Digitalization in a Mandatory Implementation Context

How digitalization is achieved in practice and the elements that affect it

Ott Velsberg
Abstract

Healthcare around the world is facing strenuous times, whereby there is a need for reduced costs, improved efficiency, and effectiveness. Digitalization is a transformational phenomenon argued to solve the many problems of healthcare. As of such, this thesis studies digitalization in a healthcare setting - considering how digitalization is achieved in practice, and what elements hamper and enable sociotechnical changes required for digitalization. To study these aspects, a qualitative case study was carried out on the recently implemented mandatory electronic dental card among the dental care professionals from a Baltic country. The study allowed contributions to digitalization research by looking at the phenomenon from industry-level analysis, also revealed the elements that hamper and enable digitalization, outlined the different digitalization patterns, and argued that digitalization relies on the extent by which the new system provides value to the users without interfering with professional expertise and ethics.

Keywords: Digitalization, Digitization, HIS, Healthcare, Sociotechnical change

1. Introduction

Digitalization is a transformational phenomenon present in all areas of life and business - reshaping societies, individuals, businesses, and industries (Björling, 2015). Those who have jumped the bandwagon are endowed with increased productivity, efficiency, and higher returns (Manyika, Pinkus & Ramaswamy, 2016). While those that lag behind, are a burden to the economy and society. One area that is affected is healthcare. Healthcare around the world is facing strenuous times – whereby, there is a need for reduced costs, improved efficiency, and effectiveness (Bower, 2004; Deloitte, 2016; OECD, 2010). Digitization is profoundly argued to revolutionize healthcare and solve many of its problems (Blumenthal & Chopra, 2016). Ergo, healthcare sector worldwide has invested heavily in IT (Meulen, 2015). However, the differences between the outcomes of this investment are dependent on the degree of digital usage, rather than a simple digitization of workplace and its many elements (Manyika, Pinkus & Ramaswamy, 2016).

Due to these developments, information system research has increasingly turned to investigating digitalization both theoretically and empirically. Digitalization has become a growing phenomenon due to the rapid development of computer and communication technologies – driving majority of innovations in the 21st century (Mack, 2011; Yoo, 2010; Yoo, Lyytinen, Boland Jr. and Berente, 2010; Nylen, 2015). Digitization of artifacts and relationships marks the shift from analog to digital format, while digitalization is the change of sociotechnical structures by digitized artifacts and relationships (Yoo, Lyytinen, Boland Jr. and Berente, 2010; Yoo, Lyytinen, Thummadi, and Weiss, 2010). Digitalization should not be a mere digitization of artifacts or business processes, but instead it should lead to the reconfiguration of existing socio-technical relationships (Yoo, 2010). However, this change could have an adverse effect on how healthcare professionals work and operate through
changing the meaning of the artifact and affecting the sociotechnical relationship, thereby changing the established structures (Nylen, Holmström & Lyytinen, 2014; Nylen, 2015).

Research has looked specifically at the role of IT in healthcare. Health information technology (HIT) has been valued as one of the key elements in the development of healthcare, with proponents arguing for the increased efficiency, improved quality, access and delivery of healthcare services, better collaboration between and involvement of the different actors, and decreased healthcare costs (Bower, 2004; Bowman, 2013; Deloitte, 2016). However, recent news have indicated that HIT does not necessarily result in an improvement – system failures that halt the work of physicians, failed IT projects that cost taxpayers billions, improper use and subsequent unintended serious consequences, and increased quantity of bad quality data are just a few appalling outcomes (Jayanthi, 2015; Wright, 2011; Bowman, 2013). As illustrated by these experiences, simply implementing an IT solution does not create value per se; rather, the success of HIT implementations depends on whether the actors are able to appropriate some value from the new systems as they enact it in practice (Haddad & Wickramasinghe, 2015; Mizik & Jacobson, 2003). As HIT is essential for more efficient, safer, and higher quality care, it is important to consider how the shift from analog to digital affects healthcare practitioners (Bowman, 2013). Failure could hinder the already frail healthcare system by affecting the way physicians operate, making it important to consider the effect this shift could have on healthcare professionals.

To study these issues in more detail, it is necessary to turn towards digitalization. Digitalization is more about the sociotechnical change, than a shift from analog to digital. This shift could hinder or improve the healthcare system by changing the way physicians operate. However little is known about the mechanisms that hamper and enable sociotechnical change in practice. Majority of research on industry-level digitalization has focused on macro-level change, however to fully understand these outcomes, adopting a micro-level perspective was necessary. To study these issues, this study has focused on digitalization theories – doing so by following the two questions - first, “How is digitalization achieved in practice?”, and secondly: “What elements hamper and enable sociotechnical changes required for digitalization?”.

In order to answer these research questions, a qualitative case study on the implementation of digital dental health cards in a Baltic country was conducted. Interviews served as the primary data source for the study, additionally the study incorporated different data sources, namely: interviews, documentation, and observations. This allows to triangulate the results, and covered actors from numerous positions – users, developers, consultants and coordinators. In total, 40 interviews were conducted, all being first recorded, transcribed, and later analyzed.

The findings from the case study revealed the different sociotechnical changes that took place after the adoption of the new mandatory health system. Illustrating the transformative potential digitization has on users – through changing routines, practices, and the very meaning of the artifact. In addition, the study revealed different digitized technology adoption and utilization patterns, allowing to categorize users into six different groups - enabling further studies on how digitization affects the users.
Based on the aforementioned findings, the thesis makes contributions to the information system research and practice by allowing policy makers, developers and managers to study the way digitization affects the professionals. The elements affecting the sociotechnical change in practice were revealed, namely: privacy, control, security, previous procedural norms and actions, alignment of analog and digital, difference between intended and existing work routines, technological capabilities, boundaries and flexibility, changed format and function, and communication and information flow. Additionally, the study demonstrated the effect digitization has on technology adoption and utilization through different digitalization patterns – potentially allowing improvements of the implementation of digitized artifacts by addressing the changing needs of users.

The remainder of the thesis is organized as follows - the reader will be briefly introduced the theoretical foundation of the study: ‘Theories of digitalization’ and ‘IT and healthcare’, followed by methodology, an overview of the implications, case overview, and findings. A brief discussion of the findings and future research perspectives for the study as well as the conclusion will conclude the thesis.

2. Related research

2.1 Theories of digitalization

Digitalization of products and services has become a growing phenomenon (Yoo, Lyytinen, Boland Jr. and Berente, 2010). Having been identified as one of the core elements behind the continuing innovation of many spheres in life, and affecting fields as diverse as healthcare, music industry, industrial manufacturing, and libraries (Yoo, Lyytinen, Boland Jr. and Berente, 2010; Nylen, 2015; Grossman, 2016). This diversification and profoundness has been supported by the rapid improvements in computer and communication technologies – supporting the digitization of previously non-digital artifacts (Mack, 2011; Yoo, 2010). For example, in 1956, IBM 350 disk file, which was as large as a cupboard, stored 5 MB of data, today an USB stick has a capacity of 1 TB (Pingdom, 2016). This has in turn helped digitalization to become the force majeure behind much of the innovation in 21st century (Yoo, Lyytinen, Boland Jr. and Berente, 2010). This said, digital innovations have been identified to have generative and non-linear effects on innovation outcomes and processes, whereby consequently both the meaning of the artifact and its usage changes (Yoo, Lyytinen, Thummadi, and Weiss, 2010). Digitized artifacts become generative due to the unique materiality of digital technology, whereby artifacts evolve in astonishing ways even to those who have designed them (Yoo, 2012). This generativity is mainly driven by the uncoordinated and heterogenous actors who produce unprompted change (Yoo, 2013).

Digitalization involves changes in sociotechnical structures mediated by digitized artifacts and relationships, whereby digitized (derived from digitization) is defined as the encoding of analog information into digital format and the ability to process it (Yoo, Lyytinen, Boland Jr. and Berente, 2010; Yoo, Lyytinen, Thummadi, and Weiss, 2010). Digitization is recognized to add capabilities to non-digital artifacts through programmability, traceability, addressability, associability and other factors (Yoo, 2010). Digitalization on the other hand marks the fundamental shift from a non-digital artifact or relationship to digitally mediated
sociotechnical structures (Yoo, Lyytinen, Boland Jr. and Berente, 2010). As of that, digitalization happens when digitization prompts a reconfiguration of a sociotechnical relationship between the artifact and the user (Yoo, 2010). However, not all digitization leads to sociotechnical reconfigurations, thus there is a need to separate the two phenomena – digitization and digitalization.

This shift towards digitalization is accompanied by a separation of formats and contents – typical elements of analog artifacts (Nylen, Holmström & Lyytinen, 2014). As of that, healthcare could go through a similar drift as seen in the newspaper and music industry, whereby new innovative solutions enable a loose coupling between the two elements (Nylen, Holmström & Lyytinen, 2014). For example, print media has gone through a shift, whereby paper-based newspapers have lost their value and are no longer necessary for the consumption of daily information (Nylen, Holmström & Lyytinen, 2014). Transforming paper-based dental health cards into digitized information available to different actors regardless of their choice of technology, this could therefore diminish the role paper-based dental card had for the storage, distribution, and content (Nylen, Holmström & Lyytinen, 2014).

Hence, the shift from paper-based to digital dental health cards could reveal that the underlying factors of an analog paper-based dental health card could be separated and reconfigured in new forms (Nylen, Holmström & Lyytinen, 2014). Electronic dental health cards demonstrate the capacity for change, whereby the final artifact distinguishes from the analog artifact to a significant degree, i.e. new forms of storage, distribution, and completion of content turn patients from passive actors to active value seeking consumers and contributors to patients health data (PWC, 2014). This push towards technology driven disruption in healthcare is argued to solve some of the challenges in healthcare (Christensen, 2011). Gastaldi & Corso (2012) further argued that digitalization of healthcare is one of the most effective solutions to simultaneously increase quality and reduce costs. However, studies have shown that active patient inclusion adversely affects clinicians’ opinion of data distribution to patients, and is regarded by clinicians to damage the doctor-patient relationship and professional satisfaction (PWC, 2014; Steinhubl & Topol, 2015). Therefore, the digital dental health card is likely to change the way clinicians work and in general distribute information regarding patients’ health.

This shift towards digitization could have a similar effect as noted by Nylen, Holmström & Lyytinen (2014), whereby the definition of a dental health card, similarly to a magazine, could shift in meaning. The dental health card has moved from a simple paper based document into a digital infrastructure. Through such a move, it does not just offer a digitized version of a dental health card, but rather affects different areas of work and forms new relationships between the actors. For example, digitalization is recognized to reduce the complexity of difficult problem solving tasks and lower the number of rule-based manual labor (Brynjolfsson & MacAfee, 2014). This strong affiliation between the social and technical has been identified by many. For example, Nylen (2015) noted that the effects of digitalization on the change of sociotechnical structures is comparable to that of 19th century industrialization - having adverse effects on the established structures through the new usage patterns. While Snabe (2015) argued that digitalization is one of the most fundamental
periods of transformation ever witnessed – challenging the status quos, and rendering obsolete entire sets of current job functions.

2.2 IT and healthcare

The implementation of electronic dental health cards at a national level and its consequential sub-systems affect all dental care professionals, who are likely to have a varying degree of ICT knowledge (Bower, 2004). Therefore, organizations and the government are faced with a difficulty - how to make users with varying degrees of technological skills use the same digital infrastructure? The value of these digital initiatives is not in the implementation of IT alone but in how the actors are able to appropriate the value of the system (Haddad & Wickramasinghe, 2015; Mizik & Jacobson, 2003). Regardless of the potential improvement in user performance, people are often reluctant to adopt an information system (Mathieson, 1991). Failure to produce an information system or a technology that is accepted and utilized will pose an additional burden on the healthcare system that is already struggling with scarce medical and financial resources (Ferraz, 2015). For example, a third of OECD countries in 2013, mostly European, reported a real term cut in overall health spending (OECD, 2015). As of that, healthcare being both an individual and societal amenity, healthcare practitioners use of healthcare information technologies becomes a critical factor to consider and efficient implementation of health information technologies is a concern of the society as a whole (Payton et al, 2011). Moreover, as the healthcare systems are used by numerous actors, it is necessary to study why, how, and for whom e-health systems work, and how they should be designed and assessed (Nicolas-Rocca, Schooley & Joo, 2014).

Utilization of healthcare information systems relies on various key factors: (a) understanding the wide array of different users and their unique needs, (b) analyzing the impact of these systems on the users, (c) raising awareness of the benefits of electronic healthcare outcomes, and (d) improving access to healthcare information (Payton et al, 2011). However, as a result of mandatory IT adoption, these critical factors might fade due to the inevitable nature of technology usage – the users may not be technically skilled or mentally motivated and using the system regardless of their free will. This could be the panacea in overcoming the lack of health IS adoption and usage within the medical field, as currently researchers, governments and organizations are concerned with the hindered progression of HIT adoption and use.

There have been calls for more accessible, affordable, efficient, and improved healthcare for decades (Erixon and van der Marel, 2011; Mendez & Van den Hof, 2013; OECD, 2010). Among the many hurdles there are (a) inconsistent healthcare records, due to which information collection and sharing is inefficient, expensive, and time-consuming, (b) distance and inadequate healthcare infrastructures, (c) difficulty of improving quality care, efficiency, and reducing costs, (d) providing greater satisfaction, and (e) lack of healthcare workforce (Bollinger et al, 2013; Mendez & Van den Hof, 2013; Strong et al, 2014; Tremblay, 2012). Information technology has been identified as a promising venue to solve these issues, as information and communication technologies have been implemented various times to improve access, quality and service efficiency (Bates et al, 2013; Bollinger et al, 2013; Mair et al, 2012; McCullough et al, 2010; PWC, 2014; Reid et al, 2005; Roham, Gabrielyan & Archer,
It is argued that using IT would allow to reduce the gap in global healthcare workforce, where more than 4 million additional healthcare workers are needed, i.e. HIT has been identified to increase the number of monthly patient visits (Bollinger et al., 2013; Cheriff, Kapur, Qiu & Cole, 2010). Additionally, electronic medical record has been valued as one of the most viable approaches in lowering healthcare costs, reducing medical error, and improving patient care (Feng et al., 2010).

On the other hand, numerous studies have shown that successful implementation of IT in healthcare is continuously lagging when compared to other industries, majority of physicians have incorporated IT to a limited degree, and even when IT is incorporated, it is still often done in an isolated manner through the implementation of standalone systems (Bakken et al., 2008; Cho, Mathiassen & Nilsson, 2008; Djamasbi, Fruhling & Ioiacono, 2009; Payton et al., 2011). These have resulted in a failure to meet the goals set out by the healthcare organizations and governments (Lau, Kuziemsky, Price, & Gardner, 2010; Linder et al., 2007; Mattson, 2014; Kaplan & Harris-Salamone, 2009). Argued by Djamasbi, Fruhling & Ioiacono (2009), the lack of IT adoption in healthcare is destined to change due to increasing healthcare costs, pull from technology savvy users, new healthcare legislation, and physician's interest to expand their practice. This shift towards the use of ICT in healthcare is already visible, as more patients pay for their medical care, are incorporated in the decision making in a collaborative manner and are inclined to rely on online sources for information - turning passive patients into active consumers of health information, healthcare devices and monitoring systems (Karppinen et al., 2014; Nicolas-Rocca, Schooley & Joo, 2014; Wilson, 2012). This e-health application characteristic is typically supported by a plethora of online sources aimed to educate both patients and physicians, and provide a communication channel between the actors (Nicolas-Rocca, Schooley & Joo, 2014).

This shift from analog to digital could hinder the already frail healthcare system by forcing a change in the way physicians operate. This could result in e-iatrogenesis - patient harm caused in-part by HIT (Weiner et al., 2007). Simultaneously this shift could solve the underlying problems in healthcare. Thus the consideration of the effect digitization of artifacts could have on healthcare professionals is of outmost importance. For a more detailed study of these issues, it is necessary to consider digitalization. As seen from the literature review, digitalization has transformative potential. This research has so far pointed to the capacity to change, however less is known about the mechanisms that hamper or enable such sociotechnical change in practice. Especially, as there are many expectations from digitization – how it enables to save, manipulate and distribute the content. This change is necessary but not sufficient as a sociotechnical change. Digitization has been advocated by many to revolutionize the different areas of life (Blumenthal & Chopra, 2016; Brynjolfsson & MacAfee, 2014; Leetaru, 2008; Parmar, Mackenzie, Cohn & Gann, 2014). This thesis however argues, that digitization is more about the sociotechnical change, than just a shift from analog to digital.

### 3. Methodology

The majority of research on industry-level digitalization has looked at macro-level change (Ciarli & Rabellotti, 2007; Pankaj, Monika, Ranjani & Vallabh, 2011). The relevance of those
studies is inarguable, however to fully understand the outcomes of the study in hand, it is necessary to consider digitalization on micro-level. The focus of this study is on the efforts to digitize health care in a Baltic country, where much has been invested in the system and its potential gains. As the system was recently implemented, it is too early to tell what the outcomes will be over an extended time frame. However, micro-level analysis offers good grounds to start tracing changes associated with emerging patterns of digitalization.

Grounded theory has been regarded to provide the necessary procedures for a thorough theoretical explanation of the social phenomenon under study – explaining, describing, and implicitly offering a degree of predictability (Corbin and Strauss, 1990). The theory is recognized to draw its theoretical basis from two significant principles – change and determinism (Corbin and Strauss, 1990). Change relates to the evolving nature of the phenomena, whereby the phenomenon under study is not static, but rather recurrently changing in response to the evolving conditions; while determinism responds to actors capacity to control their life through the responses they make (Corbin and Strauss, 1990). As of such, grounded theory tries to reveal both, the underlying conditions and actors responses to these conditions and to the consequences of their actions (Corbin and Strauss, 1990). The usage of grounded theory allows to study the interaction between the different actors and artifacts in an healthcare setting - revealing the interplay between the social and technical.

Grounded theory has been identified to offer systematic approach to data analysis with rich and in-depth data, foster creativity, and allow conceptualization, however the given study acknowledges the limitations of this method, whereby the results could have limited generalizability, risk of reviewing literature without developing assumptions, and potential for methodological errors (Hussein, Hirst, Salyers and Osuji, 2014). To counter some of the potential errors, the following precautions were taken: case-study perspective, triangulation, specific procedures outlined by Corbin and Strauss (1990), and theory-driven coding.

Corbin and Strauss (1990, p.5) argued, that the data for grounded theory can come from different sources. As of such, this study combines three different types of data sources: interviews, documentation, and observations. This allowed to triangulate the data, whereby the pluralism of data sources allowed to view diverse viewpoints on the given phenomenon (Olsen, 2004). This in return enabled to validate the information and deepen the understanding on the given issue (Olsen, 2004). Cohen & Manion (2000) further argued that triangulation allows to study human behavior in more detail, by studying it from different standpoints. This in return is argued to support the avoidance of researcher’s bias on the issue under study - allowing to draw more conclusive findings (Cohen, Manion & Morrison, 2000).

For data analysis and collection, the specific procedures outlined by Corbin and Strauss (1990) were followed, whereby data analysis started as soon as the first data was collected. This data was then used to further guide the up-coming interviews and observations – allowing to systematically capture all relevant data and ground the theory in reality only if the concept is repeatedly brought up in the data. Furthermore, the study considered other key aspects brought up by Corbin and Strauss (1990), such as the following: concepts are the basic units of analysis, the categories must be developed and related, sampling in grounded theory proceeds on theoretical grounds, analysis makes use of constant comparisons, and
accounting for patterns and variations. Thus, the research did not just sample the dentists, but concentrated on the many different elements – what facilitates, fosters or hampers dentists work, what consequences resulted, what defines the meaning of dental card and so on – while continuously comparing different incidents against one another (Corbin and Strauss, 1990). To frame the study, a case-study perspective was adopted, allowing for full and meaningful analysis of the case under study (Mason, 2002), while grounded theory guided the collection and analysis of the data. From the perspective of the case study it became important to consider what sampling categories are relevant for the study, whether enough data has been generated for meaningful analysis, and where the object of the study ends - allowing the study to retain the holistic characteristics of the real-life events (Mason, 2002).

However, as with previous studies on digitalization, it proved difficult to distinguish digitalization as a sociotechnical change and digitalization as a technological change (Rintala, 2005). As proposed by Glaser and Strauss (1967), different sources – observations, interviews and documentation – were analyzed in a similar way, whereby the emphasis did not just lie on the fieldwork or interviews, but equal attention was pertained to documentary materials. Interviews were recorded and transcribed, observations were noted and summarized – throughout the study the sources were systematically analyzed. Through such a research perspective, this study aims to contribute to the theory by offering predictions, explanations, interpretations and applications (Glaser and Strauss, 1967). Following outlined procedures allowed the study to avoid bias and retain the credibility of the results.

### 3.1 Data collection

The three methods of data collection used were interviews, observation, and documentation analysis. *Table 1* presents an overview of the data collection methods.

<table>
<thead>
<tr>
<th>Data source</th>
<th>Total (March-May 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews</td>
<td>40 interviews</td>
</tr>
<tr>
<td></td>
<td>- Length (min): mean = 33.48; S.D. = 26.48</td>
</tr>
<tr>
<td></td>
<td>- Word count: 134,264</td>
</tr>
<tr>
<td></td>
<td>- 40 respondents</td>
</tr>
<tr>
<td>Participant observation</td>
<td>49 occasions (total: 18 h)</td>
</tr>
<tr>
<td>Documentation</td>
<td>Training papers, manuals, presentations, system introduction videos, formal usage data, newspaper articles, government reports, acts of law, e-mails, paperbased dental cards</td>
</tr>
</tbody>
</table>

*Table 1. Data collection*

First, the readily accessible documents on the Internet regarding the new law were analyzed – familiarization with the available dental software’s, and formation of an
understanding about the new mandatory information submission. Before commencing with the interviews, theory and previously collected information were used to guide the data collection - preparing an initial interview guide (Sarker, Xiao & Beaulieu, 2013). However, as the interviews unfolded and new data emerged, interview guides were iteratively changed. This was apparent with the first interviews that failed to produce significant value for the analysis, but instead proved to be useful in familiarization with the elements of the system, and drawing on that, changed the interview guide for future use. This iterative process continued throughout the interview cycle, however the object of change differed – from interview guide to follow-up questions. Secondly, 35 semi-structured interviews were conducted with the dentists at their own offices. Only two respondents worked at the same organization, however in different branches. The size of the organizations ranged from one dentist offices to large organizations with over 65 dentists. All interviews were digitally recorded and transcribed. The interviews typically ranged from 20 to 30 minutes – though extremes existed on both sides of the spectrum – from 12 minutes to 1 hour. Interviews were accompanied by observation of the work practices and collection of unique paper-based dental cards. In addition, a project manager from Public software was interviewed, as well as three private software managers (one from Private software 2 & two from Private software 1), and a senior representative from an industry association. In total there are three different software firms: Public software and Private software 1 and 2. All interviews were conducted in a semi-structured manner using previously prepared interview guides. Finally, during the interviews with both dentists and other actors, project documentation was provided – instructions, manuals, system introduction videos, and formal usage data. Figure 1 presents an overview of the occupational length of the interviewees.

**Figure 1. Occupational Length Distribution of Respondents**

### 3.2 Data analysis

Data analysis was guided by grounded theory. The analysis was conducted in two separate instances Digitalization is not a mere digitization of artifacts or business processes, but instead should lead to the reconfiguration of existing socio-technical relationships, whereby the initial codes were divided into sub-categories that described different facets of the
dentists work practices. These codes were systematically examined - new codes were added and old codes were merged when deemed necessary. This process was informed by the procedures outlined by Corbin and Strauss (1990), resulting in a number of core categories that represented the different users of the system. These findings are discussed later in the findings section. Further more, to really dig deep into the digitalization of healthcare practitioners work processes, it was decided to code and map dentists regular work routines. As the study offered insight to both, the dentists who had adopted the new digitized dental health card and those who remained faithful to the paper-based cards, it offered a unique opportunity to compare how things had been and what had changed. This comparison was further supported by the interviewees reflection on the changed work processes, which offered an insightful view on the predicament and allowed comparison between the current users reflections and reflections of those still using the paper-based cards. This supported the analysis and helped in further mapping the work processes and identifying the sociotechnical changes driven by digitization.

3.3 Research context – Background of the electronic dental card

The health information system under study is the electronic dental health card implemented by public organization, a governmental organization whose task is to develop and manage National Health Information System components. On June 2014, a regulation by the Minister of Social Affairs was accepted, which stipulated the documents to be transmitted in the health information system and their storage conditions and procedures. According to the regulation, from July 2015, dentists would be obligated by law to forward data to the NHIS (National Health Information System) under the electronic dental card. NHIS is the central national database, through which healthcare providers exchange data and view patient information submitted by other doctors - this data is derived from medical professionals ranging from dentists to oncologist to family doctors and many others.

According to regulations, all dentists are obligated to submit data regarding patient’s health to the NHIS after each treatment, but not later than 24 hours. From July 2015 to May 2016, 293 HCO's (Healthcare organizations) out of 538, made 621 172 data transmissions regarding 370 936 patients to the electronic dental card system, which translates to an adoption rate of around 55 percent. Figure 2 represents the number of data submissions to NHIS. However, this is only an estimate, as not all dentists in a particular HCO must have submitted data to NHIS to count the HCO as submitting data, more so, many dentists work in more than one HCO at the same time – thus, statistics do not represent the actual data submission.

![Figure 2 - Quarterly data submissions to NHIS](image-url)
The system is described as aiming to provide more optimal and adequate data, based on universal standards, which could be used to support the organization of health policy and decision making. Dentists on the other hand can retrieve medical information regarding patient’s previous dental care and other medical visits, i.e. the status of teeth, allergies, drugs used and other time-critical data. This enables dentists to access patients data to make the optimal treatment decisions, and patients to view their health information from an electronic system. See Image 1 for system outline.

Image 1. System outline

As of April 2016, 17 percent of patients have visited patient portal. Currently all patients older than 19 years old have to pay for their dental care - although there are a few exceptions making patients eligible for a single annual small compensation, i.e. pregnant women and those with a child under 1 year old, and pensioners. However, children under 19 years can have their dental care subsidized only if they visit a governmental contractor. These contracts are signed on four year basis, whereby different dental care providers compete against one another for the contract. Therefore, majority of dentists compete for both privately and publically funded patients, while patients have a significant degree of freedom to choose their healthcare provider depending on quality, price, and service. This newly found access to patients digital dental health card could allow dentists to view other dentists work approaches and patient health information – signaling for the increasing concern for privacy. Though the law regulates that a dentist can access patients data only during the treatment.

The digital system currently runs as a combination of the National Health Information System (NHIS) and a dental software chosen by the dentist among the available alternatives, namely 'Private software 1' & 'Private software 2' produced by private companies, and a 'Public software' produced by Public organization. Private software 1 and Private software 2 are private software’s that operate under a SaaS business model, while Public software is a freeware produced by a public organization. The two private softwares provide users different additional services - calendars, SMS-notifications, private servers for saving and accessing patients dental cards (information is not transmitted to NHIS), and many other
services that support everyday work. *Public software* does not directly compete with the private software, instead offers an alternative option for the users to comply with regulations without any cost on the software. However, the freeware comes without extra services and therefore only serves as a way for dentists to comply with regulations. Consequently, dentists use different dental softwares, chosen free willingly, to fill in the patient’s electronic dental card and forward it to the NHIS. The presence of numerous softwares has resulted in the allocation of many resources from both private and public organizations to the optimization of data between the National Health Information System (NHIS) and the electronic dental card transmitted through a particular software. Every dentist, regardless of the dental software, transmits patients data to a system, where it is collected and made available to other dentists. In individual softwares, the work processes and wording differs, thus it is necessary for the dentist to know how the particular system works. Moreover, it is upon the private software developers to guarantee that the information in every bracket corresponds to the correct bracket in NHIS. After the submission of patients health data to NHIS, private companies need to ensure that information in different formats and levels of classification gets delivered in the correct format to the dentists window. Regrettably, at the time of writing (3.05.2016), this capability was missing from the biggest dental software *Private software 1*, while *Private software 2* utilized *Public software* itself, by displaying a window from the portal instead of formatting the data. Even this capability had technical problems, and dentists were unable to access the data due to ID-card security updates. Therefore, all dentists could transmit the data to NHIS, however *Public software* remains the only system that allows users to view the patients dental information without any technical malfunction. *Figure 3* reflects the data flow between the different systems.

*Figure 3 – Data submission and retrieval by dentists*

The data transmitted to the system should cover every individual, both those with and without health insurance, and those visiting private and public dentist offices. At the current state, dentists have no obligation to fill in all the fields in the dental card, however they are required to provide all the necessary information regarding the treatment (diagnoses, work carried out, and the status of the treated teeth). All the data provided by the dentist is also available for the patient in the patient portal.
Although the implementation of computer and telecommunications technology in healthcare has risen - improving and enabling the users to access electronic health records (EHR), prescriptions, clinical databases, and use digital registration among others - there are aspects that need to be considered when implementing an IT solution to a healthcare system. For example, in 2014, National Audit Office found that even though majority of the health information system projects were successfully completed in 2008, only one of the four main e-health projects was actually adopted and used by both patients and physicians. The audit noted that 92% of specialist medical care providers did not send any data to the EHR in 2012, and those who did, only did so partially. While other e-services, namely digital registration, never started to work. However, in July 2015, despite the previous failures, a new healthcare information system was implemented – electronic dental card. A system that became mandatory by law to all dentists, thereby directly affecting every healthcare provider in the field of stomatology.

4. Findings

4.1 Digitalization - from paper-based to digital format

The current digital infrastructure combines different point-of-departures, as users are increasingly relying on a wide array of different systems to transmit, and in theory, view patient health data. However, a majority of the dentists are yet to get started with transmitting data to NHIS via electronic channels. However, given the fact that the system was introduced in June 2015 those who have jumped the bandwagon by starting to use the mandatory health system have shifted to the electronic platform only recently. The key element in transmitting dental health information to NHIS is the digitization of patients’ dental health card. Patients’ dental health card is a record of patient's dental status, gathered by the dentist with the purpose of documentation, continuation of treatment, and largely for reference. Filing patients’ dental health card is also mandatory by law for all dentists for at least 110 years after the birth of the patient, regardless of the persons’ time of death. These paper-based dental cards are typically filed by each individual dental office, however this service could also be bought in from a specialized archiving organization, still the responsibility would lie with the dental office. Although, there are no mechanisms in place determining how to preserve these dental cards if the healthcare provider would decide to cease operation. Digitization has offered dentists an opportunity to discard the paper-based cards – an aspect that has already been advocated and followed by some healthcare providers. However, due to digitization, the storage of these cards shifts from dentists to mainly publically storaged. However, both Private software 2 and Private software 1 software developers still collect a significant amount of data in their private servers, while offering users the possibility to store data on-site. Having said that, paper-based dental health card is still a common element in the everyday work of dentists, making it necessary to consider the paper-based and digital versions of patients’ dental health cards in a comparative fashion, as adequately understanding an organization or an actor and their work processes requires understanding the historical processes from which they were produced (Bucheli & Wadhwani, 2014).
The standard format for saving patients' dental health information has been the paper-based dental health card. Paper-based dental health cards differ in style and complexity depending on user's preferences and typical work, however, there are some standardized questions present in all of them, i.e. performed procedures, patient's personal information (name, ID-code, gender, age, home address, phone number, and occupation), anamnesis, accompanying diseases, and dental status. The more refined paper-based dental health cards include information such as oral hygiene, status intraoralis, cardiologic anamnesis, and hygiene index.

Complexity and structure of electronic dental health cards depend on their mode of transmission, more specifically, on the software used. The most commonly used softwares include Private software 2, Private software 1, and Public software, however large hospitals have their own unique systems. For the given study, the three most frequently used systems will be analyzed in more detail - Private software 2, Private software 1, and Public software.

As with the paper-based dental health card, the information in all of these systems is similar in essence, differing in style and complexity. All offer patient's personal information, anamnesis, accompanying diseases, dental status and administered drugs among other factors. The differences between softwares include, for example, the availability of text fields, as in Public software there are none, whereby dentists are unable to write comments. More over, the available fields in Private software 2 and Private software 1 do not always partner with a field in the Public software, thereby making it somewhat unclear to what extent the data will be transmitted from the private softwares to NHIS, and later made presentable to other dentists. Data transmission is further complicated as private software Private software 1 allows dentists to take notes 'offline', that are not sent to the NHIS, and are instead saved in the private database. These capabilities are available in private software 1 but not in the governmental system and Private software 2. This leads to a situation that allows dentists to save private comments and patient health related data in the private database, thus selectively transmitting information to NHIS. The reasons for this differ – some comments are considered not appropriate to share with the public, i.e. opinion of the patient (was afraid of an injection, family member died etc.), while others do not want government agencies, patients, and other dentists to view what work has been done due to other concerns, i.e. privacy, security.

Comparing digital and paper-based dental health cards, it is clear that paper-based cards offer a degree of freedom for the dentists. On paper-based cards, dentists are able to make notes and insert comments for themselves. The biggest difference comes in the complexity of digital dental cards. While the paper-based card offers a few separate forms for performed procedures and anamnesis, the digitalized dental health cards have many additional forms to be filled in. For example, in Public software, there are separate columns for lymph nodes, joints, muscles, dentures, tooth surface, tooth formation, and many others, while in private software there are forms for immunization records, pregnancy, performed surgical operations, pacemakers, and others. The common lines identified in paper-based cards exist in all digital versions, however in a more complex form. For example, performed procedures in the digitized version could be divided into different categories, i.e. dental formula, tooth surface, the name of the procedure performed, comments. Thus, the digitalization of the
paper-based dental health card did not limit the work of dentists, but rather further opened up the categories.

### 4.2 Six groups of IT adoption

The first round of analysis revealed nine different groups of users. Through iterative analysis, these groups were categorized together into six entities as seen in Table 2.

<table>
<thead>
<tr>
<th>Time of Dental Software Adoption:</th>
<th>IT-Champion</th>
<th>IT-Rebel</th>
<th>Intermediate</th>
<th>Primitive-intermediate</th>
<th>Laggard</th>
<th>Devolution</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Type of Data submission to NHIS:</th>
<th>Majority sent, some private</th>
<th>Does not submit data</th>
<th>Laconic, only codes</th>
<th>Does not submit data</th>
<th>Does not submit data</th>
<th>Does not submit data</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Form of saving data:</th>
<th>Digital</th>
<th>Digital</th>
<th>Paper-based</th>
<th>Paper-based</th>
<th>Paper-based</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Typical software:</th>
<th>Private software 1</th>
<th>Private software 2</th>
<th>Private software 2</th>
<th>Private software 2</th>
<th>-</th>
<th>Private software 2</th>
</tr>
</thead>
</table>

Table 2. Six groups of IT adoption

The study identified three patterns of IT adoption: full adoption, partial adoption, and non-adoption. Partial-adoption group relied on both digital and analog systems for their work, while the other groups were solely digital or used paper-based dental cards. These were further categorized depending on users submission of data to NHIS and their previous exposure to digital systems. Resulting in two categories for both full adoption and partial adoption. In both cases, one group submitted information to NHIS, while the other group did not. For non-adoption groups, the first group had never used digital systems, whereas the second group stopped using digital system after the mandatory system implementation. Drawing on the aforementioned information, users could be separated into six groups: 1) IT-Champion; 2) IT-Rebel; 3) Intermediate; 4) Primitive-intermediate; 5) Laggard; and 6) Devolution (See Table 2).

Similar type of categorization has been introduced before in the innovation diffusion and evolution theories. However, according to Yoo, Lyttinen, Thummadi & Weiss (2010), this type of reductionist view fails to explain the complex pattern of transmogrification, functional expansion and geographic diffusion of the digital infrastructure under study, as they assume that the meaning of the technology does not change during its evolution.

The study identified a large variation in adoption patterns, with traces of digitalization existing throughout the groups. Variation was dependent on the degree of value dentists derived from the new system. Some dentists were pleased with the digitization of dental cards, while others found it to disrupt their work. More so, dentists opinion of the given system changed throughout their system usage in parallel with the new possibilities the system offered, i.e. when at first, a dentist from IT-Champion group found the new system to
disrupt her work, then in time her work routines progressed to match the capabilities of digital system. Her opinion of the new dental card changed – as it allowed one point access to x-rays, dental information, calendar, statistics, sms notifications, billing, remote access, and so on.

Majority of digitalization is not group universal, but rather affects several users from a distinct group, i.e. some dentists from IT-Champion group stopped filling in dental cards, others from intermediate group took work “home” where they filled in digital dental cards. There are some common examples of digitalization that are group-wide, i.e. both IT-Champion and IT-Rebel group users could no longer make notes on dental cards, however as the systems did not allow to input the information due to the format and technical limitations, it resulted in submission of false or partial data to NHIS or private server. In addition, the study identified that digitalization affected all partial and full technology adoption groups. For example, digitalization provided freedom to patients from a specific dentist, whereby patients no longer felt that their dental health information relied with a specific dentist. This affected dentists’ opinion on the system. As one dentist said: “Think who are the dentists that do not submit data to NHIS! They are usually the owners of the clinic, of course they do not want to simplify the process for patients to leave their clinic for alternative one”.

4.3 Importance of digitization on work practices

The importance of digitalization became apparent in relation to the theory driven analysis. Users who were relying on private software 1, were significantly more likely to rely on the dental software alone, not using paperbased dental cards. While those who used alternative gateways (Private software 2 and Public software), were inclined to rely on both digital and paper-based dental health cards. The research found this to be mainly due to the apparent absence of private open text data fields in other softwares, where users could write private comments about patients health and non-health related factors, i.e. patient’s teeth pulp length, agreed upon price, what to check during the next visit, gum bleeding, private comments about family affairs and so on. As dentist 1 said:

“Even though I sometimes write really specific things to NHIS, it is very rare. Most often I write that an instrument was broken inside the pulp or that I was unable to open it (teeth pulp). However, the length of the pulp, and what filling I used, always goes into the clinical notes” (Private software 1).

The study identified that this selective information distribution lies in the way digitalization changed the sociotechnical relationship – while previously dentists had the responsibility to store patients data, without surrendering the original copy of the dental card to anyone, then after digitization this information became readily available. While before clinicians had a degree of privacy regarding what they wrote about the patient, then in the digital version this information is shared with colleagues, patients, and governmental agencies. This however raises uncertainty and concern for the dentists, who feel concerned
about the effects the availability of information could have on them. As **dentist 2** illustratively said:

> “Of course we don’t send all the information to NHIS. Who knows what they (patients) read out from the data and do with it. They do not understand anything that has been done to them and then they see this information and start to think. We don’t want to voluntarily raise legal proceedings against us (giving patients an opportunity to raise legal proceedings against dentists). [...] Our work is so subjective, no one would want to submit that information” (Private software 2).

Meanwhile **dentist 3** argued for privacy of data:

> “Dentistry is how I earn a living. I do not want others (clinicians) to view my patients data, see how many patients I had, what techniques I used. They could use it for their own benefit” (Private software 2).

These and other remarks, accompanied with the lack of data submission, have raised a need to consider the effect of digitalization on healthcare practitioners – especially as there is a raising need for increased privacy and more control. Hence, the existence of these private forms could cause additional problems for the developers of NHIS as the research identified a link between the reduction of data submission to NHIS and the availability of private open text data fields. However, as the occurrence of these private fields results in increased use of electronic software, the overall benefit for the system is in doubt, calling for alternative methods to increase the submission of data to NHIS. More so, different parties need to agree which forms – private or public - serve as a legal documents. As during the time of writing, developers and the project manager did not share the same perspective on the given aspect – issue that was often brought up by dentists:

> “What does it mean that we have two different cards (forms)? One private and one that is submitted to NHIS. When something were to happen, which one protects us in the court? Which one is a legal document? No one understands what they are. No one has received any answers” (Dentist 1) (Private software 1).

Moreover, at the current state, dentists are deliberately changing the way they work to avoid submitting patients data to open public. The ways in which this is achieved differ.

**Dentist 4**: “I only send the minimum amount of information that is compulsory for the system [...] All other information I fill out the clinical form. [...] This way my colleagues from our office can see what I have done when a patient comes in while I’m away, however others would not be able to see that” (Private software 1).

From another perspective, it seems that the change in the everyday work of dentists is fueled by their intention to try to maintain their old working habits, the change consequently
occurring none the less - those using paper-based dental health cards with the electronic system often filled in as little information as possible in the electronic system for other reasons.

**Dentist 5:** “I still want to view patients data on the paper-based card, not on the computer. [...] It is easier, I do not need to walk to the computer or look for patients data from far away. I just take the card, and there is all the information I need. In the computer everything is very laconic, what we did and that’s it. I write in detail only on the paper-based card” (Private software 2).

A similar stance towards data submission was evident from other clinicians, however they were more verbal in their reactions: “Already during the drilling I am thinking, I need to do it again. It drives me mad” (Dentist 6) (Private software 2), or “I do it only because it is mandatory. I do not benefit from this system. Again something we need to do. Again a new obligation” (Dentist 14) (Public software). While others changed the division of labor and their work routines to fit the new system: “My assistant fills in everything. I dictate from the chair. I really do not understand how others do it. It is so difficult to keep everything in memory. [...] Previously I filled it in myself because it is my responsibility that everything is correct. [...] When something important does occur, then I still include it, I try to remember and after the patients departure I write everything down. In the end it is my responsibility what is written in the system” (Dentist 8) (Private software 2).

While other dentists were pleased how the work had changed: “I write everything myself, typically when I wait for the injection to start working, that takes 5 to 10 minutes. Sometimes if I do not have enough time during the treatment, I will fill it in after the patient leaves. It takes me less time than on a paper. I do not understand why someone would still use the old system (paper-based cards)” (Dentist 9) (Private software 1).

Other dentists found the digital system to change their typical work pattern, whereby the dentist had to take mundane steps in situations, which were previously reserved for casual work.

**Dentist 10:** “Every time I need to fill in the same story. I understand this if the patient visits only once a year, but for me, orthodontist, who has the same patients every month, who has the same diagnoses and anamnesis, now needs to refill the form every time. Again the same diagnoses, and anamnesis. I should be able to write only what I did, not repeat myself” (Private software 2).

### 4.4 Saving patients data – filling in the dental cards

In addition, the many available clinical and diagnostic codes caused confusion. While clinical codes are added to the dental software by the dentist, then diagnostic codes are universal among all dentists. Thus, in the digital system, the dentists need to choose codes for given
procedures, however, this often proved to be more difficult than their antecedent paper-based work routines:

“Even though, I know the most common codes by heart, I still need to search for the codes, sometimes I just don’t find the correct one, 7 minutes has passed and then I finally choose something that resembles what I did. […] With the paper-based dental card I never needed to do anything like that” (Dentist 20) (Private software 2), or “We have ICD-10 (International Statistical Classification of Diseases and Related Health Problems), however I do not understand where they (software developers) have taken their diagnostic codes, as for example, abrasion of teeth is K03.1, but in the software I have over six different versions of codes, none of which I find in any relevant literature or in ICD-10” (Dentist 7) (Private software 1).

While dentist 13 argued:

“Now that I am on a digital system (Private software 2) there are things I cannot mark on the dental card, i.e. tooth bridge, extra teeth, and tooth crown. I just write it in comments section or choose something similar - this is not correct, as there is a big difference between those things. […] See (pointing on the screen), it does not allow me to mark it (porcelain combined prostheses)”.

While dentist 14 found the new possibilities to be limitless, providing all the necessary fields to give the most comprehensive overview of patients health: “There are so many things I can fill in, some were previously present, some are new. The fields range from medical history to harmful habits, reason for dental care, lymph nodes, muscles, and so on. There are only a few mandatory fields that I need to fill in each time I send the card to NHIS, however they have provided us all the capabilities if we want to provide more information” (Public software).

On another instance, dentists felt that their work had become repetitive due to the nature of digitization: “Add work. […] Add injection, 5402, then here will be injection anesthesia, but it still requires me to write anesthesia in the work description. I often do not know what to write, thus I just write things in non-medical terms into the work description” (Dentist 22) (Public software). While others found the ban on abbreviations to cause them unnecessary difficulties: “And then they (public organization) told us that we cannot use abbreviations or other languages. […] And then we were wasting time on finding words for abbreviations that we typically used. For example, we could not use RX or x-ray. This is ridiculous” (Dentist 15) (Private software 1). Distressed by the additional work and the system, some dentists decided to submit empty dental cards to NHIS.

**Dentist 16:** “To show that I submit data, I just send empty epicrisis. At one point, I understood that they (Health Insurance Fund) only check whether you send the data (for governmental funding), but they do not check what you send” (Private software 2).
Or another example, whereby a dentist had to create clinical codes for both children (governmentally funded) and adults (privately funded). For some offices, this coding process resulted in two sets of codes, for example examination code for children was 5400, and 5400* for adults. As **dentist 17** said:

“The system really frustrates, I really feel that I do not want to be a dentist anymore. In August I really felt that I’m not going to work anymore. I’m a dentist and I need to do trivial things” (Private software 2).

In addition to the previous confusion, dentists were uncertain what to write in the patients’ digital card. As **dentist 18** said:

“I had a friend viewed his dental card so I could see what I had written about him. That was really shocking. After that I am really disciplined and I do not write everything to the NHIS. At first I felt that it is like a paper-based dental card, that I write what I want to the system, but in reality it is not like that. It really disciplined me to think about what I write in the system” (Private software 1).

Another exemplary situation is when a patient with a foreign personal identification number came in, and it appeared that it is not possible to enter them as patients in the system. The information had to be forced into the system, however capabilities that would otherwise follow, were not available, i.e. could not forward data to NHIS, write receipts and so on. As of such, majority of dentists still had paper-based cards in the office. As **dentist 5** said:

“I had a patient who did not have a personal identification number in the correct standard. I do not know what would have happened with her, if I did not have paper-based cards” (Private software 2).

Moreover, some dentists implied that the change to the electronic system disciplined them to work more efficiently and think twice about what they are about to do,

“you do not do absolutely everything, you think twice, as everything is traceable. Absolutely everything you do is traceable. You need to make sure you are doing the correct thing” (Dentist 19) (Private software 1).

**Dentist 20** mentioned that if something bad happened, he mentions it to the patient and writes it to the NHIS as now everyone can see who previously worked with the patient, “absolutely everyone makes a mistake, but now it is so easy to see who worked with the patient” (Private software 2).
However, some dentists were confused regarding the supposed addressee, whereby the dentists considered people from the patient to the dentist himself, other dentists, and governmental organizations. Thereby, dentists who were previously used to writing dental cards for themselves, were confused as to what to write in the electronic system. As **dentist 21** said: “So when I write the dental card for the patient, do I need to consider his mental capacity? Do I write for an average patient or for 90 year old Judy? Then everything technical should be left out” (Private software 1). However, a significant amount of dentists still regard the electronic dental health card as for their own benefit, though compared to paper-based cards, other dentists are increasingly mentioned as the addressee.

Furthermore, dentists argued that the compulsory fields changed the way they were used to working. Whereby due to the mandatory fields, they were filling in more information than before: “Before when I had small jobs, I only filled in the reason why the patient visited, I was not used to filling in the diagnoses. But I am now” (Dentist 12) (Public software), while **dentist 17** argued that during small jobs she is not submitting any patients information to NHIS due to the numerous mandatory fields: “When a patient has a fragment missing from the teeth or just walks in the office, then I do not bother sending the information. What is the point? It would not benefit the system in any way” (Private software 2).

While others found it impossible or difficult to change the patients information after the data submission – resulting in half-completed dental cards:

“Submitting data is not difficult, however before submission, I think twice, whether I wrote everything down because later I cannot add things. [...] Sometimes I have sent a half-completed patient card. [...] Work runs in, it is a busy day”. (Dentist 14) (Public software)

A few clinicians mentioned the aspect of control, dentist can no longer write everything on patients bill (on publically funded patients). First of all the patient can see what has been done to him, secondly other dentists, who might see the information and think, “that doctor gave him that medicine, that means he does not have an alergy, while in reality, the first doctor did not give him the medicine and the patient does have the alergy”(Dentist 2) (Private software 2).

Those still on paper-based cards argued that in the dental software they could not take a signature from the patient if he agrees to everything. Therefore, they had to use additional paper-based cards as it allows to write everything what the patient needed on the paper and have it signed - resulting in a need for storing them in paper-based format.

However, other dentists found the new digitized system to be much appreciated. Arguing for the benefits that this new way of working brings to the dentists.: “We (dentists) do not have strict treatment guidelines, that would obligate us to treat patients medical conditions
in the same way. As of that, when you treat the patient differently from the standard, then it is wonderful that you can describe and comment in detail, why you decided to do so. I send all information to NHIS. I try to write everything down in as much detail as possible” (Dentist 13) (Private software 2). The importance of this aspect was further bolstered by another dentist: “This protest by dentists that we need to write too much about the patients is totally uncalled for. It is for the protection of the dentist. When an appeal is made, and the dentist has used abbreviations, such as rcfr&c (root canal filling, risk for complications). Then it will not be a document that protects you in the court or in the commission. If only dentists would understand that this document is not our enemy but an ally” (Dentist 9) (Private software 1).

4.5 Viewing patients data

Besides the submission of data to NHIS directly or through a given dental software, the new system opened up new dimensions for viewing patient information. However, out of the 35 dentists included in the study, only 11 had viewed the data. Reasons for this were different. For example one dentist argued that viewing data from PC is more time consuming, as she would need to move from the patient to the computer that is 1 meter away, where she then would need to scroll with her rubber-gloves on for the data. With the paper-based card on the other hand, the information is right infront of her eyes. Another dentist argued that it is easier to just ask from the patient if he has some allergies or takes medicines. “That treatment they get from other medical facilities (i.e. general hospitals), is very different, and should they be allergic to some medicines, it is likely they would not be used by dentists, and they would know their allergy” (Dentist 13) (Private software 2). Others found the new dental software very beneficial, “now I see straight away if my old patient has allergies or whether he is taking any medicines. It will pop up in red. Then I do not need to ask them” (Dentist 10) (Private software 2).

Some of the dentists who had viewed information in NHIS found it to be too limiting. Dentist 8: “From dentist to dentist there is nothing for us to see, while patient would not even understand the little information that is written. We were told that all these open text fields are going to the NHIS, but they are not. Without open fields the system is useless. I will just know that 2 months ago the patient went to see a dentist, and he put a filling on tooth number 1-5, and I might see that the filling is total crap. Then I could tell the patient
through roses that maybe he should consider changing his dentist, however should it have been 7 years ago, I would know it was because the lifespan of the filling is over or the patients dental hygiene is lacking. It is the only thing I will see, when he went, what was done, but all that additional information I cannot see” (Private software 2).

However, another dentists argued in support of the capabilities:

**Dentist 10:** “When I’m doing a root canal treatment, I need to know what has been done before, how far did the dentist manage to open the root, and so on. This way I could make the most informed decision. […] It really helps me if the patient has previous information regarding his dental care” (Private software 2).

While other dentists argued: “When I have a first time patient, I usually view patients health information. However, for some reason it is really time consuming. Sometimes it just searches and searches, and only shows some data. […] When a college asks me anything, I will rather talk to him or send an e-mail” (Dentist 6) (Private software 2), or “to be honest, when I start looking for patients health data from the system and finally find it, it has already taken me 10 extra minutes, as of that, it is always easier for me to tell the patient to take the copy of the dental card with him when he comes to my office or let the clinician send it to me by e-mail. […] I do so as-well, when I send someone to see a surgeon or implantologist I always send all the relevant data by e-mail, so they would not need to go to NHIS” (Dentist 15) (Private software 1).

This said, there were dentists who regarded the newly found access to patients information to ease and support their work: “I am really pleased. All the information is in one place. It is actually even easier to read than on a paper-based” (Dentist 10) (Private software 2) or “I work in the first aid and for me this information is really beneficial. I have patients coming in, whose previous information is crucial” (Dentist 25) (Private software 2).

Meanwhile the overall concern for some users was the inexistence of a button to view patients health data directly from their dental software: “there is a button for Medical Image Repository, and there should be one here for viewing patients information, but there is not. I don’t think I even can view patients data” (Dentist 11) (Private software 1) or “I am ruling out the possibility that I would begin viewing patients data from another portal. I have a software that I am paying for, and me as a dentist, I am not going to waste my valuable time viewing patients health information using another channel” (Dentist 7) (Private software 1), while dentist 17 argued: “Viewing information takes so much time. Every extra step is time consuming. Sometimes we get frustrated at the system and time how long it takes. Sometimes it is just not normal” (Private software 2).
4.6 Additional changes driven by digitalization

In addition to the sending and viewing of patients health data and its supporting processes, there were additional changes that followed and changed dentists work. For example, before the digital system, a dentist and her assistant were sending SMS’s to patients by hand, then after the adoption of dental software, they could finally automate it. This in return, has reduced the number of patients not showing up the praxis. While others had found the new digital system to assist preparing annual reports: “I do not need to strike things, mark fillings on the paper as I used to do. I can retrieve all this data: how many children and adults have I had, what procedures I have done” (Dentist 23) (Private software 2).

Some found the digitized version to have a striking effect on their overall work, whereby the need to fill in electronic cards stole all their free time, due to which, both the dentist and the assistant could not prepare the chair for the next patient. Sometimes the dentist had to keep everything in mind until the end of the day, however it often proved difficult to remember all the details – thus dentists deliberately reduced the number of things they wrote both to themselves and others. As dentist 23 commented:

“It is the same as when I go to change my tires, and then the mechanic starts to describe what and how many tires he puts under the vehicle, and after he has changed my tires, he sends the same information to the Public Road Administration. This is the same” (Private software 2).

Then again those dentists who had switched to digital cards only, argued how it changed their work. It was no longer necessary to search the previous day for patients’ dental health cards to see what needs to be done with the patient. As dentist 19 said: “I was so tired of paper-based cards. I was tired of searching through the files for the correct dental card. It made my work easier” (Private software 1).

Others faced difficulties balancing their work between digital and analog. This happened for a few dentists who asked their patients to fill in patients information sheet before coming to see the doctor. “It is up to the patient to tell me everything I need to know about him. However, even if he fills it in on paper and we digitize it, then we still need to store those papers. Sometimes we scan them in, however it takes such a long time that we now just store them. We need it because something could always happen, we forgot to put it into the electronic system, or make a tick in the wrong box. It is for our own protection. We need the anamnesis, but it is difficult to decide how to store it ” (Dentist 18) (Private software 1). Others were facing even more difficulties: “Previously the patient came in with the patients information sheet, handed it over, I put it under his file, then now I need to ask all the questions and type it into the system - I’m not going to do that” (Dentist 20) (Private software 2).

Proponents argued that the new digital system allows them to work away from the office. Therefore, when previously a patient had to come in to the office when she had a fever, then
now she can just call, and the doctor can write a prescription for her through the dental software. However, some were still relying on paper-based prescriptions: “I do not write them digitally. I have previously written these piles of prescriptions. Now I only need to write the name, signature, temple and date – it’s ready. I’m too busy to fill in the prescriptions online” (Dentist 11) (Private software 1). While others found the new digital system to ease their work, whereby it took only a minute to send prescription: “It only takes me a minute to send the prescription. It is so easy. I do not need to worry whether someone can read my handwriting or write a new one when patient loses his prescription” (Dentist 14) (Private software 1).

Some found the digital system to distress the work, whereby during the malfunction of the online system, all work would halt. Due to which, some dentist’s still kept using the paper-based dental cards.

Dentist 17: “We keep all patients information on paper. Just in case when the servers go down. It has happened that for a whole day you do not know which patients will come, what has to be done to them, total information blockage. I would not want that” (Private software 2), or “Whole Monday, first aid taking place, system is down, they were moving the server. [...] I wrote everything on paper, [...], went back home and inserted into the system” Dentist 4 (Private software 1).

These system updates proved to cause unnecessary problems for the dentists, whereby clinicians were unaware what was updated in the system, and whether it affected them.

Dentist 6: ‘They (developers) update things without telling us what has changed. Maybe it does not affect me, however maybe it is exactly something that affects my work. Sometimes they change patient statuses or codes, and you find it out by accident. [...] They should inform all of us” (Private software 2).

5. Discussion
Currently, there is a large variation in the IT adoption patterns (as seen in Table 2), with traces of digitalization throughout the different groups. While digitalization has not meant that dentist work processes have radically changed, the findings illustrate several examples of how it has contributed to generating significant value. Digitization could be the panacea in solving the underlying problems of healthcare, however the study has pointed out a need to consider how to produce and appropriate that value. The study identified that when users do not consider the new system beneficial, but its use is mandatory, they will refrain from using the system or will form new work structures and processes to avoid the shortcomings of the system, i.e. dentists reliance on both digital and analog dental card. Should the system be designed in a way that improves the practice of dentistry, and users would feel that their professional expertise and ethics are preserved, it is likely that dentists would use the system - allowing for the creation of new sociotechnical structures that foster dentists work, i.e.
improved access to patients time-critical data. More so, dentist’s opinion of the given system was not static but rather changed throughout their system usage in parallel with the new possibilities the system offered. This research has revealed the mechanisms that hamper and enable this sociotechnical change, namely: privacy, control, security, previous procedural norms and actions, alignment of analog and digital, difference between intended and existing work routines, technological capabilities, boundaries and flexibility, changed format and function, and communication and information flow - indicating the different implications digitization has for research and practice. Hopefully some of these insights could also be used to understand digitalization in other industries, especially those associated with strong regulations and ethics, i.e. law, healthcare, and police work.

First, the findings suggest that privacy and control of digitized artifacts could significantly affect the sociotechnical change. The centralization of the dental records shifted the control from private to central - resulting in dentists generating new solutions to overcome the lack of control and sense of insecurity. This could have practical implications, whereby the digitized elements would cause unprecedented sociotechnical change - signifying the shift between the designed and observed output. For example, users submitted data to private servers instead of NHIS, some dentists used paper-based cards, while other inserted non-existent patient identification codes and so forth. In this way, they did not share the data with anyone external to their own organization. Even though this aspect altered the working routine for some, it was found to produce profound effect on the dentist community as a whole, i.e. increased control over taxes. The digitized system in some cases increased the quality of dental care, whereby the users found the new system to increase their work quality and improve information submission. This notion was brought up multiple times by dentists, who found the new and shared way of distributing information to increase work quality and information submission. The study argues that openness and centralization of digital systems could adversely affect their adoption and utilization. Calling for more contextual analysis of digitalization - guided by behavioral and social dynamics, i.e. the aspect of privacy, control, and security; and supporting procedural norms and actions, i.e. how actors previously worked. Failure to align these elements with the new digitized system could result in undesirable sociotechnical dynamics or in a non-adoption of the new system.

Secondly, this study identified a misalignment between the analog and the digital. This did not hinder the adoption of the digitized artifact, however it hampered its utilization. As of that, mandatory IT adoption could be the panacea for the adoption of new IT solutions. Digitalization could lead to unforeseeable results, that necessarily do not obsolete the system, but rather depreciate some of its intended benefits due to the mismatch between the previous processes and the digitized artifact. For example, users were unable to work using their previous dental education, as some of the codes did not exist or varied to a great extent from those in relevant literature or in ICD-10 (International Classification of Diseases) - calling for a need to learn new codes. This caused the users distress, forced them to alter their work routines, and affected their professional standing –making users feel they need to tackle problems beyond their area of expertise.

Furthermore, digitization does not necessarily improve healthcare when the gap between the intended and existing work processes is too large, i.e. the availability of private comment
fields. Mismatch between the elements caused the definition of dental card to change, i.e. the recipient shifted from the dentist himself to other dentists or patients. Making the dental card redundant for personal use, consecutively lessening the extent the card is filled in, and changing dentists work by defining new elements for the dental card, i.e. explaining work in greater detail to allow all parties an equal understanding of the work.

Digitalization is further affected by the rising level of expectations, whereby users deem the digitized system to revolutionize their work. Failed expectations result in new dynamics, whereby users combine the analog with digital - having a transformative effect on the actors work-processes and routines. This makes it necessary to align the new technological capabilities with previous work processes, while allowing a significant degree of flexibility and malleability to allow the system to generate new beneficial outcomes. For example, users found the digital system not to digitize all their work, i.e. patients information sheet. Therefore, some dentists collected these information sheets on paper, others who were pleased with the digitization, decided to not collect that information – having a negative effect on dentists work. While some shifted back to analog due to the inflexibility of the system, i.e. unique patients who could not be inserted to the dental software. Others found loopholes in the system as they continued to work with it, whereby information was submitted using peculiar solutions, i.e. non-existent identification codes.

Furthermore, the study identified communication and information flow as enabler and hamperer of sociotechnical change. Due to the lack of communication, dentists were unable to recognize the extent to which different forms could be used, reducing the confidence of using the new system. If something were to happen, dentists were uncertain which form served as a legal document in the court. On one hand, private forms offer a safe-haven from patients and other dentists, while on the other hand, they might flunk as a legal document in court. Some found the lack of information to leave them in total information blackout, whereby users did not understand the necessity of the system, how it operates, and what changed during the system updates - resulting in a hide-and-seek kind of software usage, whereby dentists ‘found’ updates by accident. This in return, pushed dentists to utilize both the digital and the analog artifact.

Additionally, technological capabilities affected the work-processes of dentists. For instance, previously dentists were able to change patient information without any limitations, and then in the digitized version this capability was limited. Furthermore, the aim of the digitized dental card was to allow dentists view patient data, however, due to the technological limitations, this became too time-consuming and little rewarding. This in turn resulted in dentists submitting data digitally, but viewing other dentist’s work on paper-based cards. Still, some users found the new system to ease their work, as it became unnecessary to continuously contact other dentists for patient dental information – shifting the dental card from private to collaborative. Some users were intimidated by the occasional technological failures, thereby unwilling to fully adopt the digitized system. While others found the new opportunities to ease their work outside their regular routines, i.e. annual reports, prescriptions, off-site access to dental cards etc.

Finally, the study found that the change of format and content affects user adoption and utilization of digitized artifacts. This became visible as the notion of dental card shifted both
in its practical use and definition. Dentists argued that they are not the beneficiaries of the digitized system—leading dentists to submit new kind of information to the NHIS, which in return provided users little value. This caused resistance among dentists, who found the paper-based dental card to be a different artifact than the digitized dental card—changing the meaning and the recipient of the dental card. This resulted in sociotechnical changes, both unprecedented and predicted, causing disturbance among the users, whereby some dentists changed their work practices to fit the new requirements, some continued to work as if nothing had changed, others adopted unique technology utilization patterns.

All in all, it became clear that user perception of the dental card changed as it shifted from analog to digital. For some users, this caused unprecedented change to the perception of the dental card, whereby it became an obligation rather than a dentist’s assistant. For others, digitization was a welcomed phenomenon, improving and changing dentists’ work processes for the better. These differing views, call for a more thorough understanding of the factors inhibiting users’ adoption and utilization of digitized systems. This study identified the following mechanisms to hamper and enable sociotechnical change: privacy, control, security, previous procedural norms and actions, alignment of analog and digital, differences between intended and existing work routines, technological capabilities, boundaries and flexibility, changed format and function, and communication and information flow. To drive change and improve healthcare, it is not sufficient to just digitize artifacts, but rather allow the creation of new sociotechnical dynamics that support and change the existing processes. For users to deem the system beneficial, it is necessary to change the existing structures in a way that would provide value for the users. If users regard the system unnecessary, not providing any value, interfering with their daily practices, and making them uncomfortable in terms of privacy—they will not use the digitized system to its full extent. This in return affects the patients, other dentists, and government agencies, who will miss out on the potential value of the new system.

6. Conclusion

HIT and overall digitalization efforts have become important elements in overcoming the underlying problems of healthcare. While the previous chapters have discussed the findings of this research, the concluding chapter will provide a summary with suggestions for future research.

Based on the implementation of mandatory digital dental health card in a Baltic country, the study makes a contribution to the information system research and practice by allowing policy makers, developers and managers study the way digitalization affects the professionals. The analysis makes several theoretical contributions. First, it makes a contribution to the study of digitalization by looking at the phenomenon from the industry-level, allowing to understand the features and affordances of the digitized system, and how it differs from the paper-based system. Secondly, the study argues that digitization and its subsequent digitalization do not result in an easy solution for problems posed by healthcare, but rather results in both negative and positive sociotechnical changes. In this way, the thesis demonstrates how digitalization relies on the users ability to appropriate value from the new
structures of the digitized artifact without the system interfering with the professional expertise and ethics. Thirdly, the study identified the different digitalization patterns, thereby illustrating digitalization as a dynamic social phenomenon - a continuous process affected by different elements throughout its course. Finally, this study presented the different mechanisms that hamper and enable sociotechnical change for individual users, namely: privacy, control, security, previous procedural norms and actions, alignment of analog and digital, differences between intended and existing work routines, technological capabilities, boundaries and flexibility, changed format and function, and communication and information flow.

While adopting an industry-level analysis, the research attended digitalization at the micro-level as it was unfolding. This supported the understanding of how IT creates value and shapes the sociotechnical relationships of healthcare professionals. HIT has been identified as a solution to fix the many problems of healthcare, however consideration should be given to both value creation and the influences of the new system on work practices. Additional research is necessary for IT adoption patterns, and for the elements that hamper and enable sociotechnical change in practice - whether they are relevant in other fields, and to what extent they affect the users. With this the thesis concludes that further research on digitalization on micro-level is needed to fully understand the changes unraveling.

7. Acknowledgments

This thesis would not have been finished without the support of my fiance Anna-Liisa. Thank you for being there for me during my highs and lows, and for your continuous support in my endeavours. I also like to express my gratitude to my supervisor Daniel Nylen, without whom, the thesis would not have been what it is. Thank you for all your comments and help. You have been a true role-model. Lastly, but not least, I would like to thank my mother, who has been there for me from the start.
References


OECD (2010), Healthcare systems: Getting more value for money. *OECD Economics Department Policy Notes, No. 2.*


Yoo, Y. (2010) Digitalization and Innovation. (IIR WP#10-09), Institute of Innovation Research Hitotsubashi University, Tokyo, Japan


