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LOG750 Logistics

Technological solutions for time and activity measurements as support to management in three Norwegian home health care services

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Summary

Norwegian home health care (HHC) services have experienced rapid changes in demand in the last decade. Demographic changes, longevity, the desire to live longer in one's own home and structural and organizational changes through the *Coordination Reform,* are contributing factors to increased demand and complexity of services rendered. Higher costs and an under coverage of staff makes efficient and effective utilization of resources in the HHC essential, and more knowledge of this is needed. This paper investigates how technological solutions for time and activity monitoring as support to management, affects the proportion of *direct* and *indirect* time in three Norwegian HHCs. According to the level of integration of technology, management in the HHCs can be described as *Manual*, *Hybrid* and *Technological* based.

Data was collected by home health care staff in a period of four weeks in 2018, during day and evening shifts in a normal activity period. Registrations were conducted using two different smartphone applications, and where one was based on RFID technology.

The highest proportion of *direct time,* 58 % was found in the HHC with *Technology* based management. Hybrid management had a proportion of direct time of 46 %. The lowest proportion, 39% were found in the HHC with a *Manual* based management. Our finding indicates that *Technological* and *Hybrid* management models have the highest degree of direct time. The implementation and utilization of technological solutions for time and activity measurements and portable electronic medical records (EMR) provide information to support management, which enables the HHC to allocate more time for direct patient care without additional resources.

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1.0 Introduction

1.1 Background

1.1.1 Home health care

This master thesis is part of the OMHOMES project at the Centre for Healthcare Operation Management, Molde University College. The aim of this thesis is to gain knowledge of time used in Home Health Care, HHC, and to investigate how technological solutions for time and activity monitoring as a support to management, affect the proportion of direct and indirect time utilized in three Norwegian HHC providers.

HHC forms part of the Norwegian public health care system and is provided by the local municipalities. There are also private providers, but these constitute only a small, often additional, part of the service. HHC is regulated by *"Lov om kommunale- og omsorgstjenester m.m (helse- og omsorgstjenesteloven)",* (Helse- og omsorgstjenesteloven, 2011), [The Health Care Law]. All municipalities are required to offer HHC. The legislation specifies the requirements, intentions, and aims of HHC services. Patient and recipients' rights are embodied in the *"Lov om pasient- og brukerrettigheter (pasient- og brukerrettighetsloven)",* (Pasient- og brukerrettighetsloven, 1999), [Law on Patient Rights]. HHC encompasses different services; necessary health care or practical help for recipients in their homes, short time stays in specially adapted facilities, care benefits and non-institutional rehabilitation (Abrahamsen, Allertsen, & Skjøstad, 2016). Services can be provided for short, or longer periods of time, and medical conditions addressed may be acute or chronic in character. This thesis concerns care given to patients living in their own home, from the perspective of HHC being a service industry.

1.1.2 Recipients and demand

The majority of recipients of HHC are elderly persons, but statistics from 2017 showed that 43 % of the recipients were under the age of 67 (Statistics Norway, 2020). There has been an increased request for HHC in the last few years: between 2011-2014 the growth was 7.4 %. This increase was highest in the group of persons under the age of 67, and those over the age of 90 (Helsedirektoratet, 2016). There are several reasons for this increase: a higher number of elderly persons, a higher rate of survival of serious medical conditions and patients living longer with their illness (Helsedirektoratet, 2016), as well as structural and organisational changes. The policy of reducing the number of hospital beds in somatic and psychiatric hospitals together with the *Coordination reform* have led to more patients receiving care in their homes (Abelsen, Gaski, Nødland, & Stephansen, 2014). The reform was implemented in 2012, with the aim to improve and strengthen cooperation between hospitals and municipality health care services, to accomplish better efficiency and provide patients with health care closer to their homestead (Det Kongelige Helse- og omsorgsdepartementet, 2009). One of the strategies of the reform is to reduce the number of patient days in hospitals by discharging patients earlier. This increases the number of patients in HHC, and at the same time adds complexity by introducing additional tasks to the services rendered. The increase in the number of home care recipients has been higher since implementation of the *Coordination Reform* (Helsedirektoratet, 2016).

Demographic factors indicate that the age structure of the population of Norway will change in the future: the number of elderly persons will increase and at the same time birth rates will decrease. Statistics Norway predicts that the percentage of persons over the age of 69 will increase from 11% in 2016, to 21 % in 2060, illustrated in figure 1-1. There is also an expectation of increased longevity. In 2020, 44 111 persons were aged between 90-99 years, and 1 119 persons over 100 years (Statistics Norway, 2020). There is an expectation of a higher need for health care services among these two cohorts. The prevalence of certain illnesses increases as we get older; 50% of newly discovered cases of cancer occur among persons over 70 years, and persons age 80 and older occupy 45% of the beds in somatic hospitals (Helsedirektoratet, 2012). The increasing demand for healthcare services will have organizational and economic consequences.

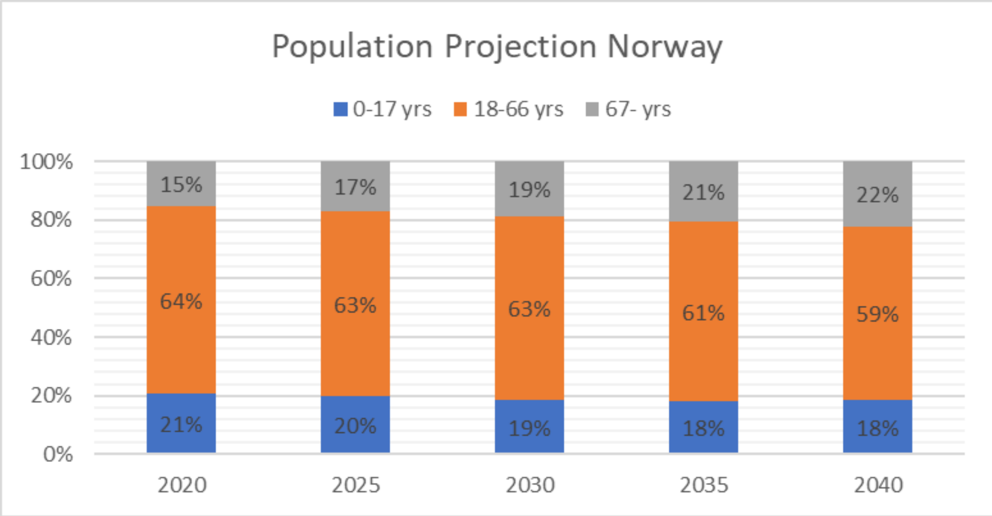

Figure 1-1 Population Projection in Norway (Statistics Norway, 2020)

1.1.3 Funding of HHC

The challenges for HHC are to provide good quality care to patients with a variety of medical conditions; cooperation with other actors through the cycle of care; difficult resource planning due to variations in demand; and since the care is provided in the patient's home, vehicle routing and staff scheduling. The challenges for society are to meet the increasing demand for health care services and related costs. Currently, funding of HHC and home-based services is through government subsidies and municipal expenditure. Healthcare services provided by HHC are at no cost to the patient, while other types of home-based services, such as cleaning, are available at a low cost. Depending on the organisational structure in each municipality, these services can either be part of HHC or organized as an independent unit. The expenditure for both services are included in the HHC budget. The organisational changes in Norwegian healthcare services implemented through the *Coordination reform*, has led to an increase of activities in HHC's, which along with an increase in the number of elderly persons has led to higher expenditure. In 2018 the costs of HHC services was 62.3 BNOK, an increase of 25.4 % from 2014 (Statistics Norway, 2020).

1.2 Research objective

The HHC service is a growing sector in Norway, as well as in most European countries (Genet, Boerma, Kroneman, Hutchinson, & Saltman, 2012). Given the choice, most people have a wish to live in their own homes for as long as possible, "ageing in place" (Brevik & Schmidt, 2005). Compared to institutional care, there is a substantial social profitability if recipients can live and receive care in their own home. The ability of individual adaptation of health care services' to the needs of the recipient, the possibility of the involvement of family and friends in addition to professional care, and the notion of a higher level of functioning of the recipients when living at home, are arguments in favour of ageing in place and HHC (Det kongelige helse- og omsorgsdepartementet, 2018).

The Coordination reform has been a major organizational change, as some of the care responsibilities have been decentralized from hospital to municipality health care. As a result, the number of recipients, and the level of complexity of care has increased. This, along with longevity, will lead to further growth, and altered demand for HHC services in the years to come. As a result of the growth of this sector, there has been a significant increase in costs in recent years. A further increase in the demand for home-based care may also, in the long run, lead to a shortage of staff (Helsedirektoratet, 2012). Projections of the future need for nurses in the Norwegian health care system shows that there will be a shortfall of 28 000 full-time equivalents (FTE) in 2035 (Hjemås, Zhiyang, Kornstad, & Stølen, 2019), and an estimated under coverage of health care personnel of 17 000 FTEs within HHC (Hjemås, Holmøy, & Haugstveit, 2019).

Providing HHC services is complex, both in the demands and requirements of the services rendered, and in planning, routing, and scheduling. Several articles and reports indicate that, despite the growing interest in HHC service, there is a lack of, and need for more knowledge (Genet, Boerma, Kroneman, Hutchinson, & Saltman, 2012) (Holm & Angelsen, 2014) (Abrahamsen, Allertsen, & Skjøstad, 2016) (Fikar & Hirsch, 2016) (Riksrevisjonen, 2018) (Helgheim, Sandbaek, & Slyngstad, A prospective investigation of direct and indirect home care activeties in three rural Norwegian municipalities, 2018). Abrahamsen et. al (2016) refers to it as an area, relatively scarcely described, where more knowledge is essential. There are few studies of *how* time is used on various activities in HHC services. Knowledge about the services, activities and costs is of utmost importance in distribution and management. Cooper et. al (2017) advocates further studies addressing different research questions such as workload, and Fikar and Hirsch (2016) calls for studies on robust settings, continual measurements of care and HHC optimization methods. A review of HHC studies, showed that most articles had routing and resource scheduling as their main focus to gain quality improvements and cost reductions. Routing and resource scheduling are time consuming activities, often done manually and therefore also with a potential for suboptimal solutions (Fikar & Hirsch, 2016).

A study by Røhne, et. al (2018) found that the use of optimization technology reduced time spent on daily planning, improved staff continuity for the patient, and increased direct patient care. Applying operations research modelling in HHC has shown that this could improve efficiency by 10-15 % (Eveborn, et al., 2009). In a study of HHCs in Copenhagen, Nielsen (2010) found that the use of smartphones or tablets for medical record keeping instead of doing this on paper, reduced documentation time by 15 minutes a day, per employee. Similar findings were reported in a study of the use of technology for *bedside medical record keeping* in hospitals, where the use of portable terminals reduced time spent on documenting by approximately 24 %; that time was then allocated to direct patient care (Poissant, Pereira, Tamblyn, & Kawasumi, 2005) (Rouleau, Gagnon, & Côté, 2015). *Direct* and *indirect* care/activities were used as measurements in studies of time allocation in Norwegian and Danish HHCs. The findings here were that more time was spent on *indirect* rather than *direct* care, (Rambøll, 2009) (Helgheim, Sandbaek, & Slyngstad, A prospective investigation of direct and indirect home care activeties in three rural Norwegian municipalities, 2018), and that time spent on transportation was underestimated (Holm & Angelsen, 2014). Direct time, i.e., time with the patient, is the core of HHC. It is a term of applicability, as it describes time allocation, and can be used as a measurement of production, also encompassing elements of quality and value.

An increase of productivity in healthcare is one way of addressing rising costs and rising demand. Jordahl and Persson (2018) studied labour productivity and quality in ten Swedish HHCs. The study used RFID technology, to measure both service production and utilization of resources: *worker utilization* through delivered hours. The authors emphasize the use of technological solutions for time and activity measurement, as this makes registering easy, and provides valid measurements. However, Jordahl and Persson (2018) warns against negative effects of using the technology with an excessive focus on increasing productivity, which in the end could lead to lower quality of services rendered.

Olivia and Sterman (2001), discuss how service erosion can be a possible answer to increased workload among employees in service industries. To counter this, an increase of productivity must be seen as a result of better management practices, with better services at a lower cost (Bloom, Propper, Seiler, & Reenen, 2010). These are ideas that we also find in the work of Porter and Teisberg (2006) who advocate addressing rising costs and increased demand in healthcare through adding value at every step in the care cycle, i.e., doing things better, where measurement and evaluation of results are the basis for management.

There is an increasing focus on performance measurements in the healthcare sector. Traditionally, the focus has mainly had an economical viewpoint, but lately there has been a greater interest in measurements that also consider non- financial aspects. This change has come about as a recognition that financial measurement of performance alone is not sufficient (Otley, 2007). Another change is the turn towards paying more attention to performance management. Melkers and Willoughby (2005), and Pollanen (2005) argue that the most interesting issue in the discussion is the use and application of information gathered in a meaningful way. Measurements in themselves cannot improve services or management, but the *use* of results can, as results must be used for evaluation and possible correction of practice (Porter & Teisberg, 2006) (Fitzgerald, 2007). The choice of measurements should reflect the organization's goals and core activities, as they will influence behaviour and activities within the organization (Kaplan & Norton, 1992). In a study of EMR technology in ambulatory care, DesRoches et. al (2008) distinguished between *basic* and *fully* integrated systems, and where findings were that the users of the fully integrated system reported positive effects on decision making and information flow which in turn led to a lower degree of adverse events and a higher patient satisfaction.

Information, knowledge, and the sharing of information are essential in healthcare systems (Lenz, Peleg, & Reichert, 2012), and according to Mamlin and Tierney (2016) this means that healthcare should be described as an information business. Information and communication technology (ICT) is a rapidly growing area, and Ford et. al (2017) describes it as a digital disruption that has the potential to transform the industry, where the technology is supporting efficient administration and better delivery of care. Porter and Teisberg (2006) argue that IT has the potential of improving almost all activities in care delivery. Several articles refer to health information technology (HIT) as a contributor to solving the challenges associated with increased costs in the healthcare system (Agarwal, Gao, DesRoches, & Jha, 2010) (While & Dewsbury, 2011), increased quality through more patient-centred healthcare, and higher efficiency through reduced travel time (Rouleau, Gagnon, & Côté, 2015). Laurenza et. al (2018) points to the importance of technology and digital solutions in information management. Yoon et. al (2016) reported a positive relationship between IT applications, as RFID technology, and process management in a study of SCM in hospitals.

The systems used to obtain information will be reflected in management (Kaplan & Norton, 1992). In HHCs without technological solutions for monitoring activities and information flow, management can be characterized as *Manual*, while, in a fully integrated system for electronic time and activity measurement, management can be classified as *Technological.* In an organisation that has technological solutions for monitoring activities, but where this is not fully integrated as a managerial tool, this can be described as a *Hybrid.* To our best knowledge, this perspective has not been described in literature.

The purpose of this study is to investigate how technological solutions for time and activity monitoring as support to management, affects the proportion of *direct* and *indirect* time spent in three Norwegian HHCs. According to the level of integration of technology, management in the HHCs will be described as *Manual* (municipality M1), *Hybrid* (municipality M2) and *Technological* (municipality M3) based.

> **RQ:** Investigate how technological solutions for time and activity monitoring as support to management, affects the proportion of direct and indirect time in three Norwegian HHCs.

The research question will be answered through analysis of time and activity measurement. The results will provide information on which management system enables delivery of the highest proportion of direct time.

2.0 Theoretical framework

2.1 Healthcare perspective

The healthcare system faces major challenges in terms of capacity, quality, and costs. To meet these, it is necessary to evaluate services today and to search for ways to create a sustainable service.

Porter and Teisberg (2007) advocate a holistic view of healthcare services. They present a way of thinking about and organizing healthcare, where the *value chain* (Porter M. E., 1985) is used as an overall perspective to picture and recognize all contributing factors in the process of care, where *value* is the key concept. A system built on the goal of value for patients, where delivery is organized around the medical conditions and care cycle of the patient (with a systematic approach of measure, evaluation, and management, all with the goal of adding value at every level), will improve quality and reduce costs in health care delivery (Porter & Teisberg, 2006). Low quality, errors, and re-treatment due to poor achievements are all factors that will influence outcomes, increase costs, and lower the patient's perception of value and quality of life (Donabedian, 1988) (Porter & Teisberg, 2006) (Liu, Bozic, & Teisberg, 2016). Lower costs are favourable, but must be as a result of better efficiency, higher quality, and less waste (Porter & Teisberg, 2007). These are ideas that correspond with Lean philosophies, which seek to address the issues of quality and cost, through reduction of waste. Central aspects here are needs of the customer, involvement of employees, and continuous improvement (Lawal, et al., 2014). Lean thinking is based on the Toyota Production System, TPS, where it was developed to continually improve manufacturing processes through reduction of non-value adding steps, and waste, (Holweg, 2006). Originally, waste was divided into seven categories. This has later been adapted for a healthcare context. The English National Health Service, NHS, refers to examples of wastes as *unnecessary movements*; either in transportation, or staff looking for paperwork or equipment, *waits or delays*, *overtreatment* as requesting unnecessary tests, and *defects*, as wrongfully discharging, or providing treatment due to lack of information (Radnor, Holweg, & Waring, 2011). Lean methods and lean thinking have become more used in the healthcare system and applied in a wide range of settings (Smith, Poteat-Godwin, Harrison, & Randolph, 2012). Although Lean is widely used, Radnor et.al (2011) refers to it as somewhat difficult to define precisely. The concept is described as either *Lean thinking*, *Lean philosophy* or just *Lean.* Womack and Jones (1996) describes Lean through five principles where (1) *value is defined from the perspective of the customer,* (2) *value stream is identified for each product and waste is eliminated,* (3) *the process and value flow is continuous,* (4) *production is pull based,* and the need to (5) *pursue perfection in every step.* Mazzocato et. al (2010) differentiates between lean as a management system with a set of *technical practices* to improve customer value, and lean theory which emphasises a holistic view.

Thoughts about quality and costs are relevant in the Norwegian healthcare sector, where expenditures has increased significantly in recent years (Riksrevisjonen, 2018) (Statistics Norway, 2020). Porter and Teisberg (2006) emphasize three basic principles for a value-based healthcare system where the goal is *(1)* value for the patient, where *(2)* delivery of care is organized around medical conditions and *(3)* measurements of results are central. The authors state that a single focus on lowering costs may increase costs in the long run and take attention away from adding value for the patient. Wrong medical treatments, poor quality care or simple solutions to a problem, may extend the time patients stay in hospital, or cause severe medical complications. In Lean theory, these are all examples of waste. This is also true in HHC, where a worsening of a medical condition may result in a reduced functional level of the patient, and as a result of this, limit the patient's ability in daily life, and increase the need for care. Lower cost then, should be a result of better efficiency, higher quality, and less waste (Porter & Teisberg, 2007).

2.2 Value and Quality from a healthcare perspective

Quality of healthcare is a central principle in health policy, frequently discussed and often quoted. The concern of providing a safe, responsive, and effective healthcare service is shared by both policy makers and service providers (Busse, Klazinga, Panteli, & Quentin, 2019). At the same time, there is increasing awareness of gaps and variations in the quality of the delivered services, and an increased focus on improving patient outcomes (Busse, Panteli, & Quentin, 2019).

The words *value* and *quality* are both central and often used terms when describing health care, its activities, and goals. In the theory of Porter and Teisberg, value is referred to as the key to improvement in healthcare. There are several definitions for both words, different and yet somewhat describing the same. *Value* may be described as the *quality of* *something*, the characteristics of something that makes it good. The definition also refers to an appointed value as a predominator when we make judgements and decisions (Sagdahl, 2019). In order to add value, quality is a necessity. How then should we define quality? It is a word extensively used and there are many definitions and descriptions of what it is and how it should be used. The Oxford dictionary defines it as a *standard* of something, measured against other things of a similar kind, and the degree of excellence it has (English Oxford Living Dictionary, 2019). The Latin word *Qualis* means *of what or such kind*. The Norwegian Encyclopaedia uses a definition close to the Latin origin; the way a thing is. For an object or service, quality is the ability to meet expectations (Gundersen & Halbo, 2018). In everyday speech quality is used to describe something good, or of good characteristics. In the Oxford dictionary definition, measurement against a similar thing, shows that quality is in relation to something, and the measurement will describe the position related to this. Quality can be high or low, good, or better. It is a word much used when discussing aspects of healthcare, so extensively used that it may even have lost its meaning (Grepperud, 2009) (Porter M. E., 2010). A WHO and OECD report argues that even though quality in care is essential, there is no common understanding of the term (Busse, Panteli, & Quentin, 2019). According to Grepperud (2009) definitions of quality can be divided into two main groups; ones used by healthcare actors or government, and the other used by economists. Examples of the first category are definitions where the term quality is used to describe *improvements* of health, or definitions where the word *desire* is emphasized to describe needs and preferences of patients, and publications where quality is used to describe different *desirable dimensions* such as safety, successful, accessible and righteousness distribution. From an economical point of view, quality is discussed in relation to markets and prizes, and customer value is central (Grepperud, 2009).

In philosophy, value is of great interest and discussion. Axiology is the study of value theory, with the primary aim of classifying *"...what things are good, and how good they are"* (Schroeder, 2016, p. 1). The theory of value also includes moral philosophy, where theoretical questions of value and goodness are central. Objectivistic value theories argue that something may have an intrinsic value, in contrast to value as instrumental (Sagdahl, 2014) (Schroeder, 2016). Definitions of value will always have a social dimension, as it will be embedded and coloured by our lives, beliefs, communities, or social environment (Putera, 2017). Value as determined by the perception of the customer, as described in Lean theory, is an example of the connection to the individual. Value is, of course, central in economic theories. Smith and Standaert (2013) show that much of the ongoing discussion of changes in the American healthcare system is built on the notion of improving value through optimizing quality and at the same time lowering costs. Value in healthcare, then, is described as an outcome relative to cost. According to Porter, the term also comprises goals of healthcare services such as *"...quality, safety, patient centeredness, and cost containments, and integrates them."* (Porter M. E., 2010, p. 1). Central for all activities in the healthcare system though, should be to add value to the patient (Porter & Teisberg, 2006). Here, value is clearly understood as something that is good for the patient and adds a perspective where moral value theory also is present. Liu et. al (2016) defines value as *"...meaningful outcomes achieved for a patient relative to the money spent on his or her care."* (Liu, Bozic, & Teisberg, 2016, p. 315) (Porter & Teisberg, 2006). As we can see from these examples, descriptions of value differ; from an economical viewpoint to descriptions of what value comprises and how it is something that is *adding value to*, and *meaningful outcomes* for patients. Central to all examples is that value should be defined around the patient. According to Porter and Teisberg (2006), value is the only thing that unites the actors in the value chain, and that the search for lower cost and higher revenue are derailments.

To add value in healthcare, then, must be seen as both improving the economic factors and adding perceived value to patients. And adding value requires higher quality. As we can see, the definitions overlap. An interpretation of value, as used by Porter and Teisberg, can be to see it as any action that will improve healthcare. Gupta et. al (2016) uses the word *practical philosophy* when describing Lean, with a multi-dimensional approach to management and continuous improvement, based on the idea of reducing all activities that are non-value adding. The term can also be used to describe Porter and Teisberg's (2006) approach of value adding as a means of improving healthcare. The cultural dimension of value is present in a definition of Lean, presented by Toussaint and Barry (2013), where cultural transformation forms the basis of changes in the way an organisation works.

2.3 Information technology

Information, knowledge, and the sharing of information is essential in healthcare systems (Lenz, Peleg, & Reichert, 2012). According to Mamlin and Tierney (2016) this means that healthcare can be described as an information business. Information and communication technology (ICT) is a rapidly growing area, and Ford et. al (2017) describes it as a digital disruption that has the potential to transform the industry, where the technology is supporting efficient administration and better delivery of care. Several articles refer to health information technology (HIT) as a contributor to solving the challenges associated with increased costs in the HC system (Agarwal, Gao, DesRoches, & Jha, 2010) (While & Dewsbury, 2011), increased quality through a more patient-centred healthcare, and higher efficiency through reduced travel time (Rouleau, Gagnon, & Côté, 2015). Laurenza et. al (2018) argue that the use of IT technology in healthcare lags behind, compared to other types of industries and points to the importance of technology and digital solutions in information management. Planning and control in healthcare management is highly dependent on valid information, and Hans et. al (2012) argue that lack of information, due to the state of information system in healthcare, will have a negative impact.

Yoon et. al (2016) reported a positive relationship between IT applications, such as RFID technology, and process management in a study of SCM in hospitals. Jordahl and Persson (2018) used digital time measurements in Swedish HHCs in a study of productivity in the public sector and argue that measurements based on digital logs give a more reliable picture than measurements based on self-reports. In their study, registrations of delivered hours were obtained through the use of RFID technology, where staff used a mobile phone and tag to log in and out of patients' homes, which provided accurate measurement. Earlier registrations had been done through use of pen and paper, something that was perceived as tedious by the employees, and gave more unreliable results. The use of RFID technology provides valid measurement of activities and is thus a support for management (Jordahl & Persson, 2018).

2.4 Measuring and evaluation

The increased focus on expenditure, demand, and quality in healthcare, has led to a discussion of the necessity of measurements, and how and what to measure. Output, input, number of patients treated, and outcomes are examples from the discussion. Porter and Teisberg (2007) state that a systematic approach of measuring and evaluation is necessary in the work of creating a more sustainable healthcare. To meet the challenges of healthcare of today, more knowledge of the services is essential, and to achieve this, information about performance, results, and costs is needed. This must be obtained through a systematic approach to measurement and evaluation.

Quality in healthcare is important, but is it possible to measure, and how should this be done? Even though there is a strong focus on this, there is no consensus on how to measure (Lee, et al., 2013). Quentin et. al (2019) argue that it is difficult to ensure high quality in healthcare without measurements, as it gives a basis for evaluation, development, and implementation of improvement strategies. Porter (2010) focuses on output measurement, the patient health outcome, when evaluating value in healthcare. Value encompasses both quality and the outcome described through patient health outcome relative to the money spent on the care (Porter & Teisberg, 2006) (Liu, Bozic, & Teisberg, 2016).

Donabedian is regarded as a pioneer in formulating a framework for evaluation of quality in medical care. In an article published in 1966 he suggested using *structure*, *process*, and *outcome* in the evaluation (Donabedian, 2005). Structure can be envisioned as input, and process describing the care delivered and effects on patient health as outcome (Panteli, Quentin, & Busse, 2019). Donabedian described *structure* as the settings where care occurs, including material, human resources, and organizational structure. The *process* describes the care and includes the patient's activities in seeking care as well as the healthcare givers activities. *Outcome* describes healthcare effects of the patient, and in populations (Donabedian, 1988).

This framework has been of extraordinary importance in forming the understanding of, and discussion about quality in healthcare. Donabedian emphasized the interdependence of *structure*, *process,* and *outcome*; A good structure increases the chances of a good process, and a good process makes a good outcome likely. All three components must be established and acknowledged, and there must be a pre-existing understanding of their interdependency, before they can be used to describe or evaluate quality.

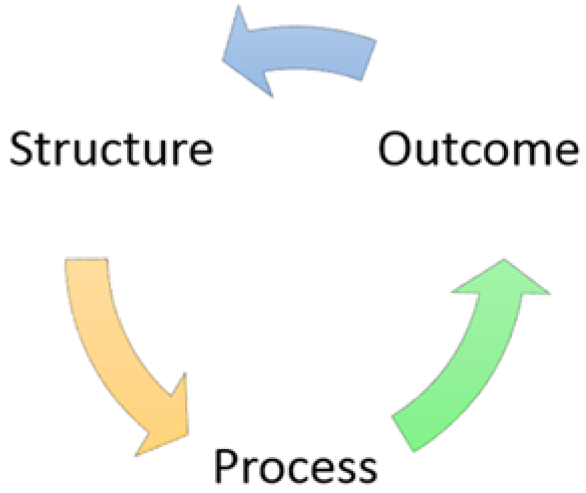

Figure 2-1 Donabedian model: Structure, Process & Outcome

Donabedian's triad model (figure 2-1) has similarities to Porter's value chain model; booth describes *structure* and *process* as necessity of outcome, and with an interdependency of the three components. Porter describes the *structure* as support activities, consisting of infrastructure of a firm, or as in this case, of the HHC, its human resources management, technology, and procurement. The *process* equals primary activities, and the *outcome* may be seen as provider margin. Donabedian shows how the three concepts influence each other, if one is good, this increases the likelihood of a good performance of the next. The feedback loops of Porter and Teisberg's Care Delivery Value Chain, CDVC, model can be seen as describing the same (figure 2-2).

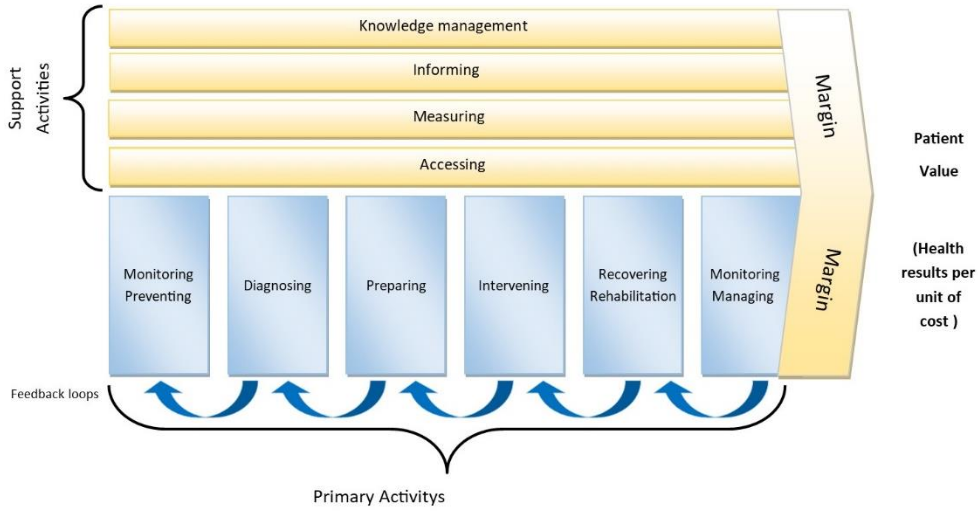

Figure 2-2 Porter & Teisberg CDVC-model

Patient perception is an important factor when describing and measuring quality. Lee et. al (2013) argue that quality of care should be measured through the patient's experience of *subjective well-being*, SWB. Hanefeld et. al (2017) discusses the complexity of matters related to the perception and understanding of quality of healthcare, and points to how a greater understanding can help to identify strategies for measurement of quality. The patient's perception of care given, and upstream factors such as management, at the level where care is given and higher up in the system, are both important factors when defining quality (Hanefeld, Powell-Jackson, & Balabanova, 2017).

PROMs, *Patient reported outcome measures*, describes the patient's assessment of quality of care. A criticism of this is that it is often focused on specific conditions and may fail to grasp the total impact of healthcare in the life of the patient (Lee, et al., 2013). Black (2013) argues that PROM is not an outcome measure, but a measurement of patient health at different times, and that PREMs, *patient reported experience measure*, which focus on the humanitarian aspects of care, is a preferred method. The patient's perspective is also central in the Three C's method, where *Capability*, *Comfort*, and *Calm* is used to measure outcome for patients with chronic or long-term illness, and end of life conditions (Liu, Bozic, & Teisberg, 2016). In measurement of results, *adverse events*, AEs, like medication errors, worsening of health conditions due to maltreatment and too much or lack of treatment, should also be included. Documentation of errors will give the organisation the possibility to learn and to improve the services rendered (Rafter, et al., 2015).

The Norwegian Health Directorate uses Donabedian's terms; *structure, process, and outcome*- when evaluating quality (Shahzadi & Narbuvold, 2018). The report, *National strategy for quality improvements in social- and healthcare services,* describes this as three different paradigms in the approach to the quality of health services; the first focuses on the system level, where internal control, quality systems and ISO- certification are central. The second is the clinical approach, where quality is measured and registered through reporting of AEs and prolonged recovery, and the third is the patient centred approach, with the patient's subjective evaluation of the services (Sosial og Helsedirektoratet, 2005). Quentin et. al (2019) suggest the use of *indicators of quality,* as a method of approaching measurements, and refers to Calhoun's (2002) definition of how an *indicator* in social sciences can be described as quantitative measure that gives information of a variable difficult to measure. There are many definitions of indicators in health care; it is important that they should provide quality goals, have specified methods for data collection, with calculations and description of how measures can be used to evaluate quality, and be patient centred (Mainz, 2003) (Quentin, Partanen, Brownwood, & Klazinga, 2019).

Knowledge of the intention of measurements, and how the results should be used will influence data requirements and levels of precision. If the focus is verification and assurance of quality, this requires a higher level of precision of data and statistics, than measurements that have quality improvements as their focus. Here, information is the important part and therefore the level of precision can be lower. Quentin et. al. (2019) argue that this makes it easy to use, and the method can be used at a local level, where it will provide grounds for discussion, and thereby also promote a process of continuous improvements.

As Donabedian's terms, and Porter's model of the CDVC show, evaluation of quality and value cannot be done without a paramount perspective of the services, organisational structures, processes, and outcome. Porter (2010) warns against using process measurements as a measure of value; they are important, but more as tactics for improvement. In lean thinking, AE's and poor processes are examples of non-value adding, and therefore regarded as waste. In an evaluation of healthcare, the use of *value,* instead of a single focus on quality, will give a broader perspective. As we can see, quality in health care encompasses many different aspects, and is difficult to measure.

2.5 Production and measurement

Production in healthcare differs from production in the manufacturing industry, as the products can be described as *intangible, simultaneous* (as services are created and consumed at the same time), and *heterogeneous* (as there is a variation between recipients in services rendered), involves *patient participation,* and is *perishable* (Parasuraman, Zeithaml, & Berry, 1985). HHC is allocated to the patient through a care resolution, issued by the municipality, which defines the type of care needed and the time duration of the activity. Production in the HHCs can be described as a pull system (Mangan, Lalwani, Butcher, & Javadpour, 2012), where production is triggered by the recipients' needs and the care resolution of the municipality.

There is a discussion of how, and what to measure in the production of the service industry, as its nature makes output measuring challenging. Ellram et. al (2004) argue that this is because human labour is a significant contributor to total value delivered, and that this is difficult to measure. Simpson (2009) argues that output measurements of the public sector are problematic, since they encompass many dimensions, which makes the construction of aggregate measures difficult. Glenngård (2013) discusses productivity in primary care, and points out to how the lack of information about the length and content of services rendered, constitutes a problem for policymakers as distribution and effects of the services are unclear. It may seem like the discussion of measurement of production is blurred through different definitions and use of terms related to production in service. Partial measurements, such as number of patients treated, changes in health (Putnam, 1994), and performance (Holzer & Lee, 2004) are examples of measurements used. The first, *number of patients treated,* is an example of an output measure, while *changes in health* and *performance* describes outcome. There is a consensus on the importance of measuring outcomes, but not on what to measure (Porter M. E., 2010). In the measurement of output, productivity, i.e., output generated per unit of input, is central. With increasing demand for HHC services and rising costs, there has been an increased focus on improvement of productivity (Linna, Pekkola, Ukko, & Melkas, 2010). To reach this, reliable performance measurements, and improvement of care processes are necessary (Plsek, 1997) (Malhotra, Jordan, Shortliffe, & Patel, 2007) (Halonen, Juntunen, Martikainen, & Naumov, 2014). Ellram et. al (2004) emphasize the importance of understanding, monitoring, and controlling the service supply chain as a means to improving outcomes. Pike and Roos (2007) argue that performance measurements should be regarded as an input, not a goal. The necessity of measurements is also emphasized in performance management where this, together with evaluation of performance combined with clear goals, form the basis for management (Otley, 1999) (Ittner & Larcker, 2001) (Heinrich, 2002) (Verbeeten, 2007). Verbeeten (2007) argues that a quantification of goals and achievements will enable organizations to reduce uncertainty and focus on core activities.

Jordahl and Persson (2018) introduce *Worker utilization* as a method of productivity measurements in the HHC. Labour productivity is measured through analysis of delivered hours (output) to patients in relation to the total amount of worked hours (input) and is described as *worker utilization*. Their use of *delivered hours* i.e., time spent with patients, corresponds to the use of the terms *direct time/ direct patient care*. Both terms can be used as measurements of activity, and *direct time/ direct patient care* also points to aspects of quality of care. The concept of *worker utilization* aims at increasing the time spent on direct patient care, and the goal is to address costs through an increase of productivity. Jordahl and Persson (2018) nevertheless point to the risk that an excessive focus on productivity, with a tighter work schedule as a result, could lead to employees experiencing increased workload, and thereby also lead to lower quality of service delivered. Porter and Teisberg (2006), advocate to addressing costs through increasing value, and where measurements are a basis for better management. The notion that better management can give higher productivity is supported by Bloom et. al (2010) and Jordahl and Persson (2018). The use of *direct time* as a measurement will provide information about allocation of time, and thereby also level of patient-centeredness in the HHC organization and be an indicator of quality.

In Jordahl and Persson's research, registrations of delivered hours were obtained through the use of RFID technology, by using a mobile phone and tag to log in and out of patients' homes. The registrations provide accurate measurements of delivered time. There is increasing interest in the technology in the health care sector, but despite this, use of RFID technology in the healthcare sector is frugal. It can be used to improve inventory and stock management, registration of patients and treatment records, (Chong & Chan, 2012), support various forms of information flows, thereby reducing human errors and improving efficiency (Lee & Shim, 2007).

2.6 Direct time as a measurement

The patient is the central focus in health care services. A simple way of ensuring attention to the patient is to investigate how much time is spent on direct activities with him or her (Helgheim, Sandbaek, & Slyngstad, A prospective investigation of direct and indirect home care activeties in three rural Norwegian municipalities, 2018). The interaction between patient and healthcare worker is essential part of health care, and an arena where quality can be created and tested (Sosial og Helsedirektoratet, 2005). The assumption that more time used on direct care, i.e. time spent with the patient, will influence quality of care and patient satisfaction is supported by a British study of General Practitioners, (Howie,, et al., 1999), and a study of nursing in Magnet hospitals (Bacon & Mark, 2010), where results showed that longer consultations improved quality and patient satisfaction. Bacon and Mark (2010) also reported higher satisfaction and lower turnover among staff. Longer visits with the patient will give the opportunity of adding value, through activities that will increase, or work against worsening, of the functional level of the patient. Examples of this may be gait- or simple mobility exercises and help to create better meal situations to maintain good nutrition. Experiences from the Nordic countries show that simple rehabilitation measures like this, provided by HHC staff have shown to improve patients' function in daily activities. In addition to a higher level of patient satisfaction, this *may* also, in the long run, lead to lower costs, as it may avoid, or postpone the need of increased help among the recipients (Birkeland, 2014) (Langeland, et al., 2016).

Two studies of HHC services in rural parts of Norway, show that more time was used on indirect activities, rather than on direct activities (Holm & Angelsen, 2014) (Helgheim, Sandbaek, & Slyngstad, A prospective investigation of direct and indirect home care activeties in three rural Norwegian municipalities, 2018). A Danish, descriptive study, with the aim of reducing bureaucracy, described the use of time, divided into *direct* and *indirect* care activities, in HHC services in ten municipalities. The results regarding nurses, corresponds to the findings of Helgheim et. al (2018); more time was used on *indirect* patient care (Rambøll, 2009). By allocating time from *indirect* to *direct* activities, patients will benefit.

Direct and *indirect* care were also used by Antinaho et. al (2014) in a study investigating nurses working time in Finnish hospitals, research built on the theory of value adding of Porter and Teisberg (2006). The study differentiated between 1) *Value-adding activities*, which were defined as direct care, and indirect care, such as documentation and contact with other health care professionals. 2) *Necessary activities* (unit- related work and types of indirect care) and 3) *Non-value adding work* (personal time, different tasks, breaks and waiting time). The categories used differ from the division of activities into two categories, *direct* and *indirect* care, as medical record keeping and documentation are regarded as indirect, but as a value adding activity. Upenieks et. al. (2008) argue that the important issue is whether an activity is beneficial to the patient or not.

Providing sufficient time for direct patient care is essential, and therefore information about the allocation of time in HHC is important (Helgheim, Sandbaek, & Slyngstad, A prospective investigation of direct and indirect home care activeties in three rural Norwegian municipalities, 2018). A lack of knowledge about time allocation constitutes a managerial problem as knowledge of processes, input and measurements of results are key factors to management and any process of improvement (Porter & Teisberg, 2006). It is important to recognize that performance measurements in themselves are not value adding, as it is through analysis that they can be a tool for improvement of the service (Radnor & McGuire, 2003). Measurement, and analysis, of *Direct time* will give a picture of the use of resources in the HHC, provide measurements of production through *worker utilization* and at the same time be an indicator of quality and the patient-centeredness of the service.

Findings indicate that organisations that use performance measurement systems as a support for management have a higher performance than organisations that do not (Lingle & Schiemann, 1996) (Rogan & Boaden, 2016). Kaplan and Norton (1992) argue that the choice of measurements is important, as this affects decision making, and that measurements should reflect the core activities, competencies, and goals of the organisation. The use of direct time as a measurement of delivered hours, i.e., patient related care, encompasses the core activity of HHC, and can thereby also increase attention toward the value perspective

3.0 Case description

There have been two series of data collections in the OMHOME project, the first in 2016, consisting of data from three municipalities and the second in 2018 with data from two municipalities. This thesis is based on the second data collection, and consists of registrations from two rural municipalities, here called M1 and M2, in the western part of Norway, and data collected from a municipality in the southern part of Norway, M3. Registrations in the data collection were gathered by electronic time registration devices.

3.1 Description of the municipalities

M1 and M2 are both rural, coastal, and located in the same area, and share much of the same geography and topography. M3 is a more densely populated, rural/urban municipality in the inland parts of southern Norway, with a somewhat different geography and topography. M2 has the largest area of the three, 370 Km^2, and has a population of 9800. The population density is 26/km^2 and 54 % of the inhabitants live in small communities (Stokkan & Thorsnæs, 2017). M1 is slightly smaller, 352 Km^2, and has a population of 6 536. Population density is 19/Km^2 and 60 % of the inhabitants live in small communities (Thorsnæs, 2017). M3 has the largest population, 25 000, but the smallest area, only 122 Km^2, and therefore the highest population density, 205/Km^2. Ninety-eight percent (98 %) of the inhabitants live in small communities (Thorsnæs, 2017).

Table 3-1 Background municipalities

Municipality	M1	M2	M3
Population (n)	6559	9775	24917
Area (km^2)	352	370	122
Population density (km^2)	19	26	204
Road kilometres (km)	333	513	219
Inhabitants living in community (%)	60	54	98

Population density, and geography /topography are factors that will have implications for HHC services. In densely populated areas, the need for transportation will differ from areas with longer distances between inhabitants as well as greater distance from the HHC office. In city- like areas there will also be a possibility to use walking, moped or bicycle as means of transportation, but in rural areas, cars will be the only option. The area of M1and M2 are almost identical, but if we look at the number of roads and density, M2 has more kilometres of road. In M1 the total length is 333 km, and in M2 513 km. The numbers for M3, which has the smallest area of the three municipalities, are 319 km (Statistics Norway, 2019). The number of kilometres driven, which in turn depends on distances, settlement patterns as well as number of daily visits to the individual patient, will have implications for the use of time in the HHC service.

Expected population projection is of importance when planning for future HHC services. Figure 3.1-3 illustrates population projection of the three municipalities. This is based on a projection where fertility, life expectancy, internal migration and immigration rates are considered medium. The statistics also provide alternatives where national growth is either considered as high or low. The medium alternative, as used here, is regarded as the main alternative (Statistics Norway, 2018).

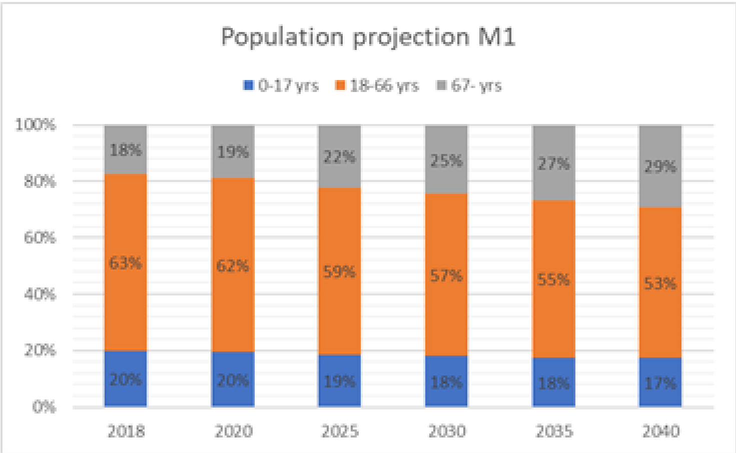

Figure 3-1 Population projections M1

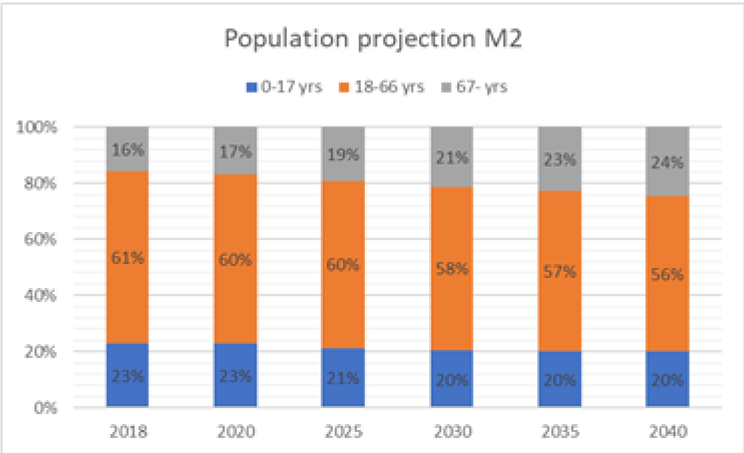

Figure 3-2 Population projection M2

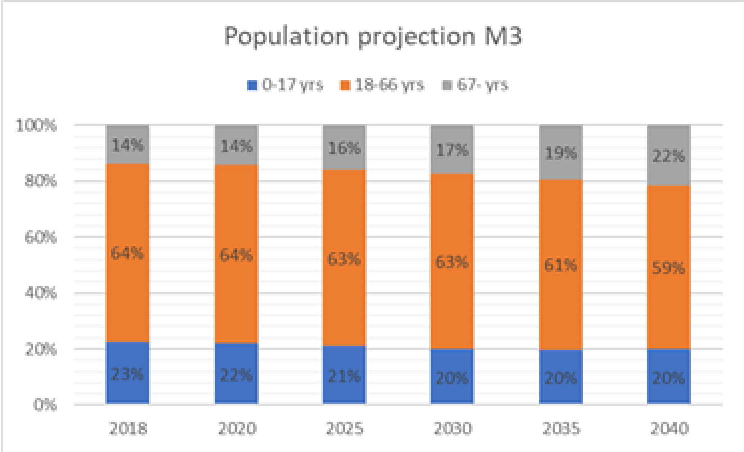

Figure 3-3 Population projection M3

The statistics show that M2 will have an 8% increase in its elderly population, a 5 % decrease in the cohort 18-66, and a 3 % decrease in the youngest, aged 1-17. M1 has the highest projected increase of elderly, 11% in 2040, a decrease in the group 18-66 of 10% and a decrease of 3 % in the group of children, aged 1-17. M3 will experience the same growth of elderly as M2, 8%, and a 3 % decrease in the group of children, but the decrease in the age 18- 66 cohort, is only 5 %. The projection shows a change in the balance of the population distribution in the years to come. The three municipalities show a higher growth of elderly than the national averages. In 2040 the cohort of elderly will constitute 21 % of the Norwegian population. In M1, M2 and M3 the numbers will be 29%, 24% and 22%. The growth of elderly will have implications for healthcare services and expenditure, as there will be an increase in the number of persons that need healthcare services. A falling rate of the number of persons who work, and pay taxes, i.e., the population cohort between 18 - 66 years will have an impact on tax revenue and fewer persons available in the labour market.

3.2 Degree of technological integration

The three municipalities use two different EMR solutions, but the way the systems are utilized differs. Both systems have available applications for worklists and EMR on smartphones and tablets. This is not implemented and used on a daily basis in M1 but is fully integrated in M2 and M3. In M1 the worklist is printed and handed out during the morning and evening reports, and employees make notes on paper after each visit and later complete the EMR when back at the office at the end of their shift.

M2 uses a different EMR system than the other municipalities. Worklists are presented on smartphone or tablet. The system simultaneously displays a graphic version of the worklists on a large screen in the office, where the various assignments are marked with the patient's name and different colour codes for start and stop of the assignment. The employee registers activity by logging in and out of the activity. This means that both the leading nurse and the employees working on the same shift can follow the progression in the worklists. If an employee finishes before the estimated time, he or she can choose to take on a nearby situated assignment if it has not yet started.

M3 uses the same EMR system as M1. In addition to electronic worklists, M3 has implemented a time and activity registration system which enables continuous registrations and measurement of activities through RFID technology. The registrations are monitored daily by administrative staff and are used as a basis for evaluation of time allocation.

There are differences in how the systems are utilized in the three municipalities. M1 does not use all the possibilities in the system, such as EMR and worklist on tablets or phones. Feedback and information from employees to management is oral or written. The system used in M2 provides an opportunity for the leader and other staff simultaneously to follow the progression in the worklist as login and logout are shown as soon as the employee registers them on the smartphone. In M3, all registrations are made through RFID tags, which provides automatic registrations, something that increases accuracy of measurements. The registration are monitored and evaluated on a daily basis by a controller or leading nurse.

Information is an essential part in the process of allocation and delivery of care, and must be *collected, integrated,* and *utilized,* to provide a basis for management (Porter & Teisberg, 2006). As the degree of integration of technological solutions differs among the HHCs, there are also differences in both how information is captured and the information flow, which will have implications for management. Management in the HHCs will therefore be described as *Manual* in M1, *Hybrid* in M2 and *Technological* in M3. In the further discussion, these are also the terms that will be used when referring to the different HHCs.

3.3 Activity measurements

The activity measurements in the 2018 data collection in the *Manual* and *Hybrid* includes four main activities: *(1) Direct patient care, (2) Transportation, (3) Administration/documentation* and *(4) Medicine room.* Registrations in *Technological* include five main activities: *1) Direct patient care*, *(2) Indoor time*, *(3) Transportation*, *(4) Security alarm* and *(5) Other time.*

Direct patient care is defined as the time spent with the patient or recipient. *Transportation* is defined as activities related to transportation from the office to patients, between patients or other transport related to care, and it does not separate driving from the use of bicycle or walking. In *Manual* and *Hybrid*, *Administration/documentation* is defined as the time spent on reports, medical documentation either done at the office or in the home of the patient, coordination and planning of daily activities, and other tasks such as shopping or collecting medication from the pharmacy. In *Technological,* the category *Indoor time* is defined as time used on documentation, reports, communication, and administration of the services. *Manual* and *Hybrid* have a category for *Medicine room,* and this is defined as the time spent on preparation of medication in the Medicine Room at the HHC facility. Drug delivery to patients is not included under this point of registration as it is part of direct patient care. *Technological* registers the drug preparation, dosage, as *Other time*. *Security alarm* is time spent with the patient as a result of a triggered alarm. *Other time* consist of seven sub-categories: *Refuel*, *Dosage*, *Meal distribution*, *collect pharmacy merchandise*, *Kitchen at work*, *Deliver car for wash* and *Tidy merchandise*.

Table 3-5 illustrates the different parameters collected from the three municipalities. Aggregated categories describe the registration categories used when comparing the data collected in *Manual* and *Hybrid*, to data from *Technological*. The registrations are combined into three categories: *(1) Direct patient care*, *(2) Transportation*, and *(3) Administration*.

Table 3-2 Aggregated categories

Manual & Hybrid
(1) Direct patient care
Direct patient care
(2) Documentation
Documentation/administration
(3) Transportation
Transportation
(4) Medicine room
Medicine room

Technological
(1) Direct patient care
Direct patient care
(2) Indoor time
Indoor time
(3) Transportation
Transportation
(4) Security alarm
Security alarm
(5) Other time
Refuel
Dosage
Meal distribution
Collect pharmacy merchandise
Kitchen at work
Deliver car for wash
Medicine room

Aggregated categories
(1) Direct patient care
Direct patient care
Security alarm
(2) Administration
Documentation/administration
Refuel
Dosage
Meal distribution
Collect pharmacy merchandise
Kitchen at work
Deliver car for wash
Medicine room
(3) Transportation
Transportation

4.0 Methods and data

4.1 Methods

The project is a case study of HHC services in three municipalities. Data for the project was gathered through triangulation of quantitative and qualitative methods; electronic registration, participating observation, and informal talks. Quantitative and qualitative methods are complementary and will thus give a broader scope of information (Ringdal, 2001). Yin (2012) describes case studies as a preferred method where how, where, and why are main questions, and when the researcher has little control over events. Taylor and Thomas-Gregory (2015) refer to Luck et. al. who describe the case study as a method with the capacity to explore and describe the case and will help in establishing meaningful and context-constituted knowledge. A case study is well suited for this project, it is exploratory, with the aim of increased knowledge of time allocation in the HHC. The questions of *how*, *why,* and *where* are all central in understanding the nature and tasks of the HHC. The research question investigates how technological solutions for time and activity monitoring as support to management, affects the proportion of direct and indirect time in three Norwegian HHCs.

Participating observations were conducted in the municipalities to provide knowledge and understanding of the services rendered. In participating observation, where the researcher is a part of the situation, all parties involved must be aware of the combined role as participating researcher (Ringdal, 2001). The employees of the different HHCs had been informed of the participating observation in advance and agreed to this. The patients were given information just before the caregiving situation and were given the choice of participation. All patients accepted participation. They gave information about their perception of the care given in short conversations during the visit. Situations that included assistance of personal hygiene were excluded from participating observations.

4.2 Data

Collected data must be read and presented in a way that makes comparison possible. Modes of analysing data differ according to the types of data collected, and purpose of the analysis. The goal of the data collection in this thesis is to gather information and knowledge of HHC activities, and to compare results between entities. Formulas and descriptions presented here are derived from Ringdal (2001) and Løvås (1999).

4.2.1 Descriptive and inferential statistics

Descriptive statistics is, as the name tells us, a way of using statistics to analyse and describe data and enables a meaningful presentation of the findings. Findings in this research are presented through statistics for each HHC, and results compared.

Measurements of central tendency describe a typical, representative value in a group of data, described through Mean, Median or Mode. **Mean** is the sum of all values in the dataset, divided by the total number, *n*, of values. It is well suited to describe the total size of the sample and population but may be less suitable as a description of what is a typical value. The mean may be affected if some of the observations are significantly larger or smaller than other observations in the sample (Løvås, 1999).

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

Median is the middle value when the dataset is arranged from the smallest to the highest value. **Mode** is the most frequently occurring value in a dataset.

Statistical dispersion is used to describe variations in the data set. This is of interest as measurements of central tendency can be the same in different data sets, while there may be great variations within the data sets (Løvås, 1999). Interquartile range, variance and standard deviation are examples of measurements that describe dispersion.

The Interquartile range, IQR, is a positional measurement that shows the relative position of a unit in a dataset, where the position is defined by comparing it to quartiles. Quartiles are three values, Q1, Q2 and Q3 that will split a distribution into four parts (Ringdal, 2001). The IQR is also called the mid-spread and describes where 50% of the findings are.

$$IQR = Q_3 - Q_1$$

Variance, σ^2**,** is a measurement of the spread between numbers in a dataset and is based on the sum of squared deviations from the mean for all units in a sample or a population.

$$Variance = \sigma^2 = \frac{1}{n-1}\sum_{i=n}^{n}(x_i - \mu)^2$$

The standard deviation, σ, is a measurement of the dispersion of a data set relative to the mean value of the set. It is calculated through the square root of the variance, and in contrast to the variance, it is expressed in the same measurements as the data.

$$Standard\ deviation = \sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \mu)^2}$$

Skewness describes asymmetry in the data. In a histogram, a perfect normal distribution of data will have a skewness value of 0, and be shaped like a bell. If data used do not have a normal distribution, but are skewed, the curve will be asymmetric.

$$Skewness \approx \frac{1}{n}\sum_{i-1}^{n}\left(\frac{x_i - \bar{x}}{s}\right)^3$$

Kurtosis is another measurement that describes asymmetry in the distribution of data. It shows the spread between minimum and maximum values, and how pointed the curve in a histogram is. The min/max points of the curve are called tails. A pointed tail will indicate that most observations are centred around the mean, while a fat tail will have more observations either around the maximum or minimum end of the curve, which shows a higher probability for extreme values in the data.

$$Kurtosis \approx \frac{1}{n}\sum_{i=1}^{n}\left(\frac{x_i - \bar{x}}{s}\right)^4 - 3$$

In statistical inference, data from a smaller sample is used to say something about a larger group or population or to find differences between groups. Testing of a hypothesis is done through the formulation of an H_0 hypothesis, and an alternative hypothesis, H_1. The purpose is to examine if the data allows to reject H_0 with a high degree of probability. Often used levels of significance is 0.05 or 0.01. If the p-value is lower than this, the H_0 hypothesis is rejected. The results from the three HHCs will be compared, and a hypothesis will be tested.

The H_0 is formulated:

$$H_0: \mu_1 = \mu_2 = \mu_3$$

H_1, alternative hypothesis:

$$H_1: \mu_1 \neq \mu_2 \neq \mu_3$$

4.2.2 Data collection period

Activity data was collected by home care staff during a period of four weeks in 2018. Registrations were conducted during day and evening shifts in a normal activity period. Participating staff included Nurses, Healthcare Workers, and Assistants. In *Manual* registration of activities were conducted between the 5th and the 18th of February, while the registrations in *Hybrid* ran from the 5th till the 25th of February. Registrations in *Technological* ran from 1st to 28th of February. Figure 4-1 illustrates the data collection period. Due to the technical formation of data received from *Technological*, extraction of detailed information was only possible in the period 1st - 6th of February.

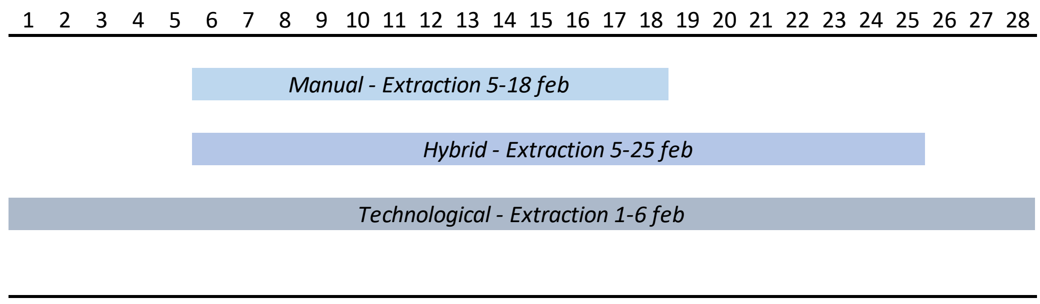

Figure 4-1 Data collection period

The three HHCs use different technological solutions for time registrations. The unit of analysis is time spent on the activities; *Direct patient care, Transportation* and *Administration.* The data collection in *Manual* and *Hybrid* is part of the OMHOMES project, while the data from *Technological* was collected solely for this thesis.

In *Manual* and *Hybrid*, data collection was conducted using an electronic app for time registration, YAST. This is a Norwegian software program that enables the user to time track activities, and can be used on different platforms, such as smartphones or computers. Registrations is done by the employee, using an anonymous key to log on. The relevant activity is found by scrolling and is then registered by touching a button on the smartphone screen at the beginning/end of each activity. Electronic activity registrations had not been used on a regular basis in the two municipalities prior to the project.

Technological uses the software M_Solution, a system where registration is done by using Radio Frequency Identification, RFID technology, and Near Field Communication, NFC receivers. This technology is integrated in newer smartphones. An RFID tag is placed in the doorframe at the home of the patient, and the employee uses an NFC receiver in a smartphone to register their entrance. When leaving, the registration stops as the employee gets into the car or on the bicycle and registers an RFID tag there. If transportation is done on foot, the employee carries an RFID tag in their tablet that will register when the caregiver leaves the home of the patient. The system is used for time registration of daily activities and is integrated in the organization as a management information system.

4.2.3 Data registrations

The data collection in *Manual* and *Hybrid* included a total of 8 629 registrations. Seven hundred and twenty-one (721) registrations, 9.12 % of the total were excluded due to coding errors, such as registrations running more than 14 hours or just a few seconds. The total number of registrations for analysis were 7908. The number of registrations from *Technological* was 21 130. In this data set, possible coding errors are corrected as all registrations are monitored daily by administrative staff, and corrections of registration errors done continuously.

Table 4-1 Total number of registrations

Data collected	**Manual**	**Hybrid**	**Technological**	**TOT**
Total registrations (n)	2347	6282	21130	29759
Coding errors (n)	170	551	0	721
Total registrations analysis (n)	2177	5731	21130	29038

Results from the data collection period are presented in table 4-2, in the categories: *Direct* activities and *Indirect* activities, which include transportation, adm/docu, drugs, other time and safety alarms, S/A. The total hours registered are 750, 1401 and 6544 in *Manual*, *Hybrid* and *Technological*. The corresponding numbers of observations are 2 050, 5 615 and 21 130.

Full time equivalent, FTE, for rotation shifts in the health care professions, is 1846 hours yearly. To illustrate how many hours are spent on the different activities, and the differences between the municipalities, the use of FTE will help clarify the picture.

Table 4-2 Registrations all categories

		Manual				**Hybrid**				**Technological**			
Category	**Activity**	*(n)*	*(min)*	*(%)*	*FTE(h)*	*(n)*	*(min)*	*(%)*	*FTE(h)*	*(n)*	*(min)*	*(%)*	*FTE(h)*
Direct	*Direct*	825	17845	40%	732	2386	38055	45%	836	10889	219257	56%	1031
Indirect	*Trans*	940	9913	22%	407	2641	30908	37%	679	7506	72487	18%	341
	Adm/docu	235	14980	33%	614	545	13221	16%	290	2294	91199	23%	429
	Drug	50	2264	5%	93	43	1886	2%	41				
	Other time									117	2284	1%	11
	S/A									324	7409	2%	35
	Total	2050	45002	100%	1846	5615	84070	100%	1846	21130	392636	100%	1846

4.3 Results

In table 4-3 registrations are combined into three categories: *(1) Direct patient care*, *(2) Transportation,* and *(3) Administration*. *Direct activity* ranges from 40% of the total registered hours in *Manual*, to 45% in *Hybrid* and 58 % in *Technological management.* The difference between the lowest and the highest rate is 18 %, a difference that equals 334 FTE hours. The difference of *Direct activities* between *Manual* and *Hybrid* based management is 104 hours in every FTE.

Table 4-3 Registrations: Direct, Transportation and Administration

		Management models					
		Manual		**Hybrid**		**Technological**	
Category	**Activity**	(%)	FTE(h)	(%)	FTE(h)	(%)	FTE(h)
Direct	*Direct*	40%	732	45%	836	58%	1066
Indirect	*Trans*	22%	407	37%	679	18%	341
	Adm	38%	707	18%	332	24%	440
	Total	100%	1846	100%	1846	100%	1846

M3 (*Technological*) has the smallest area and they also spend the least time on *Transportation*, 18 %, while M1 (*Manual)* and M2 (*Hybrid)* which are almost the same size, spend 22 % and 37 % respectively. The difference between the highest and lowest proportion of time spent, is equivalent to 388 hours in every FTE.

Reasons for the differences are not known, but factors such as route planning, distance driven between patients and office, and even the state of health of the patients, influence time spent on transportation. Often, patients are in need of more than one visit per day, which will result in more kilometres driven and time used, especially if the patient lives in remote areas of an HHC district. Helgheim et. al (2018) refer to population density and settlement patterns as important factors influencing time spent on transportation, where settlement patterns may be the most important contributor. In M3, 98 % of the inhabitants live in communities, and the HHC spends the least amount of time on transportation, 18 %. This corresponds to the findings of Trautsamwieser & Hirsch (2011), who found that traveling time in urban areas was lower than in rural areas. The other two municipalities have a more scattered pattern, as 54 % of the inhabitants in M2, and 60% of inhabitants in M1 live in small communities. M2 is also the municipality with the most road kilometres.

Hybrid management spends the least amount of time, 18% on *Administration*. The highest level is found in *Manual* management, where this constitutes 38%, a difference of 20%. *Technological* management spends 24%, 6% higher than *Hybrid*. Here, the difference between *Manual* and *Hybrid* is interesting. The HHCs have different routines for medical documentation and use different EMR systems. Both programs have solutions for registrations and EMR entries through tablet or cell phone during patient visits. *Hybrid* have implemented this technology, and medical record keeping is done either during the visit or directly afterwards. During participating observation, employees in *Manual* wrote notes during or after each visit and completed the registrations electronically when they returned to the office. This was also noted in the article by Helgheim et. al. (2018) who pointed out that documentation had to be done twice. *Technological* uses a system similar to *Hybrid*, and does most of the registrations while with the patient or directly afterwards. The difference in time spent on administration between *Technological* and *Hybrid* is 6%.

The two categories *Direct patient care*, and *Indirect patient care*, illustrated in table 4-4. gives an overall picture of the use of time, and how much is spent with the patients in the different HHCs. *Indirect activity* ranged from 42% in *Technological*, to 55% in *Hybrid* and to 60% in *Manual* based management. The distribution of indirect time in the subcategories differs in the municipalities. *Manual* and *Hybrid* have a lower rate of *Direct* care, and a higher rate of *Indirect* care. The difference between the two is 5% in both categories. When comparing Direct patient care in *Technological* and *Manual* the difference is 18 %.

Table 4-4 Direct and indirect activities

	Management models		
Category	**Manual**	**Hybrid**	**Technological**
Direct	40%	45%	58%
Indirect	60%	55%	42%
sum	100%	100%	100%

Table 4-5 illustrates the time distribution in the categories *direct*, *transportation* and *administration.* The median time of direct activities range from 10 minutes in *Hybrid*, to 13 minutes in both *Manual* and *Technological*. Mean time ranges between 16 minutes in *Hybrid*, to 18 minutes in *Technological* and 22 minutes in *Manual*. The median time spent on *transportation* varies between 6 minutes in *Manual* and *Hybrid*, and 7 minutes in *Technological* based management.

Table 4-5 Median, IQR and Mean

Category	Activity	Managment models	*(n)*	*Median (min)*	*IQR (min)*	*Mean (min)*	*Duration (min*	*(%) total*	*(%) of indirect*	*FTH(h)*
Direct	*Direct*	*Manual*	825	13	(8-26)	22	17845	40%		732
		Hybrid	2386	10	(6-18)	16	38055	45%		836
		Technological	2246	13	(8-23)	18	40177	57%		1059
Indirect	*Trans*	*Manual*	940	6	(3-12)	11	9913	22%	37%	407
		Hybrid	2641	6	(3-12)	12	30908	37%	67%	679
		Technological	1357	7	(4-12)	10	12924	18%	43%	341
	Adm	*Manual*	285	36	(22-58)	61	17244	38%	63%	707
		Hybrid	588	10	(1-31)	26	15107	18%	33%	332
		Technological	397	39	(18-58)	43	16962	24%	57%	447
Total		*Manual*	2050	11	(5-23)	22	45002	100%		1846
		Hybrid	5615	8	(4-16)	15	84070	100%		1846
		Technological	4000	11	(6-22)	18	70063	100%		1846

There is a large spread in the median of administration; it varies from between 10 to 39 minutes. *Hybrid* has the lowest median at 10 minutes, where *Manual* and *Technological* have a median of 36 and 39 minutes. The difference can to some extent be explained by differences in registration procedures. In *Hybrid* EMR is conducted while still with the patient, or when the employee is back in the car. This is registered as administration, and many of these registrations are short, around one minute. EMR on tablets or cell phones is also used in *Technological* management; it is not registered as a separate activity, but included in direct time. Staff in *Manual* writes notes when still with the patient, and register this electronically when they return to the office. This is in fact doing the job twice. Administration constitutes of 63 % of *indirect time* in *Manual*, 33 % in *Hybrid*, and 57 % in *Technological.*

For statistical analysis, a two-sample t-test with assumed different variances was conducted, this is illustrated in tables 4-6. For *Direct time* the test shows that $p < 0.05$ and is considered statistically significant, and therefore the H_0 is rejected.

Table 4-6 T-test direct activity

Managmenet models	Management models	Mean	Variance	OBS	t-stat	P(T<=t) one-sided	T-critical, one-sided	P(T<=t) two-sided	T-critical, two-sided
Manual	*Hybrid*	15.95	761.47	2386	4.523	3.34001E-06	1.64606	6.68001E-06	1.96184
	Technologicacl	17.89	267.84	2246	3.188	7.39490E-04	1.64640	1.47898E-03	1.96238
Hybrid	*Manual*	21.63	1038.32	825	-4.523	3.34001E-06	1.64606	6.68001E-06	1.96184
	Technologicla	17.89	267.84	2246	-2.928	1.71359E-03	1.64524	3.42719E-03	1.96057
Technological	*Manual*	21.63	1038.32	825	-3.188	7.39490E-04	1.64640	1.47898E-03	1.96238
	Hybrid	15.95	761.47	2386	2.928	1.71359E-03	1.64524	3.42719E-03	1.96057

5.0 Conclusion

Increasing demand for HHC services and the higher complexity of services rendered has led to higher costs and shortage of qualified staff, something that makes utilization of existing resources important. This study uses prospectively recorded data and investigates how technological solutions for time and activity monitoring as support to management, affects the proportion of direct and indirect time in three Norwegian HHCs.

The results demonstrate that the level of technological solutions for time and activity monitoring as support to management, have a positive impact on the proportion of *direct time.* Allocation of time from indirect to direct, will provide more available hours for direct care. For a provider of HHC, this means the possibility to either increase service to existing patients or provide service to a higher number of patients within the existing financial and staffing framework.

This study showed that *Technological* management had the highest proportion of direct time and spent most of their time on direct patient care, while *Manual* and *Hybrid* management spent most of their time on indirect activities.

Technological management is based on technology for time and activity monitoring and registration and use of portable devices for EMR. Continuous monitoring and evaluation of services rendered, enables leaders to do rapid changes in allocation of time when needed, due to changes in demand or change of available resources. The registrations also provide a basis for evaluation of rendered service as it helps to detect deviations in use of time. If more, or less time, compared to planned time, is suddenly used with a patient, this is investigated. If the reason is a worsening of health conditions, or if the patient has recovered and can do with shorter or no visits, this will be a background for alteration of a care resolution. This allows planning according to actual need, and resources can be allocated within the existing financial and staffing framework. The importance of how gathered information is utilized is emphasized in literature, as measurements in themselves do not create improvement and value. The use of portable EMR saves time, time that can be allocated from indirect to direct time.

In *Manual* and *Hybrid* management, lower integration and implementation of technological solutions for time and activity measurements do not provide managers with the same level of information. Portable EMR is used in the *Hybrid* management, while in *Manual* based management this is first recorded manually whit the use of paper and paper, and later rewritten on the office computer. In both *Manual* and *Hybrid* management, the use of technological solutions could increase the proportion of direct time without additional resources.

The use of electronic solutions for systematic registrations of activities in the HHC, will provide valid information, and thus also increase knowledge about the service. The use of measurement is a support to better management in the utilization of existing resources. The results in this study may serve as a basis for further research on integration of technology in management in HHC.

6.0 Research summary

6.1 Limitation of the study

There are several limitations affecting the study. First of all, not all employees participated in the inquiry. We do not have the total input i.e., total time spent in the different HHCs. The managers confirm that the distribution of the participating employees corresponds to the actual distribution, which indicates that the findings are likely to be representative of total working hours.

Secondly, data collection was conducted through the use of two different solutions for time registrations, where *Manual* and *Hybrid* used a time registration app during the data collection period, while *Technological* use electronic time and activity measurements as part of daily operations. The possible difference in experience, and the usability of the app may have had an influence on registrations.

Thirdly, two of the HHCs registered four activities, while the third registered five. In the study, activities are aggregated into three categories: *direct activities*, *transportation*, and *administration*. This is done to visualize and make comparison easier. The combination may lead to obscuring of nuances but clarifies the relationship between the different activities in the total amount of time used.

Finally, the study investigates three HHCs located in different parts of Norway; two rural, located on the west coast, and one urban/rural, a larger municipality in a more central part of the country. Since the background for comparison is the level of integration of technological solutions for time and activity monitoring and its support to management, it is our belief that results may be generalized.

6.2 Suggestion for further research

To meet the challenges of increasing demand, rising costs and shortage of staff, more knowledge of HHC is needed. There is a need for further studies on technology in the HHC, and to investigate how implementation of technology for time and activity measurements influence the capturing, and flow of information. Measurements of input and results are important, key factors in any process of improvement. Direct time and delivered hours provide measurements that encompass both the core activities of the service and elements of value and may at the same time be used to describe worker utilization and productivity. The results in this paper may serve as a basis for further research on technology, measurements, and management.

7.0 References in chapter 1-6

Radnor, Z. J., Holweg, M., & Waring, J. (2011, March 2). Lean in healthcare: The unfilled promise? *Social Science & Medicine*, pp. 364-371. doi:10.1016/j.socscimed.2011.02.011

Abelsen, B., Gaski, M., Nødland, S., & Stephansen, A. (2014). *Sammhandlingsreformens konsekvenser for det kommunale pleie- og omsorgstilbudet.* Stavanger/Alta: International Research Institute of Stavanger.

Abrahamsen, D., Allertsen, L., & Skjøstad, O. (2016). *Hjemmetjenestens målgrupper og organisering.* Oslo-Kongsvinger: Statisitsk sentralbyrå.

Agarwal, R., Gao, G., DesRoches, C., & Jha, A. K. (2010, November 18). Research Commentary—The Digital Transformation of Healthcare: Current Status and the Road Ahead. *Information Systems Research*, pp. 796-809. doi:https://doi.org/10.1287/isre.1100.0327

Antinaho, T., Kivinen, T., Turunen, H., & Partanen, P. (2014, June 30). Nurses' working time use – how value adding it is? *Journal of Nursing Management*, pp. 1094-1105.

Bacon, C. T., & Mark, B. (2010, July 23). Organizational Effects on Patient Satisfaction in Hospital Medical-Surgical Units. *The Journal of Nurcing Administration*, pp. 220-227. doi:doi:10.1097/NNA.0b013e3181a23d3f.

BDO. (2018). *ANALYSE AFHJEMMESYGEPLEJEN.* BDO Statsautoriseret revisionsaktieselskab. Retrieved from http://docplayer.dk/105825944-Analyse-af-hjemmesygeplejen.html

Birkeland, A. (2014, Mars 10). Aktiv mestring i hjemmesykepleien. *Sykepleien*, pp. 44-47. doi:10.4220/sykepleiens.2014.0023

Black, N. (2013, January 28). Patient reported outcome measures could help transform healthcare. *British Medical Association*, pp. 1-5. doi:doi: 10.1136/bmj.f167

Bloom, N., Propper, C., Seiler, S., & Reenen, J. (2010, May). THE IMPACT OF COMPETITION ON MANAGEMENT QUALITY: EVIDENCE FROM PUBLIC HOSPITALS. *NATIONAL BUREAU OF ECONOMIC RESEARCH.* doi:10.3386/w16032

Bowles, K. H., Dykes, P., & Demiris, G. (2015, Jan-Feb). The Use of Health Information Technology to Improve Care and Outcomes for Older Adults. *Res Gerontol Nurs*, pp. 1-9. doi:10.3928/19404921-20121222-01

Brevik, I., & Schmidt, L. (2005). *Slik vil eldre bo - En undersøkelse av fremtidige eldres boligpreferanser.* Oslo: Norsk institutt for by- og regionsforskining.

Busse, R., Klazinga, N., Panteli, D., & Quentin, W. (2019). *Improving healthcare quality in Europe - Characteristics, effectiveness and implementation of different strategies.* Copenhagen: World Health Organization and OECD. Retrieved from https://www.euro.who.int/en/about-us/partners/observatory/publications/studies/improving-healthcare-quality-in-europe-characteristics,-effectiveness-and-implementation-of-different-strategies-2019

Busse, R., Panteli, D., & Quentin, W. (2019). An introduction to healthcare quality: defining and explaining its role in health systems. In R. Busse, N. Klazinga, D. Panteli, & W. Quentin, *Improving healthcare quality in Europe- Characteristics, effectiveness and implementation of different strategies* (pp. 3-17). Copenhagen: World Health Organization and OECD.

Buttigieg, S. C., Dey, P. K., & Gauci, D. (2016, January 7). Business process management in health care: current challenges and future prospects. *Innovation and Entrepreneurship in Health*, pp. 1-13. doi:https://doi.org/10.2147/IEH.S68183

Calhoun, C. (2002). *Dictionary of the Social Sciences.* New York: Oxford University Press. doi:10.1093/acref/9780195123715.001.0001

Chong, A. Y.-L., & Chan, F. T. (2012). Structural equation modeling for multi-stage analysis on Radio Frequency Identification (RFID) diffusion in the health care industry. *Expert Systems with Applications*, pp. 8645-8654. doi:10.1016/j.eswa.2012.01.201

Cooper, C., Cenko, B., Dow, B., & Rapaport, P. (2017, January 16). A systematic review evaluating the impact of paid home carer training, supervision, and other interventions on the health and well-being of older home care clients. *International Psychogeriatrics*, pp. 595-604. doi:doi:10.1017/S1041610216002386

DesRoches, C. M., Campbell, E. G., Rao, S. R., Donelan, K., Ferris, T. G., Jha, A., . . . Blumenthal, D. (2008, July 3). Electronic Health Records in Ambulatory Care — A National Survey of Physicians. *The New England Journal of Medicine*, pp. 50-60. doi:10.1056/NEJMsa0802005

Det Kongelige Helse- og omsorgsdepartementet. (2009). *Samhandlingsreformen Rett behandling – på rett sted – til rett tid.* Oslo: Helse- og omsorgsdepartementet.

Det kongelige helse- og omsorgsdepartementet. (2018, Mai 4). Meld. St. 15 Leve hele livet - En kvalitetsreform for eldre.

Donabedian, A. (1988, September 23/30). The Quality of Care How can it Be Assessed? *JAMA*, pp. 1743-1748.

Donabedian, A. (2005, November 9). Evaluating the Quality of Medical Care. *The Milbank Memorial Fund Quarterly*, pp. 691-729. doi:10.1111/j.1468-0009.2005.00397.x

Dowding, D. W., Turley, M., & Garrido, T. (2012, Jul-Aug). The impact of an electronic health record on nurse sensitive patient outcomes: an interrupted time series analysis. *J Am Med Inform Assoc*, pp. 615-20. doi:10.1136/amiajnl-2011-000504

Ellram, L. M., Tate, W. L., & Billington, C. (2004, April 5). Understanding and Managing the Services Supply Chain. *The Journal of Supply Chain Management*, pp. 17-32. doi:10.1111/j.1745-493X.2004.tb00176.x

English Oxford Living Dictionary. (2019). Oxford: Oxford University Press. Retrieved May 10, 2019, from https://en.oxforddictionaries.com/definition/quality

Eveborn, P., Rönnqvist, M., Einarsdóttir, H., Eklund, M., Lidén, K., & Almroth, M. (2009, January-February). Operations Research Improves Quality and Efficiency in Home Care. *Interfaces*, pp. 18-34. doi:doi 10.1287/inte.1080.0411

Fagerström, L. (2019). Avansert klinisk sykepleie - et begrunnet behov. In L. M. Fagerström, *Avansert klinisk sykepleie* (pp. 17-25). Oslo: Gyldendal Norsk Forlag.

Fikar, C., & Hirsch, P. (2016, July 20). Home health care routing and scheduling: A review. *Computers & Operations Research*, pp. 86-95.

Fitzgerald, L. (2007). Performance measurement. In T. Hopper, D. Northcott, & R. Scapens, *Issues in Management Accounting* (Third edition ed., pp. 223-241). Harlow: Pearson Education Limited .

Ford, G., Compton, M., Millett, G., & Tzortzis, A. (2017). The Role of Digital Disruption in Healthcare Service Innovation. In M. A. Pfannstiel, & C. Rasche, *Service Business Model Innovation in Healthcare and Hospital Management* (pp. 57-70). Switzerland: Springer International Publishing AG. doi:10.1007/978-3-319-46412-1

Genet, N., Boerma, W., Kroneman, M., Hutchinson, A., & Saltman, R. B. (2012). *Home Care Across Europe, Current structure and future challenges.* Copenhagen: World Health Organization.

Ghobadian, A., & Ashworth, J. (1994). Performance Measurement in Local Government – Concept and Practice. *International Journal of Operations & Production Management*, pp. 35-51. doi:10.1108/01443579410056786

Glenngård, A. H. (2013, April 16). Productivity and patient satisfaction in primary care- Conflicting or compatible goals? *Health Policy*, pp. 157-165. doi:http://dx.doi.org/10.1016/j.healthpol.2013.04.012

Grepperud, S. (2009, Februar 29). Kvalitet i helsetjenesten- hva menes egentlig? (Å. Helland, Ed.) *Tidskrifte Norske legeforening*(11), pp. 1112-1124.

Gundersen, D., & Halbo, L. (2018, Mai 28). Kvalitet. *I Store norske leksikon*. Retrieved August 24, 2019, from https://snl.no/kvalitet

Gupta, S., Sharma, M., & Sunder M, V. (2016, December 29). Lean services: a systematic review. *International Journal of Productivity and Performance Management*, pp. 1025-1056. doi:https://doi.org/10.1108/IJPPM-02-2015-0032

Halonen, R., Juntunen, K., Martikainen, O., & Naumov, V. (2014). Seeking efficiency and productivity in health care. *Americas Conference on Information Systems*, pp. 1-11.

Hanefeld, J., Powell-Jackson, T., & Balabanova, D. (2017, March 20). Understanding and measuring quality of care: dealing with compøexity. *Bull World Health Organ*, pp. 368-374. doi:http://dx.doi.org/10.2471/BLT.16.179309

Hans, E. W., Van Houdenhoven, M., & Hulshof, P. J. (2012). A Frame work for Health Care Planning and Control. In R. Hall, *Handbook of Healthcare System Scheduling. International Series in Operations Research & Management Science* (pp. 303-320). Boston, MA: Springer. doi:https://doi.org/10.1007/978-1-4614-1734-7_12

Heinrich, C. J. (2002). Outcomes–Based Performance Management in the Public Sector: Implications for Government Accountability and Effectiveness. *Public Administration Review*, pp. 712-25. doi: https://doi.org/10.1111/1540-6210.00253

Helgheim, B. I., Sandbaek, B. E., & Slyngstad, L. (2018). A prospective investigation of direct and indirect home care activeties in three rural Norwegian municipalities. *BMC Health Service Research*. Retrieved from http://doi.org/10.1186/s12913-018-3794-2

Helgheim, B. I., Sandbaek, B. E., & Slyngstad, L. (2018). A prospective investigation of direct and indirect home care activeties in three rural Norwegian municipalities.

BMC Health Service Research. Retrieved from http://doi.org/10.1186/s12913-018-3794-2

Helsedirektoratet. (2012). *Behov for spesialisert kompetanse i helsetjenesten.* Oslo: Helsedirektoratet.

Helsedirektoratet. (2016). *Samhandlingsstatestikk 2014-15.* Helsedirektoratet.

Helsedirektoratet. (2016). *Samhandlingsstatistikk 2014-15.* Helsedirektoratet.

Hjemås, G., Holmøy , E., & Haugstveit, F. (2019). *Fremskrivninger av etterspørselen etter arbeidskraft i helse- og omsorg mot 2060.* Oslo: Statistisk sentralbyrå.

Hjemås, G., Holmøy, E., & Haugstveit, F. (2019). *Fremskrivninger av etterspørselen etter arbeidskraft i helse- og omsorg mot 2060.* Oslo: Statistisk sentralbyrå.

Hjemås, G., Zhiyang, J., Kornstad, T., & Stølen, N. M. (2019). *Arbeidsmarkedet for helsepersonell fram mot 2035.* Oslo: Statistisk sentralbyrå.

Holm, S. G., & Angelsen, R. O. (2014). A descriptive retrospectiv study of time consumption in home care services: how do employees use their working time? *BMC Health Services Research*. doi:10.1186/1472-6963-14-439

Holweg, M. (2006, May 8). The genealogy of lean production. *Journal of Operations Management*, pp. 420–437. doi:10.1016/j.jom.2006.04.001

Holzer, M., & Lee, S.-H. (2004). *Public Productivity handbook - Second Edition, revised and Expanded.* New York: Marcel Dekker, Inc.

Howie, J. G., Heaney, ,. D., Maxwell, M., Walker, J. J., Freeman, G. K., & Rai, H. (1999, September 18). Quality at general practice consultations: cross sectional survey. *British Medical Journal, 319*, pp. 738-743.

Howie,, J. G., Heaney,, D. J., Maxwell, M., Walker, J. J., Freeman, G. K., & Rai, H. (1999, September 18). Quality at general practice consultations: cross sectional survey. *British Medical Journal, 319*, pp. 738-743.

Ittner, C. D., & Larcker, D. F. (2001, December). Assessing empirical research in managerial accounting: a value-based management perspective. *Journal of Accounting and Economics*, pp. 349-410. doi:https://doi.org/10.1016/S0165-4101(01)00026-X.

Iversen, A. (1986). *Hva gjør vi i hjemmesykepleien?* (1:2 ed.). Oslo: Tano A/S. Retrieved from https://urn.nb.no/URN:NBN:no-nb_digibok_2007080601073

Jordahl, H., & Persson, L. (2018, August 31). Exploring Digital Time Measurement in the Public Sector: Labor Productivity and Service Quality in Home Care. *Research Institute of Industrial Economics*. doi:http://dx.doi.org/10.2139/ssrn.324

Kaplan, R. S., & Norton, D. P. (1992). The Balanced Scorecard - Measures That Drive. *Harvard Business Review*, pp. 71-79.

Kim, R. H., Gaukler, G. M., & Lee, C. W. (2016, Desember). Improving healthcare quality: A technological and managerial innovation perspective. *Technological Forecasting and Social Change*, pp. 373-378. doi:https://doi.org/10.1016/j.techfore.2016.09.012

Langeland, E., Førland, O., Aas, E., Birkeland, A., Folkestad, B., Kjeken, I., . . . Tuntland, H. (2016). *Modeller for hverdagsrehabilitering - en følgeevaluering i norske kommuner*. Bergen: Senter for omsorgsforskning.

Laurenza, E., Quintano, M., Schiavone, F., & Vrontis, D. (2018, sEPTEMBER 3). The effect of digital technologies adoption in healthcare industry: a case based analysis. *Business Process Management Journal*, pp. 1124-1144. doi:10.1108/BPMJ-04-2017-0084

Lawal, A. K., Rotter, T., Kinsman, L., Sari, N., Harrison, L., Jeffery, C., . . . Flynn, R. (2014, September 19). Lean management in health care: definition, concepts, methodology and effects reported (systematic review protocol). *Systematic Reviews, 113*, pp. 1-6. doi:10.1186/2046-4053-3-103

Lee, C.-P., & Shim, J. P. (2007, September 27). An exploratory study of radio frequency identification (RFID) adoption in the healthcare industry. *European Journal of Information Systems*, pp. 712-724. doi:10.1057/palgrave.ejis.3000716

Lee, H., Vlaev, I., King, D., Erik, M., Darzi, A., & Dolan, P. (2013, October 8). Subjectiv well-being and the measurment of quality in healthcare. *Sosial Science & Medicine*(99), pp. 27-34.

Lenz, R., Peleg, M., & Reichert, M. (2012, January 1). Healthcare Process Support: Achievements, Challenges, Current Research. *International Journal of Knowledge-Based Organizations*. Retrieved from https://www.researchgate.net/publication/236610494

Lingle, J. H., & Schiemann, W. A. (1996, March). From balanced scorecard to strategic gauges: Is measurement worth it? *Management Review*, pp. 56-62.

Linna, P., Pekkola, S., Ukko, J., & Melkas, H. (2010, September 10). Defining and measuring productivity in the public sector: managerial perceptions. *International Journal of Public Sector Management*, pp. 479-499. doi:10.1108/09513551011058493

Liu, T. C., Bozic, K. J., & Teisberg, E. O. (2016, December 19). Value-based Healthcare: Person-centered Measurment: Focusing on the Three C's. *Clinical Orthopaedic and Related Research*, pp. 315-317. doi:10.1007/11999-016-5205-5

Lov 2. juli 1999 nr. 63 om pasient- og brukerrettigheter (pasient- og brukerrettighetsloven). (1999, Juli 2). Retrieved from https://lovdata.no/dokument/NL/lov/1999-07-02-63

Lov 24. juni 2011 nr. 30 om kommunale helse- og omsorgstjenester m.m. (helse- og omsorgstjenesteloven). (2011, Juni 24). Retrieved from https://lovdata.no/dokument/NL/lov/2011-06-24-30

Løvås, G. G. (1999). *Statestikk- for universiteter og høgskoler.* Oslo: Universitetsforlaget.

Mainz, J. (2003, December 15). Defining and classifying clinical indicators for quality improvement. *International Journal for Quality in Health Care*, pp. 523-530. doi:doi:10.1093/intqhc/mzg081

Malhotra, S., Jordan, D., Shortliffe, E., & Patel, V. L. (2007, April). Workflow modeling in critical care: Piecing together your own puzzle. *Journal of Biomedical Informatics*, pp. 81-92. doi:10.1016/j.jbi.2006.06.002

Mamlin, B. W., & Tierney, W. M. (2016, January). The Promise of Information and Communication Technology in Healthcare: Extracting Value From the Chaos. *THE AMERICAN JOURNAL OFTHE MEDICAL SCIENCES*, pp. 59-68. doi:10.1016/j.amjms.2015.10.015

Mangan, J., Lalwani, C., Butcher, T., & Javadpour, R. (2012). *Global Logistics & Supply Chain Management* (Second Edition ed.). Chichester: John Wiley & Sons.

Mazzocato, P., Savage, C., Brommels, M., & Aronsson, H. (2010, August 19). Lean thinking in healthcare: a realist review of the literature. *Quality and Safety in Health Care*, pp. 376-382. doi: 10.1136/qshc.2009.037986

Melkers, J., & Willoughby, K. (2005, March/April). Models of Performance-Measurement Use in Local Governments: Understanding Budgeting, Communication, and Lasting Effects. *Public Administration Review*, pp. 180-190. doi:10.1111/j.1540-6210.2005.00443.x

Nielsen, K. (2010). *Slutrapport ABT Fondsprojekt ”Online Hjemmesygepleje –netbooks til Hjemmesygeplejen”.* København: Københavns Kommune Sundheds- og Omsorgsforvaltningen.

Oliva, R., & Sterman, J. D. (2001, Jul). Cutting Corners and Working Overtime: Quality Erosion in the Service Industry. *Management Science*, pp. 894-914.

Otley, D. (1999, December). Performance management: a framework for management control systems research. *Management Accounting Research*, pp. 363-382. doi:https://doi.org/10.1006/mare.1999.0115

Otley, D. (2007). Accounting performance measurement: a review of its purposes. In A. Neely, *Business Performance Measurement: Unifying theories and integrating practice* (Second edition ed., pp. 11-35). Cambridge: Cambridge University Press.

Panteli, D., Quentin, W., & Busse, R. (2019). Chapter 2: Understanding healthcare quality strategies: a five-lens framework. In R. Busse, N. Klazinga, D. Panteli, & W. Quentin, *Improving healthcare quality in Europe - Characteristics, effectiveness and implementation of different strategies* (pp. 19-29). Copenhagen: World Health Organization and OECD.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1985, January). A Conceptual Model of Service Quality and its Implication for Future Research (SERVQUAL). *Journal of Marketing*, pp. 41-50. doi:10.2307/1251430

Pike, S., & Roos, G. (2007). The validity of measurement frameworks: measurement theory. In A. Neely, *Business Performance Measurement - Unifying theories and integrating practice* (Second Edition ed., pp. 218-235). Cambridge: Cambridge University Press.

Plsek, P. E. (1997 , March). Systematic design of healthcare processes. *Quality in Health Care*, pp. 40–48. doi:10.1136/qshc.6.1.40

Poissant, L., Pereira, J., Tamblyn, R., & Kawasumi, Y. (2005, Sep-Oct). The Impact of Electronic Health Records on Time Efficiency of Physicians and Nurses: A Systematic Review. *Journal of the American Medical Informatics Association : JAMIA*, pp. 505-16. doi:10.1197/jamia.M1700

Pollanen, R. (2005, January). Performance measurement in municipalities: Empirical evidence in Canadian context. *The International Journal of Public Sector Management*, pp. 4-24. doi:10.1108/09513550510576125

Porter, M. E. (1985). *Competative Advantage.* The Free Press.

Porter, M. E. (2010, December 23). Measuring Health Outcomes: The Outcome Hirarchy - Supplementary Appendix 2 to What is value in health care? *New England Journal of Medicin*, pp. 1-19. doi:10.1056/NEJMp1011024

Porter, M. E. (2010, December 23). Value in Health Care - Supplementary Appendix 1 to What is Value in Health Care ? *The New England Journal of Medicine*, pp. 1-15. doi:10.1056/NEJMp1011024

Porter, M. E. (2010, Desember 23). What Is Value in Health Care? *The New England Journal of Medicine*, pp. 2477-2481. doi:10.1056/NEJMp1011024

Porter, M. E., & Lee, T. H. (2013, October). The Strategy That Will Fix Health Care. *Harvard Business Review*. Retrieved from https://hbr.org/2013/10/the-strategy-that-will-fix-health-care

Porter, M. E., & Teisberg, E. O. (2006). *Redefining Health Care - Creating Value-Based Competition on Results.* Boston, United States of America: Harvard Business School Publishing.

Porter, M. E., & Teisberg, E. O. (2007, Marche 14). How Physicians Can Change the Future of Health Care. *Jama*(10), pp. 1103-1111. doi:10.1001/jama.297.10.1103

Putera, I. (2017, March 3). Redefining Health: Implication for Value-Based Healthcare Reform. *Cureus*, pp. 1-11. doi:10.7759/cureus.1067

Putnam, R. D. (1994). *Making Democracy Work - Civic traditions in modern italy.* NJ: Princeton University Press.

Quentin, W., Partanen, V.-M., Brownwood, I., & Klazinga, N. (2019). Chapter 3: Measuring healthcare quality. In R. Busse, N. Klazinga, D. Panteli, & W. Quentin, *Improving healthcare quality in Europe- Characteristics, effectiveness and implementation of different strategies* (pp. 21-62). Copenhagen: World Health Organization and OECD.

Radnor, Z., & McGuire, M. (2003, December). Performance management in the public sector: fact or fiction? *International Journal of Productivity and Performance Management*, pp. 245-260. doi:10.1108/17410400410523783

Rafter, N., Hickey, A., Condell, S., Conroy, R., O’connor, P., Vaughan, D., & Williams, D. (2015, April). Adverse events in healthcare: learning from mistakes. *QJM: An International Journal of Medicine*, pp. 273–277. doi:10.1093/qjmed/hcu145

Rambøll. (2009). *Projekt kortlægning og måling - hjemmeplejeområdet.* København: Rambøll Management Consulting AS.

Riksrevisjonen. (2018). *Riksrevisjonens undersøkelse av tilgjengelighet og kvalitet i eldreomsorgen.* Oslo: Riksrevisjonen.

Ringdal, K. (2001). *Enhet og Mangfold Samfunnsvitenskaplig forskning og kvantitativ metode* (3. utgave 2013 ed.). Fagbokforlaget Vigmostad & Bjørke AS.

Rogan, L., & Boaden, R. (2016, October 30). Understanding performance management in primary care. *International Journal of Health Care Quality Assurance*, pp. 4-15. doi:10.1108/IJHCQA-10-2015-0128

Røhne, M., Grut, L., Ausen, D., Thaqi, E., Andersen, G., & Sandåker, T. (2018). *Planlegging av arbeidslister i hjemmetjenesten.* Oslo: SINTEF.

Rouleau, G., Gagnon, M.-P., & Côté, J. (2015, May 23). Impacts of information and communication technologies on nursing care: an overview of systematic reviews (protocol). *Systematic Reviews*, pp. 1-8. doi:https://doi.org/10.1186/s13643-015-0062-y

Sagdahl, M. (2014, april 30). *I Store Norske Leksikon*. Retrieved from snl.no: https://snl.no/verditeori

Sagdahl, M. (2019, juni 20.). *I Store norske leksikon*. Retrieved august 23, 2019, from snl.no: https://snl.no/verdi

Schroeder, M. (2016, Jul 28.). Value Theory. In Z. N. Edward (Ed.), *The Standford Encyclopedia of Philosophy.* Metaphysics Research Lab, Stanford University. Retrieved from https://plato.stanford.edu/cgi-bin/encyclopedia/archinfo.cgi?entry=value-theory

Shahzadi, S., & Narbuvold, H. (2018). *Rammeverk for nasjonalt kvalitetsindikatorsystem for helse- og omsorgstjenesten.* Helsedirektoratet.

Simpson, H. (2009, March 5). PRODUCTIVITY IN PUBLIC SERVICES. *Journal of Economic Surveys*, pp. 250-276. doi:10.1111/j.1467-6419.2008.00562.x

Smith, G., Poteat-Godwin, A., Harrison, L., & Randolph, G. (2012, January/February). Applying Lean Principles and Kaizen Rapid Improvement Events in Public Health Practice. *Journal of Public Health Management and Practice*(18), pp. 52-54. doi:10.1097/PHH.0b013e31823f57c0

Smith, M. J., & Standaert, C. J. (2013, March 7). Towards an expanded definition of value. *The Spine Journal*, pp. 1690-1697. doi:http://dx.doi.org/10.1016/j.spinee.2013.03.006

Sosial og Helsedirektoratet. (2005). *Nasjonal strategi for kvalitetsforbedring i Sosial- og helsetjenesten.* Oslo: Sosial og Helsedirektoratet.

Statistics Norway. (2018, Mars 14). *ssb.no*. Retrieved September 21, 2019, from Statistics Norway: https://www.ssb.no/nasjonalregnskap-og-konjunkturer/artikler-og-publikasjoner/65-000-per-innbygger-til-helse

Statistics Norway. (2019, Oktober 3). *SSB.no*. Retrieved from SSB: https://www.ssb.no/statbank/table/11845/tableViewLayout1/

Statistics Norway. (2020). *07459: Befolkning, etter alder, statistikkvariabel og år.* Oslo: Statistics Norway.

Statistics Norway. (2020). *Nasjonale befolkningsfremskrivninger.* Oslo: Statistics Norway. Retrieved from https://www.ssb.no/folkfram

Statistics Norway. (2020, May 12). *Statistisk sentralbyrå.* Retrieved from SSB.no: https://www.ssb.no/helse/statistikker/helsetjko

Stokkan, J., & Thorsnæs, G. (2017, November 2). Fræna. *I Store norske leksikon*. Retrieved April 23, 2019, from https://snl.no/Fr%C3%A6na

Taylor, R., & Thomas-Gregory, A. (2015, June 10). Case study research. *Nursing Standard*(29), pp. 36-40. doi:10.7748/ns.29.41.36.e8856

Teperi, J., Porter, M. E., Vuorenkoski, L., & Baron, J. F. (2009). *The Finnish health Care System: A Value-Based Perspective.* Helsinki: SITRA.

Thompson, D., Osheroff, J., Classen, D., & Sittig, D. (2007, February 1). A review of methods to estimate the benefits of electronic medical records in hospitals and the need for a national benefits database. *Journal of healthcare information management*, pp. 62-68.

Thorsnæs, G. (2017, Juni 17). Nedre Eiker. *I Store norske leksikon*. Retrieved April 23, 201, from https://snl.no/Nedre_Eiker

Thorsnæs, G. (2017, Mai 7). Vestnes. *I Store norske leksikon*. Retrieved April 23, 2019, from https://snl.no/Vestnes

Tønnessen, M., Løkken, S., Leknes, S., & Syse, A. (2018, Juni 26). *Statistisk sentralbyrå.* Retrieved from ssb.no: https://www.ssb.no/statbank/table/11668/tableViewLayout1/

Toussaint, J. S., & Berry, L. L. (2013, January 1). The Promise of Lean in Health Care. *Mayo Foundation for Medical Education and Research*, pp. 74-82. doi:https://doi.org/10.1016/j.mayocp.2012.07.025

Trautsamwieser, A., & Hirsch, P. (2011, January). Optimization of daily scheduling for home. *Journal of Applied Operational Research*, pp. 124-136.

Upenieks, V. V., Akhavan, J., & Kotlerman, J. (2008, September-October). Value-Added Care: A Paradigm Shift in Patient Care Delivery. *Nursing economic$,* pp. 294-300.

Verbeeten, F. H. (2007, April 17). Performance Management Practices in Public Sector Organizations: Impact on Performance. *Accounting Auditing & Accountability Journal*, pp. 427-454. doi:10.1108/09513570810863996

While, A., & Dewsbury, G. (2011, October). Nursing and information and communication technology (ICT): A discussion of trends and future directions. *International Journal of Nursing Studies*, pp. 1302-1310. doi:https://doi.org/10.1016/j.ijnurstu.2011.02.020

Womack, J. P., & Jones, D. T. (1996, September-October). Beyond Toyota: How to Root Out Waste and Pursue Perfection. *HARVARD BUSINESS REVIEW, 74*(5), pp. 140-158.

Yin, R. (2012). *Case Study Research: Design and Methods* (Fifth edition ed.). SAGE Publications, Inc.

Yoon, S., Lee, D., & Schniederjans, M. (2016, July 18). Effects of innovation leadership and supply chain innovation on supply chain efficiency: Focusing on hospital size. *Technological Forecasting & Social Change*, pp. 412–421. doi:http://dx.doi.org/10.1016/j.techfore.2016.07.015

8.0 Research paper

Technological solutions for time and activity measurements as support to management in three Norwegian home health care organisations.

By Magnus Strømme

Abstract

Norwegian HHC services have experienced rapid changes in demand in the last decade. Demographic changes, longevity, the desire to live longer in one's own home and structural and organizational changes through the *Coordination Reform,* are contributing factors to increased demand and complexity of services rendered. Higher costs and an undercoverage of staff makes efficient and effective utilization of resources in the HHC essential, and more knowledge of this is needed. This paper investigates how technological solutions for time and activity monitoring as a support to management, affects the proportion of *direct* and *indirect* time utilized in three Norwegian HHCs. According to the level of integration of technology, management in the HHCs will be described as *Manual*, *Hybrid* and *Technological* based. Data was collected by home health care staff in a period of four weeks in 2018, during day and evening shifts in a normal activity periode. Registrations were conducted using two different smartphone applications, where one was based on RFID technology. The highest proportion of *direct time,* 58 % was found in the HHC with *Technology* based management, while the proportion in *Hybri*d and *Manual* was 45% and 40% respectively. Our finding indicates that the level of technological integration affects the proportion of direct time. The implementation and utilization of technological solutions for time and activity measurements and portable electronic medical records (EMR) provide information to support management, which enables the HHC to allocate more time for direct patient care without additional resources.

8.1 Background

Home health care (HHC) forms part of the Norwegian public health care system funded by the government and provided by the municipalities. There has been an increased request for HHC services in recent years, in Norway as well as in most European countries (Genet, Boerma, Kroneman, Hutchinson, & Saltman, 2012). Reasons for this can be divided into two categories: (1) demographic changes with an ageing population, development of new medical treatments and a higher rate of survival of serious medical conditions, patients living longer with their illness (Helsedirektoratet, 2016) combined with persons wish to live longer in their own homes (Brevik & Schmidt, 2005), and (*2)* structural and organizational changes in health care. Population projection indicates a growth in the population of the elderly in Norway, from 15 % in 2020 to 21% population in 2040 (Tønnessen, Løkken, Leknes, & Syse, 2018), something that will have implications for healthcare services and expenditure. A falling rate in the number of persons who work, and pay taxes, i.e., the population cohort 18 - 66 yrs., will have an impact on governmental tax revenue. The results of the predicted demographic changes will be an increase in the number of people that need healthcare services and, at the same time, lower governmental income.

Structural and organizational changes were introduced by the Health Care Reform of 2012, with the aim of strengthening cooperation between hospitals and municipality health care services, reducing costs, and giving patients health care closer to their home (Helsedirektoratet, 2016). The number of hospital beds in somatic and psychiatric hospitals was reduced by discharging patients earlier through a transferral to further care within the patient’s municipality, either through HHC services or institutions. The reform has led to an increase in the number of patients receiving care in their own home (Abelsen, Gaski, Nødland, & Stephansen, 2014) or in the municipal healthcare services, and as a consequence of this, municipal expenditure has increased (Helsedirektoratet, 2016). The added complexity of services rendered by the HHC have led to requirements for higher clinical expertise in the organisation (Fagerström, 2019). Between 2014 and 2018, there was a growth in expenditure in the HHC of 25.4% (Statistics Norway, 2020). Projections of future need for nurses in the Norwegian health care system estimates an under coverage of 28 000 Full-time equivalent (FTE) in 2035, (Hjemås, Zhiyang, Kornstad, & Stølen,

2019) and an under coverage of health care personnel of 17 000 FTEs in the HHC (Hjemås, Holmøy , & Haugstveit, 2019).

Information technology (IT) is an increasing part of healthcare and is often mentioned as an important contributor in the discussion of how to meet the challenges healthcare is facing (Ford, Compton, Millett, & Tzortzis, 2017). Porter and Teisberg (2006) describes IT as fundamental in the process of capturing, utilization, and distribution of information, and therefor essential in the work of creating a sustainable healthcare. The objective of this paper is to investigate how technological solutions for time and activity monitoring, as support to management, affects the proportion of *direct* and *indirect* time in three Norwegian HHCs. The level of integration and utilization of technology differs in the municipalities studied, and management will therefore be described as *Manual*, *Hybrid* and *Technological* based.

8.1.1 Introduction

Production in health care differs from production in the manufacturing industry. The nature of the products of the HHC can both be described as intangible, simultaneous, heterogeneous, perishable, and involving patient participation. Service is created and consumed at the same time and variations in the needs of the recipients calls for differences in care given, (Parasuraman, Zeithaml, & Berry, 1985), while the services involve both patients and a number of actors, all of which makes management of the healthcare industry complex (Laurenza, Quintano, Schiavone, & Vrontis, 2018). In manufacturing as well as healthcare industries, planning and control involves decisions of utilization, allocation, and coordination of production resources to meet customer needs efficiently and effectively (Hans, Van Houdenhoven, & Hulshof, 2012). Hans et. al (2012) and Buttigieg et. al (2016) argue that healthcare management appears to lag behind when it comes to planning and control. Lack of cooperation between involved parties and lack of information, due to the state of information systems in healthcare, are mentioned as possible reasons for this (Hans, Van Houdenhoven, & Hulshof, 2012). Information, knowledge, and the sharing of information is essential in healthcare systems (Lenz, Peleg, & Reichert, 2012), and according to Mamlin and Tierney (2016) this means that healthcare can be described as an information business.

8.1.2 HHC

Production in HHC is the delivery of care, allocated to the patient through a care resolution, issued by the municipality, who defines the type of care needed and time duration of the activity. Production in HHCs can be described as a pull system (Mangan, Lalwani, Butcher, & Javadpour, 2012), where production is triggered by the recipients' needs and the care resolution from the municipality. Information is an essential part in the process of allocation and delivery of care, and must be *collected*, *integrated*, and *utilized*, to provide a basis for management (Porter & Teisberg, 2006). Glenngård (2013) discusses productivity in primary care and points out how the lack of information about the length and content of services rendered, constitutes a problem for policymakers as distribution and effects of the services are unclear. It may seem as if the discussion of measurement of production may be blurred through different definitions and use of terms related to production in service. Partial measurements, such as numbers of patients treated, changes in health (Putnam, 1994), and performance (Holzer & Lee, 2004) are examples of measurements used. The first, *number of patients treated*, is an example of an output measure, while *changes in health* and *performance* describes outcome. There is a consensus on the importance of measuring outcomes, and ongoing discussion about *what* to, and *how* to measure (Porter M. E., 2010). Output measurements in healthcare and service industries have been described as difficult, due to the nature of the industry (Ghobadian & Ashworth, 1994), as it encompasses many dimensions, which makes the construction of aggregate measures complicated (Simpson, 2009), and Ellram et. al (2004) points to the difficulties of measuring the contribution to the total value delivered that human labour constitutes.

In the measurement of output, productivity i.e., output generated per unit of input, is central. The economical viewpoint has traditionally been the main focus of measurements, but lately there has been a change in the recognition that this alone is not sufficient (Otley, Accounting performance measurement: a review of its purposes, 2007). Ghobadian and Ashworth (1994) points to the importance of including both qualitative and quantitative aspects in an effective performance measurement. According to Rogan and Boaden (2016), the understanding of performance measurement and performance management are often confused where focus is on easily captured measurements while other aspects of care are omitted. Melkers and Willoughby (2005) and Pollanen (2005) argue that what is most interesting in the discussion is the change of focus to *use* and *apply* information gathered in a meaningful way. Pike and Roos (2007) emphasise that measurement is an input not a goal. Measurements in themselves do not improve the services or the management, but the *use* of results can, as results must be used for evaluations and possible corrections of practice (Porter & Teisberg, 2006) (Fitzgerald, 2007). Findings indicate that organisations that use performance measurement systems as a support for management have a higher performance, than organisations that have not applied this (Lingle & Schiemann, 1996) (Rogan & Boaden, 2016). Kaplan and Norton (1992) argue that the choice of measurements is important, as this affects decision making, and that measurements should reflect the core activities, competencies, and goals of the organisation. The use of direct time as a measurement of delivered hours, i.e., patient related care, encompasses the core activity of the HHC, and can thereby also increase attention toward the value perspective.

8.1.3 Utilization of resources

With increasing demand for HHC services and rising costs, there is an increased focus on improvement of productivity, (Linna, Pekkola, Ukko, & Melkas, 2010), as well as quality (Kim, Gaukler, & Lee, 2016). To reach this, reliable performance measurements, and improvement of care processes are necessary (Plsek, 1997) (Malhotra, Jordan, Shortliffe, & Patel, 2007) (Halonen, Juntunen, Martikainen, & Naumov, 2014). Ellram et. al (2004) emphasize the importance of understanding, monitoring, and controlling the service supply chain as means to improving outcomes. Teperi et.al (2009) points to the challenges for society to create solutions that provide the best health outcome achieved per unit of cost incurred (Porter & Teisberg, 2007), and that this can be achieved through a change of focus with the objective of adding value to every step of the services. According to Porter (2010) a unilateral focus on cost reductions without regards to outcomes, leads to false savings and potentially, to healthcare of a lower quality, while a value-based system with a systematic approach of measurement, evaluation and management, all with the goal of adding value at every level, will improve quality and thereby reduce costs in health care delivery (Porter & Teisberg, 2007) (Porter & Lee, 2013). Low quality, errors, and re-treatment due to poor achievements are all factors that will influence outcomes, increase costs, and lower the patient's perception of value and quality of life (Donabedian, 1988) (Porter & Teisberg, 2007) (Liu, Bozic, & Teisberg, 2016). Lower costs are favourable, but must be as a result of better efficiency, higher quality, and less waste (Porter & Teisberg, 2007). These are ideas that to some extent, correspond with Lean philosophies, which seek to address the issues of quality and cost, through reduction of waste and waits. Central aspects here are the needs of the customer, involvement of employees and continuous improvement (Lawal, et al., 2014). Examples of waste in healthcare can be *unnecessary movements*; either in transportation, or staff looking for equipment, *waits or delays, overtreatment*, and *defects*, such as wrongful discharging, or treatment, due to lack of information (Radnor, Holweg, & Waring, 2011). Knowledge about services, activities, and costs in the HHC is of utter importance in distribution and management. Even though the service plays an important role in the healthcare system, several articles and reports indicate that, despite growing interest, there is still a lack of thorough knowledge about it and more information is needed (Genet, Boerma, Kroneman, Hutchinson, & Saltman, 2012) (Holm & Angelsen, 2014) (Abrahamsen, Allertsen, & Skjøstad, 2016) (Fikar & Hirsch, 2016) (Riksrevisjonen, 2018) (Helgheim, Sandbaek, & Slyngstad, 2018). Without knowledge of *how* resources are utilized today, changes and improvements will be difficult (Porter & Teisberg, 2006) (Helgheim, Sandbaek, & Slyngstad, 2018). A systematic approach to mapping, measuring, recording, and evaluating is the basis for gaining knowledge, and implementing changes (Porter & Teisberg, 2006).

8.1.4 Direct and indirect activities

Studies on time allocation of HHC in Norway and Denmark investigated time use in HHC, using *direc*t and *indirect* care/activities as a category to describe types of work. Findings were that more time was spent on indirect, rather than direct care (Rambøll, 2009) (Holm & Angelsen, 2014) (Helgheim, Sandbaek, & Slyngstad, 2018). Measurement of direct and indirect time gives a picture of how much time is actually spe\nt with the patient (Iversen, 1986). *Direct* and *indirect* care were also used by Antinaho, et. al. (2014) when investigating nurses working time in Finnish hospitals. Jordahl and Persson (2018) used the categories to describe delivered hours in a study of productivity and quality in Swedish HHCs, where labour productivity was measured through analysis of delivered hours (output) to patients in relation to the total amount of worked hours (input) and described as *worker utilization*.

The assumption that more time spent on direct care, i.e., time spent with the patient, will influence the quality of care and patient satisfaction is supported by a British study of General Practitioners, (Howie, et al., 1999), and a study of nursing in Magnet hospitals

(Bacon & Mark, 2010), where results showed that longer consultations improved care quality and patient satisfaction. Bacon and Mark (2010) also reported higher satisfaction and lower turnover among staff. Longer visits with the patient will also give opportunities for activities where rehabilitation is central. Experiences from the Nordic countries show that rehabilitation measures, in addition to ordinary care activities, provided by the staff of HHC, improved patients' function in daily activities. This may postpone the need of increased help among the recipients, which in addition to a higher patient satisfaction, may also lead to lower costs in the long run (Birkeland, 2014) (Langeland, et al., 2016). The necessity of measurements is also emphasized in performance management where this, together with evaluation of performance combined with clear goals are the basis for management (Verbeeten, 2007) (Heinrich, 2002) (Ittner & Larcker, 2001) (Otley, 2007). Verbeeten (2007) argues that a quantification of goals and achievements will enable organizations to reduce uncertainty and focus on core activities.

8.1.5 Technology and healthcare

Information and communication technology (ICT) is a rapidly growing area, and Ford et. al (2017) describes it as a digital disruption that has the potential to transform the healthcare industry, where the technology is supporting efficient administration and better delivery of care. Several articles refer to health information technology (HIT) as a contributor to solving the challenges associated with increased costs in the healthcare system (While & Dewsbury, 2011) (Agarwal, Gao, DesRoches, & Jha, 2010), increased quality through a more patient-centred healthcare, and higher efficiency through reduced travel time (Rouleau, Gagnon, & Côté, 2015). Laurenza et. al (2018) points to the importance of technology and digital solutions in information management. Porter and Teisberg (2006) even argue that IT has the potential of improving all activities, and promote efficiency, in the delivery of care, where IT is the basis for capture and utilization of information, and EMR is the backbone. Yoon et. al (2016) reported a positive relationship between IT applications, as RFID technology, and process management in a study of SCM in hospitals. Jordahl and Persson (2018) used digital time measurements in Swedish HHCs in a study of productivity in the public sector and argued that measurements based on digital logs give valid and reliable measurements that enhance transparency and clarity.

A review of HHCs studies, showed that most articles had routing and resource scheduling as their main focus to gain quality improvements and cost reductions (Fikar & Hirsch, 2016). Cooper et. al (2017) advocate further studies addressing different research questions such as workload, and Fikar and Hirsch (2016) call for studies on robust settings, continual measurements of care and HHC optimization methods. Research on optimization technology found that this reduced time spent on daily planning, improved staff continuity for the patient and increased direct patient care (Røhne, et al., 2018). Applying operations research modelling in HHC has shown that this could improve operational efficiency by 10-15 % (Eveborn, et al., 2009). Nielsen (2010) found, in a study of HHCs in Copenhagen, that the use of smartphones or tablets for electronic medical recording (EMR) instead of doing this on paper, reduced time by 15 minutes a day, per employee. Similar findings were reported in a study on the use of technology for *bedside medical record keeping* in hospitals, where the use of portable terminals reduced time spent on documenting by approximately 24 %, time that were allocated to direct patient care (Poissant, Pereira, Tamblyn, & Kawasumi, 2005) (Thompson, Osheroff, Classen, & Sittig, 2007). In a research of electronic health records (EHR), Dowding et. al (2012) found that this improved documentation, which led to a 13 % reduction in adverse events in a Gerontological unit.

In a study of implementation of EMR solutions in ambulatory care, DesRoches et. al (2008) distinguish, depending on the degree of implementation and utilization, between *Basic* and *Fully* integrated systems. The study reported positive effects on decision-making, access to information, lower degree of adverse events and a higher patient satisfaction in both categories, but where *Fully integrated* systems gave the best results. In the care delivery value chain model, Porter and Teisberg (2006) classify IT as a support activity. The level of integration of IT in the HHC organisation will thus affect both gathering, validity and availability of information. In organisations with a low degree of integration, some of the gathering of information will be through the use of pen and paper, which will influence both the level of information and its validity (Jordahl & Persson, 2018). A higher degree of technological integration will provide the organisation with more information and of higher validity and thereby also form a better basis for management. According to the level of technological integration, management can therefore be described as either *Manual*, *Hybrid*, and where technological systems are fully integrated, management may be described as *Technological*. To our knowledge, this is not described in literature earlier.

8.2 Case description

The research for this project was conducted in three municipalities: M1 and M2 in the western part of Norway, and M3 in the south east. HHC activity data were collected and analysed. M1 and M2 are both rural, coastal, located in the same region, and share much of the same geographical topographical features. M3 is a more densely populated, inland municipality in the southern part of Norway, with quite a different geography and topography. M2 covers the largest geographical area of the three and has a population of 9 800. M1 is slightly smaller and has a population of 6 536. M3 has the largest population, 25 000, but the smallest geographic area. The area size of M1 and M2 is almost the same, but if we look at the number of roads and their density, M2 has more kilometres of road. In M1 the total length is 333 km, and in M2 it is 513 km. The numbers for M3, which has the smallest area of the three municipalities, are 319 km (Statistics Norway, 2019).

Table 8-1 Facts of the municipalities

Municipality	M1	M2	M3
Population (n)	6559	9775	24917
Area (km^2)	352	370	122
Population density (km^2)	19	26	204
Road kilometres (km)	333	513	219
Inhabitants live in comunity (%)	60	54	98

The degree of technological solutions for worklists, medical record keeping, and measurements varies between the municipalities. In M1, much of this is done manually, whereas M2 has a hybrid solution, where worklists and medical record keeping are done electronically, but where the system is not used for measurements and statistics. In M3, medical record keeping, worklists and activity monitoring are done electronically. Management can therefore be described as *Manual* in M1, *Hybrid* in M2 and *Technological* in M3. In the further discussion, these are also the terms that will be used when referring to the different HHCs. Facts such as geography, population, road kilometres and population density will be presented referring to M1, M2 and M3.

The three HHCs use two different EMR systems, where *Manual* and *Technological* use the same, but utilization differs. Both systems have applications for portable medical record keeping and worklists available on both smartphones and/or tablets. This is fully integrated in *Hybrid* and *Technological*, but tablets and smartphones for EMR are not used on a daily basis in *Manual*. Here, worklists are printed and handed out during the morning and evening reports. Staff use pen and paper to make notes after each visit, and the medical record keeping is completed on a computer when the employee returns to the office at the end of the shift.

The system used in *Hybrid*, enables simultaneous display of graphic versions of the worklist on screen at the office and on smartphones to staff on duty. Registration of an activity is done by the employee who logs in or out of an activity in the home of the recipient. This way, the leading nurse and employees on the same shift can follow the progression of the worklists. Changes of allocation can be made by the leading nurse. If an assignment has finished before its estimated time, the employee can choose to take on another one situated nearby. The medical record is completed electronically while the employee is still with the patient. As used in this HHC, the monitoring system does not provide activity measurement.

In *Technological* management portable devices for medical record keeping while still with the patient is used, and in addition to this, a time and activity registration system, which enables continuous registrations and measurement of activities through RFID technology, is implemented. The registrations, which are monitored daily by administrative staff, provide valid information about care delivery. Activities are evaluated, and changes or corrections of time allocation can be done rapidly. This way, information captured through electronic registrations forms the basis for management, and measurements can be used for statistics and evaluation of production.

8.3 Data

Activity data was collected by home care staff during a period of four weeks in 2018. Registrations were conducted during day and evening shifts in a normal activity period. Participating staff included Nurses, Healthcare Workers and Assistants.

The data collection in *Manual* and *Hybrid* included a total of 8 629 registrations. Of these, 721 registrations (8.3 % of the total) were deleted because of coding errors, such as registrations of activities running more than 14 hours or just a few seconds. The total number of registrations for analysis is 7908. The number of registrations from *Technological* is 21130. In their data set, possible coding errors were corrected as all registrations were monitored daily by administrative staff, and corrections of registration errors done continuously. If we combine the coding errors of the results from the three municipalities the total coding error is 2.4 %.

Table 8-2 Observations

Data collected	Manual	Hybrid	Technological	Total
Total registrations (n)	2347	6282	21130	29759
Coding errors (n)	170	551	0	721
Total registrations analysis (n)	2177	5731	21130	29038

The activity measurements in the data collection in *Manual* and *Hybrid* consists of four activities, while registrations conducted in *Technological* consists of five. As there is a difference in how the data is categorized, they are aggregated into three main categories: *direct patient care, transportation,* and *administration* to make comparison between the municipalities valid, illustrated in table 8-3. *Direct patient care* is defined as the time spent with the patient or recipient. *Transportation* refers to activities related to transportation from the office to patients, between patients or other transportation related to care, and it does not separate driving from cycling or walking. *Administration* is defined as time spent on reports, administrative tasks at the office, shopping, pharmacy, coordination, and planning of daily activities.

Table 8-3 Aggregated categories

Manual & Hybrid	Technological	Aggregated categories
(1) Direct patient care	**(1) Direct patient care**	**(1) Direct patient care**
Direct patient care	*Direct patient care*	*Direct patient care*
(2) Documentation	**(2) Indoor time**	*Security alarm*
Documentation/administration	*Indoor time*	**(2) Administration**
(3) Transportation	**(3) Transportation**	*Documentation/administration*
Transportation	*Transportation*	*Refuel*
(4) Medicine room	**(4) Security alarm**	*Dosage*
Medicine room	*Security alarm*	*Meal distribution*
	(5) Other time	*Collect pharmacy merchandise*
	Refuel	*Kitchen at work*
	Dosage	*Deliver car for wash*
	Meal distribution	*Medicine room*
	Collect pharmacy merchandise	**(3) Transportation**
	Kitchen at work	*Transportation*
	Deliver car for wash	
	Medicine room	

The data analysed in this research was obtained through data recordings where staff members used time tracker applications (apps) to register the activities. *Manual* and *Hybrid* used the same type of application, a time registration software that can be used on different platforms such as smartphones or computers. In *Technological* registration was done through the use of Radio Frequency Identification, RFID technology, and Near Field Communication, NFC receivers. The two systems have different solutions for time registrations. In the time tracker application, the employee uses an anonymous key to log on, scrolls to find the right activity and registers it by punching a button on the smartphone screen at the beginning/end of each activity. In *Technological,* the log on is done by the employees, using their own credentials. Registration is conducted by holding the smartphone or tablet in front of a tag placed in the car or in the doorway of the home of the patient. When transportation is done by cycling or walking, the employee carries an RFID tag in their tablet that registers when they leave the home of the patient

Table 8-4 Activities

		Manual				**Hybrid**				**Technological**			
Category	**Activity**	*(n)*	*(min)*	*(%)*	*FTE(h)*	*(n)*	*(min)*	*(%)*	*FTE(h)*	*(n)*	*(min)*	*(%)*	*FTE(h)*
Direct	*Direct*	825	17845	40%	732	2386	38055	45%	836	10889	219257	56%	1031
Indirect	*Trans*	940	9913	22%	407	2641	30908	37%	679	7506	72487	18%	341
	Adm/docu	235	14980	33%	614	545	13221	16%	290	2294	91199	23%	429
	Drug	50	2264	5%	93	43	1886	2%	41				
	Other time									117	2284	1%	11
	S/A									324	7409	2%	35
	Total	2050	45002	100%	1846	5615	84070	100%	1846	21130	392636	100%	1846

Table 8-4 presents the findings in the different categories before being aggregated; *Direct* and *Indirect* activities, which include transportation, administration/documentation, drugs, other time, and safety alarms, (S/A). The total hours registered are 750, 1401 and 6544 in *Manual*, *Hybrid* and *Technological*. The corresponding numbers of observations are 2050, 5615 and 21 130.

Registration data from the three HHCs were transferred as excel files after the registration period. In *Manual* and *Hybrid* this was done by the app provider, and in *Technological* by the Controller in charge of registrations. For statistical analysis $p < 0.05$ was considered statistically significant.

8.4 Results

This paper uses prospectively recorded data to document the use of time in three HHCs, where management is described as *Manual*, *Hybrid* and *Technological*. In *Manual* management, *direct activities* constitute 40 % and *indirect activities* 60 % of the total registered hours. In *Hybrid*, 45 % of total hours were *direct activities* and 55% *indirect activities.* The results in *Technological* were 58% *direct activities* and 42 % *indirect activities.* There is a difference in the results of 18 % in the category direct activities between lowest and highest.

Table 8-5 illustrates the findings which are aggregated into the two main categories *direct* and *indirect* activities, the latter consisting of transportation and administration. Transportation constitutes 18% in *Technological*, 24 % in the *Manual* and 37 % in *Hybrid* based management. 18% of total time is used on Administration in the *Hybrid*, 23 % in *Technological*, and 37 % in *Manual.*

Table 8-5 Activities: direct, transportation & administration

		Management models					
		Manual		**Hybrid**		**Technological**	
Category	**Activity**	(%)	FTE(h)	(%)	FTE(h)	(%)	FTE(h)
Direct	*Direct*	40%	732	45%	836	58%	1066
Indirect	*Trans*	22%	407	37%	679	18%	341
	Adm	38%	707	18%	332	24%	440
	Total	100%	1846	100%	1846	100%	1846

The full time equivalent, FTE, for rotation shifts in the health care professions, is 1846 hours yearly. The use of FTEs will give a further illustration of how many hours are spent on different activities and the differences between the management models. The difference then, of *Direct activities* between the *Manual* and *Hybrid* management is 104 hours in every FTE. Comparison between the *Manual* and *Technological* gives a difference of 334 hours in an FTE. In the sub-category *transportation*, there is a difference of 338 FTE hours between the highest and lowest results, and in administration the difference amounts to 375 FTE hours.

Table 8-6 Median, IQR and Mean

Category	**Activity**	**Managment models**	***(n)***	***Median (min)***	***IQR (min)***	***Mean (min)***	***Duration (min***	***(%) total***	***(%) of indirect***	***FTH(h)***
Direct	*Direct*	*Manual*	825	13	(8-26)	22	17845	40%		732
		Hybrid	2386	10	(6-18)	16	38055	45%		836
		Technological	2246	13	(8-23)	18	40177	57%		1059
Indirect	*Trans*	*Manual*	940	6	(3-12)	11	9913	22%	37%	407
		Hybrid	2641	6	(3-12)	12	30908	37%	67%	679
		Technological	1357	7	(4-12)	10	12924	18%	43%	341
	Adm	*Manual*	285	36	(22-58)	61	17244	38%	63%	707
		Hybrid	588	10	(1-31)	26	15107	18%	33%	332
		Technological	397	39	(18-58)	43	16962	24%	57%	447
Total		*Manual*	2050	11	(5-23)	22	45002	100%		1846
		Hybrid	5615	8	(4-16)	15	84070	100%		1846
		Technological	4000	11	(6-22)	18	70063	100%		1846

Table 8-6 illustrates time distribution in the categories *direct, transportation* and *administration*. In this table, the registrations for *Technological* concerns the period 1st - 6th of February. This is due to technical formation of data received from the HHCs, and where extraction of detailed information was only possible in this period.

The median time of *direct activities* range from 10 minutes in *Hybrid*, to 13 minutes in *Manual* and *Technological*. Mean time is 16 minutes in *Hybrid*, 18 minutes in *Technological* and 22 minutes in *Manual*. There are minor differences in the IQR between the HHCs: in *Manual* the range is 8-26 minutes, in *Hybrid*, 6-18 minutes and in *Technological* 8-23 minutes. The results may indicate longer visits in *Manual*, here, the mean is higher, and the median is at the same level as *Technological*, but the spread in IQR is larger. This indicates that there is a difference in the length of visits. Reasons for this are not known but may be explained by health-related factors in the patient group.

The median time spent on *transportation* varies between 6-7 minutes, with the lowest time in *Manual* and *Hybrid*, and 7 minutes in *Technological*. Transportation constitutes 67%, 43% and 37% of the indirect time in *Hybrid*, *Technological* and *Manual* management models respectively.

There is a large spread in the median of *administration*; it varies between 10 - 39 minutes. *Hybrid* has the lowest median at 10 minutes, whereas *Manual* and *Technological* have a median of 36 and 39 minutes respectively. The difference can to some extent be explained by differences in registration procedures. In the *Hybrid*, EMR is conducted when still with the patient, or when the employee is back in the car. This is registered as administration, and many of these registrations are short, around one minute. EMR on tablet or cell phones is also used in the *Technological*, but is not registered as a separate activity, but included in direct time. Staff in the *Manual*, writes notes when still with the patient, and registers this electronically when they return to the office. This is in fact doing the job twice. Administration constitutes of 63 % of *indirect time* in *Manual*, 33 % in *Hybrid*, and 57 % in *Technological.*

8.5 Discussion

This paper investigates how technological solutions for time and activity monitoring as support to management, affects the proportion of direct and indirect time spent in three

Norwegian HHCs. Based on the degree of integration and adaptation of technology solutions, management in the HHCs is described as *Manual*, *Hybrid* and *Technological*. *Direct* and *indire*ct time is used to measure activities in HHCs, and the ratio between them provides information of time allocation and utilisation. *Direct time* is well suited as a measurement of productivity and output, and since it describes time spent with the patient, it also comprises elements of value and quality (Porter & Teisberg, 2006) (Antinaho, Kivinen, Turunen, & Partanen, 2014) (Jordahl & Persson, 2018), and is thereby a measurement that include both quantitative and qualitative aspects (Ghobadian & Ashworth, 1994). Kaplan and Norton (1992) emphasise the importance of measurements that comprise goals and core activities, as this will increase attention to this, and thereby influence activities of the organisation. The interaction between patient and healthcare worker is the essential part of healthcare (Sosial og Helsedirektoratet, 2005). The assumption that more time used on direct care, i.e., time spent with the patient, will influence quality of care and patient satisfaction is supported by several studies, (Howie, et al., 1999) (Bacon & Mark, 2010).

The results demonstrate that the level of technological solutions for time and activity monitoring as support to management, affects the proportion of *direct time. Technological* based management delivered the highest proportion of direct time, 58% and *Manual* based management had the lowest score of 40 %, a difference of 18 %. With the exception of the highest score, this corresponds to the findings of Helgheim et. al. (2018) in their study of home care activities, where *direct time* constituted 44 to 49%, and to the findings in a Danish study of HHC in a semi-urban municipality, where *direct time* constituted 35 to 41% of total time (BDO, 2018). *Direct time* used as a measurement of delivered hours, shows that the result in *Technological* based management, is substantially higher than in the other HHCs. The difference between *Manual* and *Technologica*l based management constitutes 334 FTE hours, and between *Technological* and *Hybrid* is 230 FTE hours. In *Technologica*l based management, information from measurements is used actively in the evaluation of results and planning of the service. There is support in research literature that the use of measurements through IT applications, such as RFID, will give valid and reliable information, as well as enhance transparency and clarity (Yoon, Lee, & Schniederjans, 2016) (Jordahl & Persson, 2018), and that performance measurement, as a support for management, gives a higher performance (Lingle & Schiemann, 1996) (Rogan & Boaden, 2016). Allocation of time, from indirect to direct activities in *Manual* and

Hybrid management, will enable the HHCs to either increase the number of patients, if this is needed, or to increase the time spent in each visit without additional costs. This is time that can be utilized on rehabilitation activities, which may improve, or maintain the level of function of the patient, and thereby reduce the need for increased services.

Transportation is an *indirect* activity that is an essential part of HHC. The time spent on transportation varied between 18% and 37%, a difference of 19%. With the exception of the highest value, this corresponds with the findings of Helgheim et. al. (2018), and Holm and Angelsen (2014), who found that transportation in rural HHCs constituted 22- 30 %, and 18-26% of the total time used. If transport is the factor that has the greatest influence on time spent on direct activities, the assumption would be that the HHC with the lowest proportion of direct time, would have the highest level of time spent on transportation, but they had the second-best results on transport, 22 %, four percent higher than in *Technological* management. The findings illustrate that settlement patterns and road kilometres influence time used on transportation, as *Hybrid*, which has the largest area, and the most scattered settlement pattern, uses most time on transport, 37 %. This is supported by the findings by Helgheim et. al. (2018). Here, there has been a 7 % increase in time spent on transportation since 2016. The reasons for this are not known but may be a result of changes in demand, either through an increase in the number of recipients, or requirements of a higher level of care to the individual which has led to more visits. These are all factors mentioned in literature that make routing and scheduling of the HHC complex (Fikar & Hirsch, 2016).

The spread in time spent on administration was 18-38 % of the total time. This corresponds roughly with the findings of Holm and Angelsen (2014), where time spent on administrative tasks amounted to 19-32 % of working time, but differs somewhat from the findings of Helgheim et, al. (2018), where 26-29 % of total working time was spent on administration. *Manual* based management has the highest proportion of time spent on administration, 37 %. Portable EMR during visits is not implemented, and worklists are presented on paper. The notion that the use of portable EMR systems, reduces time for documentation, time that may be allocated to patient related care, is supported by literature (Poissant, Pereira, Tamblyn, & Kawasumi, 2005) (Nielsen, 2010) (Rouleau, Gagnon, & Côté, 2015). Transportation is a factor often discussed in articles concerning improvements and planning in HHCs (Fikar & Hirsch, 2016), but our findings show that administration is the category that mostly affects direct time in *Manual* based management. Here, this is the main factor that needs to be addressed.

Findings acquired in the research conducted in 2016 by Helgheim et. al. (2018) were that *Hybrid* spent 27% of time on *administration, reports, documentation, drug,* and *teaching*. The findings in the 2018 collection showed that *administration* now constitutes 18%, a reduction of 9%. This reduction is equal to 166 FTE hours available for other activities. In the same period, transportation increased by 7 %. This HHC implemented a portable EMR system in 2016. Helgheim et. al (2018) predicted that this, in the long-term, would provide efficiency results, something that the results from this study supports. Without this implementation, the number of available hours for direct time would have been reduced, as transportation time increased in the period.

The implementation and integration of technological solutions for activity measurements and EMR provides knowledge of inputs and measurements of results, both key factors to management in any process of improvement (Porter & Teisberg, 2006). This enables allocation of resources to increase patient related care. Patient admittance to HHC is based on evaluations of their need for care, and the care resolution gives a time estimate. Monitoring and evaluation of measurements will show if there is a discrepancy between assigned time and time actually used, so corrections in care resolutions can be made. This way, planning can be done according to the actual need, not to an estimate. Valid information is also essential for visibility, and as background for policymakers in allocation of framework and funding of HHC (Glenngård, 2013).

Even though there are differences among HHCs, the results show that the major difference is the implementation of a continuous digital registration of activities. This is used as a managerial tool and has enabled leaders to allocate time to more direct activities. With existing systems, *Manual* and *Hybrid* do not have the same level of information about the service as *Technological,* which affects effective resource planning. In the *Technological* based management, where the system is fully integrated, management of resource planning is built on knowledge of the actual need for care.

8.6 Limitations

There are several limitations affecting this study. First, the data collection was conducted using two different solutions for time registration, and while *Manual* and *Hybrid* had limited experience with registrations, this is part of daily activities in *Technological*. Secondly, not all employees participated in the registrations, so we do not have a full overview of total time spent. However, the HHCs confirm that the distribution of staff participating in the registrations corresponds to an average shift, which indicates that the findings are likely to be representative of total working hours. Thirdly, registered activities are aggregated in order to visualize and make comparison easier. The combination may lead to obscuring of nuances but clarifies the relationship between the different activities in the total amount of time used. Finally, the study investigates three HHCs located in different parts of Norway; two rural, located on the west coast, and one urban/rural, larger municipality in a more central part of the country. Since the background for comparison is the level of integration of technological solutions for time and activity monitoring and its support to management, it is our belief that results may be generalized.

8.7 Conclusion

Increasing demand for HHC services and a higher complexity of services rendered has led to higher costs and a shortage of qualified staff, something that makes utilization of existing resources important. Information and knowledge are central in healthcare, which makes capturing and utilization of information essential. Technological solutions for time and activity measurements provide valid measurements and information for management support. The use of portable EMR saves time, time that may be allocated to increase direct patient time.

This study uses prospectively recorded data and investigates how technological solutions for time and activity monitoring as support to management, affects the proportion of direct and indirect time in three Norwegian HHCs. The results show that this has implications on direct time. *Technological* based management spends more time on *direct* than on *indirect* activities, while both *Hybrid* and *Manual* based management use more time on indirect activities.

Technological based management, where measurements are used to monitor and evaluate activities, enables planning according to actual need. This allows rapid response to deviations in demand and allocation of time from indirect to direct patient related activities, and thus provides more available work hours. A higher utilization of resources will allow delivery of care to a larger number of patients, or allocation of more *direct* time to the current patient group, something that can contribute to increased value for patients.

There is a potential to increase the proportion of direct time without additional resources in the two HHCs that use *Manual* and *Hybrid* based management if technological solutions for time and activity measurement and portable EMR are used. This implementation will at the same time affect management as it gives an increased level of valid information. Depending on the level of integration, management will then evolve to become either *Hybrid* or *Technological* based.

The results in this paper may serve as a basis for further research on technological solutions for time and activity measurement and management.

8.8 References

Radnor, Z. J., Holweg, M., & Waring, J. (2011, March 2). Lean in healthcare: The unfilled promise? *Social Science & Medicine*, ss. 364-371. doi:10.1016/j.socscimed.2011.02.011

Abelsen, B., Gaski, M., Nødland, S., & Stephansen, A. (2014). *Sammhandlingsreformens konsekvenser for det kommunale pleie- og omsorgstilbudet.* Stavanger/Alta: International Research Institute of Stavanger.

Abrahamsen, D., Allertsen, L., & Skjøstad, O. (2016). *Hjemmetjenestens målgrupper og organisering.* Oslo-Kongsvinger: Statisitsk sentralbyrå.

Agarwal, R., Gao, G., DesRoches, C., & Jha, A. K. (2010, November 18). Research Commentary—The Digital Transformation of Healthcare: Current Status and the Road Ahead. *Information Systems Research*, pp. 796-809. doi:https://doi.org/10.1287/isre.1100.0327

Antinaho, T., Kivinen, T., Turunen, H., & Partanen, P. (2014, June 30). Nurses' working time use – how value adding it is? *Journal of Nursing Management*, ss. 1094-1105.

Bacon, C. T., & Mark, B. (2010, July 23). Organizational Effects on Patient Satisfaction in Hospital Medical-Surgical Units. *The Journal of Nurcing Administration*, ss. 220-227. doi:doi:10.1097/NNA.0b013e3181a23d3f.

BDO. (2018). *ANALYSE AFHJEMMESYGEPLEJEN.* BDO Statsautoriseret revisionsaktieselskab. Hentet fra http://docplayer.dk/105825944-Analyse-af-hjemmesygeplejen.html

Birkeland, A. (2014, Mars 10). Aktiv mestring i hjemmesykepleien. *Sykepleien*, pp. 44-47. doi:10.4220/sykepleiens.2014.0023

Brevik, I., & Schmidt, L. (2005). *Slik vil eldre bo - En undersøkelse av fremtidige eldres boligpreferanser.* Oslo: Norsk institutt for by- og regionsforskining.

Buttigieg, S. C., Dey, P. K., & Gauci, D. (2016, January 7). Business process management in health care: current challenges and future prospects. *Innovation and Entrepreneurship in Health*, pp. 1-13. doi:https://doi.org/10.2147/IEH.S68183

Cooper, C., Cenko, B., Dow, B., & Rapaport, P. (2017, January 16). A systematic review evaluating the impact of paid home carer training, supervision, and other interventions on the health and well-being of older home care clients. *International Psychogeriatrics*, ss. 595-604. doi:doi:10.1017/S1041610216002386

DesRoches, C. M., Campbell, E. G., Rao, S. R., Donelan, K., Ferris, T. G., Jha, A., . . . Blumenthal, D. (2008, July 3). Electronic Health Records in Ambulatory Care — A National Survey of Physicians. *The New England Journal of Medicine*, ss. 50-60. doi:10.1056/NEJMsa0802005

Donabedian, A. (1988, September 23/30). The Quality of Care How can it Be Assessed? *JAMA*, ss. 1743-1748.

Dowding, D. W., Turley, M., & Garrido, T. (2012, Jul-Aug). The impact of an electronic health record on nurse sensitive patient outcomes: an interrupted time series analysis. *J Am Med Inform Assoc*, ss. 615-20. doi:10.1136/amiajnl-2011-000504

Ellram, L. M., Tate, W. L., & Billington, C. (2004, April 5). Understanding and Managing the Services Supply Chain. *The Journal of Supply Chain Management*, pp. 17-32. doi:10.1111/j.1745-493X.2004.tb00176.x

Eveborn, P., Rönnqvist, M., Einarsdóttir, H., Eklund, M., Lidén, K., & Almroth, M. (2009, January-February). Operations Research Improves Quality and Efficiency in Home Care. *Interfaces*, ss. 18-34. doi:doi 10.1287/inte.1080.0411

Fagerström, L. (2019). Avansert klinisk sykepleie - et begrunnet behov. I L. M. Fagerström, *Avansert klinisk sykepleie* (ss. 17-25). Oslo: Gyldendal Norsk Forlag.

Fikar, C., & Hirsch, P. (2016, July 20). Home health care routing and scheduling: A review. *Computers & Operations Research*, ss. 86-95.

Fitzgerald, L. (2007). Performance measurement. In T. Hopper, D. Northcott, & R. Scapens, *Issues in Management Accounting* (Third edition ed., pp. 223-241). Harlow: Pearson Education Limited .

Ford, G., Compton, M., Millett, G., & Tzortzis, A. (2017). The Role of Digital Disruption in Healthcare Service Innovation. In M. A. Pfannstiel, & C. Rasche, *Service Business Model Innovation in Healthcare and Hospital Management* (pp. 57-70). Switzerland: Springer International Publishing AG. doi:10.1007/978-3-319-46412-1

Genet, N., Boerma, W., Kroneman, M., Hutchinson, A., & Saltman, R. B. (2012). *Home Care Across Europe, Current structure and future challenges.* Copenhagen: World Health Organization.

Ghobadian, A., & Ashworth, J. (1994). Performance Measurement in Local Government – Concept and Practice. *International Journal of Operations & Production Management*, ss. 35-51. doi:10.1108/01443579410056786

Glenngård, A. H. (2013, April 16). Productivity and patient satisfaction in primary care-Conflicting or compatible goals? *Health Policy*, ss. 157-165. doi:http://dx.doi.org/10.1016/j.healthpol.2013.04.012

Halonen, R., Juntunen, K., Martikainen, O., & Naumov, V. (2014). Seeking efficiency and productivity in health care. *Americas Conference on Information Systems*, pp. 1-11.

Hans, E. W., Van Houdenhoven, M., & Hulshof, P. J. (2012). A Frame work for Health Care Planning and Control. In R. Hall, *Handbook of Healthcare System Scheduling. International Series in Operations Research & Management Science* (pp. 303-320). Boston, MA: Springer. doi:https://doi.org/10.1007/978-1-4614-1734-7_12

Heinrich, C. J. (2002). Outcomes–Based Performance Management in the Public Sector: Implications for Government Accountability and Effectiveness. *Public Administration Review*, ss. 712-25. doi: https://doi.org/10.1111/1540-6210.00253

Helgheim, B. I., Sandbaek, B. E., & Slyngstad, L. (2018). A prospective investigation of direct and indirect home care activeties in three rural Norwegian municipalities. *BMC Health Service Research*. Retrieved from http://doi.org/10.1186/s12913-018-3794-2

Helsedirektoratet. (2016). *Samhandlingsstatistikk 2014-15.* Helsedirektoratet.

Hjemås, G., Holmøy , E., & Haugstveit, F. (2019). *Fremskrivninger av etterspørselen etter arbeidskraft i helse- og omsorg mot 2060.* Oslo: Statistisk sentralbyrå.

Hjemås, G., Zhiyang, J., Kornstad, T., & Stølen, N. M. (2019). *Arbeidsmarkedet for helsepersonell fram mot 2035.* Oslo: Statistisk sentralbyrå.

Holm, S. G., & Angelsen, R. O. (2014). A descriptive retrospectiv study of time consumption in home care services: how do employees use their working time? *BMC Health Services Research*. doi:10.1186/1472-6963-14-439

Holzer, M., & Lee, S.-H. (2004). *Public Productivity handbook - Second Edition, revised and Expanded.* New York: Marcel Dekker, Inc.

Howie, J. G., Heaney, ,. D., Maxwell, M., Walker, J. J., Freeman, G. K., & Rai, H. (1999, September 18). Quality at general practice consultations: cross sectional survey. *British Medical Journal, 319*, ss. 738-743.

Ittner, C. D., & Larcker, D. F. (2001, December). Assessing empirical research in managerial accounting: a value-based management perspective. *Journal of Accounting and Economics*, pp. 349-410. doi:https://doi.org/10.1016/S0165-4101(01)00026-X.

Iversen, A. (1986). *Hva gjør vi i hjemmesykepleien?* (1:2. utg.). Oslo: Tano A/S. Hentet fra https://urn.nb.no/URN:NBN:no-nb_digibok_2007080601073

Jordahl, H., & Persson, L. (2018, August 31). Exploring Digital Time Measurement in the Public Sector: Labor Productivity and Service Quality in Home Care. *Research Institute of Industrial Economics*. doi:http://dx.doi.org/10.2139/ssrn.324

Kaplan, R. S., & Norton, D. P. (1992). The Balanced Scorecard - Measures That Drive. *Harvard Business Review*, pp. 71-79.

Kim, R. H., Gaukler, G. M., & Lee, C. W. (2016, Desember). Improving healthcare quality: A technological and managerial innovation perspective. *Technological Forecasting and Social Change*, pp. 373-378. doi:https://doi.org/10.1016/j.techfore.2016.09.012

Langeland, E., Førland, O., Aas, E., Birkeland, A., Folkestad, B., Kjeken, I., . . . Tuntland, H. (2016). *Modeller for hverdagsrehabilitering - en følgeevaluering i norske kommuner.* Bergen: Senter for omsorgsforskning.

Laurenza, E., Quintano, M., Schiavone, F., & Vrontis, D. (2018, sEPTEMBER 3). The effect of digital technologies adoption in healthcare industry: a case based analysis. *Business Process Management Journal*, pp. 1124-1144. doi:10.1108/BPMJ-04-2017-0084

Lawal, A. K., Rotter, T., Kinsman, L., Sari, N., Harrison, L., Jeffery, C., . . . Flynn, R. (2014, September 19). Lean management in health care: definition, concepts, methodology and effects reported (systematic review protocol). *Systematic Reviews, 113*, pp. 1-6. doi:10.1186/2046-4053-3-103

Lenz, R., Peleg, M., & Reichert, M. (2012, January 1). Healthcare Process Support: Achievements, Challenges, Current Research. *International Journal of Knowledge-Based Organizations*. Retrieved from https://www.researchgate.net/publication/236610494

Lingle, J. H., & Schiemann, W. A. (1996, March). From balanced scorecard to strategic gauges: Is measurement worth it? *Management Review*, pp. 56-62.

Linna, P., Pekkola, S., Ukko, J., & Melkas, H. (2010, September 10). Defining and measuring productivity in the public sector: managerial perceptions. *International Journal of Public Sector Management*, pp. 479-499. doi:10.1108/09513551011058493

Liu, T. C., Bozic, K. J., & Teisberg, E. O. (2016, December 19). Value-based Healthcare: Person-centered Measurment: Focusing on the Three C's. *Clinical Orthopaedic and Related Research*, pp. 315-317. doi:10.1007/11999-016-5205-5

Malhotra, S., Jordan, D., Shortliffe, E., & Patel, V. L. (2007, April). Workflow modeling in critical care: Piecing together your own puzzle. *Journal of Biomedical Informatics*, ss. 81-92. doi:10.1016/j.jbi.2006.06.002

Mamlin, B. W., & Tierney, W. M. (2016, January). The Promise of Information and Communication Technology in Healthcare: Extracting Value From the Chaos. *THE AMERICAN JOURNAL OFTHE MEDICAL SCIENCES*, pp. 59-68. doi:10.1016/j.amjms.2015.10.015

Mangan, J., Lalwani, C., Butcher, T., & Javadpour, R. (2012). *Global Logistics & Supply Chain Management* (Second Edition ed.). Chichester: John Wiley & Sons.

Melkers, J., & Willoughby, K. (2005, March/April). Models of Performance-Measurement Use in Local Governments: Understanding Budgeting, Communication, and Lasting Effects. *Public Administration Review*, pp. 180-190. doi:10.1111/j.1540-6210.2005.00443.x

Nielsen, K. (2010). *Slutrapport ABT Fondsprojekt "Online Hjemmesygepleje –netbooks til Hjemmesygeplejen".* København: Københavns Kommune Sundheds- og Omsorgsforvaltningen.

Otley, D. (2007). Accounting performance measurement: a review of its purposes. In A. Neely, *Business Performance Measurement: Unifying theories and integrating practice* (Second edition ed., pp. 11-35). Cambridge: Cambridge University Press.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1985, January). A Conceptual Model of Service Quality and its Implication for Future Research (SERVQUAL). *Journal of Marketing*, ss. 41-50. doi:10.2307/1251430

Pike, S., & Roos, G. (2007). The validity of measurement frameworks: measurement theory. I A. Neely, *Business Performance Measurement - Unifying theories and integrating practice* (Second Edition. utg., ss. 218-235). Cambridge: Cambridge University Press.

Plsek, P. E. (1997 , March). Systematic design of healthcare processes. *Quality in Health Care*, pp. 40–48. doi:10.1136/qshc.6.1.40

Poissant, L., Pereira, J., Tamblyn, R., & Kawasumi, Y. (2005, Sep-Oct). The Impact of Electronic Health Records on Time Efficiency of Physicians and Nurses: A Systematic Review. *Journal of the American Medical Informatics Association : JAMIA*, pp. 505-16. doi:10.1197/jamia.M1700

Pollanen, R. (2005, January). Performance measurement in municipalities: Empirical evidence in Canadian context. *The International Journal of Public Sector Management*, pp. 4-24. doi:10.1108/09513550510576125

Porter, M. E. (2010, Desember 23). What Is Value in Health Care? *The New England Journal of Medicine*, pp. 2477-2481. doi:10.1056/NEJMp1011024

Porter, M. E., & Lee, T. H. (2013, October). The Strategy That Will Fix Health Care. *Harvard Business Review*. Hentet fra https://hbr.org/2013/10/the-strategy-that-will-fix-health-care

Porter, M. E., & Teisberg, E. O. (2006). *Redefining Health Care - Creating Value-Based Competition on Results.* Boston, United States of America: Harvard Business School Publishing.

Porter, M. E., & Teisberg, E. O. (2007, Marche 14). How Physicians Can Change the Future of Health Care. *Jama*(10), pp. 1103-1111. doi:10.1001/jama.297.10.1103

Putnam, R. D. (1994). *Making Democracy Work - Civic traditions in modern italy.* NJ: Princeton University Press.

Rambøll. (2009). *Projekt kortlægning og måling - hjemmeplejeområdet.* København: Rambøll Management Consulting AS.

Riksrevisjonen. (2018). *Riksrevisjonens undersøkelse av tilgjengelighet og kvalitet i eldreomsorgen.* Oslo: Riksrevisjonen.

Rogan, L., & Boaden, R. (2016, October 30). Understanding performance management in primary care. *International Journal of Health Care Quality Assurance*, pp. 4-15. doi:10.1108/IJHCQA-10-2015-0128

Røhne, M., Grut, L., Ausen, D., Thaqi, E., Andersen, G., & Sandåker, T. (2018). *Planlegging av arbeidslister i hjemmetjenesten.* Oslo: SINTEF.

Rouleau, G., Gagnon, M.-P., & Côté, J. (2015, May 23). Impacts of information and communication technologies on nursing care: an overview of systematic reviews (protocol). *Systematic Reviews*, ss. 1-8. doi:https://doi.org/10.1186/s13643-015-0062-y

Simpson, H. (2009, March 5). PRODUCTIVITY IN PUBLIC SERVICES. *Journal of Economic Surveys*, pp. 250-276. doi:10.1111/j.1467-6419.2008.00562.x

Sosial og Helsedirektoratet. (2005). *Nasjonal strategi for kvalitetsforbedring i Sosial- og helsetjenesten.* Oslo: Sosial og Helsedirektoratet.

Statistics Norway. (2019, Oktober 3). *SSB.no*. Hentet fra SSB: https://www.ssb.no/statbank/table/11845/tableViewLayout1/

Statistics Norway. (2020, May 12). *Statistisk sentralbyrå.* Hentet fra SSB.no: https://www.ssb.no/helse/statistikker/helsetjko

Teperi, J., Porter, M. E., Vuorenkoski, L., & Baron, J. F. (2009). *The Finnish health Care System: A Value-Based Perspective.* Helsinki: SITRA.

Tønnessen, M., Løkken, S., Leknes, S., & Syse, A. (2018, Juni 26). *Statistisk sentralbyrå.* Hentet fra ssb.no: https://www.ssb.no/statbank/table/11668/tableViewLayout1/

Verbeeten, F. H. (2007, April 17). Performance Management Practices in Public Sector Organizations: Impact on Performance. *Accounting Auditing & Accountability Journal*, pp. 427-454. doi:10.1108/09513570810863996

While, A., & Dewsbury, G. (2011, October). Nursing and information and communication technology (ICT): A discussion of trends and future directions. *International Journal of Nursing Studies*, pp. 1302-1310. doi:https://doi.org/10.1016/j.ijnurstu.2011.02.020

Yoon, S., Lee, D., & Schniederjans, M. (2016, July 18). Effects of innovation leadership and supply chain innovation on supply chain efficiency: Focusing on hospital size.

Technological Forecasting & Social Change, pp. 412–421. doi:http://dx.doi.org/10.1016/j.techfore.2016.07.015

9.0 Appendix

Descriptive Statistics: Direct patient time	*Manual*	*Hybrid*	*Technological*
Gjennomsnitt	21.63006061	15.94934199	17.88824577
Standardfeil	1.121857777	0.564926609	0.345327154
Median	13.25	10.24	13
Modus	6.03	30.01	7
Standardavvik	32.22291141	27.59480003	16.36573842
Utvalgsvarians	1038.31602	761.4729885	267.8373941
Kurstosis	123.210635	247.5397882	12.45980746
Skjevhet	9.217425343	13.13315483	2.75344258
Område	537.01	695.5	166
Minimum	0.2	0.18	0
Maksimum	537.21	695.68	166
Sum	17844.8	38055.13	40177
Antall	825	2386	2246
Størst(1)	537.21	695.68	166
Minste(1)	0.2	0.18	0
Konfidenskoeffisient(95.0%)	2.202035303	1.107798	0.677193882

Descriptive statistics: Transportation	*Manual*	*Hybrid*	*Technological*
Gjennomsnitt	10.54625532	11.70326392	9.523949889
Standardfeil	0.617259343	0.529186818	0.268704449
Median	6.41	6.23	7
Modus	1.93	6.01	5
Standardavvik	18.925	27.19526019	9.898395017
Utvalgsvarians	358.149	739.5821768	97.97822391
Kurstosis	128.198	320.7404146	22.18428386
Skjevhet	9.787	14.29634915	3.724578244
Område	312.340	805.1	114
Minimum	0.210	0.18	0
Maksimum	312.550	805.28	114
Sum	9913.480	30908.32	12924
Antall	940	2641	1357
Størst(1)	312.550	805.280	114
Minste(1)	0.210	0.180	0
Konfidenskoeffisient(95.0%)	1.211367492	1.03766284	0.527121544

Descriptive statistics: Administration	*Manual*	*Hybrid*	*Technological*
Gjennomsnitt	60.50494737	25.69207483	42.72544081
Standardfeil	5.448123219	2.108952073	1.729822178
Median	35.66	9.75	39
Modus	29.95	0.28	0
Standardavvik	91.97490573	51.13936998	34.46646273
Utvalgsvarians	8459.383285	2615.235162	1187.937053
Kurstosis	23.01571635	37.7093586	7.788292913
Skjevhet	4.332759017	5.354242563	2.009298764
Område	790.72	507.12	241
Minimum	0.18	0.18	0
Maksimum	790.9	507.3	241
Sum	17243.91	15106.94	16962
Antall	285	588	397
Størst(1)	790.9	507.3	241
Minste(1)	0.18	0.18	0
Konfidenskoeffisient(95.0%)	10.7238251	4.142010419	3.40078302

T-test Transportation

Managmenet models	Management models	Mean	Variance	OBS	t-stat	P(T<=t) ensidig	T-kritisk, ensidig	P(T<=t) tosidig	T-kritisk, tosidig
Manual	Hybrid	11.703	739.582	2641	-1.423	7.74E-02	1.64550	1.54853E-01	1.961
	Technologicacl	9.524	97.978	1357	1.519	6.46E-02	1.64603	1.29119E-01	1.962
Hybrid	Manual	10.546	358.149	940	1.423	7.74E-02	1.64550	1.54853E-01	1.961
	Technologicla	11.703	97.978	1357	3.672	1.22E-04	1.64527	2.44084E-04	1.961
Technological	Manual	10.546	358.149	940	-1.519	6.46E-02	1.64603	1.29119E-01	1.962
	Hybrid	11.703	739.582	2641	-3.672	1.22E-04	1.64527	2.44084E-04	1.961

T-test Administration

Managmenet models	Management models	Mean	Variance	OBS	t-stat	P(T<=t) ensidig	T-kritisk, ensidig	P(T<=t) tosidig	T-kritisk, tosidig
Manual	Hybrid	25.692	2615.235	588	5.959	2.95178E-09	1.64897	5.90356E-09	1.966
	Technologicacl	42.725	1187.937	397	3.110	1.01270E-03	1.64932	2.02540E-03	1.967
Hybrid	Manual	60.505	8459.383	285	-5.959	2.95178E-09	1.64897	5.90356E-09	1.966
	Technologicla	42.725	1187.937	397	-6.245	3.15382E-10	1.64641	6.30764E-10	1.962
Technological	Manual	60.505	8459.383	285	-3.110	1.01270E-03	1.64932	2.02540E-03	1.967
	Hybrid	25.692	2615.235	588	6.245	3.15382E-10	1.64641	6.30764E-10	1.962