems to be a common barrier among patients and service suppliers. Lacking the support of these two major actors would create problems in any telehealth implementation regardless of cost-efficiency. While telehealth is a field of innovation, where technology and processes are developed and tested, integrating the most affected actors in this process would be beneficial in its adaption. Scarcity in literature on how relatives perceives telehealth is a barrier in itself. Research on how spouses and family members perceive and handles Telehealth can be an important tool in achieving successful telehealth implementation.

5 Drivers for Telehealth

A driver is something that makes a process easier or less difficult to accomplish. Discovering ways to help the spread of telehealth is thus an essential tool for policy makers.

The organisation and chapters will follow an identical style used when describing barriers. The collected literature on drivers suffer the same lack of documentation on relatives, Government, Business and others/society. But is additionally narrow on drivers in general. This can be related to the search strategy, but also the fact that it is easier to focus on the problems, rather than the solutions.

5.1.1 Patients

5.1.2 Improved health management

57% (n=21) out of the articles synthesized by (Gorst et al., 2014) refers to patient empowerment, self-management or health literacy for patients as an important driver. Making the patient play a more active role in their disease management is a heavy promoter in the usage of telehealth technology. Radhakrishnan et al. (2016), also documents patients experiencing that tele-homecare promoted daily self-monitoring activities.

While QoL studies often report on non-conclusiveness in statistical analysis, patient satisfaction is often mentioned as a qualitative observation. The drivers documented in these two systematic reviews confirm this observation

5.1.3 Ease of use

Device usability are still a main barrier in the endorsement of telehealth amid patients. However, there is a tendency leaning towards patients finding telehealth uncomplicated (Radhakrishnan et al., 2016). Articles in the early 2000s cited usability more often than contemporary research. Technological development, better implementation strategies and greater technological-knowledge across populations are all aspects making telehealth more accessible for patients.

5.2 Service Suppliers

5.2.1 Easy-to-use

50% (7/14) of the articles gathered by Brewster et al. (2014), cites having easy-to-use equipment as major driver for healthcare worker acceptance.

5.2.2 Improved access to care

Gorst et al. (2014), describes how Healthcare professionals are able to review the results of patient self-testing immediately, and see any early warnings of health status deterioration, thus reducing the number of emergency department visits and hospital admissions. This positive assessment fits well with the acquired literature on reduction in hospital rates found in the effects chapter.

5.3 Government

Nohr, Villumsen, Bernth Ahrenkiel, and Hulbaek (2015), discusses how the Danish Government, Local Government Denmark, and the Danish Regions launched a national action plan for diffusion of telemedicine in August 2012. The aim of this national plan is extensive and opportunistic[44]. To help facilitate these goals, an easily accessible database, including all telemedicine projects have been constructed. The database includes master data, involved actors, disease area, activities and applied technologies.

While no records have documented what kind of effect this might have, it is easy to imagine that the information and statistics made available would be a useful tool for any actor involved in telemedicine.

5.4 Relatives

Kapadia et al. (2015), describes how patients can be influenced by family members or friends when utilizing telehealth. Encouragement in the form of verbal praise can help patients accept technology. Older people might also be helped safety measure. This hypothesis is supported in Chatwin et al. (2016); (Kenealy et al., 2015) which experiences increased family

[44] Improved and more coherent patient care, more individually planned treatment and self-reliant patients Increased professional competences across sectors, financial gains in municipalities and regions

knowledge about the disease, while also making relatives feel safer about the well-being of the patient.

A positive sign in the literature is the tendency that patients are becoming more comfortable with telehealth solutions, while also finding the technology easier to operate. Patients receiving appraisal from family members also seems to be a driver often forgotten when implementing telehealth solutions. Including relatives in Telehealth implementation can be an effective solution in making the patient more comfortable with the technology, while also perhaps finding it more useful.

5.1 SUMMARY: DRIVERS

A positive sign in the literature is the tendency that patients are becoming more comfortable with telehealth solutions, while also finding the technology easier to operate. Patients receiving appraisal from family members seems to be a driver often forgotten when implementing telehealth solutions. Including relatives in Telehealth implementation can be an effective solution in making the patient more comfortable with the technology.

CONCLUSION: BARRIERS AND DRIVERS

A common barrier among patients and service supplier’s is difficulty in handling the technology. Patients with lower-educational background might lack technological understanding, while also finding the equipment too expensive to purchase. Hence, making it overall difficult to find any use of the technology. Non-native service suppliers might also find the technology challenging to manage.

The reviews by (Gorst et al., 2014; Radhakrishnan et al., 2016), reveal that patients level of satisfaction regarding telehealth solutions are much more positive than those of clinicians. A positive tendency in the literature describes how contemporary research show patients feeling more comfortable with telehealth solutions. If this is happening because elderly people are becoming more technological, or if the Telehealth solutions are becoming easier to use, is however difficult to assess.

Relatives are often neglected in research conducted within barriers for Telehealth implementation. However, as a driver, relatives can influence patients positively. More research should be done on how relatives can be included in telehealth implementation.

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ATTACHMENT 2: INTERVIEW GUIDE

Procedure before starting the interview

1. Inform about the purpose and background for the interview
2. Explain and inform about how the interview will be used, and who that might read it
3. Discuss questions around anonymity and the use of tape recording
4. Ask the respondent: "Do you have any further questions about the interview, anonymity or any other topics?
5. **Start sound recording**

What is your…..?

Sex (Man/Women)	**(filled in before interview)**
Age	X
Educational background	X
Total years in the healthcare sector	X
Position within the project	X

1. **Can you tell me about yourself….?**
   - ➔ How did you get involved in the project?
   - ➔ What is your role in the project (more information)?

2. **Can you briefly explain how your project organises RPM?**
   - ➔ Structure
   - ➔ Response-centre
   - ➔ Other employee positions
   - ➔ type of technology

3. **How do you recruit patients, and what "kind" of patient do you recruit?**
   - ➔ General practitioners (Do they function in other roles than gatekeepers for recruitment?)
   - ➔ (Tildelingskontoret) Municipal health grant office

4. **Interest organisations**
   - ➔ How are they involved?
   - ➔ Are all target groups represented?
   - ➔ How those the communication and advice from such groups function in practise?
   - ➔ Has there been any disputes?

5. **Which other healthcare organisations, governmental, municipal, regional, private, do you collaborate/work with in this project?**

6. **How does the communication between the response centre, and the patient work?**
   - ➔ Types of communication
   - ➔ Frequency of contact
   - ➔ Length of contact
   - ➔ Communication with the general practitioners

7. **What do you experience as the most troublesome/problematic feature of the response centre/RPM?**
   - ➔ Knowledge?
   - ➔ Time?
   - ➔ Organisation?

8. **What do you experience as the most positive feature of the response centre/RPM?**
   - ➔ Any specific target groups?
   - ➔ Can you see the benefit for certain patients?
   - ➔ For certain healthcare workers?

9. **How does the artefact/technology work?**
   - ➔ Is it reliable?
   - ➔ Has there been any issues?
   - ➔ What has been the projects major problem with the technology?
   - ➔ What works fine?

10. **If you could change anything that you wanted with the project (organisation, technology, target group etc) what would it be?**
    →technology
    →Target group
    ➔ Organisation?

11. **From project to implementation, what discussed topics do (or other experiences that you have) do you think is essential to solve?**
    → On a municipal level?
    → On a national level?

12. **According to a literature review I have conducted, can you elaborate on the following statements or topics that has been analysed:**
    → immigrant population and "immigrant workforce and RPM
    → The loss of patient contact
    → patients becoming more self-sufficent, better QOL etc
    → Other topics

13. **What do you experience as major challenges for the acceptance of RPM among healthcare personnel?**
    - ➔ General practitioners?
    - ➔ Nurses?
    - ➔ Homecare workers?
    - ➔ Other

14. Do you have any thoughts towards the private industry becoming more active within municipal healthcare?
→Positive/Negative

15. Can I contact you later for follow-up questions?

16. Now I am done with all my questions, do you have any additional information or topics that I haven't asked which you would like to share?